Ayal, DY and Leal Filho, W (2017) Farmers' perceptions of climate variability and its adverse impacts on crop and livestock production in Ethiopia. Journal of Arid Environments, 140. pp. 20-28. ISSN 0140-1963

Publisher: Elsevier

DOI: https://doi.org/10.1016/j.jaridenv.2017.01.007

FARMERS' PERCEPTIONS of CLIMATE VARIABILITY AND ITS ADVERSE IMPACTS ON CROP AND LIVESTOCK PRODUCTION in ETHIOPIA

Journal of Arid Environments, Volume 140, May 2017, Pages 20-28
https://www.sciencedirect.com/science/article/pii/S0140196317300071?via%3Dihub

Desalegn Yayeh Ayal[a*], Walter Leal Filho[b]

a. Debre Berhan University Geography and Environmental Studies

b. Manchester Metropolitan University, Manchester. UK

*****Corresponding author

Abstract

This article explores farmers' perceptions of the manifestations of climate variability and its effects on the agricultural production in selected highland areas of Ethiopia. Primary Data was collected using group and individual interviews, overt observation and a survey. Temperature and rainfall data was collected from NMSA. The study shows that more that eighty percent of farmers perceived the manifestations and effects of climate variability. The study reveals that sex, age, income and educational level are determinant factors of farmers' perception on the manifestations and effects of climate variability on crop and livestock production. Farmers' perception of change in temperature is 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 attendant physical, biological and epidemiological challenges on crop and livestock production so that any shortfalls on farmers adaptive capacity can be leveraged.

Key words: Climate, Climate Variability, Farmer, Perception, Adaptation Strategy,

1. Introduction

1.1. Background and justification

The purpose of this research is to explore farmers’ perception about the manifestations of climate variability and its effect on their livelihood. Climate variability and change is the greatest developmental challenge of the 21st century (IPCC, 2007). Developing countries are most vulnerable due to the sensitive nature of their livelihoods and low adaptive capacity. Van den & 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, Cited in Banjade, 2003). Likewise, Wolf, Allice & Bell, (2013) & Saarinen (1976) states that human perception is shaped by varying cognitive structures caused by socioeconomic and cultural differences that dispose people to differing attitudes, values and interests. Therefore, farmers’ perceptions of climate variability and its effect are influenced by psychological and socioeconomic differences.

The observation of scientists could vary from the perception of farmers due to the different lens or perspective underlying their observation (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. Moreover, farmers perceive trends based on their assessment of the frequency and intensity of the highs and lows of climate data. However, scientists depend on the mean value of climate data in generating arguments (Wolf, Allice & Bell, 2013; Weatherhead, Gearheard & Barry, 2010). Hence, scientific claims could coincide with the perception of farmers in some cases while differing in others. For instance, 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 (Rees, Danks & Vitebsky, 2008; Forbes & Stammler, 2009).

Understanding farmers’ perceptions on manifestations and impacts of 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, Kahaka, & Okurut, 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 Deign 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 10^0 18'- 10^0 40' and 38^0 00'- $38^0$22' and 10^0 20'- 10^0 40' and 37^0 15'- 37^0 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 meters 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* (cordial Abyssinia Lam), *warka* (ficusalicitolia), *shoal* (Ficus sur Forssk), *tid* (juniperus procera), *girar* (Acacia abyssinica), *zigb*a (Podocarpus falcatus), and *Bisana* (Croton macrostachyus Del.) are found.

The area receives an annual rainfall amount ranging from 800 mm - 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

[1] Woreda is administrative unit equivalent to district

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 (Respective woreda report, 2013).

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 Enemy 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.

A multistage sampling procedure involving purposive sampling resulted in the selection of 6 experts, 12 crop and livestock development agents, 6 community key informants and 36 FGD (focus group discussion) participants. 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

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

and *woreda* experts, development agents, community key informants, farmers and relevant institutions such as NMSA, CSA and respective woreda annual reports were data sources for the research. Data from farmers and concerned bodies were gathered using a questionnaire survey and PRA (for example, FGD, overt observation, individual interview). Using a questionnaire survey, both quantitative and qualitative data on farmers' perceptions of climate variability and its effect on their socio-economic were collected from sample households using Likert scale typology questions.

PRA allows wider community participation for the collection of more accurate information (Chambers, 1994). Hence, data was gathered from male headed and female headed farmers (who have long farming experience and different economic and educational status), knowledgeable community members, experts and DAs using the PRA approach. The PRA method was implemented using three major tools. Three FGD sessions were arranged to get in depth information and insight about the situations, socio-economic, psychological and biophysical effects and opportunities brought by climate variability. Key informant interviews were also the main source of data on perceptions of events and trends of climate variability and extremes, as well as non-climate stressors on their livelihood. In both group and individual interviews, a trend line was employed to collect data on climate variability, extreme indicators and impacts of agricultural production over the past two decades. The overt observation method was used to triangulate data collected using various methods.

Rainfall and temperature areal (10X10km) grid dikadal data were collected from NMSA. This is purposefully done to avoid amount and distribution variations caused by topographic factors and to calibrate distortions caused by missing data for different years. The validity of areal grid rainfall and temperature data is tested and confirmed from a scientific point of view by NMSA. Point historical data of rainfall was also used to examine trends regarding the number of rainy days on an annual and seasonal basis. Days with rainfall less than 0.3mm were considered as dry days (Vargas, Naumann & d Minetti, 2010).

2.2.3. Data Analysis Techniques

The analysis of rainfall and temperature involved characterizing long-term mean values, calculations of indices of variability and trend at annual and seasonal time steps. Standard anomaly was calculated to assess rainfall and temperature variability.

$$\mathrm{SRA} = P_t - P_m / \sigma$$

Where Pt is annual (rainfall or temperature) in year t, Pm is long-term mean annual (rainfall or temperature) over the period of observation and σ is standard deviation of rainfall.

Mann-Kendall test as described by Sneyers (1990) was used to detect trends. The significance level of the slope was estimated using Sen's method. The nonparametric Mann-Kendall test and Sen's method are less affected by outliers (Salmi *et al.,* 2002). The study applied Agnew &

Chappel's (1999) drought severity assessment method. This method provides a more elaborate classification of drought magnitudes. The model differentiated drought severity into four scales: extreme drought, severe drought, moderate drought and no drought (S<-1.65), (-1.28 > S > -1.65), (-0.84 > S > -1.28) and (S > -0.84) respectively.

Farmers' climate variability and its impact perceptions were measured using average aggregated mean scores of their responses to multidimensional climate variability indicators. Furthermore, to examine the role of predictor variables in causing climate variability and its interactional effect perception differences, MANOVA was used. Farmers' age groups were classified using Erikson's psychosocial theory of age classification. In this study the last three age stages namely early adult hood (20 to 40's years), middle adulthood (41 to 60's years) and late adulthood (60 years above) were considered (Santrock, 2011). Similarly, a local wealth classification criterion was applied to group farmers' wealth status (see Ayal & Muluneh, 2014). Different descriptive statistics such as coefficient of variations and standard deviations were also used to analyze the data. For quantitative analysis of results, SPSS version 16 was used. The qualitative data collected from interviews, individual households, focus group discussions and observations were analyzed thematically.

3. Results and discussions

3.1. Farmers Perceptions of Climate Variability Indicators

Table 1 below illustrates the perceptions of farmers about different indicators of climate variability and change in their localities. The total mean score illustrates the degree with which farmers have perceived different indicators of climate variability, allowing the most and least perceived aspects of climate variability to be identified. The grand mean shows farmers' perception about their locality climate situation.

Table 1. Mean Score of Farmers Perception of Climate Variability Indicators

Item	Mean score
Perception of Temperature Variability Indicators	
Temperature increases	4.8
Number of hot days increased	4.2
Number of warm nights increased	4.2
The degree of coldness of cold seasons increased	3.7
Perception of Rainfall Variability Indicators	
Rainfall amount decreases	3.5
The onset of rainfall becomes more unpredictable	4.7
The cessation of rainfall become more unpredictable	4.7
Number of rainy days decreased	3.0
The intensity of rainfall increased	4.0
The occurrence of untimely rainfall increased	3.5
Drought occurrence frequency increase	3.0
Grand mean	4.0

Source: From authors' field survey, 2013

3.1.1. Perception about Temperature Situation

The majority of farmers perceived the increasing trend of temperature, hot days and warm nights and decreases in the number of cold nights from time to time in their localities. Their perceptions of increasing temperature tally with the meteorological records of mean temperature (see Table 2). Moreover, farmers' perception is consistent with scientific claims about the increasing trend of temperature in Ethiopia and globally (Woldeamlak, 2012; Ogalleh *et al.*, 2012; Nyanga & his colloquies, 2011; Kemausuor *et al.*, 2011; Maddison, 2006; Gbetibouo, 2009).

Table 2. Trends of Annual Temperatures (1982-2011)

Site	Temperatures (in Degree Celsius) per decade					
	Minimum		Maximum		Mean	
	Trend	Sign level	Trend	Sign level	Trend	Sign level
Gozamin	0.24^0 C	0.01	0.26^0 C	0.05	0.25^0 C	0.05
Enemay	0.14^0 C,	0.01	0.4^0 C	0.05	0.26^0 C	0.05

Source: Authors construction from NMSA data

Table 2 illustrated that minimum, maximum and mean temperature of Gozamin and Enemay have been increasing significantly from 1982-2011.

Farmers' perception of the increasing trend of hot days and warm nights and decreases in the number of cold nights are in line with instrumental record of previous local and country level studies (for example, UNDP, 2007/2008; McSweeney, New & Lizcano, 2008; Woldeamlak, 2012). During FGD sessions, participants metaphorically expressed hot days and warm nights as 'hell'. However, the reported perception on increment in the degree of coldness of cold season stands at odds with the increasing trend of annual minimum and maximum temperatures. The discrepancy between instrumental records and farmers' perception could be attributed to the emphasis farmers give to isolated instances while instrumental assessment measures long-term mean values. We argue that the instrumental record aggregate mean value of annual minimum and maximum temperature computation could overshadow a possible occurrence of extreme cold days. Therefore, it is difficult to dismiss informants' opinions as misinformed.

3.1.2. Perceptions about Rainfall Situations

Table 1 revels that the majority of farmers perceived rainfall onset and cessation as becoming more erratic with increased rainfall intensity and decreasing trends of rainfall amount and the number of rainy days. Farmers also felt increased occurrence of untimely rainfall and drought frequency. Hence, rainfall distribution behavior, timing and volume are major problems to farmers for agricultural production. The farmers' observations are supported by Woldeamlak, (2007), as his meteorological data analysis in the study sites indicated that rainfall intensity is increasing.

FGDs and key informants observed that the main rainy season and *belg*[3] season rain are starting later and ending earlier. According to participants, two decades ago the amount and number of rainy days varied significantly, with rainfall occurring from April to October (the *belg* rain starts and the *tsedy*[4] rain ends); nowadays however, participants stated that it usually starts in the middle of June and ends in the middle, or even sometimes at the beginning, of September. This corresponds to the survey participants' responses about the shortening of rainy days, with a mean score of 3.0. The perceived erratic behavior of rainfall matches only with spring season rainfall of the instrumental record (see Table 3). Farmers' perceptions that the annual and main rainy season are highly variable negates from meteorological analysis since the recorded data shows consistent rainfall distribution.

Table 2. Annual and seasonal rainfall (mm), standard deviation and coefficient of variation, 1983–2012.

Station	Annual (total)			Main Rainy Season			Spring Season Rainfall		
	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV
Enemay	1163.3	128.3	11.02	722	80.2	11.2	186	75.6	40.5
Gozamin	1360.2	142.7	10.5	816	64.4	7.9	208	78.5	37.6

SD= standard deviation, CV= coefficient of variation

Source: Authors construction from NMSA data

According to NMSA (1996), a rainfall amount with CV of less than 0.20 is less variable, CV between 0.20 and 0.30 is moderately variable and CV greater than 0.30 is highly variable. As Table 2 shows long-term annual rainfall and main rainy season rainfall were evenly distributed in both woredas. High rainfall variability was observed in the *belg* season in Enemay (CV =40.5%) and Gozamin (CV= 37.6%).

Table 3. Trends of Annual and Seasonal Rainfall (1983-2012)

Site	Trend of annual and seasonal Rainfall (mm) per decade					
	Annual rainfall		Main rainy season		Spring season rainfall	
	Trend	Sign level	Trend	Sign level	Trend	Sign level
Gozamin	53.54	0.1	26.41	-	1.99	-
Enemay	44.05	-	39.09	-	-5.00	-

[3] Belg is the traditional season classification representing Spring

[4] Tsedy is the traditional season classification representing Autumn

Table 3. shows that annual rainfall amount in Gozamin has increased significantly from 1983-2012. However, the Enemay spring season rainfall showed a statistically insignificant reduction in amount. Unlike the perception of farmers, meteorological analysis proves the absence of rainfall amount reduction. From meteorological records, the reported decreases in rainfall amount apply only for a few recent years. In between 2008-2012 annual rainfall amount in Enemay and Gozamin decreased by 18.41 mm and 77.73 mm respectively. Fatuase & Ajibefun, (2013); Gbetibouo, (2009); & Maddison, (2006) observed that if the perception of respondents tallies with short-term analysis of instrumental records, it is because they are psychologically influenced by the latest phenomenon. As a result, by way of regression, they tend to believe the unique characteristics of rainfall observed over the last five years are true for the years before. Farmers' perceptions about the number of rainy days 'drastic' reduction also contradict with the meteorological analysis. This shows that the perceptions of farmers did not make distinction between the nature of rainfall trend at annual and seasonal levels. FGD and key informants acknowledged that the water absorption capacity of soil in their locality had decreased. According to these informants, most rain water is lost as runoff and erodes the top soil and even crops and fertilizer. Informants highlighted that surface and ground water had been depleted in their locality.

From the instrumental record, the increment of temperature and its resultant evapotranspiration and crop water demand could have also influenced their perception about rainfall amount. Therefore, reasons for the disparity between farmers perceptions and instrumental records could possibly be explained by what Slegers (2008) speculated. She suggested that decreasing moisture availability due to environmental stress and the gap between supply and demand could give farmers the impression that rainfall amount and number of rainy days has decreased. A similar problem of incongruence between local people's rainfall perception and instrumental records in other parts of Ethiopia revealed the impact of dry spell and rainfall disturbance in distorting perceptions (Meze-Hausken, 2004; Woldeamlak, 2012). Being pragmatic, farmers usually express their perception of climate variability in light of observed effects on their livelihood (Ogalleh et al., 2012).

According to NMSA (1996), cited in Meze-Hausken (2004), a negative anomaly of rainfall at 25% and 50% refers to dry and very dry conditions respectively. The annual rainfall drought assessment meteorological result showed that over the last thirty years, there were 11 and 11 very dry years and 2 and 5 dry years in Enemay and Gozamin respectively. The rainfall distribution behavior of both woredas proves most years with rainfall amount below normal had very dry conditions. In this regard, farmers' perceptions coincide with meteorological assessment result.

3.1.3. Farmers Perceptions of Climate Variability

In general, Table 1 shows that majority of farmers perceived the changes of climate variability in their localities in the last two decades with a total grand mean score of 4.0. The result is supported by previous climate variability and change perception studies for example (Kalungu, Filho, & Harris, 2013; Juana, Kahaka, & Okurut, 2013;Woldeamlak, 2012; Ogalleh *et al.,* 2012; Kemausuor *et al.,* 2011; Nyanga, & his colloquies, 2011; Temesgen *et al,* 2008; Slegers, 2008; Maddison, 2007; Maddison, 2006; Apata, Samuel & Adeola, 2009). Although this study has similar finding about the perceptions of farmers' temperature increment and decrement of rainfall amount, it does not neatly fit with the actual behavior of climate variability.

The aggregated mean score values confirmed that farmers observed the change of each climate variability indicator over the last two decades. The most perceived aspects of climate variability in decreasing order are: i) increase of temperature, ii) increment of erratic rainfall cessation and onset time, iii) increase of the number of hot days and hot nights, iv) increment of rainfall intensity, v) increase of the degree of coldness of cold season, vi) reduction of rainfall amount, vii) increment of untimely rainfall occurrence, viii) increase of drought frequency and decrement of rainy days .

What is noted above demonstrates that the main challenges of climate variability in the study areas are related to increment of temperature and extremes, more erratic rainfall and increment of rainfall intensity in there order of importance to agricultural production and activities. The problem of water deficiency (the resultant effect of perceived rainfall amount reduction, more frequent drought and depletion of surface and underground water), however, can easily be understood if looked from the point of view of 'agricultural drought' rather than absolute decrease in seasonal and annual rainfall amount. The main problem is rising temperature and bad rainfall distribution that affect agricultural production. As Speranza (2010) observed, what really matters to perception is not total lack of rainfall but lack of sufficient precipitation required for the normal agricultural activity and pasture growth. Therefore, farmers' rainfall amount perception tacitly implies automatic recognition of the existence and effect of adequate rainfall on the right time (Sene, Diop & Dieng, 2006). Hence, for farmers the optimal amount in the right time may perhaps influence their perceptions to climate variability.

If the reported perceptions of clear trends in temperature increase and rainfall amount decrease among farmers (Slegers, 2008; El-Marsafawy & Ouda, 2007) contradict the instrumental records, as is in the study areas, then it seems that their perception would literally appear a common mistake. From a pragmatic point of view, however, farmers' perceptions come closer to explaining complications brought about by climate variability on agriculture than abstract mean figures of instrumental records would suggest otherwise.

On the other hand, it could be stated that respondents' climate variability perception could be influenced by their assessment of changes regarding impacts on their livelihood. Because the livelihood of farmers in the study areas is directly influenced by climate conditions, they are likely to be perceptive of factors that undermine more of their major livelihood strategies. Because rainfall timing and distribution behavior had a more pronounced negative effects on crop and livestock production, it is natural that farmers would emphasize the existence and effects against meteorological analysis. The result reinforces the contention that the livelihood nature influence farmers' perceptions of climate change (ATPS, 2013; Diggs, 1991).

3.1.4. Farmers Climate variability and its Impact attribution

To understand the causal attribution of farmers, FGD and key informants were asked to describe the causes of climate variability in general and in particular, increment of temperature and unpredictable rainfall behavior. They are divided and supported two diametrically opposite views. The majority of them believed that increasing temperature and unpredictable rainfall and associated extremes are caused by God's anger against their sins while others attributed the problem to the massive deforestation problem. In a sense, it may be difficult to consider the latter as the right perceivers since local climate change could be induced by processes elsewhere and not necessarily due to local vegetation cover changes. Likewise, the divine attribution may not be right due to the fact that climate variability is caused by natural factors and human interferences. Notwithstanding that limitation, the natural explanation indicates rational thinking among the few farmers. Most of the participants, believed to be the children of God, expressed hope that God would deliver them from the calamites they suffer; believing that God punishes them temporarily only to educate them.

In a debate involving supporters of the two opposing views, those who attributed climate variability and extremes to divine providence were able to impress those who believe that climate variability is caused by environmental degradation. This shows that farmers in the study area had mythical perceptions of causation to climate variability as is the case elsewhere in Africa, Australia, Europe, America and Asia. From scientific point of view, farmers with correct perception attributed climate variability to the degradation of biophysical conditions using the proverb "tree brings rain" (Slegers, 2008; Di Falco, Bezabih & Yesuf, 2010), political problems (Ogalleh *et al.,* 2012) and resource misuses and competitions (Kuruppu & Liverman, 2011). Those with perceptions thought that God or spirits are behind climate variability (Nyanga, *et al.*, 2011; Kuruppu & Liverman, 2011; Apata, Samuel & Adeola, 2009; Salick & Byg, 2007; Patt & Schroter, 2008).

An attribution of the 'God-caused' perception is the thought that risk is inevitable and unavoidable. As Kuruppu & Liverman (2011) noted, such a perception limits self-efficacy beliefs in taking adaptation measures to climate variability related risks. Farmers' adaptation options and intention for taking action to cope with climate variability related risk is the reflection of their causal attribution. In a similar vein, Grothmanna & Patt, (2005) assert that farmers perceived adaptive capacity could undermine the scope of their objective adaptive capacity. Hence, farmers would develop avoidance maladaptation responses (such as denial, wishful thinking, fatalism) which are adaptive responses to protect their psychological wellbeing rather than combating the real problem of climate variability. Their action could be followed by preventive maladaptation response such as land contracting, charcoal production and migration (Ayal & Muluneh, 2014). Consequently, the victims would develop helplessness attitudes. Lawrence (2007) asserted that without reflexive ways of interacting with a changed environment, people feel disengaged and powerless to change anything at the time of shock.

From a religious point of view, like other divine explanations, it is anathema to prove or disprove the perception that God caused climate variability. However, since perception defines peoples propensity for adaptation strategy (Hanson-Easey *et al.,* 2013), the 'God-caused' perception stops coping initiatives and adaptation strategies and must be tackled. Considering that few respondents having similar religious identities have embraced scientific explanations, it seems that changing the 'God-caused' perception is possible without challenging religious values. This illustrates how much religious leaders need to be involved in awareness creation campaigns to cope with the changing climate.

3.2. Determinants of Climate Variability Perceptions

Multivariate Analysis of Variance (MANOVA) was carried out to examine the extent to which demographic and economic variables such as sex, age, household education level and household income, had effects (variations for variance accounted) on farmers' climate variability perception and adverse effect of climate variability on crop and livestock. Although the main effects of the independent variables are of considerable interest, interaction effects can also be extracted from multivariate analysis, with which sort of interdependent factors will be taken in to account in the recurrent face of climate variability. The multivariate analysis produced some important results indicating farmers' decisions to take action are increasingly important in the areas of intervention.

Sex was shown to be statistically significant, $F(1, 229) = 10.572$, $p < 0.05$ and $F(1, 229) = 5.820$, $p < 0.05$ on farmers perception to climate variability and its effect on crop production respectively. The mean scores and standard deviations between male and female reveals that females M = 2.8, SD = 1.813 felt changes of climate in their locality more than males M, = 2.0, SD, = 1.620 participants. Similarly, females (M = 2.7, SD= 1.901) are more aware of the adverse effects of climate on crop production than their male counterparts (M = 2.2, SD = 1.624). As pointed out by (Safi, Smith & Liu, 2012), females are more perceptive of changes of climatic condition in their localities. Therefore, females' greater awareness of the change of climate variability can be attributed to the role of culture. This is because females are in charge of fetching of water, cut and carry, collecting firewood, and weeding before and after crop planting, responsibilities that become more arduous as climate disturbances and especially drought increases. The extensive field activities related to females by the socially constructed gender role differences (Brody, Demetriades & Esplen, 2008; Agwu & Okhimamhe, 2009; UNFPA, 2009; UNDP, 2009) could have given them a more subtle environment to perceive climate variability. Research found mixed results: females appeared to exceed males (Safi, Smith & Liu, 2012). On the contrary, males perceive better than females (Swai, Mbwambo & Magayane, 2012). Whereas Mertz *et al.* (2005) reported that there is no gender difference in perception.

Age difference was shown to be statistically significant $F (2, 229) = 3.474$, $p < 0.01$, $F (2, 229) = 2.620$, $p < 0.05$ and $F (2, 229) = 2.425$, $p < 0.05$, on perception variations of farmers change in climate variability, and adverse effects on crop and livestock production respectively. The mean scores and standard deviations among age groups showed that those above 60 years of age M, = 4.4, SD 2.314, M, = 4.2, SD 2.302, and M, = 4.6, SD 2.640, perceived changes of climate variability as an adverse effects in the crop and livestock sector more than respondents in the other age groups. The result is supported by previous researchers (Maddison, 2007; ATPS, 2013; Temesgen, Hassan & Ringler, 2011; Glwadys, 2009; Maddison, 2007). The reason is that older age signifies more experience to witness climate variations through a longer time horizon (Maddison, 2006; Ishaya & Abaje, 2008). Although other researchers argued that younger people are more perceptive of climate variability (Semenza *et al.*, 2008; De Jonge, 2010; Temesgen, 2009), no sound explanation is given. We argue that unless extraneous variables give advantages to younger farmers, age factor alone would favor older individuals to sense changes and report it with more legitimacy. However, the ambiguity of age factor for climate variability perception among farmers requires further research.

Household income differences were shown to be statistically significant, $F (5, 229) = 0.982$, $P < 0.05$, for the impact of climate variability on the crop production. The mean scores and standard deviations between income groups reveal that those with annual agricultural income of 100-200 US Dollars M, = 4.1, SD, 2.841 perceived better than other income categories. Whereas, with a mean score perception of 3.3, the economically better-off, with annual agricultural income of more than 3000 US dollar, perceived climate variability less well. Therefore, the poorer farmers are found to be in a better position to feel the change of climate variability. A possible reason could be that the adverse effects of climate variability are more pronounced on the livelihood of the poor since diverse sources of income could make the effect of climate variability less painful to the better-off, as argued by Bryan *et al.* (2009). With limited objective adaptive capacity, the poor hardly get all agricultural inputs ready for use on time. This would result in poor productivity which has to be compensated by working more hours in the field which would in turn expose them to feel the change of climate variability. Others argue that richer farmers better perceive climate variability since they are the ones who lose much from climate variability (Slegers, 2008; Semenza *et al.*, 2008; Speranza, 2010; Maddison, 2007). Both contentions seem equally appealing.

Education brought statistically significant (F (4, 229) = 4.289, P < 0.05) and (F (4, 215) = 3.416, P < 0.05) differences on farmers perceptions of both climate variability and its effect on crop production respectively. The mean and standard deviation (M = 4.421, SD = 2.461) for 11-12 graders indicated that they felt more climate variability and its effect on crop production than illiterates with the lowest M= 3.42, SD, 1.317. Therefore, the more educated farmers could better realize change of climate and its impact on crop production in their locality. The result seems valid especially given similar assertions among other researchers (ATPS, 2013; Semenza *et al.*, 2008; De Jonge, 2010; Temesgen, 2009) and the absence of counterclaims, at least measured by consulted literature. Education commences farmers' interest about modern technology and information. Therefore, education gave exposure to various information sources to perceive the changing climate situation. The absence of farmers' perception variation on the effect of climate variability on the livestock sector reflects the dominance of the crop sector in supporting the livelihood of farmers in the study sites.

Given the interactive effect between age and sex (F (2, 229) = 17.310, P < 0.01), it is logical that the multivariate analysis of variance showed that age and sex had a statistically significant effect on farmers' perception on the changing of climate variability in their locality.

Table 4. MANOVA Results of sex, age, household income and education on farmers perception on climate variability, impact on crop and livestock sector

Source	Dependent Variable	SS	df	MS	F	Sig.
Intercept	Climate variability perception	718.236	1	718.236	1.306E3	.000
	Adverse effect of climate variability on crop	539.725	1	539.725	2.214E3	.000
	Adverse effect of climate variability on livestock	419.677	1	419.677	1.497E3	.000
Sex	Climate variability perception	5.816	1	5.816	10.572	.001
	Adverse effect of climate variability on crop	2.200	1	3.200	5.820	.014
	Adverse effect of climate variability on livestock	.013	1	.013	.045	.832
Age	Climate variability perception	3.822	2	1.911	3.474	.000
	Adverse effect of climate variability on crop	.790	2	.395	2.620	.001
	Adverse effect of climate variability on livestock	.799	2	.400	2.425	.013
HH_Income	Climate variability perception	1.982	5	.396	.721	.609
	Adverse effect of climate variability on crop	1.197	5	.239	.982	.004
	Adverse effect of climate variability on livestock	1.786	5	.357	1.274	.278
EduHHH	Climate variability perception	9.438	4	2.360	4.289	.002
	Adverse effect of climate variability on crop	3.331	4	.833	3.416	.001
	Adverse effect of climate variability on livestock	1.557	4	.389	1.388	.240
Sex * Age	Climate variability perception	19.044	2	9.522	17.310	.000
	Adverse effect of climate variability on crop	.694	2	.347	1.424	.244
	Adverse effect of climate variability on livestock	.039	2	.019	.069	.933
Sex * HH_Income	Climate variability perception	1.001	3	.334	.607	.611
	Adverse effect of climate variability on crop	.090	3	.030	.122	.947
	Adverse effect of climate variability on livestock	1.727	3	.576	2.053	.108
Sex * EduHHH	Climate variability perception	.789	1	.789	1.434	.233
	Adverse effect of climate variability on crop	.102	1	.102	.419	.519
	Adverse effect of climate variability on livestock	.416	1	.416	1.485	.225

Age * HH_Income	Climate variability perception	7.166	9	.796	1.447	.172
	Adverse effect of climate variability on crop	2.825	9	.314	1.287	.247
	Adverse effect of climate variability on livestock	2.189	9	.243	.867	.556
Age * EduHHH	Climate variability perception	4.775	7	.682	1.240	.284
	Adverse effect of climate variability on crop	.759	7	.108	.445	.873
	Adverse effect of climate variability on livestock	1.224	7	.175	.623	.736
HH_Income * EduHHH	Climate variability perception	9.370	13	.721	1.310	.211
	Adverse effect of climate variability on crop	3.702	13	.285	1.168	.307
	Adverse effect of climate variability on livestock	6.213	13	.478	1.704	.064
Sex * Age * HH_Income	Climate variability perception	.687	1	.687	1.249	.265
	Adverse effect of climate variability on crop	.012	1	.012	.051	.821
	Adverse effect of climate variability on livestock	.015	1	.015	.052	.819
Age * HH_Income * EduHHH	Climate variability perception	3.461	9	.385	.699	.709
	Adverse effect of climate variability on crop	1.483	9	.165	.676	.730
	Adverse effect of climate variability on livestock	2.749	9	.305	1.089	.373
Error	Climate variability perception	92.416	168	.550		
	Adverse effect of climate variability on crop	40.957	168	.244		
	Adverse effect of climate variability on livestock	47.108	168	.280		
Total	Climate variability perception	3752.590	230			
	Adverse effect of climate variability on crop	3101.813	230			
	Adverse effect of climate variability on livestock	2670.389	230			
Corrected Total	Climate variability perception	230.068	229			
	Adverse effect of climate variability on crop	66.478	229			
	Adverse effect of climate variability on livestock	72.907	229			

a. R Squared = .598 (Adjusted R Squared = .452); b. R Squared = .384 (Adjusted R Squared = .160); c. R Squared = .354 (Adjusted R Squared = .119)

4. Conclusion and Recommendations

Farmers are not only victims of climate variability and extremes but also active observers. Despite some variations observed across age, education, sex and income, the majority of farmers have perceived the manifestations of climate variability and its effect on crop and livestock sector in their locality. The inconsistency between meteorological record and farmers climate observations is because changes are explained using temperature and rainfall in statistical averages and in absolute terms. Whereas farmers focus on extreme events relative to experienced effect on crop and livestock production and interpret qualitatively. Both have their own strengths and weaknesses. Instrumental analysis of climate variations and trends based on only average rainfall and temperature records makes it difficult to appreciate how exactly crop and livestock sectors are affected. On the other hand, farmers' perceptions deviate from characterizing the exact behavior of climate variability in quantifiable terms. Moreover, they might be influenced by recent climatic phenomena.

From the instrumental record, farmers should realize that the real problem in the study site is not a gradual rainfall amount reduction but unpredictable distribution of rainfall in amount and duration. From the life experiences of farmers, scholars should deemphasize long-term mean rainfall and temperature values that are hardly usable from the pragmatic agricultural practice point of view, to that of determining the likelihood of climate extreme scenarios, e.g. the timing and magnitude of drought, flooding, dry spells etc.

The question to be asked, therefore, is not which of the two is better but how the two could be exploited for the best results in order to provide accurate climate information. Hence, to protect farmers' livelihood from climate related risks and enhance adaptability policy makers should integrate both climate information sources. Farmers' right perception of manifestation and impact of climate variability could not be guaranteed for successful adaptation. Therefore, there is a need of improving the provision of basic extension services, and adaptation strategies should encompass modification of the agricultural calendar, selection of crop and livestock varieties and harness supplementary sources of moisture to balance the effect of erratic rainfall. We also propose awareness creation for farmers on causes of climate variability and extremes. Religious leaders and elderly farmers need to be a party in awareness creation campaigns.

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