Determinants of farmers’ choice of land management strategies to climate change in drought prone areas of Amhara region: The case of Lay Gayint woreda, Northwest Ethiopia

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Abstract: Climate change is one of the life-threatening challenges that face the ecosphere in recent decades. Climate change exacerbates the rate and magnitude of several ongoing land degradation processes. The impact is particularly high in unindustrialized states like Ethiopia. In recognition of the impact adaptation become the policy options to minimize the adverse effects of climate change. The main objective of this research paper is to analyze the determinants of farmers’ choice of land management approaches to climate change in drought prone areas of Amhara region: the case of Lay Gayint woreda, Northwestern Ethiopia. The study employed a multistage stratified sampling procedure (purposive and simple random). Data were obtained from 232 sample households. Primary data were collected from households via questionnaires, interview and focus group discussion. The households’ land management strategies to climate change were summarized by using percentage. Binary logistic regression model was also applied to analyze the factors that influence farmers’ choice of land management strategies. The farming households of the study area have attempted to give response to the impacts of climate change; but their capacity to adapt is challenged by a number of factors. Model results indicate that, Agro ecological setting and non-farm activities are found to be the most statistically significant determinants in the adoption of land management strategies. Solving financial problems, improving extension service, providing timely information and establishing early warning system, livelihood diversification and integrated watershed management practice would enable to increase the adaptive capacity of farmers.

Keywords: adaptation, climate change, land management strategies, Lay Gayint woreda

Introduction

Global studies showed that climate change is a truth; it has altered in earlier, it is varying at present-day, and it will change in forthcoming. Climate change exacerbates the rate and magnitude of several ongoing land degradation processes (Marye. 2011). Land degradation affects ecosystems and people throughout the planet and is both affected by climate change and contributes to it. Land-use changes and unsustainable land management are direct human causes of land degradation, with agriculture being a dominant sector driving degradation (Menberu, 2014). This changing climate leads the developing countries of Africa the most exposed to the powers of climate change (IPCC, 2007). This is because the majority of their people are depending on agriculture that is highly exposed and extremely sensitive to climatic variability. Besides the national adaptive capacities are very...
low due to widespread poverty, illiteracy, lack of skills, armed conflicts, unfair land allocation, inadequate access to capital and technology and insufficient public organization (Boko et al., 2007; Woldeamlak, 2009; Akinmagbe and Irohibe, 2014). In recognition of the impacts of climate change, adaptation becomes the reaction mechanisms to enable farmers to cope with the adverse effects of climate change by using effective and efficient strategies. In the context of the human dimension of global change, adaptation refers to adjustment in natural or anthropological systems in answer to real or probable climatic incitements or their effects, which curbs harm or exploits valuable prospects (IPCC, 2001). Numerous climate change adaptation studies (Yesuf et al., 2008; Deressa et al., 2008, 2009; Temesgen, 2010; Woldeamlak et al., 2013; Menberu, 2014; Kide, 2014; Asnake and Mammo, 2016; Menberu and Addisu, 2018) have been identified several land management strategies to counter balance climate change impact in Ethiopia. The common identified land management adaptation strategies were compost, chemical fertilizer, irrigation, terracing, planting trees and pond construction.

Land degradation is one of the leading challenges for farmers’ choice of land management, biodiversity conservation, mitigating and adapting to climate change. It is the reduction or loss of the biological or economic productivity and complexity of land (Boko et al., 2007). When land is degraded, soil carbon can be released into the atmosphere, along with nitrous oxide, making land degradation one of the biggest contributors to climate change (Menberu, 2014). Agriculture, forest and other land-use sectors generate roughly a quarter of all anthropogenic greenhouse gas emissions. Agriculture remains a foremost pecuniary sector in Ethiopia hiring 85% of the work force and paying 40% to the countries’ general GDP (Conway and Schipper, 2011). Despite its contributions to the economy of the country is high, this sector is still impotent to feed its people for many years due to different factors, of which climate-related hazards (particularly drought and flood) are prominent (Temesgen, 2007; NMSA, 2007). According to Temesgen (2007) knowledge of the adaptation systems and factors touching farmers’ choices enhance policies engaged toward alleviating the challenges imposed by climate change.

Even though studies have been undertaken to understand the existing adaptation tactics in response to climate change in Ethiopia (Marye, 2011; Hamasso, 2015; Menberu and Addisu, 2018) the determinants of the choice of adaptation strategies are not well studied. However, the choices of adaptation strategies are affected by specific variables (Maddison, 2006; Temesgen, 2010; Woldeamlak et al., 2013). In this regard, Menberu and Addisu (2018) also argued that knowledge on the determinant variables help in targeting mediation towards effective adaptation strategies against the impact of climate change. The majority of the previous empirical studies have used multinomial logit model to analyze the determinants of farmers choice of agricultural adaptation strategies to climate change (Deressa et al., 2009; Woldeamlak et al., 2013; Kide, 2014; Asnake and Girma, 2016), where farming households choose only one from the given adaptation strategies. However, it was far from reality. This is because farming households use a mix of adaptation strategies simultaneously. Hence, the objective of this study was to examine the factors that determine the choice of land management strategies in response to climate change in Lay Gayint woreda, Northwest Ethiopia.

Materials and Methods

Study area description

Lay Gayint woreda is found in South Gondar Administrative Zone of Amhara Regional State. It is one of the 13 rural woredas of South Gondar administrative Zone. The woreda lies 11° 04’ to 12° 10’ N latitude and 38° 12’ to 38° 37’E longitudes and covers a total area of 1,320.31 km² of 31 kebeles, 2 town and 29 rural kebele administrations. The seat of the woreda administration is Nefasmeucha which is located 75 km distance from the zonal capital Debre Tabor and found at about 175 km away from Bahir Dar and 739km distance from Addis Ababa (Lay Gayint woreda Administration Office/LGWAdO, 2018). Lay Gayint woreda is bordered in the north by Ebinat, in the south by Tach Gayint then Simada, in the east by Meqit and Lasta Bugena woredas of South Wollo and in the west by Guna Begimider and Estie Districts of South Gondar Zone (LGWAO, 2018).

The physiographic setting of the study area is characterized by Mountain (198 sq km or 15%), undulating/ups and downs (660 sq km or 50%), Plain (132 sq km or 10%) and Valley bottom (66 sq km or5%). In the study area, elevation ranges from 1300 to 4231 meters above sea level. Agro ecologically, the study area is characterized by dega/highland (15.2%), woyna dega/midland (39.4%) and kolla/lowland.
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According to LWAO (2018) the mean lowest and mean extreme temperature for the study woreda ranges from 5°C to 24°C, correspondingly. Explicitly, the mean annual maximum temperature is high from March to May and the mean annual minimum temperature is low from December to January. The wet seasons in Lay Gayint include Belg and heavy Kirmet with erratic distribution fluctuating from 600 mm to about 1200 mm (LGWAO, 2018). In Lay Gayint woreda diverse types of vegetation are found (Berlie, 2013).

The total population of Lay Gayint woreda is 217,975 (LGWAdO, 2018). The population concentration of the woreda is 165 individuals per km² (LGWAdO, 2018). About 12% of the populations live in urban and the rest in rural areas. Subsequently, the denser population is found in Dega and Woina Dega zones, but it befits sparse as one move towards the north of the study place. This indicates that the distribution of the population has a strong relationship with the climate of the area (Berlie, 2013). The majority of farmers in the area are tied up in mixed agriculture. Crop production is exclusively rain fed, except in very specific and small areas where vegetables are cultivated based on old-fashioned and small-scale irrigation (LGWAO, 2018). The development of infrastructure in the area is very low. Plenty of the kebele’s in the study site are not united with roads and are secluded from each other. This led to in information dissemination to fail and greatest of the areas is unreachable to integrate them with the marketing systems (Figure 1).

**Sampling methods and procedures**

Because of time as well as financial restraints this research employed a cross-sectional survey research design using mixed research methods. Using quantitative and qualitative approach simultaneously help the researcher in complementing the weakness of each data sources (Cresswell, 2003). The study used a multi-stage stratified random sampling procedure with combinations of purposive and simple random sampling techniques to handpicked sample woreda and households respectively. First, out of 13 rural woredas in south Gondar zone, Lay Gayint woreda was purposively chosen due to the fact that the woreda has diverse agro-ecological zones stretching from Kolla to Dega, which will denote the socio economic, demographic and physical features of Northwest Ethiopia. In the second stage, three Kebeles (lower administrative units next to woreda) were carefully chosen - one from each agro ecological zone - using simple random sampling method.

![Figure 1. Study area.](image-url)
This is because, in an agro ecological zone farmers to some extent might share similar adaptation strategies. Accordingly, these three kebeles are Titera (dega), Safda Giorgis (woyna dega) and sofiya meda (lowland). To decide the sample size to be included in the survey for each sample kebele, Cochran's (1977) sample size determination formula was used and then by using simple random sampling method, sample household heads were selected from each kebele. A total of 232 sample households (71 from Safda Giorgis, 69 from sofiya meda and 92 from Titera) were joined in this study. The lists of recorded sample households were got from the respective kebele Agriculture Office.

**Data collection methods**

This study entirely used primary data collected by using household survey, focus group discussion and interview. The household survey was employed to collect farmers’ socio economic, demographic and institutional factors that sway the choice of land management schemes used by farming households in response to climate change. The questionnaires were, first prepared in English and then converted into Amharic. Finally, the variables were encoded into English at the time of data manipulation. To assess the appropriateness of questions, the pretest of 10% of the sampled households from both male and female headed households in the woyna dega agro ecology (Zagoach kebele) was conducted. For pretest Zagoach kebele was selected purposively because it served as a market center for the three agro ecologies. Market is one of the means of farmers’ information exchange that shares a similar accent and local language. The Pretested kebele and farming households were not included in the tangible data collection time. After pretesting, words that were not local and redundant questions were deleted and replaced. Most of the farmers were contacted on natural resource conservation works, on Sundays around churches and public activities. The data collectors for this study were each kebele development agents in collaboration with unemployed educated youth above grade ten who are living in the sample kebeles. The authors’ skilled data gatherers about the survey procedures and the data were collected with close supervision of the authors.

**Methods of data analysis**

Binary logit was employed to examine the factors that influence the choice of land management strategies. Before entering into the actual survey, a multinomial logit (MNL) model was planned to analyze the determining factor of the adoption of land management strategies. This was because the majority of the previous studies employed the MNL model (Deressa et al., 2009; Woldeamlak et al., 2013; Kide, 2014; Asnake and Girma, 2016), where farming households choose only one strategy from the given strategies. However, in the course of data gathering, farming households use a mix of strategies simultaneously. To fix such problems of the model, some made adjustments to merge similar strategies into one (Woldeamlak et al., 2013). However, such type of grouping of strategies may reach to wrong conclusion. This is because the set of independent variables affecting the farmers’ choice are likely to be not the same for different adaptation tactics. This characteristic made to leave to use the MNL.

As a result, this study employed binary logistic regression or multiple response models to know the effects of the explanatory variables on the choice of each strategy. In binary or multiple response model there may either an intrinsic order or the categories in the dependent variable could be truly discrete. When the data are believed to be truly discrete a Logit model is appropriate (Greene, 2012). Its counterpart i.e. Probit involves solving multiple integrations and difficult to compute variable function estimation (Gujarati, 2003; Greene, 2012). Such type of model is also relatively simple to use and appropriate when the explained variable is binary in nature pleasing a charge of 1 or 0. Following Gujarati (2003), the logistic probability function for adaptation is defined as:

\[ P_i = \frac{1}{1 + e^{-z_i}} \]  

(1)

For ease of exposition, it can be rewritten as

\[ P_i = \frac{e^{z_i}}{1 + e^{z_i}} \]  

(2)

As shown in equation [1 and 2] above, if \( P_i \) is the household probability to adapt a given land management strategy, the probability of households not to adapt land management strategies, that is, \( 1 - P_i \), is given as follows

\[ 1 - P_i = \frac{1}{1 + e^{z_i}} \]  

(3)

Therefore,

\[ P_i = \frac{e^{z_i}}{1} = \frac{1 + e^{z_i}}{1 + e^{z_i}} = e^{z_i} \]  

(4)

Taking the natural logarithms of the odds ratio, the logistic regression model of adaptation is a function of several determinant factors given as follows:
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\[ \text{Logit}(y) = \ln \left( \frac{P}{1-P} \right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_p X_p \]  

Where, \( y \) is the binary explained variable, \( \beta_0 \) is intercept term, \( \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_p X_p \) are the regression coefficients with each explanatory variable

\( P \) is the probability to adopt which is coded with 1 (predicted),

\( 1-P \) is the likelihood of the decision to adopt a certain land management strategy,

\( X_1, X_2 + \cdots + X_p \) are the explanatory variables entered.

**Dependent Variables:** The dependent variable is dichotomous which takes 1 if the farmer adopted at least one adaptation strategy and 0 otherwise.

**Independent variable:** Researches concerning technology adoption in general and land management adaptation practice in particular are undertaken in various countries including Ethiopia, which identifies household characteristics, institutional, wealth and environmental factors are the key determinants of adoption of a given option. The choice of the variable was based mainly on previous studies, for instance (Deressa et al., 2008; Deressa et al., 2009; Kide, 2014) anchored with author’s experience (Table 1).

**Evaluation of the fitness of the model**

Before undergoing the analysis, making the assessment of the fitness of the model to test whether the chosen model well suits to the variables is important. Accordingly, the fineness of the model to the data for this study was evaluated by using the Hosmer-Lemeshow Test, co linearity and multi-co linearity statistics. The fitness of the model can be observed in Hosmer and Lemeshow Test due to the incorporation of the explanatory variables. In this case, the fitness of it is determined via checking the closure between the observed and the expected values (Berlie, 2013). The same author was referring to Alemu (2007), the more closely the predicted and observed frequency; the best fits it to the logistic model. In this study the results of Hosmer and Lemeshow Test were appeared to be closed the two frequencies for all dependent variables (land management strategies) showed the models were better fitted to the data. For multicollinearity test pair-wise correlation technique for categorical variables and variance inflation factor (VIF) was used for continuous variables.

**Table 1. Independent variables description.**

| Independent variable                  | Description                                      |
|--------------------------------------|--------------------------------------------------|
| Agro ecological zone                 | Takes 1= dega, 2= woyna dega, 3= kola             |
| Gender                               | Takes 1 if male and 0 if female                   |
| Education                            | Takes 1 if literate and 0 if illiterate           |
| Access to water                      | Dummy: takes 1 if yes; and 0 otherwise            |
| Access to input                      | Dummy: takes 1 if yes; and 0 otherwise            |
| Credit access                        | Dummy: takes 1 if yes; and 0 otherwise            |
| Extension                            | Dummy: takes 1 if yes; and 0 otherwise            |
| Farmer to farmer extension           | Continuous (in years)                            |
| Age                                  | Continuous amount of Birr households gain         |
| Farm income                          | Continuous amount of Birr households gain         |
| farm income(non)                     | Continuous (Number of household member)          |
| Family size                          | Farm size owned by households in qada             |

As a rule of thumb, Contingency coefficient value ranges from 0 to 1. Based on literature, when Coefficient of variables below 0.75 indicates low relationships and in contrast value above this number noted that strong relationship. The other system helps to detect multi-co linearity problem was a variance inflation factor (VIF). Variance inflation factor reveals how the variance of an estimator is inflated by multicollinearity. This means that as \( R^2 \) gets nearer and nearer 1, the VIF increased immensely. As the level of collinearity between variables increases, the variance of an estimator also increases and the boundary turns into infinite. If the value of VIF is more than 10 and tolerance value close to zero shows the presence of multi-co linearity among predictors (Gujarati, 2003). But in this case, no multicollinearity problem was observed, because VIF in all variables are less than 10 (1.046-1.234) and the tolerance value is not close to zero.
Results and Discussion

Land management strategies used by farmers in the study area

Farmers were asked to answer which climate change adaptation measure they have been using so far in their locality. Based on the results of the survey data, compost (72.9), chemical fertilizer (92.9), irrigation (8.6), water harvesting (22.3), tree planting (49.4) and pond construction (11.9) are the type of land management strategies used by farmers in response to climate change. Modern fertilizer is the most commonly used method, this is probably because ease of access by farming households, whereas irrigation, construction of water ponds, are the least practiced strategies identified in Lay Gayint woreda. These were due to the application of more capital and the absence of water resource.

Model results and discussion

Based on the survey data, from a number of explanatory variables, small number of factors influence the decision to implement a given strategy. This is probably because in most cases most adaptation strategies have been practiced in mass mobilization and there have been common adaptation strategies in the locality. These made it difficult to know the difference resulted from the socio economic and demographic profiles of farmers in the choice of different adaptation strategies. If the odds ratio \( \exp(B) \) is less than one the beta coefficients \( B \) are negative and if the odds ratio \( \exp(B) \) is greater than one the beta coefficient is positive. Based on the relationship explained in the above, no need of putting the beta coefficients in the (Table 2) simplify it.

Education

The educational status of the farming household increases the possibility of adapting land management strategies to climate change. As observed in (Table 2), education considerably increases the construction of water ponds and terracing as adaptation techniques in climate change impacts. A one year increase in number of schooling would result in 3.448 and 4.933 times more likely to increase the propensity of construction of water ponds and terracing to their counter parts respectively. Moreover, some of the coefficients of education are getting positive across certain strategies showing a progressive relationship between education and adoption of land management strategies to climate change. This suggests that education provides access to and conceptualize information pertaining to adoption choice. This finding was similar with the studies of (Nhemachena and Hassan, 2007; Nhemachena and Hassan, 2008; Temesgng et al., 2009; Gebetivouo, 2009), which noted that levels of education may enhance access of information and improved technology up take.

Family size

Family size positively and significantly enhances the application of compost as an adaptation strategy. A unit increases in the family size, the probability of farmers using compost increase more likely by 1.285 times. This is because preparing compost is a labor-intensive activity. Except for compost, family size is statistically insignificant to the majority of the adaptation strategies and it was found negatively related. This means the large size of family challenges the use of different strategies in response to climate change, because of food insecurity problem in the district. The finding of this study is in contour with the finding of Asnake and Mamo (2016), who argued that farming households with a large family size need high expense to feedstuff their family rather than purchasing new inputs, it is directly or indirectly related to poverty. However, the finding of this study is in contrast with Yirga (2007), who believed that enormous family size is related with labour contribution that would permit to do agricultural activities timely and this might be forced to entertain part of its labour force into non-farm activities to make income and adopt a number of adaptation strategies.

Gender

Gender is the imperative variables that considerably affect farming households’ choice of adaptation options. In the occurrence of climate variability, the gender of the household head showed a significant association with planting trees at \( p < 0.05 \). Based on the results of the model, male- headed farming households’ increase more likely the probability of using planting trees by 9.520 times relative to their counterpart. This result is consistent with the finding of Temesgen (2010), which contended that female-headed households have inadequate access to information, land, and other resources due to traditional and social barriers, while male-headed households have high adaptive capacity than its complement. However, this result denies the verdicts of Nhemachena and Hassan (2007) and Deressa et al. (2008), which noted that female farmers are highly engaged in much of the agricultural activities.
## Determinant factors of farmers’ choices of land management strategies

| Independent variable | Irrigation | Planting trees | Compost | Fertilizer | Terracing | Water harvesting | Water ponds |
|----------------------|------------|----------------|---------|------------|------------|-----------------|-------------|
|                      | Sig (Exp(B)) | Sig (Exp(B)) | Sig (Exp(B)) | Sig (Exp(B)) | Sig (Exp(B)) | Sig (Exp(B)) | Sig (Exp(B)) |
| Agroeco-kolla        | .008*       | .000*         | 0.119   | 0.22       | 0.343      | .021*          | .000*       |
| Agroeco(1)_dega      | .003*       | 14.691        | .000*   | 26.078     | .041*      | 2.411          | .006*       | 3.727       | .001*       | 31.209      |
| Agroeco(2)_w/dega    | 0.152       | 4.571         | .000*   | 10.128     | 0.463      | 0.517          | .063*       | 1.303       | 0.103       | 2.31         | 0.098        | 6.785       |
| Gender (1)           | 0.393       | 3.192         | .000*   | 9.52       | 0.086      | 0.157          | 0.467       | 1.872       | 0.241       | 1.922        | 0.067        | 4.458       | 0.835       | 0.851       |
| Education (1)        | 0.684       | 0.767         | 0.665   | 0.856      | 0.369      | 0.726          | 0.951       | 1.036       | .000*       | 4.933        | .006*        | 0.375        | .023*       | 3.448       |
| Water access (1)     | .000*       | 35.997        | 0.414   | 1.466      | 0.76       | 1.149          | 0.632       | 1.484       | 0.942       | 1.035        | 0.179        | 0.525        | .022*       | 3.5         |
| Input access (1)     | 0.998       | 120017841     | 0.103   | 2.746      | 0.144      | 2.041          | 0.314       | 0.334       | 0.149       | 2.154        | 0.409        | 1.652        | 0.998       | 148319163   |
| Credit access (1)    | 0.999       | 5559328       | 0.769   | 1.448      | 0.692      | 1.313          | 0.443       | 2.585       | 0.244       | 0.259        | 0.932        | 0.929        | 0.999       | 30221758    |
| Extension (1)        | 0.186       | 2.647         | 0.33    | 1.437      | .033*      | 2.081          | 0.072       | 2.781       | 0.316       | 1.477        | .029*        | 2.321        | 0.056       | 2.871       |
| Farmer to farmer (1) | 0.399       | 1.74          | .005*   | 3.072      | .007*      | 4.05           | 0.298       | 2.323       | 0.318       | 1.608        | 0.294        | 0.645        | 0.846       | 0.905       |
| Age                  | 0.199       | 1.024         | 0.071   | 1.023      | 0.088      | 1.023          | 0.744       | 0.993       | .000*       | 0.87         | 0.432        | 0.99         | 0.127       | 1.026       |
| Farm income          | 0.243       | 1             | 0.215   | 1          | .013*      | 1             | 0.487       | 1           | 0.315       | 1           | 0.305        | 1           | .000*       | 1           |
| Non- farm income     | 0.091       | 1             | .000*   | 1          | 0.626      | 1             | 0.08        | 1           | .046*       | 1           | 0.292        | 1           | .000*       | 1           |
| Family size          | 0.097       | 0.715         | 0.184   | 0.857      | .046*      | 1.285          | 0.186       | 0.803       | 0.722       | 1.06         | 0.333        | 0.891        | 0.419       | 0.878       |
| Farm size            | 0.327       | 1.189         | .003*   | 1.504      | 0.586      | 1.085          | 0.795       | 1.055       | 0.407       | 1.183        | 0.482        | 0.909        | 0.584       | 0.905       |
| Constant             | .021*       | 0.05          | .000*   | 0.05       | .026*      | 0.162          | 23.261      | .000*       | 4082.83     | 0.92         | 1.084        | .004*        | 0.033       |             |
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**Age**

The age of the household is directly attached to the experience of the farmer in agriculture. In this research work contrary to expected, the age of the household head negatively correlated with adoption of strategies. For instance, a one-year increase in the age of the farming household head results in the probability of using terracing as an adaptation strategy to climate change decreases by 0.870 times. This is because old age farming households have no labour power to implement the majority of the strategies. The result of this paper is in line with the findings of Million and Belay (2004), which conclude that old age means more health problems and being conservative to accept new technologies. On the contrary, the majority of the findings argued that age means a better experience, access to information, knowledge, and capability to assess the features of modern technology than younger(Nhemachena and Hassan, 2007; Deressa et al., 2008; Gebetibouo, 2009).

**Farm income**

The farm income of sample farming households has a positive and significant impact on using compost and water ponds. This could be apparent because the use of compost and pond construction requires financial resources and hence increased income will encourage farmers to dig water from underground. Confering to Cimmyt (1993), high-income farmers are less risk-averse, more access to information, low discount rate, and long-term development prospect. The outcome of this study is similar to the inferences of Deressa et al. (2008).

**Non-farm income**

This parameter is positively related to many land management strategies for climate change. For example, nonfarm income expressively increases the probability of pond construction, and, tree planting and construction of terracing as adaptation actions. This implies that when farmers have an alternative to non/off-farm income, they are inspired towards capital intensive strategies. This study is parallel to Deressa et al. (2009), who reported that having non-farm income motivates farmers to use different adaptation strategies.

**Farm size**

This has been found to be significantly related to planting trees at 5% significance. The possible justification is as farm size increases by one qada (a local term which is equivalent to $\frac{1}{4}$ of a hectare) the probability of planting trees increased more likely by 1.504 times in comparison to those farming households whose farmland is small. But, farm size is negatively correlated to many of the land management strategies. The result implies that most of land management strategies engaged by farmers are agriculture–based. Those farmers who do not have land (have a small farm size) may not have chance other than traveling to other places and involving in off-farm activities where employment opportunities are vacant. The finding of this study is in line to the study Atinkut and Mebrat (2016) which gave similar justification to this study. However, it contradicts the study of Temesgen (2010) which noted that farm characteristics highly determine the need for a specific option to climate change rather than the size of the farm.

**Access to extension services**

Access to extension service is one of the determinant variables that affect farmers' choice of adaptation options from the major category of institutional factors. Logistic regression models output indicate that extension contact has a significant association with the possibility of selecting the adaptation strategies such as compost and rainwater harvesting at $p < 0.05$. A unit increase in the frequency of extension contact is likely to increase the probability of the farmer to adapt the above adaptation methods by 2.081 and 2.321 times respectively higher than those farming households' who do not have access to extension services. This could be because of the fact that extension services create exposure to information on climate change adaptation strategies. The finding of this study is consistent with many empirical works in Ethiopia and abroad (Maddison, 2007; Nhemachena and Hassan, 2007; Yirga, 2007; Atinkut and Mebrat, 2016) who suggested that access to quality extension service means providing information to the farming community and that access to information, in turn, increases the probability of adapting to climate change.

**Farmer to farmer extension service**

In the Ethiopian context farmer to farmer, extension means that farmers sharing and looking at the experience of other farmers who are better in their agricultural activity performance. Similar to the expected, farming households who had access to extension services from model farmers increase the probability of using compost and planting trees increase more likely by 4.050,3.072
times respectively. This study is in line with Deressa et al. (2008); Menberu (2014) and Kide (2014) who reported the role of social capital in climate change adaptation.

Access to credit

Access to credit influence the likelihood of using different land management strategies to climate change compared to the farmers who have no credit access. This implies that the adoption of new technologies entails borrowing or owning capital that allows farmers to buy inputs (Deressa et al., 2009; Tesso et al., 2012; Kide, 2014). In this study, more than 94 percent of the respondents have opportunity/access to get credit, but who took credit is found to be 33 percent due to high-interest rate and fear of inability to pay the credit. Farmers who took credit used the money out of the purpose of climate change adaptation strategies such as for daily consumption and building house. This means that took the credit and using the credit for adaptation purposes influence the adoption strategies than access to credit.

Agro ecological setting

Agro-ecological zones have created positive and significant variations among farming households in the adoption of different climate change adaptation strategies. For instance, farming in the dega zone increases more likely using irrigation, changing planting date, compost, rainwater harvesting, construction of water ponds, and planting trees by 14.691, 4.351, 2.411, 3.727,31.209, and 26.078, times respectively, compared with farming in wayna adega and kola.

Conclusions

The farming households of the study area have attempted to give a response to the impacts of the changing climate. Their ability to adapt to the problem is challenged by several factors that are indispensable to land management strategies. Model results indicate that, agro ecological setting and non-farming activities are found to be the most statistically significant determining factor in the adoption of land management strategies. In comparison to government extension service, farmer to farmer extension is found to be a statistically significant determinant of the choice of adaptation strategies. This implies that farming households learn what suitable adaptation strategies is from neighbors/their peers than the external bodies. In this study, most adaptation strategies have been practiced in mass mobilization and there have been common adaptation strategies in the locality. These have posed difficulty to understand the difference resulted from the socio economic and demographic profiles of farmers in the choice of different adaptation strategies. As result, further study at agro ecology and farm level would be required to realize the underlying factors that determine the tendency of agrarians to apply land management strategies against climate change impacts.

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