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Research Paper

Analyzing farmer's awareness to climate change and trends of climate change in Bale Zone of Oromia National Regional State, Ethiopia

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Agriculture is the most important sector in the economy of most African countries. In Ethiopia about 83% of populations are predominantly agricultural based. However, climate change and variability poses particular risk to poor farmers who have an immediate daily dependence on climate sensitive livelihoods and natural resources. The research tries to analyze farmer's awareness to climate change and climate change trend in Bale zone of Oromia Regional state, Ethiopia. The study uses Agarfa and Sinana Woreda of Bale Zone as a case study and examines the local climatic trends of thirty consecutive years. Agarfa and Sinana woreda were randomly selected from highland Woredas' of Bale zone. Six peasant associations which are potential for cereal crop production and sensitive to the impacts of climate related risks were purposively selected from Agarfa and Sinana woreda. Finally, 396 households were participated in the study. Both qualitative and quantitative research approach were employed. The qualitative was analyzed by narrative descriptive whereas quantitative was analyzed by stata11 and time serious analyses were made. The findings of the study show that there is a gap on awareness level of the farmers for climate change. Furthermore, findings of the study reveal that the temperature of the woredas has increased with variability per year and the total annual rainfall shows variability while the spring and summer rainfall has been decreasing over the years considered. The combined effects of these two parameters (mean temperature and summer and spring rainfall) have influencing the Agarfa and Sinana Woreda's cereal crop production and productivity. Based on the research findings the researchers recommend that there should collaborative works between research institution, agricultural development enterprises, University and other organizations in awareness creation of climate change and related risks. Further, there should be focus on income diversification and coping strategies that bring sustainable solutions to overcome the problems of climate change.

Key words: Climate, climate variability, temperature, precipitation, farmers' awareness, vulnerability.

INTRODUCTION

Climate changes over the late part of the 20th century are well documented. Since 1960s, mean temperatures have increased and precipitation has become frequently variable, with extreme drought and flood events occurring with increased frequency. Global models predict future temperatures and precipitation, and generally they concluded that many region of the world will become warmer with great precipitation variation and more frequent climatic extremes (UNCCC, 2006).

Climate variability will impact global agriculture in

terms of productivity, trade commodity and food security. Climate change threatens economic development in many countries but this effect may be particular consequence in tropical climate zone where many developing countries are situated and where climatic variability is already a significant challenge to poverty alleviation. Therefore, climate changes and variability will directly and significantly affect the current and the future agriculture (White et al., 1994; Greg et al., 2010).

Different scholars believe that in developing countries like Africa particularly sub Saharan Africans agriculture are highly affected by climate change and variability such as droughts, temperature and fluctuation of rain which need high concern. For instance, the finding of Temesgen (2010) reveals that the agricultural sector in Ethiopia is dominated by small-scale crop-livestock production which is susceptible to climate change. He also stated that insufficient complementary services like credit, marketing and infrastructure are playing role for reduction of yield per hectare in Ethiopia.

The degree of vulnerability to climate change is different from country to country or region to region due to various factors. For instance, (IPCC, 2014) identified that differences in vulnerability and exposure arise from non-climatic factors and from multidimensional inequalities often produced by uneven development processes. For example people who are socially, economically, culturally, politically, institutionally marginalized are especially vulnerable to climate change and also fewer attempts made to take part in some adaptation and mitigation responses. Not only this but also discrimination on the basis of gender, educational level, and disability as well as agro-ecology they live in with respect to their livelihood activities determine the degree of vulnerability and adaptation capacity (FAO, 2010).This heightened vulnerability due to intersecting social processes that result inequalities in socio-economic status and income, as well as in exposure.

The main objective of this study was to assess farmer's awareness to climate change and trends of climate change in Bale Zone of Oromia National Regional State, Ethiopia.

MATERIALS AND METHODS

Sampling techniques and procedure

Multi stage sampling techniques were used to select sample respondents. On the first stage two Woreda (Sinana and Agarfa) were randomly selected from nine Highland Woredas of Bale Zone. On the second stage six peasant associations (three from each) were purposively selected. Finally, 396 wheat and barley producer households were selected through stratified simple random sampling.

Data collection methods

Formal sample survey method was used to collect primary data for this study. More specifically, a structured questionnaire was administered to collect primary data from selected sample households. Furthermore, Meteorological data of thirty year were collected from National Meteorological Agency. The primary data were supplemented by secondary data whenever necessary.

Data analysis methods

In this study, descriptive statistics were computed, along with climate trend analysis, and arranged in a way that allows one to quickly comprehend their meanings.

RESULTS AND DISCUSSIONS

Livelihoods and crop production trends

The survey results show that 51.52% of sampled households were relaying on cattle raring as main source of livelihoods. About 47.98 per cent of sampled households depend on crop productions. Cereal crops which account 97.47% were the main crop production activity in Sinana and Agerfa Woreda of Bale Zone. Wheat 95.96% followed by barley 3.03% were the main cereal crop production in study area (Table 1).

Trends of wheat and barley production

The survey result shows that the highest percentage of the household respondents, 85.61% estimated that trends of wheat production in past 10 years has been varies from time to time. Only 7.83% of households were perceived as trends of wheat production in past 10 years in the study area has been improved. Furthermore, 87.85% of sampled households argue that there is a decline in crop production in study area.

The survey results show that the Cause for decline in crop production were climate change and variability (90.28%), Soil infertility (6.39%), Lack of technology transfer (2.56%) and Market fluctuation (0.77%) respectively (Table 2). This finding is in line with Wondewosen (2008), Temesgen (2010), and Nigus, 2011 noted in recent times, a significant number of people in Ethiopia are being affected chronically by recurring droughts, leading to deaths and loss of assets and to an appeal for international support.

Table 1. Sample respondents Livelihoods.

Sources	Livelihoods	Frequency	Percentage
Source of income	Crop production	190	47.98
	Cattle rearing	204	51.52
	Both	2	0.51
		396	100
Main crop	Cereals	386	97.47
	Cash crop	6	1.52
	Both	4	1.01
		396	100
Main cereal	Wheat	380	95.96
	Barley	12	3.03
	Maize	4	1.01
		396	100

Table 2. Trends of wheat and barley production.

Production trends	Responses	Frequency	Percentage
Trends of wheat production in past 10 years	Improved	31	7.83
	Remained the same	12	3.03
	Varies from time to time	339	85.61
	Don't know	11	2.78
	Undetermined	3	0.75
		396	100
Decline in crop production	Yes	347	87.63
	No	49	12.37
		396	100
Cause for decline in crop production	Climate change and variability	353	89.14
	Soil infertility	25	6.31
	Market fluctuation	8	2.02
	Lack of technology transfer	10	2.53
		396	100

Table 3. Awareness for change of climate.

Sources of Information	Responses	Frequency	Percentage
Information about climate change	Yes	341	86.11
	No	55	13.89
		396	100
Extension workers	Yes	363	91.67
	No	33	8.33
		396	100
Friends	Yes	327	82.58
	No	69	17.42
		396	100
Farmers' cooperatives	Yes	220	55.56
	No	176	44.44
		396	100
Media	Yes	387	97.73
	No	9	2.27
		396	100

Poverty, limited resources, little alternative sources of income and livelihoods, lack of knowledge and expertise, and the absence of appropriate public administration and financing, increase vulnerability and decrease people's capacity to cope.

Awareness for change of climate

Farmers were asked Information about climate change. Majority of the respondents (above 86.55%) reported that they have information about climate change from different sources.

Table 4. Climate trend comparison.

Woreda	Trend type	MAPE	MAD	MSD
Sinana/Robe	Linear	**13.83**	**13.15**	**236.42**
	Quadratic	14.32	13.71	254.55
	Exponential	14.31	13.92	265.26
Agarfa	Linear	7.60	6.71	101.1
	Quadratic	10.61	12.15	206.87
	Exponential	15.62	10.24	260.87

Table 5. Parameters of annual linear trend model.

Woreda	Intercept			Slope		
	Estimate($\widehat{\beta_0}$)	SE	Pr**(>|t|)**	Estimate($\widehat{\beta_1}$)	SE	**Pr(>|t|)**
Sinana/Robe	852.56	60.83	<0.01	0.85	3.32	0.79
Agarfa	1253.64	115.72	<0.01	-13.67	6.30	**0.04**

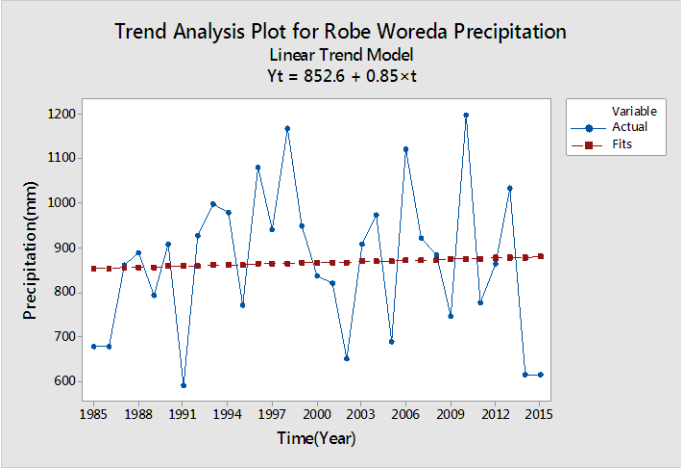
Table 6. Periodic linear trend models.

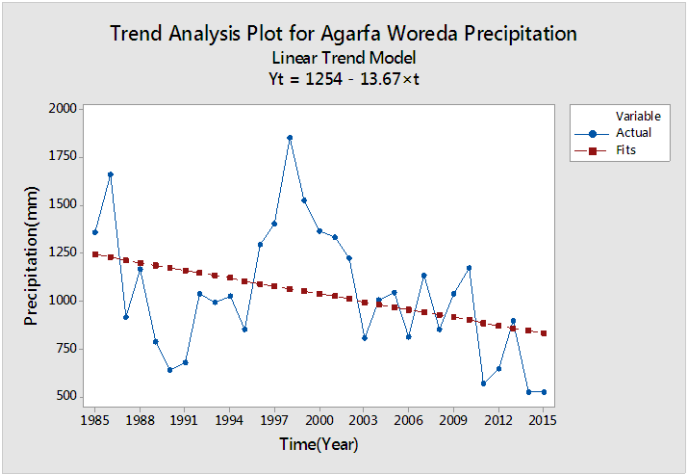
Woreda	Season	Intercept			Slope		
		Estimate($\widehat{\beta_0}$)	**SE**	**Pr(>|t|)**	**Estimate($\widehat{\beta_1}$)**	**SE**	**Pr(>|t|)**
Sinana/Robe	Winter	76.65	16.63	<0.01	-0.73	0.9	0.43
	Spring	309.72	40.21	<0.01	-0.72	2.19	0.74
	Summer	245.79	34.73	<0.01	1.2	1.8	0.51
	Autumn	217.31	23.35	<0.01	1.4	1.32	0.29
Agarfa	Winter	106.55	28.17	<0.01	-1.26	1.54	0.42
	Spring	460.19	54.17	<0.01	-7.3	2.95	**0.02**
	Summer	399.71	46.6	<0.01	-3.60	2.54	0.16
	Autumn	284.89	46.14	<0.01	-1.3	2.59	0.62

Table 7. Respondents' perceptions on changes occurred on yields due to irregularity of rainfall.

Outcome from irregularity of rainfall	Responses	Frequency	Percentage
Decline in crop yield	Yes	382	96.46
	No	14	3.54
		396	100
Food insecurity	Yes	385	97.22
	No	11	2.78
		396	100
Food price increase	Yes	392	98.99
	No	4	1.01
		396	100
Early maturity of crops	Yes	368	92.93
	No	28	7.07
		396	100
Flooding and erosion hazard	Yes	336	84.85
	No	60	15.15
		396	100

The main sources of information for climate change were extension agents which accounts more than 95%. The other sources that have been used as source of information were Friends (87.67%), farmers' cooperatives (59.78%) and different media (97.73%) (Table 3). The finding is supported by Mertz et al. (2009) noted some smallholder farmers are very aware of climatic changes and the impact these have on yields and successful production. Many farmers associate droughts and periods of prolonged heat stress with poor yields and food insecurity. Despite this awareness of climate, most farmers do not perceive climatic change





to be the biggest risk to their livelihoods and success. Thus, vulnerability of farmer is not only due to exposure and sensitivity but also due to lack of awareness on the potential impacts of climate change and variability on their activity and livelihood.

Analysis and discussion of climate data trends

This part of the study focused on analysis of secondary data such as mean maximum and minimum annual temperature, mean seasonal maximum temperature, total annual rainfall and seasonal rainfall trends analysis and interpretation. Thus, for comparison with the awareness of farmers who believe that temperature has increased and precipitation has been \fluctuated, the following sections show the actual change in temperature and precipitation as recorded by weather monitoring station in the Bale Zone.

The annual mean trend of rainfall

Trend comparison

The goodness of fit of different trends can be compared by using Mean Squared Deviation (MSD), Mean Absolute Percentage Error (MAPE), and Mean Absolute Deviation (MAD) where a trend with minimum of these measures is 'best' in describing the actual time series data. Accordingly, it can be seen that the Linear trend model describe the mean annual precipitation(Rainfall) data well compared to quadratic and exponential models for all study woredas of Bale zone.

The annual linear trend model

From the above time series plot with the estimated linear trend, for the past 3 decades, the annual mean precipitation has increased in Robe and declined in Agarfa woreda.

The change in annual mean precipitation is significant in Agarfa woredas (Table 5). Significant downward trend was identified in Agerfa woreda and on average the annual mean rainfall of Agarfa woreda decreased at a rate of 13.67mm/year. The finding is supported by Studies indicate that mean temperature and precipitation have changed over time (Table 5). For instance according to Kindie and Mulugeta, 2010 rainfall variability currently costs the Ethiopian economy over one-third of its growth potential, and it is expected to reduce the rate of economic growth by 38% per year and to increase poverty by 25% over a twelve years period. The average annual minimum temperature over the country has increased by about 0.25°C every ten years. While the average annual maximum temperature has increased by about 0.1°C every decade. The average annual rainfall of the country showed a very high level of variability over the past years ,even though the trend remained more or less constant(NMS, 2007). If the current climate trends continue Ethiopia becomes warmer and drier, the number of agricultural areas outside of tolerable crop growing conditions will increase. Due to the current climate change and variability the total number of tolerable crop growing sites in East Africa has declined by 9.8%. Furthermore, the decline in distribution sites noticeably in Zambia and southern Ethiopia (Frances, 2010).

The seasonal linear trend model

The following periodic linear trend models were fitted on mean temperature of seasons of different years to determine if there is significant trend in mean precipitation of the past consecutive 31 years of winter, spring, summer and autumn.

Table 6, shows that the mean rainfall has decreased significantly in spring season in Agarfa Woreda. The decreasing trend in seasonal precipitation is found to vary from 1.26 mm/year (Winter season Agarfa) to 7.3 mm/year (spring season Agarfa).The fitted model also show that the mean precipitation has increased in summer and autumn season in Robe Woreda. Furthermore, both the highest (1.4 mm/year) and lowest (1.2 mm/year) increase in mean seasonal precipitation were observed in Robe woreda during autumn and summer season respectively.

The researchers tried to identify respondents' perceptions on changes occurred due to irregularity of rainfall. Accordingly, 96.71% of sampled respondents understood that irregularity of rainfall result in decline in crop yield. Furthermore, taking food insecurity as parameter 97.22% of sampled respondents agree that irregularity in rainfall contributes for food insecurity of farm households. The survey results also reveal that food price increase (98.99%), early maturity of crop (92.93%) and flooding and erosion hazard (84.85%) were aggravated by irregularity of rainfall in study area (Table 7). This finding is supported by Frances et al. (2010) and GIZ (2010) who argues that ecology precipitation and water availability is central to agriculture, with productivity being optimal at a particular water balance. If this is decreased (towards drought) or increased (towards saturation), then productivity would decrease. The global average precipitation is projected to be highly variable with certain regions experiencing prolonged droughts and/or extensive heavy rainfall. Such changed precipitation patterns are expected to greatly impact agriculture, in terms of yield, distribution of crops across the landscape, opportunities for new crops and the expansion of marginal agricultural practice.

CONCLUSION AND RECOMMENDATION

Awareness of farmers on long term climatic trends and consequences are low and one of the challenges in implementing adaptation and coping strategies is to raise awareness of climate impacts and the potential risks for crop producers. The impacts of climate change and fluctuation is exacerbated by lack of adaptation, awareness and commitment from both farmers and local institutions. Since farmers are prioritizing their immediate benefits rather than sustainable development. Almost half of communities still were not clearly identify the cause and long term consequences of climate change and variability on their activity and livelihood. Therefore, although majority of the respondent farmers were aware that climate is changing depending on their farming experience and indigenous observation of weather and climate, raising awareness on the implications of climate change and sustainable coping strategies and adaptation options will be needed.

The finding indicates that temperature is increasing whereas rainfall shows fluctuation in the study area. The impacts of increasing temperature and decreasing with great fluctuation observed on cereal crop productivity. Using seasonal climatic variables a linear regression model was developed and able to account for much of the variation in cereal crop yields. The decline and fluctuation of productivity significantly associated with spring and summer rainfall and mean annual temperature. Therefore, government agency has to give due attention and give awareness to the farming community to arrange their cropping time as early as possible.

The change in temperature and fluctuation in rainfall also alter pests and disease pressures and hence, farmers will need to adapt their management practices. Crop berry borer, wilting and fungal manifested in the study area recently benefited from higher temperature. Furthermore, the interview result revealed that increasing temperature adversely results in abnormalities within leaves, stems, flowers or plants and reducing crop yields and quality in the study area. Therefore, government organization and other agency working on agriculture have to give due attention in reducing risks that will be emerged from change of climate and related risks.

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