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Determinants of Agro-pastoralist Climate Change Adaptation Strategies: Case of Rayitu Woredas, Oromiya Region, Ethiopia

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ABSTRACT

This study analyzed determinants of pastoralist climate change/variability adaptation strategies in Rayitu woreda using a binary logistic regression model fitted to data from a cross-sectional survey collected in 2013. The study kebele was identified purposively due to reasons of accessibility to socioeconomic resource, natural resource, frequency of climate related hazard. A proportional size method (10%) of the total population was used to determine 155 sample respondents. Systematic random sampling was employed to select respondents from the Kebele for interview. This study presents result of significant association between household size, level of education, assets, land holdings, access to credit and extension service, cattle and shoat ownership, annual income with climate change adaptation strategies. The results showed that temporal migration, livestock mobility, herd diversification, rearing of shoats rather than cattle,shifting to crop production, herd splitting, tree planting, practicing non-farm activities, changing planting date, planting tree and use irrigation were identified as the most practiced types of climate change adaptation strategies. The model analysis revealed that access to credit services ($p<0.01$, 238), access to extension services ($p<0.01$, 1.73); annual income farm and no-farm sources ($p<0.05$, 1.00), land ownership ($p<0.01$, 2.32), household head sex ($p<0.01$, 0.10) and level of education ($p<0.01$, 4.45) were influential factors to any of climate change adaptation strategies. In view of the above findings, it could be suggested that interventions and development efforts should take these determinant factors into consideration to make climate change adaptation strategies effective and ultimately contributes to the general sustainable development.

Key words: Climate change, adaptation strategies, Rayitu woreda

INTRODUCTION

Global climate change induced by increased greenhouse gas concentration has been widely accepted by the international community (IPCC, 2007a). Scientists observing the global climate show, a collective picture of a changing climate and a warming world. The global mean surface air temperature has increased by 0.6°C over 20th century (IPCC, 2007b). It is projected to rise between 1.4-5.8°C by 2100 depending largely on the level of fossil-fuel combustion. Most of the observed increase in temperature will likely be due to the increase in anthropogenic greenhouse gas concentrations (IPCC, 2007a). Besides to temperature increase of some 1-2.5°C by 2030, it is

predicted that during this period, billions of people, particularly those in developing countries will face changes in rainfall patterns and extreme events such as severe water shortages, droughts or flooding.

The extent of climate change effects on individual regions vary over time and with the ability of different societal and environmental systems to mitigate or adapt to change. The East African region is considered in several climate analyses that it will be drier, with reduction in the length of the growing season. Maping of vulnerability to climate change of Africa has put Ethiopia as one of the most vulnerable and with the least capacity to respond (Thornton *et al*., 2006). Ethiopia is highly vulnerable to drought which is the most important climate related natural hazard impacting the country from time to time. Drought occurs anywhere in the world but its damage is not as severe as in Africa in general and in Ethiopia in particular. The other climate related hazard that affects Ethiopia from is flood. The reason why Ethiopia is vulnerable to climate change is, because of its greater reliance on climate sensitive economic sector like subsistence crop cultivation and livestock production. Studies of national climate trends from the 1960s shows temperature in Ethiopia have increased by 0.5-1.3°C and it is predicted to increase by 0.9-1.1°C in 2030, 1.7-2.1°C by 2050 and 2.7-3.4°C by 2080 over compared to the 1961-1990 normal (NMA, 2007).

More than 10 million people of Ethiopia are pastoralists (CSA, 2008), herding their livestock in the arid and semi-arid lowlands that constitute about 61% of the country's land mass (MARD, 2008). These areas are prone to rainfall variability, extreme drought and flash floods. In pastoral areas of Ethiopia, climate change increased the burden of those who are already poor and vulnerable by affecting their livelihood pattern and strategies and triggering food, feed, water and social insecurity. In the pastoral systems which are reliant on rainfall as the source of pasture growth, seasonal rainfall variability is inevitably mirrored in both highly variable production levels as well as risk averse livelihood and coping strategies that have emerged overtime amongst the rural population (Cooper *et al*., 2008). In general the pastoralists have experienced devastating droughts and their strategies based on centuries of exposure to the droughts are not working due to partly an inability to implement them. It is likely that the nature of the climate variability that pastoralists are used to dealing with will itself change adding new variability to the system (IPCC, 2001).

Drought and livestock disease which are climate related hazards recurrently affecting the Rayitu woreda pastoralist. Due to recurrent drought the woreda is facing with water shortage for both human and livestock consumption. Rayitu woreda is known to be chronically food insecure mainly drawn from climate change related calamities. Due to this, the woreda has been targeted by the PSNP (Productive Safety Net Program), hence, very poor and poor households' access food and income through the program. This food aid is also contributes 5-15% of annual food requirements for very poor and poor households (LIU, 2008). Alike other parts of the pastorals community Raytu pastoralist are highly dependent on livestock production and on the availability of natural resources such as water and pasture which has been repeatedly explained to be affected by frequent drought which left their livelihood in problem recurrently.

Moreover, the changes have had serious impacts on the livestock rearing and crop production. For instance, in Borana zone the average number of livestock per household has declined from 10 oxen, 35 cows and 33 goats 20 years ago to 3 oxen, 7 cows and 6 goats in 2010 (Amsalu, 2010). In general, the impact of climate change is pronounced in pastoralists, as the livelihood system by itself relies on the basic natural resources such as water and pastures. The mechanisms used by pastoralists to cope with high climatic variability include moving their livestock and families,

keeping different animal species and within species, sometimes different type of animals making reciprocal arrangements with other pastoralist groups for access to pasture and water, developing water conservation technique, observing early warning signs of impending drought and practicing complementary livelihood activities (McKee, 2008).

Rayitu woreda is one of the pastoralist woreda in Bale administrative zone which has typically experienced drought since the 1991. Since very recently, drought has become more frequent and more disastrous compared to that of previous decades. However, there is no any systematic study that has been carried out in identifying and analyzing the determining factors for climate change adaptation strategies of pastoralist in Raytu woreda. It is with this motivation that the researcher motivated to conduct the research at the pastoralist community of Rayitu woreda. Therefore, this study aims to investigate the constraint factors which influence the adaptation strategies of pastoralist in the study area which is essential for designing incentives to enhance private adaptation.

MATERIALS AND METHODS

Description of the study area: The study was conducted in Rayitu woreda, in Bale zone, south eastern Ethiopia (Fig. 1). It covers an area of about 6139.39 km^2 of land. It is bordered by Sewena and Ginir woredas in the north, Sewena woreda in the east, Goro in the west and Somali Regional State and Goro woreda in the south. The northern and Southern tips are dominated by mountainous terrain while the remaining part of the woreda is flat plain land. Wabi Shebele, Weyib and Dinikte are the well known perennial rivers bordering the woreda. About 5% of the woreda is semi desert, 90% is tropical and 5% is sub-tropical agro-climatic zone.

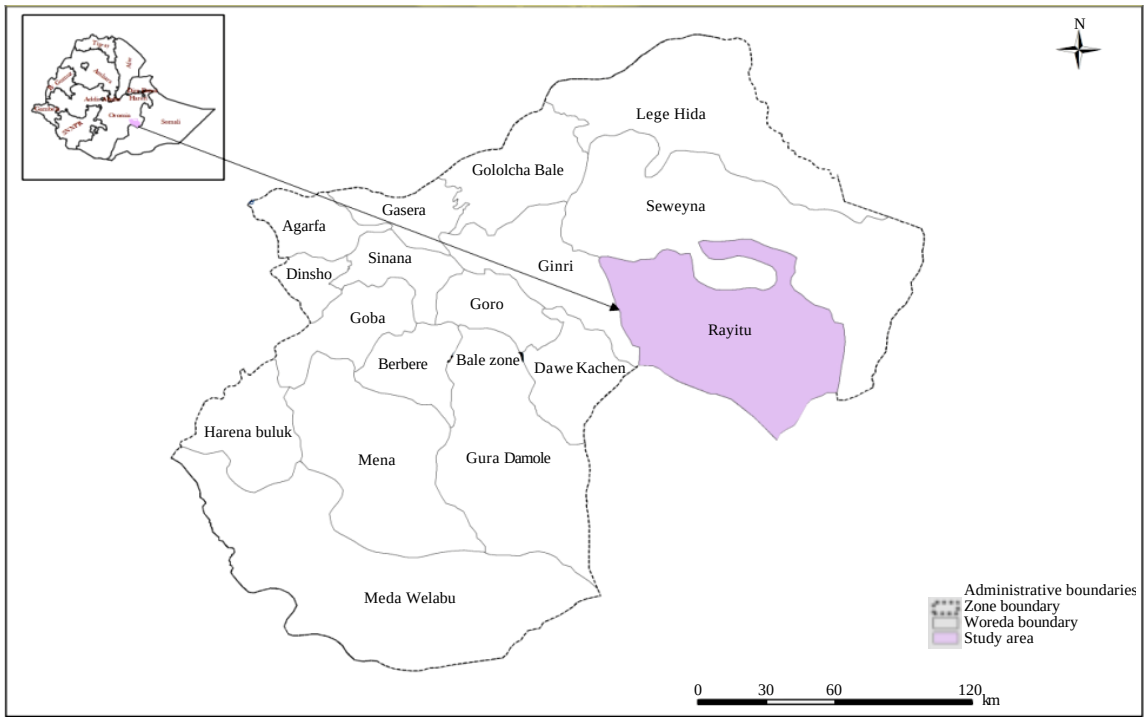

Fig. 1: Map of the study area and selected sampling sites

The rainfall pattern is bimodal with erratic distribution; the main rainy season extends from March to end of June and the short rainy seasons usually extending from September to end of October. The production system in the woreda is pastoral (PADS, 2004). The district is dominated by hot, dry climate and is considered pastoral area. The area experience hot climatic condition with mean annual temperature of 26°C and a maximum of 40°C and the average annual rainfall is less than 300 mL. The woreda lies within an altitudinal range between 500-1,785 m.a.s.

Sampling procedure: The primary data was obtained through administration of structured questionnaire on pastoralist in the study area. Sampling woreda and Kebele were selected purposively in consultation with the concerned bodies based on the accessibility to natural resource and frequency of climate related hazard. A sample sizes of 241 were pre-determined using scientific formula (Yamane, 2001). However, due to financial and transport limitation 155 sample were collected from one Kebele. Systematic random sampling technique used to select the households in which every k-th subject on a list of selected households for inclusion in the overall sample. The "K" refers to the sampling interval and that was every 4th (K = 4) households. The value of K is determined by dividing total households in the kebele N = 647 (male = 447, female = 200) by the sample size:

$$\text{Sample size (n)} = \frac{N.t^2 \times p.q}{d^2N + t^2 \times p.q}$$

Where:

N = Number of household in Gurrura kebele in Rayitu woreda
t = Number which is the required confidence interval (for 95% CI, t = 1.96)
p = Probability for and event to occur (the rate of population choose that particular adaptation strategies p = 0.5)
q = Possibility for an event not to occur (the rate of population not choose that particular adaptation strategies q = 0.5)
d = An acceptable error rate during sampling (0.05 again associated with 95% CI)

Methods of data collection

Household survey: A cross-sectional interview survey was conducted among households selected by using systematic random sampling technique. Of the 19 Kebeles in the Woreda, Gururra Kebele was purposively selected by the pattern of the accessibility to natural resources and occurrence of climate related hazard. A total of 155 households were selected to collect information about the constraints to adapt the changes and relevant adaptation strategies in the study area.

Focus group discussion: Two focus group discussions comprising twelve participants in mixed gender and age groups were achieved. Focus group discussions were made to clarify the subjective issues and to benefit from the group interactions in getting further insight on the determinants of climate change adaptation strategies.

Key informant interview: A total of four Key informant interviews were conducted with specific members of the government bodies like Development agency, Kebele leaders and head of pastoral office (Woreda Disaster Prevention and Preparedness Bureau) and local and international NGOs

staffs in the woreda. A check-list of questions was used to guide and narrow the discussions to relevant issues around the main research questions. They were therefore well placed to understand community norms and culture and kinship and social-economic systems and structures that bound the community. These individual interviews were taken in-depth approach where by the respondents freely discussed the determinants factors which influence adaptation strategies.

Methods of data analysis: Data were analyzed using Statistical Package for Social Science (SPSS) version 16.0. Correlation analysis was used to analyze the association between independent and dependent variables. The hypothesized explanatory variables were checked for the existence of multi-collinearity problem. Variance Inflation Factor (VIF) for association among the continuous explanatory variables and contingency coefficients for dummy variables are the two measures used to check multi-collinearity problem. Binary Logistic regression model was used to analyze the determinant factors on pastoralist the climate change adaptation strategy (Gujarati, 2004).

$$\log (Pi/1-Pi) = \text{Log } (Pi) = \beta_0+\beta_1 X_i \quad (1)$$

where, Pi is the probability of choosing climate change adaptation strategy and Xi is predictor variable. Therefore, the parameter β_0 gives the log odds of the dependent variable.

The probability of occurrence of an event relative to nonoccurrence is called odds ratio and given by:

$$Pi/(1-Pi) = \exp(\beta_0+\beta_1 x_i) \quad (2)$$

Or in terms of the probability of the outcome (e.g., household choosing climate change adaptation strategies) occurring as:

$$Pi = \exp(\beta_0+\beta_1 x_i)/(1+\exp(\beta_0+\beta_1 x_i)) \quad (3)$$

Conversely the probability of the outcome not occurring is:

$$1-Pi = 1/(1+\exp(\beta_0+\beta_1 x_i)) \quad (4)$$

RESULTS AND DISCUSION

Demographic dimension: Hypothetically, there was an assumption that demographic characteristics would affect the households' climate change adaptation in the woreda. The correlation analysis reported that there was negative relationship between the household age and level of education at $p<0.01$ level of significance (Table 1). Similarly, there has been a negative association between household number of family size and level of education at $p<0.05$% level of significance. In the same token, household head sex has strong positive correlation with level of education at $p<0.01$. Obviously, household level of education is believed to be a very important indicator of human capital which could have a pivotal role to attain other type's assets in the household (DFID, 1999). Level of education as a demographic variable, showed significant positive association with the household choice of climate adaptation strategies which are herd diversification, livestock mobility, temporal migration and rearing of sheep and goat rather than cattle ($p<0.05$) (Table 1).

Table 1: Correlation analysis of pastoralist demographic characteristics and their climate change adaptation strategies

Parameters	Gender	Age	Level of education	No. of families	Composition of member of HH	Herd diversification	Livestock mobility	Use shoat rather than cattle	Engaging in crop production	Temporal migration
Gender										
Pearson correlation	1									
Sig. (2-tailed)										
Age										
Pearson correlation	0.117	1								
Sig. (2-tailed)	0.149									
Level of education										
Pearson correlation	0.368**	-0.178*	1							
Sig. (2-tailed)	0.000	0.026								
No. of families										
Pearson correlation	0.125	0.116	-0.190*	1						
Sig. (2-tailed)	0.123	0.149	0.018							
Age composition of member of HH										
Pearson Correlation	0.062	0.445**	0.043	-0.063	1					
Sig. (2-tailed)	0.445	0.000	0.599	0.433						
Herd diversification										
Pearson correlation	0.389**	-0.027	0.454**	-0.023	-0.127	1				
Sig. (2-tailed)	0.000	0.743	0.000	0.779	0.114					
Livestock mobility										
Pearson correlation	0.541**	0.055	0.227**	0.071	0.110	0.235**	1			
Sig. (2-tailed)	0.000	0.498	0.004	0.379	0.173	0.003				
Use sheep and goat rather than cattle										
Pearson Correlation	0.390**	-0.016	0.176*	0.025	0.014	0.231**	0.434**	1		
Sig. (2-tailed)	0.000	0.848	0.028	0.761	0.859	0.004	0.000			
Engaging in crop production										
Pearson correlation	-0.020	-0.082	-0.085	0.036	-0.104	-0.084	0.104	0.113	1	
Sig. (2-tailed)	0.803	0.312	0.291	0.654	0.199	0.296	0.198	0.161		
Temporal migration										
Pearson correlation	0.390**	0.008	0.251**	-0.070	0.155	0.231**	0.623**	0.441**	-0.059	1
Sig. (2-tailed)	0.000	0.919	0.002	0.388	0.054	0.004	0.000	0.000	0.463	

In the case of this study the correlation result of age has not significant association with any of adaptation strategies. Gender positively correlate with herd diversification, rearing of sheep and goat rather than cattle, temporal migration and livestock mobility adaptation strategies at $p<0.01$ level of significant (Table 1). Similarly, De Groote and Coulibaly (1998) and Gbetibouo (2009) report the lesser access of women to critical resources (finical asset and natural asset like livestock, cash, labor and land) which often undermines their ability to carry out labor intensive agricultural innovations.

Livelihood asset dimension: Hypothetically, there was an assumption that livelihood asset would affect the choices of climate change adaptation strategies of households in the woreda. All variables which are under five livelihood assets (human, natural, social, financial and physical assets) discussed under this dimension. The households total land holding which was classified under natural asset, had strong positive correlation to households using crop production as climate change adaptation measures at $p<0.01$ significance level (Table 2).

The study revealed that access to livestock and crop agriculture service has not any significant association to choice of climate change adaptation except it has a positive association with problematic months for pasture availability and a negative association to access to veterinary service at $p<0.05$ level of significant (Table 2). However, it was hypothesized that pastoralist who has significant extension contacts have better chances to be aware of changing climatic conditions as well as adaptation measures in response to climatic changes. It is because the community who has information on climate change through extension agent can well mange pasture utilization and diversify their income. Moreover, Maddison (2006) report that access to information on climate change through extension agents or other sources creates awareness and favorable condition for adaptation of farming practices that are suitable under climate change. As it is deployed in Table 2 temporal migration and engaging on crop production choices of climate change adaptation strategies had negative correlation with household road accessibility at $p<0.05$ level of significant.

Herd diversification had strong relationship with number of sheep, goat and cattle owning and household annual income ($p<0.05$) (Table 3). This is because pastoralists diversify their livestock species to effectively utilize the scared pasture and to increase their annual income. Indeed, herd diversification adaptation measure is possible through maintaining mixed herds which can withstand different climate and ecological conditions (Toulmin, 1994). However, as it is clearly stated in Table 3 herd diversification choice of adaptation strategies was negatively associated with access to saving at $p<0.01$ level of significant. Pastoral mobility refers to the time space behavior of herds and their handler in response to variations in pasture and the distribution of water. Livestock mobility has a positively correlated with household number of cattle and goats owner, annual income and access to market ($p<0.05$) (Table 3). In addition, herd diversification and livestock mobility strongly related in the study area at $p<0.01$.

The choice of sheep and goat was strongly correlated with the herd diversification at $p<0.01$ but cattle were not (Table 3). Similarly the rearing of shoat rather than cattle, had significant relationship with households whose source of annual income was non-farm and farm and number of cattle owners ($p<0.05$). This might be due to recurrent drought is causing the depletion of water sources and causing an overall decline in livestock production. As pasture condition deteriorated over the years, agro-pastoral communities shifted from fewer cattle to more camel production with shoats to sustain subsistent households' income (Belay and Sugulle, 2011).

Table 2: Correlation analysis of the physical, social, natural and human assets with their climate change adaptation strategies

Parameters	Access to agri extension service	Land own	Distance to water	Pasture availability	Road accessible	Access to health care	Access to vet. service	Food aid assistance	Climate change info source	Herd diversification	Livestock mobility	Use shoat rather than cattle	Engaging in crop production	Temporal Migration
Access to agri extension service														
Pearson correlation	1													
Sig. (2-tailed)														
Land own														
Pearson correlation	-0.037	1												
Sig. (2-tailed)	0.646													
Distance water														
Pearson correlation	-0.109	0.069	1											
Sig. (2-tailed)	0.175	0.395												
Pasture availability														
Pearson Correlation	0.182*	0.012	0.259**	1										
Sig. (2-tailed)	0.026	0.881	0.001											
Road accessible														
Pearson correlation	-0.150	-0.015	0.165*	-0.072	1									
Sig. (2-tailed)	0.062	0.858	0.040	0.382										
Access to health care														
Pearson correlation	-0.098	0.041	-0.161*	-0.017	0.255**	1								
Sig. (2-tailed)	0.225	0.611	0.045	0.838	0.001									
Access to vet. service														
Pearson correlation	-0.181*	-0.080	0.013	-0.313**	0.501**	-0.207**	1							
Sig. (2-tailed)	0.024	0.319	0.868	0.000	0.000	0.010								
Food aid														
Pearson correlation	-0.050	-0.097	0.092	-0.122	0.178*	-0.051	0.129	1						
Sig. (2-tailed)	0.533	0.229	0.255	0.137	0.027	0.525	0.110							
Climate change info source														
Pearson correlation	0.152	0.163	-0.063	0.015	-0.060	0.041	-0.004	-0.007	1					
Sig. (2-tailed)	0.103	0.080	0.503	0.875	0.521	0.661	0.967	0.943						
Herd diversification														
Pearson correlation	-0.027	-0.040	-0.084	-0.057	-0.071	0.079	-0.130	0.024	-0.155	1				
Sig. (2-tailed)	0.740	0.618	0.301	0.485	0.378	0.330	0.107	0.770	0.097					
Livestock mobility														
Pearson correlation	-0.011	0.147	0.179*	0.114	0.133	-0.080	-0.164*	0.133	0.123	0.235**	1			
Sig. (2-tailed)	0.889	0.067	0.025	0.165	0.100	0.325	0.041	0.098	0.188	0.003				

Table 2: Continue

Parameters	Access to agri extension service	Land own	Distance to water	Pasture availability	Road accessible	Access to health care	Access to vet. service	Food aid assistance	Climate change info source	Herd diversification	Livestock mobility	Use shoat rather than cattle	Engaging in crop production	Temporal Migration
Use shoats rather than cattle														
Pearson correlation	-0.042	0.040	0.042	-0.058	0.084	0.058	-0.151	-0.098	0.129	0.231**	0.434**	1		
Sig. (2-tailed)	0.603	0.623	0.604	0.479	0.298	0.471	0.061	0.225	0.167	0.004	0.000			
Engaging in crop production														
Pearson correlation	0.087	0.223**	-0.012	0.132	-0.188*	0.105	-0.193*	0.219**	0.110	-0.084	0.104	0.113	1	
Sig. (2-tailed)	0.284	0.005	0.883	0.106	0.019	0.195	0.016	0.006	0.242	0.296	0.198	0.161		
Temporal migration														
Pearson correlation	0.060	0.103	0.034	-0.058	0.164*	-0.090	-0.042	0.167*	0.139	0.231**	0.623**	0.441**	-0.059	1
Sig. (2-tailed)	0.455	0.204	0.670	0.479	0.042	0.264	0.600	0.038	0.137	0.004	0.000	0.000	0.463	

Table 3: Association of pastoralist financial assets with their climate change adaptation strategies

	No. of cattle you owned	No. of camel you owned	No. of goats you owned	No. of sheep you owned	Annual income	Access saving	Access to credit	Access t to market	Herd diversification	Livestock mobility	Use shoat rather than cattle	Engaging in crop production	Temporal Migration
No. of cattle you owned													
Pearson correlation	1												
Sig. (2-tailed)													
No. of camel you owned													
Pearson correlation	0.128	1											
Sig. (2-tailed)	0.113												
No. of goats you owned													
Pearson correlation	0.511**	0..251**	1										
Sig. (2-tailed)	0.000	0.002											
No. of sheep you owned													
Pearson correlation	0.239**	0.125	0.437**	1									
Sig. (2-tailed)	0.003	0.120	0.000										
Annual income													
Pearson correlation	0.295**	0.135	0.247**	0.118	1								
Sig. (2-tailed)	0.000	0.094	0.002	0.144									
Access to saving													
Pearson correlation	-0.104	-0.124	-0.259**	0.020	0.050	1							
Sig. (2-tailed)	0.197	0.125	0.001	0.809	0.537								
Access to credit													
Pearson correlation	0.069	0.083	0.256**	0.034	0.081	-0.426**	1						
Sig. (2-tailed)	0.393	0.307	0.001	0.677	0.319	0.000							
Access to market													
Pearson correlation	0.072	0.159*	0.068	0.108	0.067	0.035	0.166*	1					
Sig. (2-tailed)	0.373	0.049	0.398	0.181	0.407	0.663	0.038						
Herd diversification													
Pearson correlation	0.164*	-0.007	0.262**	0.255**	0.226**	-0.242**	0.149	-0.023	1				
Sig. (2-tailed)	0.041	0.929	0.001	0.001	0.005	0.002	0.064	0.780					
Livestock mobility													
Pearson correlation	0.308**	0.146	0.273**	0.147	0.191*	-0.036	0.063	0.171*	0.235**	1			
Sig. (2-tailed)	0.000	0.070	0.001	0.067	0.017	0.660	0.440	0.033	0.003				
Use shoat rather than cattle													
Pearson correlation	0.174*	-0.011	0.115	0.048	0.212**	0.023	-0.004	0.087	0.231**	0.434**	1		
Sig. (2-tailed)	0.030	0.888	0.154	0.552	0.008	0.774	0.959	0.283	0.004	0.000			
Engaging in crop production													
Pearson correlation	-0.117	-0.069	0.016	-0.038	-0.018	0.101	-0.020	0.132	-0.084	0.104	0.113	1	
Sig. (2-tailed)	0.146	0.396	0.840	0.638	0.819	0.211	0.807	0.102	0.296	0.198	0.161		
Temporal migration													
Pearson correlation	0.255**	0.104	0.172*	0.177*	0.148	0.023	-0.031	0.144	0.231**	0.623**	0.441**	-0.059	1
Sig. (2-tailed)	0.001	0.196	0.032	0.028	0.066	0.774	0.698	0.075	0.004	0.000	0.000	0.463	

Temporal migration to highland area is one of the most common coping strategies practiced by pastoral and agro-pastoral communities during the drought period in the study area. This climate change adaptation strategy was positively and strongly correlated with the number of cattle, sheep and goats owners ($p<0.05$) (Table 3).

Determinants of pastoralist climate change adaptation strategies: The Variance Inflation Factor (VIF) values have shown that all the continuous explanatory variables have no serious collinearity problem among the continuous independent variable because of VIF value was less than 3. The values of the contingency coefficients were also less than 0.5 which told us the weak association between variable. Based on these tests, both the hypothesized continuous and dummy variables were included into the model.

The study employed binary logistic regression analysis to test significance of the covariate and dummy dependents in the model for each dependent variable (adaptation strategies). For analysis purpose, the study considered two generic dimensions categories of independent variables. The first dimension was household characteristics such as; sex, age, education level, age composition of household member and family size. The second dimension was livelihood assets like access to climate information, average landholding, access to veterinary service, access to health, access to agricultural extension service, access to saving and credit, average annual income, number of livestock holding, access to market and road accessibility.

The results showed that access to climate information, sex, household age composition, access to food aid, education level, annual income, land holding and access to saving and credit were statistically significant ($p<0.05$) for most of the dependent variables (Table 4).

Gender: Gender was one of the hypothesized dummy variables affecting the climate change adaptation strategies of the pastoral community. Men and women have different roles in the production and management of farming practices and in turn differently affected by climate change.Their responses to climate change have also been affected by different factors. As indicated in Table 4 there is significant difference between male and female in choosing the climate change adaptation strategies. The study entails that female were found to be less likely to choose moving temporarily from their place compared to male (β = -2.296, $p<0.05$). Similarly, females found to be less likely in diversifying herd (β = -3.446, $p<0.05$) and making livestock mobility (β = -8.862, $p<0.001$) at times of climate related shocks. Inline to these findings, Deressa and Hassan (2009) study results indicated that male-headed households adapt more readily to climate change. Male-headed households were more likely to conserve soil (9%), to change crop varieties (11.6%) and to plant trees (10%). The higher adaptation of male headed households than female headed households to climate change by switching from mono-cropping to irrigation, multiple cropping and mixed systems were reported by Hassan and Nhemachena (2008). In the same token, the research conducted by Kebede and Adane (2011) entails that there is significant difference between the sexes in the use of irrigation, change in planting date, rearing of sheep and goats rather than cattle, herd splitting and herd diversification as adaptation strategies. In addition, Yesuf *et al.* (2008) showed that gender is one of the major determinant factors to household climate change adaptation strategies. On the other hand female farmers have been found to be more likely to adopt natural resource management and conservation practices (Dolisca *et al.*, 2006; Bayard *et al.*, 2007).

Table 4: Determinants of pastoralist's climate change adaptation strategies

	Dependent variable														
	Temporal migration			Herd diversification			Livestock mobility			Sheep and goat rather than cattle			Engage crop production		
Independent variable	B	Sig	Exp (B)	B	Sig	Exp (B)	B	Sig	Exp (B)	B	Sig	Exp (B)	B	Sig	Exp (B)
HR2 (1) Gender	-2.30	0.05	0.10	-3.45	0.04	0.03	-8.86	0.01	0.00	-0.67	0.60	0.51	0.30	0.80	1.35
HR3 Age	0.00	0.93	1.00	-0.08	0.19	0.93	-0.02	0.76	0.98	-0.04	0.27	0.97	-0.04	0.19	0.96
HR4 level of education	0.55	0.81	0.45	0.55	0.05	4.45	2.45	0.09	4.23	2.56	1.00	4.67	2.89	0.99	1.00
HR4 (1) illiterate	-21.68	1.00	0.00	-30.14	1.00	0.00	-27.42	1.00	0.00	-22.54	1.00	0.00	-19.16	1.00	0.00
HR4 (2) primarily	-22.70	1.00	0.00	-24.57	1.00	0.00	-31.79	1.00	0.00	-22.64	1.00	0.00	-18.83	1.00	0.00
HR4 (3) technical/ vocational	-7.05	1.00	0.00	-39.61	1.00	0.00	-12.72	1.00	0.00	-4.59	1.00	0.01	-3.78	1.00	0.02
HR5 family size	-0.34	0.07	0.72	-0.37	0.12	0.69	0.06	0.82	1.06	-0.01	0.94	0.99	-0.08	0.59	0.93
HR6 (1) age composition (1-15 years old)	0.64	0.62	1.89	-0.56	0.74	0.57	-0.16	0.94	0.85	-0.65	0.60	0.52	-1.92	0.16	0.15
SE1 main source of income		0.11			0.18			0.29			0.01			0.12	
SE1 (1) pastoral	0.93	0.66	2.54	-4.85	0.18	0.01	3.40	0.55	29.92	-19.58	1.00	0.00	1.99	0.30	7.35
SE1 (2) agro pastoral	-1.29	0.53	0.28	-2.53	0.53	0.08	0.18	0.98	1.19	-22.42	1.00	0.00	3.73	0.07	41.71
SE6 access to agi. extension	0.55	0.03	1.73	0.26	0.28	1.30	0.63	0.02	1.88	0.49	0.65	1.63	0.17	0.35	1.19
LN (landholding)	0.10	0.62	1.10	-0.92	0.05	0.40	0.17	0.62	1.18	0.08	0.67	1.09	0.84	0.00	2.32
SE91 (Noof cattle)	0.61	0.07	1.84	-0.25	0.57	0.78	1.60	0.02	4.97	0.21	0.40	1.24	0.03	0.89	1.03
SE92 (No. of camel)	0.96	0.14	2.61	-1.84	0.04	0.16	2.90	0.12	18.22	0.00	0.99	1.00	-0.38	0.24	0.69
SE93 (No. of goat)	0.21	0.29	1.23	0.60	0.02	1.82	-0.38	0.19	0.69	0.03	0.83	1.03	0.13	0.42	1.14
SE94 (No. of sheep)	0.28	0.52	1.32	1.32	0.06	3.72	0.22	0.59	1.25	-0.03	0.91	0.98	-0.10	0.73	0.90
SE10 (distance to domestic water)	0.10	0.47	1.11	0.08	0.62	1.08	0.18	0.45	1.19	-0.07	0.49	0.94	-0.16	0.23	1.35
SE501 (Radio)	-0.34	0.70	0.71	2.46	0.15	11.68	1.77	0.32	5.87	0.65	0.55	1.91	-1.35	0.82	0.69
SE504 (mobile)	1.04	0.25	2.84	-3.31	0.03	0.04	2.91	0.10	18.34	0.34	0.68	1.40	-0.17	0.14	0.26
SE26 (annual income)	0.00	0.10	1.00	0.00	0.04	1.00	0.00	0.48	1.00	0.00	0.61	1.00	0.00	0.05	1.00
SE27 (access to saving)	1.33	0.28	3.79	6.25	0.03	515.47	-2.42	0.21	0.09	0.25	0.81	1.28	1.78	0.14	5.94
SE31 (access to credit)	1.65	0.15	5.22	5.47	0.02	238.23	1.35	0.46	3.85	-0.65	0.50	0.52	0.27	0.77	1.31
SE17 (2) (December to February)	-2.38	1.00	278200	-12.02	0.01	0.00	-0.71	0.87	0.49	3.00	0.13	20.00	3.04	0.35	1229.04
SE51 (access to food aid)	0.17	0.93	1.19	0.41	0.21	-1.58	-3.44	0.13	0.03	3.00	0.01	20.00	-2.95	0.04	0.05
CCV5 (info source)		0.23			0.66			0.92			0.77			0.79	
CCV5 (1) (radio)	-17.32	1.00	0.00	13.02	1.00	451588.94	15.80	1.00	7252788.39	-20.42	1.00	0.00	-23.27	1.00	0.00
CCV5 (2) (cell phone)	-14.05	1.00	0.00	11.87	1.00	142297.52	16.57	1.00	1577	-21.38	1.00	0.00	-23.85	1.00	0.00
CCV5 (3) (government official)	-17.32	1.00	0.00	10.70	1.00	44208.49	16.90	1.00	2186	-21.44	1.00	0.00	-22.48	1.00	0.00
Constant	7.09	1.00	1204.55	55.02	1.00	782200	-0.18	1.00	0.83	82.67	1.00	80260	46.08	1.00	1.032E20

Age of household head: In relation to the age of the household head, the findings were not in line with the prior expectations. The study presented that the household age was not significant to choose any types of the climate adaptation strategies. However, as the age of the household head increased, the person expected to acquire more experience in weather forecasting and that helps to increase in likelihood of practicing different adaptation strategies to climate change (Tazeze *et al.*, 2012). Moreover, study conducted by Kebede and Adane (2011), reported the significant relationship of farmer age and experience in use of crop variety selection, livestock mobility, herd diversification, tree planting and use of water harvesting schemes.

Access to food aid: In this study, the majority of respondents (89.7%) have an access to food aid. Those households who have access to food aid were statistically significant to choose rearing of sheep and goat rather than cattle types of climate change adaptation strategies ($\beta = 2.996$, $p<0.01$). On the other hand, the households who received food aid were less likely to be engaging in crop production adaptation strategies by 5.2% compared with the household who doesn't received aid ($\beta = -2.949$, $p<0.05$). In contrary to this finding, Bryan *et al.* (2009) stated food and other aid as significant determinants of changing crop varieties.

Education level: Majority of the respondents were illiterate. Only 38.06% attended primary education and above. As indicated in the Table 4 the overall level of education came to be one of the significant variable that affect decision to herd diversification among households ($p<0.05$).This is because higher education was more likely to expose farmers to any available information on climate change. Education was likely to enhance the household's ability to receive, decipher and comprehend information relevant to making innovative decisions in their farmers and about their livestock status. Similar to this result, research conducted by Deressa and Hassan (2009), Yesuf *et al.* (2008) and Kebede and Adane (2011) reported that education increases the probability of adapting to climate change. However, Mandleni and Anim (2011) revealed the significant and negative effect of education on awareness of pastoralist to climate change and didn't have any significant effect on adaptation.

Access to credit: Majority of the respondents (57.4%) have no access to credit. The present study shows that access to credit shows a significance difference to adapt herd diversification as climate change adaptation measure compared to their counter parts ($\beta = 5.473$, $p<0.01$). Access to credit increases financial resources of pastoralists and their ability to meet transaction costs associated with adaptation strategies. The reports from Deressa *et al.* (2008) explained that access to credit increases the likelihood that farmers will employ soil conservation methods, change planting dates and irrigate. Moreover, credit access could help to reduce cash constraints and allow households to purchase essential inputs such as purchasing drought resilient seed varieties (Gbetiobouo and Hassan, 2004). Access to affordable credit increases financial resources of farmers and their ability to meet transaction costs associated with various adaptation options they might want to adopt (Hassan and Nhemachena, 2008). Hence, with more financial and other resources at their deposit, farmers able to change their management practices in response to changing climatic and other factors and better able to make use of all the available information they might have on changing conditions, both climatic and other socioeconomic factors.

Access to livestock and crop extension service: Given an increase in access to agricultural and pastoral extension services, the log odds of choosing temporal migration were found to be increasing keeping other explanatory variables constant. Therefore, access to agricultural and pastoral extension services were found to be significantly affecting their climate change adaptation choices; those who have this access were significantly adapting temporal migration ($\beta = 0.545$, $p<0.05$) and livestock mobile ($\beta = 0.631$, $p<0.05$) choices of climate change adaptation strategies. Therefore, this study shows that the more pastorals and agricultural got the extension service, the odds of choosing temporal migration and livestock mobility increased by 1.725 and 1.880, respectively. Deressa *et al.* (2008) also found that access to crop and livestock extension services significantly increased the likelihood of adaptation, particularly the probability of planting trees. Similarly, Bryan *et al.* (2009) reported the significant determination of access to extension services for farmers to plant trees in response to perceived climate change.

Land ownership: The logistic regression analysis indicated that a unit increase in household land holding size, increased the choice of engaging in crop production climate change adaptation strategies by 2.323 ($\beta = 0.84$, $p<0.01$). Thus, land ownership plays pivotal role for the households' to adapt the changing climate. However, households who have farm land less likely adapt the herd diversification choice of climate change adaptation strategies ($\beta = -0.921$, $p<0.05$). The finding of Bryan *et al.* (2009) shown that household who has large farm land were more likely to change crop variety. Similarly, Kebede and Adane (2011) study confirmed that average landholding was significant determinant factor to use of change in planting date, crop variety selection, crop diversification and tree planting as adaptation strategies. Besides, study conducted by Hassan and Nhemachena (2008) shown that larger farm sizes were found to encourage the use of multiple cropping and integration of a livestock component, especially under dry land conditions.

Annual income: The study found that total annual farm and non-farm income of the household has a positive and significant impact on the choice of herd diversification and more engaging on crop production climate change adaptation strategies ($\beta = 0.000$, $p<0.05$). Similarly, Deressa and Hassan (2009) reported the significant impact of farm income on household choice of conserving soil, using different crop varieties and changing planting date climate change adaptation strategies. In addition, Bryan *et al.* (2009) research finding presented that access to non-farm source of income is more likely to plant tree as an adaptation strategies. In general, Deressa and Hassan (2009) study result indicated that lack of money, lack of information, inadequate labour, inadequate land and poor potential for irrigation are the major's barriers which prevented farmers from adopting various adaptations measures.

CONCLUSION

A binary logistic regression model was used to analyze the determinants of household level adaptation measures. The study hypothesis was stated as "The household climate change adaptation strategies are related to the demographic and livelihood assets (human, financial, natural, social and physical asset) variables". The model analysis revealed that access to credit services ($p<0.01$, 238), access to extension services ($p<0.01$, 1.73); annual income farm and no-farm sources ($p<0.05$, 1.00), land ownership ($p<0.01$, 2.32), household head sex ($p<0.01$, 0.10) and level of education ($p<0.01$, 4.45) were influential factors to any of climate change adaptation strategies.

All the specific objectives were met; firstly, one of a specific objective of this study was to identify climate change adaptation strategies pursued by pastoralist community. In responses to the changing climate, pastoralist and ago pastoralists have been adjusting their livelihoods through strengthening already existing farming practices and climate change adaptation strategies. Descriptive statistic was used to summarize and traces climate change adaptation strategies. The results showed that for the changing climate household promoted adoption of temporal migration, livestock mobility, herd diversification, rearing of shoats rather than cattle,shifting to crop production, herd splitting, tree planting, practicing non- farm activities, changing planting date and use irrigation.

Secondly, this study aimed at to investigate the association between demographic and livelihood assets and pastoral's climate change adaptation strategies with regard to this objectives both household level of education and gender are major demographic characteristics were found to be significant at 1 and 5% level of significance for taking herd diversification, livestock mobility, temporal migration and rearing of shoats rather than cattle climate change adaptation strategies. Total land holding size of a household, used as one of an economic variable, the finding has shown a strong positive association with households who are engaging in crop production as climate change adaptation strategies at 5% level of significant. Access to credit hypothesized that one of the financial asset that may have correlation with the households adaptation strategies, this study result found that access to credit has a positive correlation with herd diversification choice of adaptation at 5% level of significant. Besides, number of cattle owned by the household correlated with the choice of shoats rather than cattle as an adaptation strategy at 1% level of significant. In addition, number of cattle and goat owned, annual income and household access to market has strongly associated with the choice of livestock mobility climate change adaptation strategy at 1% and 5%, respectively level of significant.

Finally, the third objective was also met by the binary logistic regression analysis model and it was confirmed that household head that have access to livestock and crop extension service, credit, food aid and with opportunity to education were in a better position to adapt to the changing climate. In the other hand, household who have large farm land more likely engaged on crop production activities to adapting the changing climate. The female headed household were less likely to choose temporal migration, herd diversification and livestock mobility climate change adaptation strategies at $p<0.05$ and 0.01, respectively. In addition this study presented that low infrastructure like low water point coverage; school, road and electricity and lack of awareness and information on climate change and lack of river for irrigation (poor potential for irrigation), community production system being they are pastoralist were mentioned in focus group discussion and key informant interview as the major constraint factors to adapt in the changing climate.

On the basis of the conclusions made above, the following recommendations are suggested:

- The study revealed that there was low level of literacy and when the overall level of education increased the household adaptation to changing climate is increased therefore, the findings suggest that pastoral and ago-pastoral level of understanding on the basic factors of climate change is low and there is a need to educate and show the available adaptation options
- Lack of information and awareness on the issues of climate change and adaptation options or strategies were identified as main constraint. Improve access to climate information (incorporating climate information within the extension service and providing location specific meteorological info via radio and other communication pathways available to pastoralist)

- Access to agricultural and pastoral extension services were found to be significantly affecting their climate change adaptation choices therefore strengthen extension advice which plays a great role in promoting adaptation. In this regard, awareness raising and training on the issues of climate change is crucial. Expand and integrate adaptation measures in various long term national and local development sectors like agriculture, water supply, health, etc. and strengthen animal health services
- The study revealed that access to credit and household head sex has significant contribution on the choices of climate change adaptation strategies therefore, the researcher suggests that enhancing financial mechanisms and promoting sustainable development through mainstreaming gender issues in the overall livelihood diversification is paramount. Introduction of appropriate technologies for the pastoral and ago pastoral community like building water harvesting schemes, drought resistant and early maturing crop varieties, adaptive livestock breed selection and management will definitely seeks financial institutions like credit organizations and need to make it access to these communities
- The study result indicated that households who have an access to food aid less likely to engaging on crop production as climate change adaptation, therefore the researcher suggests, in order to make this households find other ways of adaptation strategies like crop production, this food aid should be supported by others like helping these people with productive assets, for instance providing them with Oxen, farm equipments, seeds, irrigation implements etc. Therefore, in addition to providing emergency assistance following major climate shocks, more should be done to build the resilience of these communities to with stand future climate crises. In particular, drought management and preparedness plan should be integrated to pastoral development plan
- Climate change has been fueling pastoral and ago pastoral poverty. Attempts have been made in this study to assess the determinants of climate change adaptation strategies in the pastoral and ago pastoral livelihood system, but there is still a need to further analyze the significant contribution of determinants climate change to pastoral and ago pastoral livelihood and poverty in Ethiopia

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