E3 Journal of Agricultural Research and Development Vol. 7(2). pp. 092-0102, April, 2017
Available online http://www.e3journals.org
ISSN: 2276-9897 © E3 Journals 2017
DOI: http://dx.doi.org/10.18685/EJARD(7)2_EJARD-16-027

Full Length Research Paper

Farmers' Perceptions of Climate Change and Its Implication on Livestock Production in Mixed-Farming System Areas of Bale Highlands, Southeast Ethiopia

Girma Defar[1*], Ashenafi Mengistu[2] and Gebreyohanes Berhane[2]

[1]Madawalabu University, College of Agriculture & Natural Resource, P.O. Box 234. Bale-Robe, Ethiopia
[2]Addis Ababa University, College of Veterinary Medicine & Agriculture, P.O. Box 34, Bishoftu, Ethiopia

Accepted 18 February, 2017

Climate change affects the farming community of Ethiopia basically as a decrease and/or unpredictable time and duration of rainfall and increased temperature that expose farmers to frequent drought. The study was conducted to assess the perception of farmers on climate change and its implication to livestock production in mixed-farming system of the area. Structured questionnaire was used to collect primary information. Secondary data, field observation and focus group discussions were employed to generate the detail data. Farmers' asset holding, climate information access, farm productivity condition, climate change perception, climate change indicators, climate change implication on livestock production and adaptive strategies used by farmers were assessed through an interview of 156 systematically sampled wealth group households (HHs). The study indicated that temperature was rising while unpredictable and declining rain was significantly (P<0.05) between wealth groups. The situation resulted in livestock feed shortage, water scarcity, animal diseases incidence, low animal productivity and frequent drought cause problems across all wealth groups. These factors become determinant to herd livestock in the area by wealth group HHs. Decreased seasonal rainfall (47.4%), increased temperature (83.3%), increased disease incidence (47.4%), increased drought occurrence (66.0%) and variable plant growth period (48.7%) were observed by wealth group HHs as indicators of climate change and found affecting livestock production. Lack of climate related information source media (70.7%), less fertile land holding (97.4%), lack of alternative livestock feed and water supply and meager provision of advanced livestock production packages were basic problems of the community. Moreover, individuals' susceptibility to the climate attributes change varies on the asset they hold and their adaptive capacity. Therefore, improved weather forecasting and dissemination of climate change information source provision, identifying climate resistant and productive livestock species and promoting farm level adaptation options and adjusting market oriented livestock production should be sought based on wealth status and implemented for sustainable livestock productivity in the area.

Keywords: Climate change, Farmers' perception, Livestock, Mixed-farming, Wealth groups

INTRODUCTION

Agriculture is the largest economic sector in Ethiopia with 47% (national GDP), 80% (employment of labour force) and 90% of the smallholder depend on the sector (Salami *et al*., 2010). The highland that makes up 45% of Ethiopia supports 85% of the total human population (Deressa *et al*., 2008) where, majority of the rural people depend heavily on rain-fed subsistence mixed-farming system (Bewket, 2010). World Bank (2011) reported that the livestock subsector provides 16 % of the total GDP and generates 14 % of the country's foreign exchange

*Corresponding authors E mail: gdefaru@gmail.com

earnings. However, Thornton (2010) reported that the biggest impacts of climate change are going to be seen in mixed-farming system in developing countries where people are already highly vulnerable. The vulnerability to climate changes in developing countries is mainly due to their reliance on rainfed agriculture (IPCC, 2007). In this view, climate change and variability becomes one of the biggest threats to agricultural production for the current and future in developing countries.

Climate change is a key concern to Ethiopia and the most serious global problem that affects many sectors in our time and need to be attempted in a state of emergency (IPCC, 2007; Huq *et al*., 2006). The phenomenon is occurring throughout the country and affecting every community although it is assumed to be in a different degree from place to place varied agro-ecologies (Ayana *et al,* 2011) of the country. Smallholder farmers of Ethiopia are continuously in a challenging state of climate change impacts. In the near past, the community is severely challenged by the negative impacts of climate change and the ability to endure these changes is constrained by technical, institutional and financial capacity (Ayana *et al*, 2011). Moreover, the report by Rosenzweig *et al*. (2002) in Tanzania revealed that changes in rainfall patterns and amounts have led to loss of crops and reduced livestock production that resulted in famine. To this end, restraining the impact and boosting adaptive capacity and resilience of farmers to climate change could be addressed through different adaptation strategies. However, farmers' adaptation decisions are guided by their perception to climate change and climate related risks (Jiri *et al*., 2015). Smallholder farmers need to be able to identify the changes already taking place in their areas and establish appropriate coping and adaptation strategies at local level (Shemdoe, 2011; Kassie *et al*., 2013) for the betterment of their livelihood.

To this end, there are scanty or no quantitative information concerning farmers' perception to climate change and its implication to livestock production in mixed-farming system areas of Ethiopia, particularly Bale highlands. In Bale highland areas, the land uses were under pressure of competition between livestock and crop c production. In addition, under such similar circumstances of the existing farming system in the area, farmers have different view to the scenario of climate change and its interaction with the livestock production. This entail, the situation stays limiting for policy formulation and decision making in terms of future livestock husbandry and feeding systems as well as mitigation options of the impacts to livestock sector nationwide. Thus, information accrued from the study expected to be used by stakeholders, scientific communities and policy makers to address issues related to climate change in highland mixed-farming system. Therefore, the study was initiated to assess farmers' perception of climate change and its implication to livestock production in mixed-farming system of Bale highlands.

METHODOLOGY

The Study Area: The study was conducted in Bale zone of Oromia National Regional State, South East of Ethiopia. The zonal town Robe is located at 430km, from Addis Ababa. The study area districts are situated at highland altitude with mean annual rainfall of 1065mm and average daily temperature of 13.8 ^{O}C (Bale Zone ARDO, (Bale Zone ARDO, NMA Bale branch).

Sampling Procedures: Three districts namely Sinana, Gasera and Agarfa were identified and purposively selected from nine mixed-farming districts of the zone based on land use land cover and livestock population potential. The districts further stratified in to three wealth group households (HHs) based on asset holding (land and cattle): Better-off who owned (≥4.12hectare land, ≥5.17 heads cow and ≥5.25 heads ox); Medium who owned (1.84-4.12hectare land, 1.09-5.17 heads cow and 1.86-5.25 heads ox) and low-income who owned (≤1.84hectare land, ≤1.09 heads cow and ≤1.86 heads ox) (Assefa, 2005; Salami *et al*., 2010; District's Finance and Economic Development Office, and consultation with the local community). The majority (85) sample HHs were grouped in Medium, whereas 40 and 31 resides in Better-off and Low-income groups, respectively. Again three mixed-farming highland Farmer Associations (Kebeles) systematically selected from each district. A random sample of HHs from the population that was initially stratified by asset holding was selected. A total sample size of 156 HHs (Arsham, 2005); were 25.6% from Better-off, 54.5% from Medium and 19.9% from Low wealth group randomly selected with the help of district agriculture office experts. The number of sample HHs from each wealth group was determined using proportional probability to size approach.

Data Source and Analysis: A single visit multiple subject formal survey technique (ILCA, 1990) was used for data collection using a pre-tested structured questionnaire. Before the interview of the sample HHs, discussion was held with key informants of the farming community and districts' agriculture office experts to have an overview of the general livestock production system and climate change. The questionnaire for the formal survey was developed using the information generated by key informants. The data collected were HH characteristics, land holding, livestock holding, climate information sources, farm condition, climate change perception, climate change indicators, impact of climate change and adaptation strategies. The primary data was collected by enumerators which are from the study area under close supervision and participation of the author. The data was analyzed using Statistical Packages for Social Sciences (SPSS) software, version 20. The

Table 1: Frequency (%) of sample household's general characteristics of the study area

Description of variables	Household wealth group				
	Better (40)	Medium (85)	Low (31)	Overall (156)	P value
Age of respondent	51.83(1.7)[a]	47.79(1.0)[ab]	46.13(2.1)[b]	48.49(0.8)	0.047
Family size (%)					0.027
2-5 family size	15.0	29.4	48.4	29.5	
6-9 family size	72.5	64.7	41.9	62.2	
>9 family size	12.5	5.9	9.7	8.3	
Farm experience (%)					0.392
≤ 20 years	35.0	47.1	48.4	48.2	
> 20 years	65.0	52.9	51.6	55.8	
Education level (%)					0.222
Illiterate	10.0	5.9	22.6	10.3	
Read & write	30.0	27.1	16.1	25.6	
Primary (1-6)	40.0	42.4	35.5	40.4	
Secondary & above	20.0	24.7	25.8	23.7	

Means within the same row with different superscripts are significantly different; figures in the bracket are standard errors

Table 2: Land use types (ha HH^{-1}) and livestock (TLU) holding of households in the study area

Description of variables	Wealth group households				
	Better (40) Mean(SE)	Medium (85) Mean(SE)	Low (31) Mean(SE)	Overall (156) Mean(SE)	P value
Land use type					
Grazing land	0.59(0.08)[a]	0.32(0.04)[b]	0.10(0.02)[c]	0.34(0.03)	0.000
Cropland	4.17(0.12)[a]	3.09(0.08)[b]	1.89(0.09)[c]	3.13(0.08)	0.000
Fallow land	0.27(0.05)	0.23(0.03)	0.13(0.03)	0.22(0.02)	0.186
Improved forage land	0.12(0.03)[a]	0.04(0.01)[b]	0(0.0)[c]	0.05(0.01)	0.000
Rented in/out cropland	0.14(0.08)	0.13(0.05)	0.06(0.04)	0.12(0.03)	0.703
Total land holding	5.23(0.19)[a]	4.12(0.29)[b]	2.19(0.11)[c]	4.03(0.19)	0.000
Cropland %	81.22	84.33	90.66	85.40	
Livestock holding					
Cattle	13.99(0.44)[a]	7.59(0.27)[b]	3.48(0.19)[c]	8.40(0.35)	0.000
Sheep	0.70(0.10)[a]	0.31(0.05)[b]	0.16(0.05)[b]	0.38(0.04)	0.000
Equine	2.12(0.10)[a]	0.98(0.06)[b]	0.51(0.08)[c]	1.18(0.060	0.000
Total TLU holding	17.09(0.40)[a]	8.83(0.28)[b]	3.87(0.19)[c]	9.97(0.41)	0.000
Cattle (TLU) %	81.86	85.96	89.92	84.25	

Means within the same row with different superscripts are significantly different; figures in the bracket are standard errors

analysis included descriptive statistics (means, frequencies and Chi-square test). Indices (weighted averages) developed to obtain the aggregate ranking of the considered parameters.

RESUIT AND DISCUSSION

HOUSEHOLD CHARACTERISTICS

The general characteristics of the sample households (HHs) in the study area are presented in Table 1. Average age of respondents were significantly ($P<0.05$) between better and low wealth group HHs. The present study revealed that the overall 6-9 family size (72.5%) was high ($P<0.05$) for better wealth group compared to others. Farm experience and education level attended were not significant ($P<0.05$) between the study wealth groups (Table 1). However, numerically the more farm experienced HHs (65.0%) belongs to better wealth group and education levels attended were almost uniform across studied wealth groups. The present result was comparable with Anley *et al*. (2007) that revealed level of education correlates to level of knowledge and the simplicity of making sound decisions while higher levels of education coupled with farm experience improves farmer's perceptions of climate change.

LAND USE TYPE AND LIVESTOCK HOLDING

In the study area agriculture is livelihood pillar of the community and comprises crop-livestock farming that grounded on land and livestock owned. Table 2 presents

Table 3: Frequency (%) of respondent farmers on climate change information sources in the study area

Description of variables	Household wealth groups				
	Better (40)	Medium (85)	Low (31)	Overall (156)	P value
20years climate consistency -Yes	2.5	0	0	0.6	0.232
-No	97.5	100	100	99.4	
Access to climate information -Yes	100	89.4	67.7	87.8	0.000
-No	0	10.6	32.3	12.2	
Climate change information sources					
Own Radio and/or Television -Yes	40.0	24.4	27.3	29.3	0.204
-No	60.0	75.6	72.7	70.7	
Newspaper -Yes	2.5	0.0	0.0	0.7	0.284
-No	97.5	100	100	99.3	
Academic institutions -Yes	2.5	2.6	0.0	2.1	0.751
-No	97.5	97.4	100	97.9	
Government offices -Yes	97.5	96.2	90.9	95.7	0.452
-No	2.5	3.8	9.1	4.3	

different types of land use pattern and livestock species owned by the wealth groups in the area. The average land allotted for grazing, crop cultivation, improved forage production and total land holding were significantly (P<0.001) between the wealth groups. The better wealth group has more grazing land compared to other wealth groups. This indicates how livestock feed was a vital input for animal productivity. The study revealed that major portion of the land 81.22%, 84.33% and 90.66% were allocated for crop cultivation by the better, medium and low wealth group HHs, respectively. The result is in line with Belay *et al*. (2012) and Dawit *et al*. (2013) were more land is allocated for crop cultivation. The mean TLU herded cattle, sheep, equine and total TLU kept were significantly (P<0.001) between the wealth groups. From the total livestock herded by the wealth groups, 81.86%, 85.96% and 89.92% of cattle were kept by better, medium and low wealth HHs, respectively. This is due to the fact that cattle are primarily used for draught power and milk, and secondly used to sale and other purposes. The purpose of different livestock species herded in the study area was consistent with earlier report by Solomon (2004).

CLIMATE CHANGE AND FARM CONDITION

Climate change information access: Climate change related information sources for the targeted wealth groups in the study area are indicated in Table 3. Negligibly, only one farmer from better wealth group was observed consistent climate (weather) pattern in the course of 20years perception. This implies all wealth group HHs perceived climate attributes related to farming activity were changed at a level that they observed the change by their own methods. Similarly, Dejene (2011) reported that climate change is well perceived by the farmers in Adiha village (Ethiopia) that they have observed changes in temperature, precipitation, timing of rainfall and related frequent drought,

They perceived the information by their own indigenous means as in the rural area there were limited modern climate information sources. The present study showed access to climate information was significantly (P<0.001) between the wealth groups in the study area. This is due to the fact that more number of better wealth HHs might be own radio and/or television as information source. In the study area, access to climate information sources includes plausible and/or oral reports) and that is why overall (87.8%) indicated as they accessed the information. However, FGD confirmed the problem was to brought likely solution in to practice due to knowledge gap, resource limitation and credibility of sourced information by the farmers' belief.

Farm Conditions

Farm productivity determinant factors and productivity status of the farm are presented in Table 4. Based on the HH survey of study area, it was found that climate change factors were important constraints to agricultural productivity. All (100%) respondents were involved in rain-fed agriculture that easily affected by weather attributes inconsistency. This might be one of the basic reasons why farmers' perception of climate change becomes recognizable in the study area (Table 3, 4) as they able to learn from farm productivity failure. Majority of the respondents from better (97.5%), medium (96.5%) and low (97.4%) wealth groups cultivated less fertile land compared to fertile land they owned which might be the reason for low farm productivity. Moreover, they were cropping their land for the consecutive years with no/few organic matter additions to the land. It was the reason for farmers of the wealth groups to obtain declined product from crop cultivation (P<0.001) and livestock herding in the study area (Table 4). This might be due to climate

Table 4: Percent of respondents' opinion on farm productivity and determinant factors in the study area

Description of variables	Household wealth groups Better (40)	Medium (85)	Low (31)	Overall (156)	P value
Farming system practiced (%)					---
Rain fed	100	100	100	100	
Irrigation	0	0	0	0	
Land fertility status (%)					0.332
Infertile	30.0	42.4	45.2	39.7	
Less fertile	97.5	96.5	100	97.4	
Fertile	57.5	30.6	6.5	32.7	
Crop land productivity (%)					0.000
Low	67.5	88.2	100	85.3	
Medium	32.5	11.8	0	14.7	
High	0	0	0	0	
Livestock productivity (%)					0.460
Low	95.0	95.3	100	96.2	
Medium	5.0	4.7	0	3.8	
High	0	0	0	0	
Raining time (%)					0.020
Predictable	20.0	33.3	51.6	33.5	
Unpredictable	80.0	66.7	48.4	66.5	

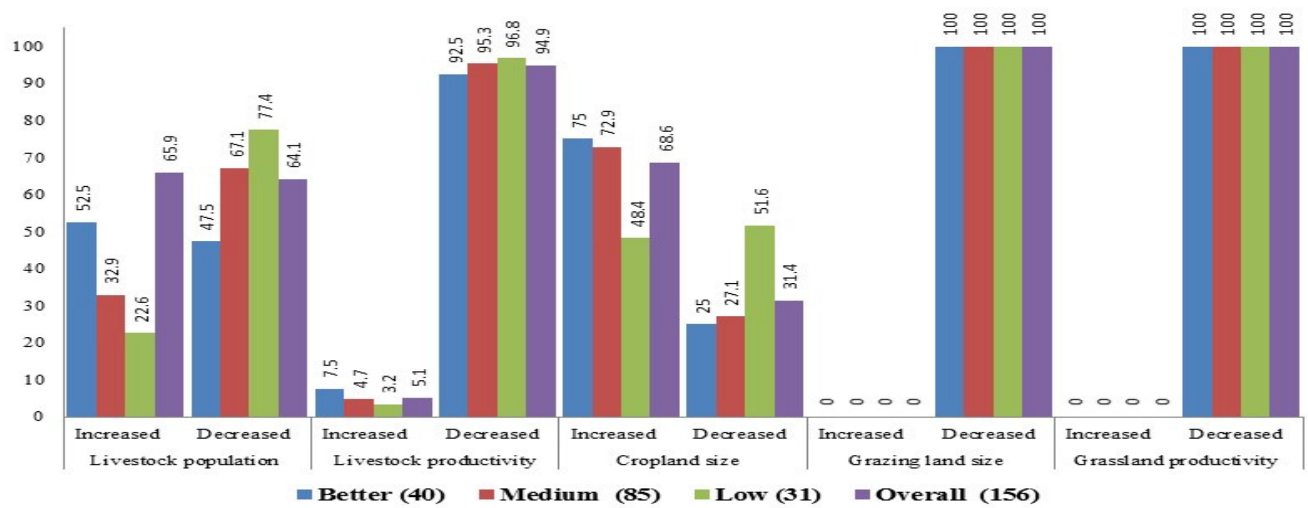

Figure 1: Households' perception of livestock and farm productivity condition of the past 20years in the study area

factors which have negatively affected crop production and livestock feed resources because of decline in rainfall amounts and intensity, reduced length of rainy season and increased heat and occasionally hot conditions that directly affected the farm performance (Never, 2014).

The perceived raining time by the respondents were significant (P<0.05) between wealth groups. In line with present study, Dejene (2011) reported that the problems were associated with unpredictable rainfall time (onset & offset), increased pest and disease incidence linked to warming and declined soil fertility that associated with frequent drought. Additionally, Thornton and Herrero (2008) explore the indirect effect of climate change on feed resources, which refer to its significant impact on livestock productivity.

Climate Change and Livestock Productivity

Households' view on the increasing and decreasing trends of livestock and feed resource related factors of wealth groups is indicated in Figure 1. The increase in total livestock population (65.9) and cropland size (68.6) might be due to increase of human population which were a case to create subsistence living assets (land and livestock). The livestock productivity, grazing land size and grassland productivity were indicated decreased by

Table 5: Farmers' perception (%) of climate change indicators in the study area

Description of variables	Household wealth groups				
	Better (40)	Medium (85)	Low (31)	Overall (156)	P value
Rainfall condition (amount)					0.158
Increased seasonal rainfall	12.5	18.8	6.5	14.7	
Decreased seasonal rainfall	57.5	38.8	58.1	47.4	
Unpredictable seasonal rainfall	30.0	42.4	35.5	37.8	
Temperature condition (warmness)					0.196
Increased seasonal temperature	92.5	80.0	80.6	83.3	
Decreased seasonal temperature	0	0	0	0	
Variable seasonal temperature	7.5	20.0	19.4	16.7	
Drought frequency (occurrence)					0.205
Increased drought frequency	77.5	62.4	61.3	66.0	
Decreased drought frequency	0	0	0	0	
Variable drought frequency	22.5	37.6	38.7	34.0	
Diseases occurrence (diseased animal)					0.048
Increased livestock diseases	62.5	48.2	25.8	47.4	
Decreased livestock diseases	10.0	16.5	22.6	16.0	
Unpredictable disease occurrence	27.5	35.3	51.6	36.5	
Length of growth period (crop)					0.131
Increased growth period	5.0	21.2	19.4	16.7	
Decreased growth period	47.5	29.4	32.3	34.6	
Variable growth period	47.5	49.4	48.4	48.7	

94.9%, 100% and 100% of respondents, respectively (Figure. 1). However, FGD confirmed that the indigenous animal breeds and some crop varieties have adapted over the past years of climate change period to survive, reproduce and produce under the stressful environmental situations. In support of the stated scenario, CRGE (2011) and Never (2014) reported climate change effect greatly felt in grazing systems, especially in tropics. Indeed, livestock system have accelerated ecological damage together with climate change and increased carrying capacity as a result of grassland shrinkage in the study area that in turn decline animal productivity. Hence, the current situation of mixed crop-livestock system request change in feed sources and feeding system to reconcile the productive sustainability of the system in the study area. However, it commands the farming community and stakeholders to pay attention to use of pasture and different forage species in some rehabilitation areas. This helps to match feed resources to livestock requirement in adverse condition that will be a current and future task. The reason was that the increased mortality and poorer reproductive performance.

Livestock and plant disease incidences were observed differently ($P<0.05$) between better, medium and low wealth groups. Plant growth period observed decreased and/or inconsistent was not different ($P<0.05$) between wealth group HHs. In agreement with the present finding, Thornton *et al*. (2006) presented length of plant growth change will continue for Africa to 2050, even though there were few areas (especially humid and sub-humid highlands) where the combination of increased temperature and rainfall changes may lead to an extension of the growing season. According to Elsa *et al*. (2012), of all the factors influencing livestock production, combination of increased temperature, shifted rainfall amount and pattern had effect on livestock system, while feed was and will remain a critical constraint of livestock production in the tropics. Thus, IPCC (2007) and Thornton *et al*. (2007) were reported that crop productivity is a valuable proxy for feed availability in most regions of the tropics.

Climate Change Indicators

Table 5 presents HH's view on some attributes of climate change indicators of the wealth groups in the study area. Numerically, majority of the HHs from better (57.5) and low (58.1) wealth group observed seasonal rainfall amount was decreasing. On the other hand, more HHs from all wealth groups perceived temperature and drought frequency were increased over the past years. The current result was in line with the report of Herrero *et al*. (2010) that increased probability of drought once every three years. This could decrease herd sizes due to climate attributes (ambient temperature and rainfall patterns) found undoubtedly the most significant contributors for the newly emerging diseases and parasites of livestock and plants in tropics.

In general, the entire wealth group HHs agreed on the listed climate change indicators under the variable state than be in constant situation in the study area. Moreover, the farmers in the study area were informed about the coming weather situation of their area through some elderly people who were knowledgeable about climate scenarios from their life time experiences. Some make their predictions from star orientations, wind direction and intensity and cloud patterns or some others by

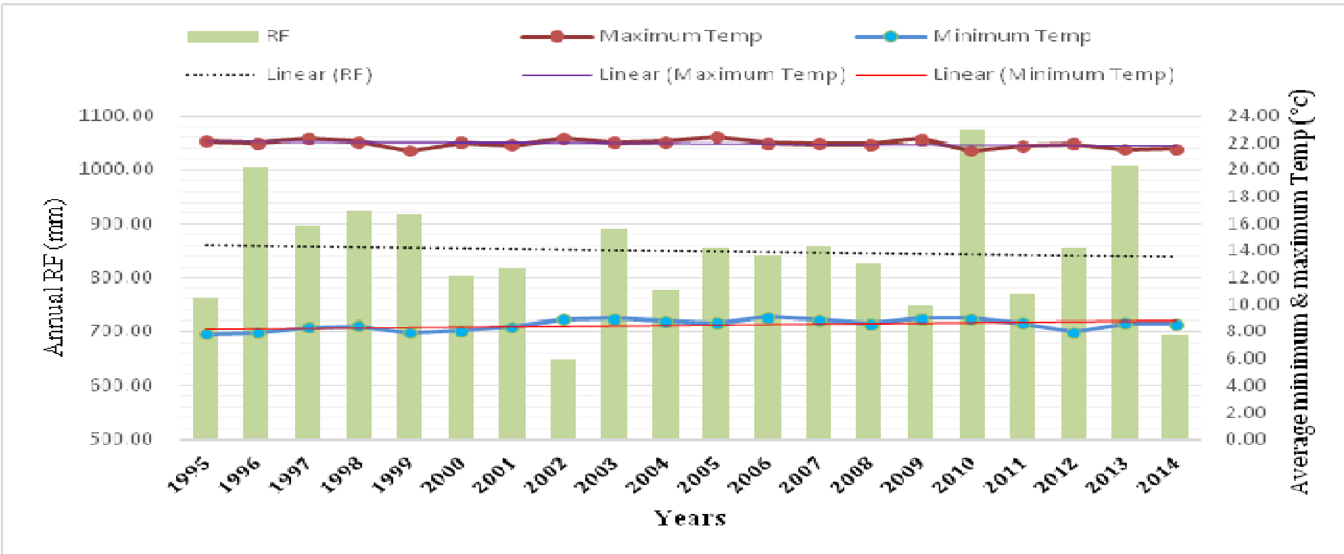

Figure 2: Rainfall and temperature variability trend over the past 20years (1995-2014) in the study area

considering behavior of some wild animals and the flowering time of some indigenous plants (ONRS, 2011).

Rainfall and Temperature Trends

Climate change basically includes increased temperature, erratic rainfall patterns and drought. The annual average rainfall and average annual minimum and maximum temperature trends from 1995-2014 is presented in Figure 2. Since 1995 temperature has been steadily increasing reaching as high as 22.46 ^{O}C (2005) and 9.02 (2006) as for annual mean maximum and minimum, respectively in the study area. There have been also a lot of variations in rainfall amount and patterns in the study area (Figure 2). Annual precipitation had varied from 648.90mm recorded in 2002 to high as 1075.95mm in 2010. There was a deviation of 427.05mm of annual rainfall between the highest (in 2010) and the lowest (in 2002). The lowest rainfall year might be due the occurrence of ELINO. The change in seasonality, distribution and regularity of rainfall were becoming more of concern than the overall amount of rainfall. Even the main rainy season progressively become shorter some times in some areas; it starts later and stops earlier than it accustomed to (Table 4). The present result was consistent with Herrero *et al.* (2010) findings that in East Africa regions across Ethiopia, Kenya, Somalia and Tanzania while mean temperature varies with elevation, the more remarkable climate variation is with respect to precipitation in a given area.

The indicated trends in Figure 2 were in agreement with respondents' perception of the variability and decrease of rainfall in the past 20years (Table 5). Muna (2006) and NMA (2007) reported the average minimum temperature in Ethiopia has been increased by 0.37^{O}C per decade in the past 60years and in Ethiopian highlands the temperature has been increasing 0.3^{O}C per decade, respectively. Furthermore, (ONRS, 2011) reported the average annual minimum and maximum temperature over the country has been increase by about 0.25^{O}C and 1^{O}C every ten years, respectively. However, both seasonal and annual rainfall has exhibited high variability in Oromia region which is characterized by a bimodal rainfall pattern (NMA, 2007). All the wealth group farmers in the study area said that they were aware of climate change and variability, mainly through their life time experiences. In general, this study presented farmers' believe that the climate is changing for the bad and had led to changes in livestock productivity. Similarly, few studies which assessed farmers' perception elsewhere in Africa have reported comparable findings (Nyanga *et al.*, 2011; Rao *et al.*, 2011).

Effect of Climate Change on Livestock Production

The importance of climate change observed on livestock system among the wealth group HHs in the study area is demonstrated in Figure. 3. Lack of feed due to unpredictable rainfall and increased temperature; poor animal health due to extended drought and increased disease incidence were responded in varied degree between the better and low wealth group HHs (85.0 vs 61.3; 92.5 vs 67.7; 65.0 vs 32.3; 65.0 vs 35.5 and 92.5 vs 58.1) % respectively, while other effects remain not quite different between the groups. Comparable to the present result, Hoffman and Coleen (2008) and NMA (2007)

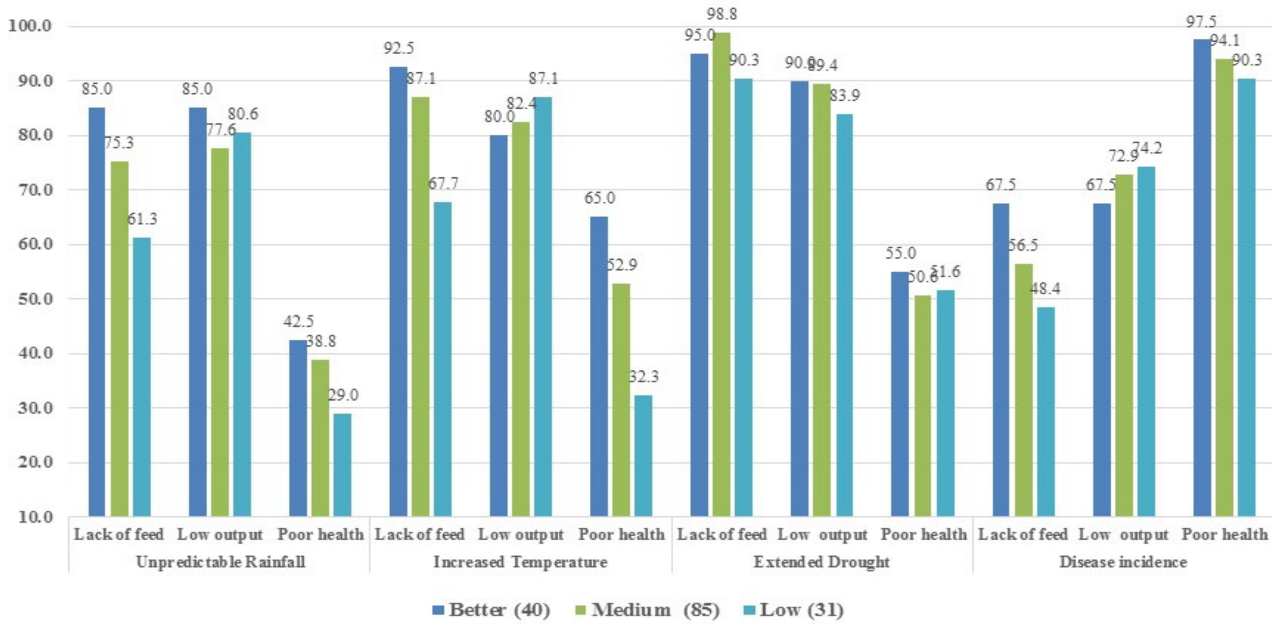

Figure 3: Climate change implication on livestock system in the study area (respondents %).

reported that during drought, as the animals are less access to pasture they become weak and more susceptible to different diseases. Ayana *et al.* (2011) also added that the amount and duration of rainfall is declining and the dry season is becoming longer, resulted in shortage of water and pasture, that further led to the loss of livestock assets. Furthermore, Thornton and Herrero (2008) and Thornton (2010) stated that effect of climate change on livestock production is measured through the effects on natural pastures, water sources, livestock diseases and biodiversity.

In the study area, climate change affects livestock production in different ways. This includes the effect on feed availability, pasture quality, emerging diseases and parasites. Similarly, the direct effect of extreme weather variability causes significant effect on animal health, growth and reproduction (Thornton *et al.*, 2007; Rust and Rust, 2013). Effect from feed resources cause were due to change in forage species composition that brought a significant effect on type of animal species or category feed on it and eventually modifies the feeding pattern. This was due to the change in quality of forage plant by increased temperature and reduce the rate of degradability of species which further reduce nutrient availability to animals (Thornton *et al.*, 2007; Kassahun, 2016). Different studies had concluded agriculture in Ethiopia is mostly affected by climate change whereby decline in precipitation and increase in temperature are both destructive factors (Deressa *et al.*, 2008; Ayana *et al.*, 2011). Although the direct effects of heat stress on livestock have not been studied in the study area, increased heat alters feed intake, growth, reproduction and production of animals. Thus, the collective effects of these factors were likely to have a negative impact on livestock productivity in the area.

Climate Change Adaptation Strategies

In the study area, livestock were one of the limited options to increase wealth of farmers to sustain livelihoods. The rank of adaptation measures practiced to adapt climate change among the wealth groups in study area are shown in Table 6. The communities practiced the adaptation tools which were affordable and available to the potential of their economic, social and their indigenous knowledge. The significant adaptation measures taken by the farming community were gradual decrease of HH livestock size, change in some crop varieties, soil and water conservation work and change in livestock herd structure; ranked 1st, 2nd, 3rd, and 4th, respectively by the better and medium wealth groups. To the contrary, the low wealth group HHs ranked change in crop varieties (1st) and decreasing livestock size (2nd) with the other adaptation measures ranked similar to other groups. This might be due to the low number of livestock owned by low wealth group HHs that exclusively minimized because of the asset owned. On the other hand, change in animal species and/or breed was ranked 4th by entire wealth groups. The reason was they all owned local breeds with species diversification (if feed was available). In agreement, Thornton et al. (2007) reported that livestock are important to increase resilience of vulnerable for those subjected to climate factors, through risk diversification and asset increment. The reason why changes in crop varieties ranked as 1st

Table 6: Rank of the adaptation measures practiced by farmers to manage the climate change in the past 20years

Household wealth groups	Adaptation measures	Scores of adaptation measures 1st	2nd	3rd	4th	Index	Rank
Better (40)	Change in animal species/ breed	0	0	2	18	0.058	4
	Minimizing livestock number	30	8	2	0	0.389	1
	Change in crop varieties	8	30	2	0	0.332	2
	Soil and water conservation	2	2	34	2	0.221	3
Medium (85)	Change in animal species/breed	0	0	4	13	0.027	4
	Minimizing livestock number	53	27	5	0	0.389	1
	Change in crop varieties	30	53	2	0	0.363	2
	Soil and water conservation	2	4	74	4	0.221	3
Low (31)	Change in animal species/breed	0	0	0	1	0.004	4
	Minimizing livestock number	12	9	10	0	0.342	2
	Change in crop varieties	15	14	2	0	0.381	1
	Soil and water conservation	4	8	18	0	0.273	3

Table 7: Frequency (%) of farmers' coping mechanisms to livestock drinking water and feed scarcity

Description of variables	Household wealth groups Better (40)	Medium (85)	Low (31)	Overall (156)	P value
Water scarcity					0.004
Hand dug well	57.1	85.3	100	79.7	
Migrate to water points	42.9	14.7	0	20.3	
Feed shortage					0.002
Alternative feeds & cut-carry	47.5	63.5	93.5	65.4	
Migrate to other places	20.0	12.9	0	12.9	
Destocking	32.5	23.5	6.5	22.4	

or 2nd as adaptation option was due farmers have access to sporadically released wheat varieties (major crop) with some packages for the agro-ecology by the concerned organization. Soil and water conservation works are recent emerging adaptation measures with support from the government and non-government organizations as part of the country's Climate Resilient Green Economy (CRGE) program. Thus, with the unceasing changing climate, livestock has paramount roles as part of adaptation tools by the rural community.

Adaptation to Livestock Feed and Water Scarcity

The percentage of wealth group HHs choice of coping mechanisms to water and feed scarcity are given in Table 7. Use of hand dung wells and migration to water source areas with livestock was practiced differently ($P<0.01$) between the wealth groups during water scarcity. This happened particularly HHs with more number of livestock unable to provide water daily or once in two days for their animal. In support of the present result, IPCC (2007) reported climate change have the potential to affect negatively on water availability and access to and demand for water in most countries, particularly in Africa. Thornton *et al*. (2007) added that the coming decades are likely to increase demand and competition for water in many places. Thus, policies that can address the allocation and efficient use of water will be increasingly needed than ever. because increase in heat stress will significantly increase water requirements of the livestock. This is true for Bos indicus, were water intake increases by 3 kg per kg DM intake at 10°C ambient temperature to 5 kg at 30°C and to 10 kg at 35°C (NRC, 1981).

The effects of climate change on livestock production notably mediated through changes in feed sources, even though the indirect effect on feed sources can have a significant impact on livestock productivity. Use of alternative feeds, destocking and migrating part of the herd to other areas were seen sound with the wealth groups differently ($P<0.01$) to maintain their animals during feed shortage in the study area. The cut-carry system include improved forage, maize twinges and juvenile stage crops assumed not be productive. However, it was not well practiced by the community of the area compared to other options. Use of alternative feeds were common during marked seasonal feed quantity and quality discrepancy (Table 7). The alternative feeds (milled grains, concentrates, HH wastes and others) mostly fed to milked cows and draught oxen. Thus, introduction of adaptive forage species those have a wide spread of adaptation to environmental stresses, ease of management and acceptable by livestock herders assumed to minimize feed scarcity due to the effects of climate change.

CONCLUSIONS AND RECOMMENDATIONS

Livestock production is one of the hub sectors that play an important role in food security in Ethiopia. It is driven by population and income growth that further increases the demand for its products. However, the sector is facing increased and continued risks of climate change that adds extra burden to development challenges posed by the driving factors. The farming communities in the study area were entirely dependent on rain-fed mixed system. They noticed that their area gets warmer and drier than before due to increased temperature and variability in timing of rainfall and intensity. Some years back temperature and rainfall meteorological data trends support farmers' perception of climate attributes change (Figure 2). Change in seasonal rainfall pattern, increased temperature, increased drought frequency, increased livestock disease incidence and decreased livestock productivity were among the major indicators of climate change in the study area. Low wealth group HHs were more susceptible to changing climate since degrees of susceptibility related to amount of asset owned and adaptive used.

Farmers were ranked herding small number of livestock, change crop varieties and practicing natural resource conservation as a major adaptation tools in order of importance. Getting weather information found as a precondition to minimize the adverse effect of climate change on farming community whose livelihood depends on rain-fed agriculture. Hence, improving access to climate information has a paramount importance to improve the livestock productivity and efforts must be made to guarantee. Addressing these issues to improve farmers' perceptions on climate change create wider choices of adaptation options that sustain the productivity of the sector. Therefore, understanding: What are all the aforementioned influential factors? How livestock keepers take advantage of the increasing demand for livestock products? where the solution is feasible? And implementing adaptation options that maintain HHs livelihood were key concern of policy makers, stakeholders and concerned bodies in a more urgent approach than ever.

ACKNOWLEDGEMENT

The authors thank Addis Ababa University for research grant offered. The authors are also grateful to the zonal and districts' agriculture office experts, enumerators, respondent farmers, friends and colleagues for their cooperation.

REFERENCES

Anley Y, Bogale A, Haile-Gabriel A (2007). Adoption decision and use intensity of soil and water conservation measures by smallholder subsistence farmers in Dedo district, Western Ethiopia. Land Degradation Development 18: 289-302.

Arsham H (2005). Questionnaire design and surveys sampling, 9th Ed.

Assefa A (2005). Farm Management in Mixed Crop-livestock Systems in the Northern Highlands of Ethiopia. Doctoral thesis, Plant Production Systems Group, Wageningen University, Wageningen, The Netherlands.

Ayana S, Beyene S, Nebil Sh, Sertse S and Tefera T (2011). Agriculture Sector Programme of Plan on Adaptation to Climate Change, Technical working group, Addis Ababa.

Belay D, Azage T, Hegde BP (2012). Smallholder Livestock Production System in Dandi District, Oromia Regional State, Central Ethiopia. *Global Veterinaria 8 (5)*: 472-479, 2012

Bewket A (2010). Analysis of Farmers' Perception and Adaptation to Climate Change and Variability: The Case of Choke Mountain, East Gojjam. MSc thesis, Addis Ababa University.

CRGE (Ethiopia's Climate-Resilient Green Economy) 2011: Green economy strategy. Federal Democratic Republic of Ethiopia, Addis Ababa, November 2011.

Dawit A, Ajebu N, Sandip B (2013). Assessment of feed resource availability and livestock production constraints in selected kebeles of Adami Tullu Jiddo Kombolcha District, Ethiopia. *African Journal of Agricultural Research, Vol. 8 (29)*, pp. 4067-4073.

Dejene KM (2011) Farmers' perception and knowledge of climate change and their coping strategies to the related hazards: Case study from Adiha, central Tigray, Ethiopia. *Agricultural Sciences, Vol.2*, No.2, 138-145.

Deressa TT, Hassan RM, Ringler C (2008). Measuring Ethiopian farmers' vulnerability to climate change across regional states, IFPRI discussion paper No. 806, http://www.ifpri.org/pubs/dp/

Elsa L, Sofia van H, Elvira S, Maria M, Mendes G, André M (2012). Factors Influencing Livestock Productivity: Environmental Stress and Amelioration in Livestock Production, Springer-Verlag Berlin Heidelberg.

Herrero M, Ringler C, van de Steeg J, Thornton P, Zhu T, Bryan E, Omolo A, Koo J, Notenbaert, A (2010). Climate variability and climate change and their impacts on Kenya's agricultural sector. Nairobi, Kenya. ILRI.

Hoffman MT, Coleen V (2008). Climate change impacts on African rangelands. South Africa, 21 March 2008.

Huq S, Reid H, Murray L (2006). Climate Change and Development. Gatekeeper Series 123. *Int. Insti. For Environ. Dev*.

ILCA, (International Livestock Center For Africa), (1990).Livestock Systems Research Manual. Working Paper 1, Vol, 1, International Livestock Center for Africa (ILCA). Addis Ababa, Ethiopia.

IPCC (Intergovernmental Panel on Climate Change), (2007). Climate Change 2007: Impacts, Adaptation and Vulnerability. Summary for policy makers. Online at http://www.ipcc.cg/SPM13apr07.pdf

Jiri O, Mafongoya P, Chivenge P (2015). Smallholder Farmer Perceptions on Climate Change and Variability: A Predisposition for their Subsequent Adaptation Strategies. *J Earth Sci Clim Change* 6: 277. doi:10.4172/2157-7617.1000277

Kassahun D (2016). The Climate Change Impacts on Livestock Production: A Review, *Global Veterinaria 16 (2)*: 206-212.

Kassie B, Hengsdijk H, Rötter R, Kahiluoto H, Asseng S (2013). Adapting to climate variability and change: experiences from cereal-based farming in the central rift and Kobo Valleys, Ethiopia. *J Environ Manage 52*: 1115-1131.

Muna M (2006). Variations and trends in observed temperatures in the Ethiopian highlands (1973-2003). MSc. Thesis, Addis Ababa University.

Never A (2014). Possible impact and adaptation to climate change in livestock production in Southern Africa. *IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT), Volume 8*, Issue 2, Mar-April 2014.

NMA (National Meteorological Agency) (2007). Climate Change National Adaptation Program of Action of Ethiopia. Addis Ababa.

NRC (National Research Council) (1981). Effect of environment on nutrient requirements of domestic animals. Subcommittee on environment stress, National Research Council. National Academy Press, Washington DC.
Nyanga PH, Johnsen FH, Aune JB, Kalinda TH (2011) Smallholder Farmers' Perceptions of Climate Change and Conservation Agriculture: Evidence from Zambia. *J Sust Dev* 4(4): 73-85.
ONRS (Oromia National Regional State) (2011). Program of Plan on Adaptation to Climate Change. Environmental Protection Authority of the Federal Democratic Republic of Ethiopia.
Rao KP, Ndegwa W, Kizito K, Oyoo A (2011). Climate variability & change: Farmer perceptions and understanding of intra-seasonal variability in rainfall and associated risk in semi-arid Kenya. *Experimental Agriculture* 47: 267-291.
Rosenzweig C, Tubiello F, Goldberg R, Mills E, Bloomfield J (2002). Increased Crop Damage in the U.S. from Excess Precipitation under Climate Change. *Global Environ. Change*: 12(3): 197-202.
Rust JM and Rust T (2013). Climate change and livestock production: A review with emphasis on Africa. *South African Journal of Animal Science, 43 (No. 3)*.
Salami A, Kamara, Abdul B, Brixiova, Zuzana (2010). Smallholder Agriculture in East Africa: Trends, Constraints and Opportunities, Working Papers Series No. 105 African Development Bank, Tunis, Tunisia.
Shemdoe RS (2011). Tracking effective indigenous adaptation strategies on impacts of climate variability on food security and health of subsistence farmers in Tanzania. African Technology Policy Studies (ATPS) Network working paper series No.51. UNESCO.
Solomon B (2004). Assessment of Livestock Production Systems and Feed Resource Base in Sinana-Dinsho District of Bale Highlands, Southeast Oromia of Ethiopia. MSc. thesis, Haramaya University.
Thornton P, Herrero M (2008). Climate Change, Vulnerability, and Livestock Keepers: Challenges for Poverty Alleviation. In: Livestock and Global Climate Change Conference Proceeding, May 2008, Tunisia.
Thornton P, Herrero M, Freeman A, Mwai O, Rege E, Jones P, McDermott J (2007). Vulnerability, Climate change and Livestock Research Opportunities and Challenges for Poverty Alleviation. International Livestock Research Institute (ILRI), An Open Access Journal published by ICRISAT, Volume 4, Issue 1.
Thornton PK (2010). Livestock Production: Recent Trends, Future Prospects. CGIAR/ESSP Program on Climate Change, Agriculture and Food Security (CCAFS), *International Livestock Research Institute (ILRS) 365,* 2853-2867.
Thornton, PK, Jones PG, Owiyo TM, Kruska RL, Herrero M, Kristjanson P, Notenbaert A, Bekele N, Omolo A, with contributions from Orindi V, Otiende B, Ochieng A, Bhadwal S, Anantram K, Nair S, Kumar V, Kulkar U (2006). Mapping Climate Vulnerability and Poverty in Africa. Report to the Department for International Development, ILRI, Nairobi, Kenya.
World Bank (2011). Climate-Smart Agriculture: Increased Productivity and Food Security, Enhanced Resilience and Reduced Carbon Emissions for Sustainable Development. Opportunities and Challenges for a Converging Agenda: Country Examples, October, 2011.