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Climate Change andmajoradaptation strategies on Livelihood of farmerin case of Lay-Gayint District, South Gonder Zone, Ethiopia

Tamiru Bezabih Sisay

Debre Tabor University Dean of Social Sciences and humanities Collage. Department of Geography and Environmental study, Debre Tabor, Ethiopia
tamirubezabih74@gmail.com

Corresponding Author: **Tamiru Bezabih Sisay**

Abstract Background: Climate changes the present time one of biggest worldwide agenda. It considered serious threat natural resources and sustainable agricultural development.Objective: to asses' climate change adaptation strategies for socioeconomically transformation ofrural community. Methods: Primary and secondary datawerecollectedthrough semi-structuredquestionnaires, field observation,interview, focus group discussion, key informant interviews and national meteorological data. Totally 120 sampling household randomly selected. Data analyzed SPSS, Livelihood vulnerability Index andMicrosoft-Excel. Result: Empirical evidence annual and maximum average annual rainfall isdecreasing a the rateof 17.21mm and 7.499mm perlast 30 year respectively. The rainfalldecreasing trendLinearequation(Y=-17.21X-41)R^2=0.68,(Y=-7.499X-14574)R^2=0.64 with at 5% level ofsignificance.The annual and average annual temperature increase the rate 0.09^{o}c and 0.06 ^{o}c per last twenty-five year respectively. Theresultof Multinomial logitModelfarmers chooses differentclimate change adaptation strategies. Resultsconfirmedthat from dependent variables like age, access information, social capital, access technology havestatistically significantimpact onclimate change. Independent variables/climate adaptationstrategies soil conservation, adjusting planting,crop diversification, using improved varieties, and irrigation havestatistically significant. Marginal effect indicates that 23.6% a one-year increment in age of the households. 42.8% more vulnerable climate-changedue to higher magnitude impact, low adaptive capacity, lack education, weak livelihood strategy, and being exposed to extreme climate shock and climate sensitive resources. Government should be developing different climate adaptation strategic practice,

raising awareness. Climatevulnerability should supportintervention government, policy, and decision maker to improve existing policies of rural livelihood.

Keywords:- 1. Adaptation 2. Multnomial logit Mode

Back ground and Justification

Many believe agriculture is the most susceptible sector to climate change. This is attributed tothe fact that climate change affects the two most important direct agricultural productioninputs, precipitation and temperature [1,2]. Climate change also in directly affects agriculture by influencing emergence and distribution of crop pests andlivestock diseases, exacerbating the frequency and distribution of adverse weather conditions,reducing water supplies and irrigation; and enhancing severity of soil erosion [3,4].

Climate refers to the average weather and represents the state of the climate system over a given time period. Climate and climate change will certainly have an effect on the future sustainable development of much of our planet's resources such as those relating to biodiversity, water, forests, land, and oceans as well as in relation to various sartorial activities like agriculture, forestry and biodiversity [5]. The has stated that as a result of climate change least developed countries including Ethiopiawill experience arrange ofadverseimpacts [4].

In the study area Lay-GayintDistrict the agriculture is characterized by extreme dependence on rainfall, low use of modern agricultural inputs and low output levels.More than75%oflivelihood is dependent on rain fed agriculture that rendersthemveryvulnerabletoclimatevariabilityandchange [7]. The climate of Lay-GayintDistrict is characterized by high variability annually and seasonal distributions of precipitation are varying and difficult to predict. According to Lay-Gayint District Rural development offices in the area frequently droughts, hunger and the recent floods are among the most serious problems affecting more than thusand people almost every year changes in climate will only make the situation worse. Drought and flood most serious climate related natural hazard affecting the from time to time. Rainfall variability and associated droughts have been major causes of the food shortage and famine because agriculture is the foundation of the national economy and constitutes the primary source of livelihood for the overwhelming majority of the population [6,2,7].Even though there are few research works which have been done by different researchers on the vulnerability of agriculture to climate change, they focused on farmers' vulnerability by considering the socio-economic aspects and neglecting the physical factors which play a great role on its vulnerability to any change [8].Lay-Gayint

District have long period of time variability in climate change in climatic conditionlike it occur prolonged droughts, increase level of temperature, death of crop duty shortage rain, storms and flooding. As a result of this factor affect livelihoods of the people especially rural household in the study area their high vulnerability to climate change. For this reason, climate adaptation strategies become every important; and investigations into the lack of understanding of those constraints facing poor communities that may impede their ability to adaption should be prioritized future climate change.

Research methodology

Description of the Study Area

The study was conducted in Lay-Gayint district. The district is found in South Gondar Zone of the Amhara National Regional State, Ethiopia. It is located between $11^{0}02'$-$11^{0}39'$ N of latitude and $38^{0}06'$-$38^{0}38'$ E of longitude. Its altitude ranges between 1300-3500 metres above sea level. It has an area of 132031ha [7]. With a population of 242 900, the district is among the most populous areas in the country. Its population density rate of 183 km^{-2} is nearly three times higher than the national average of 66 personsindicating the pressure on the resource base of the area. Households are of fairly large size in the district. According to the A.D. 2000 projection, the population is distributed along 40433 households in the district, averaging 5.2 persons per household.There are four agro-climatic zones in the district namely wurch, dega, weinadega, and kola. The alpine zones are areas of extreme altitude (over 3200 metres above sea level) with a low temperature and short growing seasons. The wurch area comprises 2% of the total area of the district. The dega and weinadega zones are the most important zones in which the majority of the households live. The dega lies between 2300–3200m altitude, while which lie below 1500 m above sea level, are classified under the kola zone; the climate is hot, over 27^{0c}, and dry with rainfall less than 450mm. The shortage of farmland has led to the removal of forests to hillside terracing in the area. As population grew rapidly there was a need for more farmland, which was made by removal forests and by resorting to marginal lands that are not conducive to farming. Forest resources in the Lay-Gayint district have been decreased over time, owing to the population growth and the growing competition for resources.

In spite of dwindling tree resources, the cultivation and management of woody species remains important activity in the farming systems of the district. Since the natural forests of the district are exhausted the only available resources in the production of

forest products are the agroforestry practices that are implemented side-by-side with the agricultural and livestock production. Some of the common agroforestry practices of the district include scattered trees on farmland, live fences, homegardens, woodlots and farm boundaries. From these agroforestry practices the people produce farm implements, construction material, fuelwood, medicine, fruits and other products. Farmers have managed these practices without having had training in agroforestry. Coppicing, pruning, thinning and pollarding of trees is practiced in the area in order to have better products and utilization. The farmers have used trees for numerous purposes for centuries, during which they have accumulated extensive knowledge about the management of indigenous tree species for these purposes in the past. But no research is being done to document and incorporate this knowledge which can be later used in the planning and implementations of different agroforestry practices and alleviate rural poverty in the area. The district has four types of soil, comprising of Red 16%, Brown 48%, Black 30%, and White 6 %. The common soil types are Vertisol, Cambisol, Rigosol, Liptosols, Flovisols and Arenosols. Rainfall is mainly uni-modal in the district. With the exception of some showers in the belg, which accounts for only 5% of the crop production the majority of rain is received during the meher season (June to September). Rainfall ranges between 1000–1600mm. The dominance of cereals stands out when the share of the area under cultivation and crop production is considered.

Data Collection methods and Data analysis

Study Site Selection

In Lay-GayintDistrict was selected because of its higher exposure to the climatic hazards and also selected as the study site after consultation with the district Lay-GayintDistrictAgricultural Rural Development Office District.

Primary Data Collection

1). Reconnaissance Survey: It was carried out for general field observation was done to become familiar with the study area.

2). Key Informant Interview: Model farmers, villagers elders, heads of religion members, and other knowledgeable persons were taken as the key informants' persons who lived in that area for 30 years.

3). **Household Survey and Semi-structured Questionnaire:** -HHS were conducted together information on socio-economic condition, a climatic phenomenon on their livelihoods and their adaptation practices to cope with the negative effect of climate change.

Sampling size determination

The overall sample size was determined by the method proposed by [9]. A total of 120 samples of households were randomly selected using simple random sampling

technique from Kebeles household list households provided by the Kebeles agricultural development office and administration. In order to determine the sample household size for each Kebeles, applied proportional sampling formula.

$$n_i = \frac{n(s_i)}{N}$$

Where:

n_i = samples size of each kebele

n= total sample size of the study;

s_i= Total households of each kebele;

N= total number of households in all sample Kebeles;

Methods of Data analysisand Presentation

Data Analytical Techniques

In this study, data were analyzed using both qualitative and quantitative statistical tools. Qualitative data were analyzed using narrative data analysis procedures. Qualitative data were summarized and discussed in detail and finally the results were substantiated with quantitative data and reported under separate section. Descriptive, inferential, and econometric model was employed to analyze the data.

Inferential statistics (econometrics model) analysis

MultnomalLogit model regression is the appropriate **regression** analysis to conduct when the dependent variable is dichotomous (binary). **Logistic regression** is used to describe data and to explain the relationship between one dependent binary variable and one or more nominal, ordinal, interval or ratio-level independent variables.The logit econometric model was applied for analyzing factors influencing the assessing nontimber forest product. Logit model was used to determine the relative influence of various explanatory/independent variables on the dependent variable. This model was chosen because, it has an advantage that easily interpreted the result. To identified factors affecting adoption of improved upland rice variety among farmer. It is an extremely flexible and easily used function and the study, was used to estimate the probability 'of assessmentclimate change.

Independent variables

The choice of dependent variables to be used influenced on factors of the farmers' decision about adaptation to climate change in the district.

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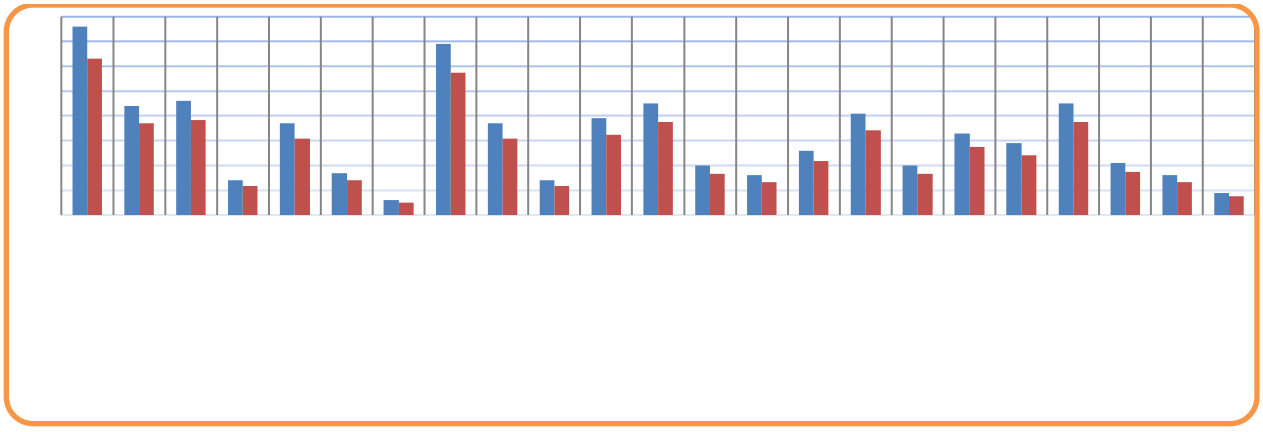
Results and discussion

Socioeconomic and Demographic Characteristics of Respondents

Socio-economic characteristics of farmers observed in this study were sex, age, marital status, family size**,** and farm size, and education level. As described figure 2 majority of respondent Male respondents 63 %(76), while females were 37 %(44).

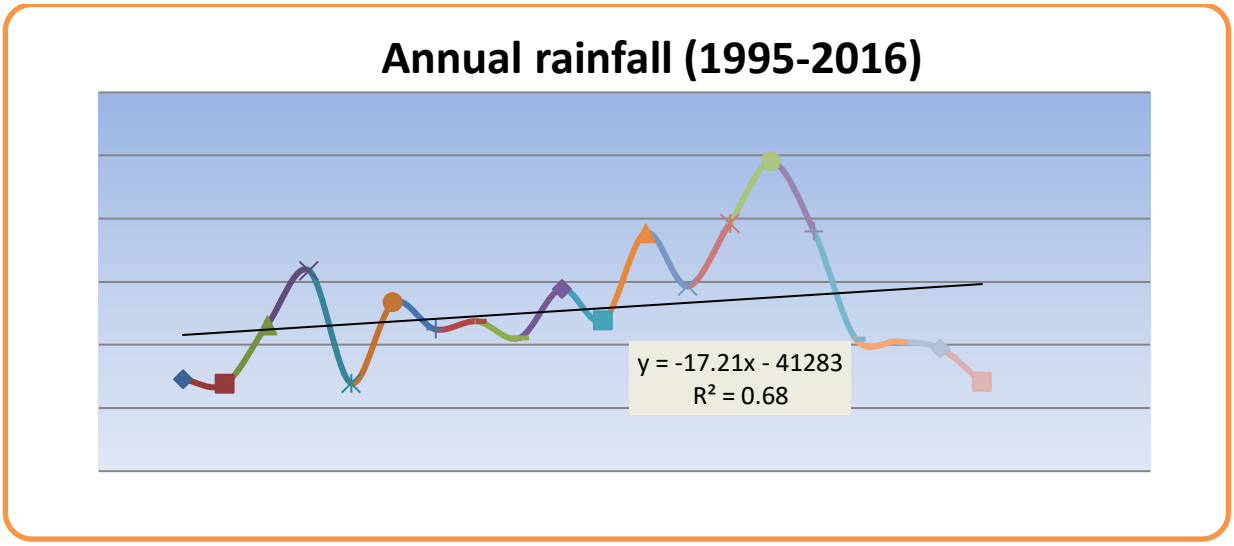


General characteristics of the respondent (Household survey 2017)

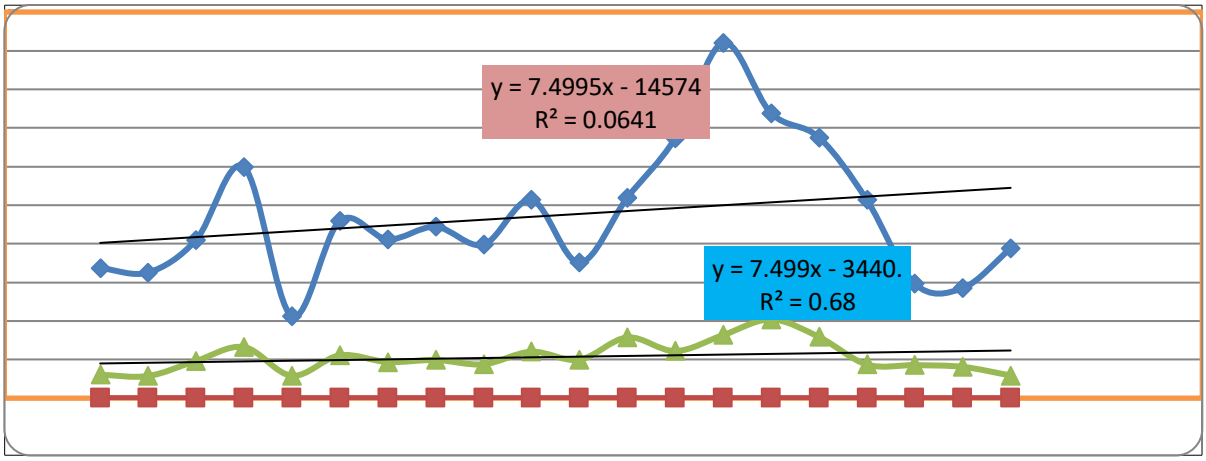
Elements of Climate Changes

Annual rainfall Features of Gaynt District

The statistical record of temperature data from the area between1996 up to 2016 also shows increasing. Thus, farmers' perceptions appear to be following the statistical record of the area. The annual rainfall distribution decrees the trend with an erratic pattern. Annual rainfall is decreasing at the rate of -17.21mm per year. Even though the rainfall is decreasing trends has not been predictable ($\mathbf{R^2=0.68}$). Most climate models predict that the Sahel region will be drier in the 21st century than it had been earlier. Even slight increases in rainfall are unlikely to reverse the situation since a warmer climate means that evapotranspiration will be more intense, and worsening the already arid conditions [15].



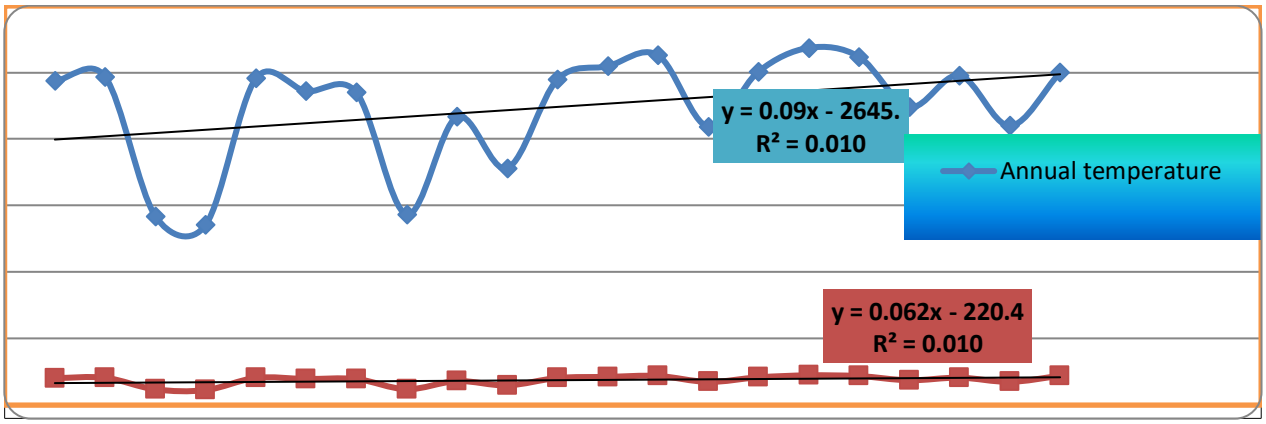
Annual rainfall distributions (1998-2016).



Average annual, Minimum, and maximum annual rainfall distribution (1995-2016)

Annual and average annual temperature the District

The distribution of temperature, the maximum, and minimum mean monthly temperatures was 43.88°C and 6.62°C, respectively. The annual and average annual temperature starting from 1996-2016 increase rate0.09°c and 0.062°c respectively. Despite this fact, R-value imply the variations are significant in the case of annual temperature,R=0.01 (which is >0.5) which implies significant variability in the 1996-2016. (EPA 2010) statesthe average surface temperature has, since the mid1970increased by about 1°F or 0.5°C. IPCC 2007states that the earthtemperature has increased by approximately 0.74°C.



Trend of annual temperature

Vulnerability and its Assessment

Vulnerability Defines as "the extent to which climate change may damage or harm a system." It adds that vulnerability "depends not only on a system's sensitivity, but also on its ability to adapt to new climatic conditions" [3]. The vulnerability of a system is a function of three elements:1) exposure to climate change effects 2) sensitivity and 3) adaptive capacity. So, vulnerability V=ƒ (exposure, sensitivity and adaptive capacity). The poor rural people are more vulnerable to long drought ($\chi 2$ =19.79 with d.f.4 at 5% level of significance issignificant) and landslide and floods ($\chi 2$ = 12.31 with d.f.4 at 5% level of significance issignificant) than rich rural people [15].

Vulnerable index long drought

		Vulnerability to long drought			
Economicclass		Low	Medium	High	Total
Poor		0	28	7	35
Medium		0	19	27	46
Rich		2	16	23	39
Total		2	63	57	120

chi-square test for long drought and vulnerability					
O	E	O-E	(O-E)2	(O-E)2/E	
0	1.3	-1.3	1.69	1.3	
18	18.5	-0.5	0.25	0.013513514	
17	15.3	1.7	2.89	0.188888889	
0	0.4	-0.4	0.16	0.4	
5	6.3	-1.3	1.69	0.268253968	
7	5.2	1.8	3.24	0.623076923	
2	0.3	1.7	2.89	9.633333333	
6	4.2	1.8	3.24	0.771428571	
0	3.5	-3.5	12.25	3.5	
				$\mathbf{X^2=19.79}$	

Determinants of Farmers Adoption of Adaptation Strategies

Sex of household head:

The sex of the household head is an important variable affecting adaptation decisions at the farm level. The negative coefficients for the sex variable show that female-headed households are more likely to take up soil conservation practices as climate change adaptation options. Women perform many activities for the well-being of their family members, as well-designed adaptation practices. These resultsconsistent with findings [10,11,12]

Farming experience of household head: Experience of the household head affected user of adjusting planting date as an adaptation strategy to climate change positively

Literacy status of the household head: This variable significantly affected use of crop diversification and soil conservation practices as an adaptation strategy.

Livestock ownership: It isan important variable affecting adoption decision at the farm level. The ownership of livestock of the households has a positive and significant impact on the use of soil conservation practices as an adaptation strategy.

Off/non-farm income: The result of the model indicates that off/non-farm income increases the uptake of improved crop varieties as adaptation strategies to climate change.

Farm income: The farm income of the household surveyed has a positive and significant impact on the use of improved crop varieties as an adaptation strategy.

Extension Contact: Extension services are an important source of information on

agronomic practices as well as on climate [13].

Access to credit: The result indicates that access to credit has a positive and significant impact on the likelihood of using improved varieties of crops and soil conservation practices

Access to training: Participation in climate change-related training programs is found to be positively and significantly associated with us in irrigation onand adjusting planting dates an adaptation strategy to reduce the negative impact of climate change.

Farmer to farmer extension: Access to the farmer-to-farmerextension (information and input sharing) has a positive and significant impact on the likelihood of using adjusting planting date as an adaptation strategy to climate change.

The findings further reveal that access to extension services for climate change information increases the likelihood of smallholder farmers adapting to new crop variety and diversify their enterprises ($P<0.09$). This is because access to extension service assists farmers through educational trainings; help them improve their farming methods and techniques through the provision of up-to-date information [14]. The study findings are similar to [15] found in Ethiopia, that having access to extension services increases the probability of using improved crop variety and soil and water conservation techniques. The adaptation capacity of the smallholder farmers on human capital was affected by the low level of education within the farmers, since a majority of the smallholder farmers had no formal education (54.7%).

Conclusions and Recommendation

Climate change affects agriculture in the past and continues. 120sampledhouseholdheadswere selected. The trend analysis of annual temperature and average annual temperature increases by about 0.096^{o} Ceachyear and average 0.062^{o}c respectively. Annual rainfall decreases21mm last 30year. Adaptation strategies used by farmers in include changing/ adjusting planting dates, use of soil conservation techniques, use of improved crop varieties, crop diversification (mixed cropping, intercropping, and dividing farmlands into varying crops), and use of irrigation. Multinomial logit model results also confirm that sex, landholding, family size, off/non-farming mean success to training have a significant impact on the use of irrigation as a climate change adaptation strategy. The result also shows that landholding, family size, access to credit, access to media, farm income, and off/non-farm income significantly affect the use of improved crop varieties to adapt to climate change. Besides, farming experience,

family-size, extension contact, farmer extension and distance from the market center significantly affect using adjusting planting dates.Based on theevidencesPolicy focus on encouraging formal (training)and informal social networks (farmer-to-farmer extension) increase farmers' use of different climate change strategies to reduce the impact of climate change. Farmer to increase awareness creation on climate change through different sources like media and extension, facilitating the availability of credit especially to adaptation technologies, enhancing research on the use of new crop varieties that are more suited to drier conditions, improving farmers farm and off-farm income-earning opportunities, improving their literacy status, and improving their access to markets. Moreover, encouraging inform asocial net-works and environmental settings enhanced the adaptive capacity of smallholder farmers. The government should be facilitated a different project to support climates vulnerable areas and scaling up the rest of other regions.

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