Determinants of adaptation strategies to climate change among the smallholder farmers in Adama District, Ethiopia

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Abstract

Purpose – The Ethiopian economy is mainly based on the rain-fed agriculture practiced by smallholder farmers. The sector is highly vulnerable to climate change impacts. This study aims to examine the determinants of adaptation strategies to climate change among the smallholder farmers in Adama District, Ethiopia.

Design/methodology/approach – A cross-sectional survey design was used to collect quantitative data using questionnaire with 351 randomly selected smallholder farmers. To collect qualitative data focus group discussions, key informant interviews and field observations were also used. Triangulated with thematic analysis, descriptive statistics and binary logistic regression model were used for the analysis.

Findings – The result indicated that the majority of the smallholder farmers use at least one climate change adaptation strategy in their local areas though the strategy is generally weak. In this regard, some of the dominant climate change adaptation activities identified in the study area are using improved crop varieties, planting trees, watershed management, adjusting planting date and terracing. The result from binary logistic regression model showed that age and sex of household head, as well as their education, family size, access to

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agricultural extension services and training on climate change significantly influence the practices of adaptation measures.

Originality/value – This study would help the practitioners to modify the existing weak adaptation activities by introducing advanced and technological-based adaptation strategies to the rural farming communities.

Keywords Strategies, Adaptation, Climate change, Determinant, Smallholder farmers, Adama

Paper type Research paper

1. Introduction

Nowadays, climate change is the most critical global concern as it is affecting all nations and regions of the world differently depending on their contexts. The concern is due to its huge impact on environmental, economic and social aspects of the world communities (Hargreaves *et al.*, 2005; Aklilu and Alebachew, 2009; IPCC, 2014b). The earth's climate is still changing, posing a serious challenge on the environment, and hence on the lives in it. It is widely accepted among scientists and communities of practice that climate change rigorously influences the major environmental components that are directly related to the well-being of the world nations. In this case, the developing countries and the poor are the most vulnerable group. This is because the countries and their people are characterized by low adaptive capacity to climate change due to limited financial resources and minimal access to technology (Mannke, 2010; AMCEN, 2011; Maponya and Mpandeli, 2012). The problem is further aggravated by the existing challenges such as poverty, high unemployment, inequality, complex degradation of resources, poor dissemination of information, shortage of educated human resources, ecosystem disturbance and recurrent disasters. Scientific communities agree that the change in climate is mainly attributed to anthropogenic factors (Winkler, 2010; Ofuoku, 2011; IPCC, 2014b).

Though the impacts of climate change varies temporally and spatially, the threat to rain-fed crop production is considered the most prevalent as future impacts are again projected to worsen following change in temperature and precipitation (Dinar *et al.*, 2008; Kurukulasuriya and Mendelsohn, 2008; Deressa *et al.*, 2011). Similarly, climate change is very likely to have an overall adverse effect on the yields of major cereal crops (Deressa *et al.*, 2008; IPCC, 2014b). According to some studies (Deressa *et al.*, 2008; Jensen, 2011; IPCC, 2014b), the observed climate change would make even people face losses in terms of their daily activities and routines, change in planting seasons, experience decline in crop yield and biomass production, encounter increased risk of food shortage and famine. Smallholder farmers in poor and least developing countries feel more harshly the negative impacts of climate change.

Even if the levels of greenhouse gasses were kept constant at the existing values, the climate change would continue to pose threat in the coming decades due to the inertia of the climate system (Camino, 2010; Oswald and McNeil, 2013) regardless of mitigation measures (Mertz *et al.*, 2009; IPCC, 2013). With the unavoidability of significant climate change impacts through mitigation approach (Farber, 2011), adaptation is a necessity as its effects manifest relatively almost immediately (Fussel, 2007). Similarly, Hassan and Nhemachena (2008) point out that with increasing realizations of low stage of adaptive capacity and vulnerability to climate impacts in low income countries, the need of adaptation is so urgent because it can take place at regional or local level. Adding to this, Esham and Garforth (2013) indicate that the susceptibility of smallholder farmers to change of climate is increasingly growing in low-income countries. This shows that adaptation to climate change strategies is a fundamental factor for their living as agriculture is the only source of income

the majorities of them. Though smallholder farmers have a long records of managing the impacts of climate-related events (Kotir, 2011), further adaptation actions will be needed to reduce the projected negative impacts of climate change.

Climate change has far-reaching implications to the Ethiopian farmers as the majority of the people practice rain-fed crop production. The country has already begun practicing adaptation strategies, but efforts are still at a relatively early stage: it is almost more appropriate to say that the attempts are fragmented and limited. In line with this, a research undertaken in southern part of Ethiopia by Hurst *et al.* (2012) indicate that adaptation to climate change often takes place in the form of small changes. Much of the actual efforts to climate change adaptations are taking place in the context of inappropriate policies, amidst maladaptive practices, poor institutional frameworks and implementation practices.

Considerable studies have been carried out on adaptation strategies of climate change and their determinants in some areas of the country (Deressa *et al.*, 2008; Deressa *et al.*, 2011; Di Falco, 2009; Tazeze *et al.*, 2012; Tessema *et al.*, 2013; Belay *et al.*, 2017). Nevertheless, none of them has focused explicitly on the Central Rift Valley region of Ethiopia, specifically Adama district, the current study area. As a result, adaptation strategies to climate change practiced by smallholder farmers and their determinant factors of the study site have not been sufficiently identified and documented. The shortage of documented data about climate change adaptation in Africa including Ethiopia has been also acknowledged by McSweeney *et al.* (2010). Furthermore, most of the studies were concentrated in Nile Basin of Ethiopia (Deressa *et al.*, 2011; Di Falco *et al.*, 2009) and the studies did not address explicitly adaptation strategies of smallholder farmers at the farm level as they used regional data. To cement the existing research gap, this study, therefore, set out to analyze the major determinants of adaptation strategies to climate change practiced by the smallholder farmers in Adama district. The study also aims at examining the ongoing climate change adaptations strategies used by smallholder farmers in the study area. Knowing the adaptation practices and the major determinant factors will help for designing policies that can tackle major problems associated with adaptation activities to climate change.

2. Description of the study area

The term "Adama" is said to have originated from an Oromo word "Adaamii," the name of a tree species that was abundantly growing in the area (Figure 1). It is a variety of "cactus" tree in English (APO, 2004). Hence, the area is named after cactus tree that was found widely in the area during its establishment. According to Finance and Economic Development Office of the District (FEDAD) (2014), in Adama District there are about 29 sectoral offices, 37 *kebeles* (smallest administrative units), 4 towns and 18 NGOs having their own mandates and responsibilities. Adama is one of the 10 districts in East Shewa zone and one of the 180 districts in Oromia Regional State of Ethiopia. Adama district is bordered in the south by Arsi zone, in the southwest by Koka Reservior, on the west by Lome, on the north by the Afar Region and on the east by Boset district. It is located at about 100 km southeast of the capital city of the country, Addis Ababa. As indicated in Figure 1, it is located between 8° 33'35′N–8°38′46N latitudes and 39°10′57′E–39°30'15′E longitudes.

Some of the key livelihood activities practiced in the district are agriculture, industry and construction, agriculture being the domination activity. Adama is one of the agriculturally rich districts of East Shewa zone. Though its major soil is characterized by low water retention capacity, it is relatively fairly productive particularly during periods of sufficient rain. Some of the major crops produced in the district are teff, wheat, barely, maize, sorghum and bean. Cereals and pulses accounted for 96% of the cultivated land (CSA, 2012). The

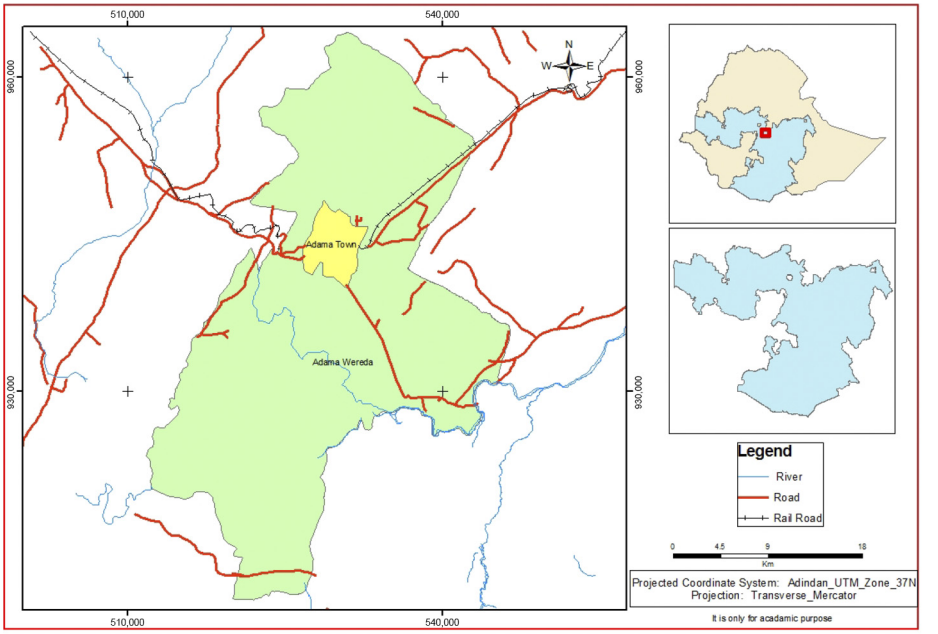

Figure 1.
Map of Adama district in Ethiopia

Source: Developed by the researcher based on EthioGIS data using ArcMap 10.2

most commonly used methods of maintaining soil fertility in the district are using organic fertilizer and agroforestry.

3. Research methodology

3.1 Research design

To address the stated objective, the study applied a cross-sectional survey research design to guide the whole processes of this research i.e. from data collection to its analysis. This design has been used based on the nature of the research problem and the objective of this article. In cross-sectional survey research design, mainly questionnaires and/or interview checklists are applied to gather both quantitative and qualitative data at a single point in time (Bryman, 2008). Both primary and secondary data sources were used to address the objectives of the study. The data collection tools were household survey questionnaire, focus group discussion, key informant interview and observation.

3.2 Data sources and data collection tools

Before administering the questionnaire, head of each household was informed about the aim of the study and asked for his/her consent to provide the necessary information for questions contained in the data collection tools. Both close and open-ended questions were prepared to gather data about the adaptation strategies and the determinants of adaptation strategies of climate change from the perspectives of smallholder farmers. The survey questionnaire was administered with the support of experienced research assistants. Each of the questions in the questionnaire was discussed with the research assistants before starting the field survey. This gave the assistants the opportunity to help the respondents who

cannot read and write. The data was collected between February and April 2016 during the weekdays and the weekends as the smallholder farmers are not busy during that specified season.

A total of six focus group discussions each consisting of six members at a time (one in each sampled *kebele*) were conducted. The participants who participated in the questionnaire were excluded from key informant. As much as possible suitable conditions were set for the discussants so allow them to discuss issues under investigation in their own languages. Semi-structured checklists on adaptation strategies to climate change and their major determinants were developed to guide the discussions. Each focus group discussion was conducted by the researcher and an assistant who played a facilitation role.

A key informant interview is among the essential instruments used in this study with the intention of capturing more firsthand data. The key informant interview guide was prepared based on the data collected from both the focus group discussions and the household questionnaire survey and the data that need further elaborations. This helped using multiple data collection tools to triangulate the data obtained using different tools. The interviews were conducted with elderly farmers, agricultural extension workers and experts at *kebele* district, zonal and regional levels. Based on the scope of their responsibilities, they attempted to provide scientific facts and views about the problem under investigations.

With the guidance of the *kebele* chairpersons, elderly people, agricultural extension workers multiple field visits were conducted in sampled *kebeles*. This enabled the researchers to gain first hand overview of the level of climate change adaptation practices in the area. In the meantime, the researchers tried to substantiate and augment farmers' responses with actual physical observations. Finally, various experts and administrators were consulted to look into the real climate change adaptation strategies.

To maintain the reliability and validity, the instruments have been reviewed by experts of the field. Accordingly, most of the comments received from the experts were related to repetition and length of some questions of the questionnaire. As a way of ensuring the reliability and the validity of instruments, data triangulation techniques were also used in this manuscript. To include all important variables in data collection instruments, several research works were also reviewed (Deressa *et al.*, 2011; Tazeze *et al.*, 2012; Tessema *et al.*, 2013; Belay *et al.*, 2017). Questions used in these research works were tested for their validity and reliability. Thus, some questions were adopted from previously tested questionnaires by modifying them in a way that they fit the need and the context of this manuscript.

3.3 Determination of sample size and sampling strategy

Two stage sampling techniques were used to come up with an appropriate representative sample size. In the first stage, as the sites of the study area are almost similar in practicing climate change adaptation strategies, a total of six *kebeles* were taken into considerations out of the total *kebeles* found in the district using simple random sampling technique. Accordingly, in this stage, six *kebeles* Adulala Boku, Kilnto, Kachema, Didimtu, Awash Melkasa and Battu Degaga were selected. The *kebeles* were selected in such a way that they can be representative of the district in biophysical, agricultural practices, climate change adaptation practices and socio-economic aspects. Simple random sampling technique was used because the researchers thought that the sampling frames are somewhat homogeneous. Finally, systematic random sampling technique was used to draw the sample size households from the *kebeles*. The statistical formula developed by Yemane (1967) was used to determine the sample size as follows: Thus:

$$n = \frac{N}{1 + N(e)^2} \quad (1)$$

According to the unpublished document obtained from Adama district administration, the total number of the households in the respective *kebeles* are Adulala Boku (578), Qilnto (407), Kachema (524), Didimtu (397), Awash Melkasa (451) and Battu Degaga (519) making a total of 2,876 households. Hence, using the equation (1), sample size was determined as follows:

$$n = \frac{2876}{1 + 2876\,(0.05)^2} = 351 \quad (2)$$

Purposive sampling technique was used to identify key informants and focus group discussants that were thought to be profoundly well-informed about climate change adaptation practices and their major determinants. Accordingly, seven individuals were thoroughly interviewed, and 36 individuals were grouped into six heterogeneous focus group discussions. The very objective of having the key informants and the focus group discussants is to figure out the theme of the study from the ideas and the opinions raised from varied groups. The purposive sampling was mainly based on their special engagement in the issues of climate change adaptation and their major determinants. In other words, it was believed that they have sufficient knowledge about the area and that they can memorize historical trends of adaptation practices.

3.4 Data analysis techniques

Before carrying out the analysis, the household questionnaires were coded and organized. The coding system was prepared during the questionnaire development. Following the coding system, all the valid household questions were input in a coherent format of a Statistical Package for Social Sciences (SPSS) version 20 database for processing and analyzing purpose. Then, using descriptive statistics such as frequency distribution, the collected data were interpreted in line with the stated objectives. During the analysis and interpretation, the data collected from both qualitative and quantitative methods were cross-checked, sorted, summarized and categorized into themes. In this process, the qualitative and the quantitative data were combined in explaining, confirming, refuting and enriching the data obtained through different instruments. The analysis of the qualitative data was carried out using case summaries and thematic content methods thereby categorizing the data into themes based on their similarities.

In addition, the binary logistic regression model was also applied to identify the determinants of adaptation to climate change practices of the smallholder farmers. This model is the relevant statistical model when the dependent variable is dummy in its nature. In this study, the dependent variable was represented by 0 and 1 indicating the appropriateness of the model. In this case, the smallholder farmers who practiced at least one climate change adaptation strategy in their farming were coded as 0, while those who did not practice any of the strategy were coded as 1 throughout the model. Kothari (2004) states that an application of this model is essential to identify the influence of the independent variables on the outcome variable. Identifications of independent variables were carried out based on the existing literatures and knowledge of the study area about climate change adaptation strategies practiced by the rural farming communities. The summary of independent variables is presented in Table 1. Accordingly, the model is represented as:

Independent variables	Measurement	Expected sign
Sex of household head (x_1)	Takes the value of 0 for male and 1 for female	+/−
Family size of household (x_2)	Less than six family members takes 0 and 1 otherwise	+
Age of household head (x_3)	Less than 40 years old takes 0 and 1 otherwise	+/−
Marital status of household head (x_4)	Takes the value of 0 if unmarried and 0 for otherwise	+
Education of household head (x_5)	Cannot read and write takes 0 and 1 otherwise	+
Duration of the stay (x_6)	Lived in the study area for less than 40 years takes 0 and 1 otherwise	+
Training on climate change (x_7)	Have access to training takes 0 and 1 otherwise	+
Weather related information (x_8)	Have access to information takes 0 and 1 otherwise	+
Agricultural extension services (x_9)	Do not have any contact takes the value of 0 and 1 otherwise	+

Table 1. Summary of variables, their measurement and expected sign

$$\Pr(\textit{climate change adaptation strtegies}) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8 + \beta_9 x_9 \quad (3)$$

4. Results and discussion

4.1 Characteristics of the respondents

According to the survey of the households, the majority of the respondents are men (82.9%) which are almost similar with the national coverage as revealed by CSA (2012). According to this source, only 18% of households in rural areas of Ethiopia are headed by woman due to natural and social-related factors including death and separation of the couples. As indicated in Table 2, nearly half (49%) of the respondents have got a family size of 4–6 members, while those with family members between 7–9 constitute 32.8%. According to the data, the study area is relatively characterized by households with larger family size indicating the potential for the increment in population size in the study area. The mean of the family members in study area was six which is similar with the report of CSA.

Variables	No. of respondents	(%)
Sex		
Male	291	82.9
Female	60	17.1
Family members		
1–3	38	10.8
4–6	172	49
7–9	115	32.8
10–12	23	6.6
13–15	3	0.8

Source: Compiled from field survey result

Table 2. Sex and family sizes of the respondents

According to CSA (2012), on average, one household in rural regions has about five individuals.

With respect to age, indicated in Table 3, the majority of the respondents (45.9%) were between 41–50 years, while the respondents whose age group was 31–40 years constituted about 31.1%. In the same way, 19.9% and 2.6% of the respondents were in age group of 51–60 years and less than 30 years, respectively. This shows that even though there is high variability in the ages of the sampled households, they are generally within the productive age that can fully and efficiently engage in agricultural activities.

According to Table 3, some of the respondents (36.5%) have not gone beyond Grades 1–4 level of education, whereas about 29.1% of the respondents are those who cannot write and read. Those respondents who completed Grades 5–8 constituted about 21.9% and the remaining 12.5% of them are those who have better educational level (above Grade 9). This has significant impact on the practices of modern climate change adaptation strategies because a minimum threshold qualification is necessary for the activities related to climate change adaptations. Relating agricultural practices with qualification of farmers, Asfaw and Admassie (2004) state that for agricultural productivity to be enhanced educational status of farmers has to be enhanced as it plays a significant role in applying adaptation activities.

The duration of the stay in study area has significant implications in identifying historical profile of climate change and its adaptation practices. As it can be seen from Table 4, out of the total respondents, the majority (36.8%) of them have lived in study area for about 41–50 years. Those respondents who lived for more than 50 years account 25.6%, while 20.8% of them have lived in the study area for about 31–40 years. Again, the respondents who have lived in the study area for less than 31 years accounted for only 16.8%. This appears to be *s* logical to collect data pertinent to climate change and its adaptation practices from communities who lived in the area for longer period of time as they can easily provide climate related data over the past 30 years.

The result of the survey also revealed that majority (87.7%) of the respondents have not attended any training on climate change issues (Table 4). This scenario limits the probability of undertaking climate change adaptation techniques as training is believed to be an essential input for implementing new technologies. With regard to access to weather related information, only about 17.4% of the respondents have access, while large

Table 3.
Age and educational level of the respondents

Variables	No. of respondents	(%)
Age		
Less than 30	9	2.6
31–40	109	31.1
41–50	161	45.9
51–60	70	19.9
Greater than 60	2	0.6
Education level		
Not read and write	102	29.1
Grade 1–4	128	36.5
Grade 5–8	77	21.9
Grade 9–12	26	7.4
Certificate and diploma	8	2.3
First degree and above	10	2.8

Source: Compiled from field survey result

Variables and their attributes	No. of respondents	(%)
Duration of the stay in study area		
Less than 21	33	9.4
21–30	26	7.4
31–40	73	20.8
41–50	129	36.8
Greater than 50	90	25.6
Access to training on climate change		
Got training	43	12.3
Not got training	308	87.7
Access to weather related information from stations		
Accessible	61	17.4
Not accessible	290	82.6
Contact with agricultural extension services per month		
There is contact	83	23.6
No contact	268	76.4

Source: Compiled from field survey result

Table 4. Duration of the stay and access to information about climate change

proportions (82.6%) of them have no access to weather information given from the stations (Table 4). This implies that most of the rural farming communities do not make use of the information provided by the stations which adversely affects them to carry out adaptation practices. Deressa *et al.* (2008) argues that accessibility of information about climate change characteristics by farming community can accelerate and diversify the implementation of climate change adaptation strategies. Regarding the contact with agricultural extension services per month, only about one fourth of the respondents reported that they have access to advices of agricultural officers (Table 4). This implies that most of the farming communities of the study area rely on their own experiences for the information about climate change issues. Some of the smallholder farmers rely on the local knowledge or indigenous knowledge system due to lack of access to extension services and climate advisory information. This is also an indication to revisit the interaction between rural remote farming communities and agricultural extension workers with respect to the content and communication approach.

4.2 Climate change adaptation strategies

Respondents were asked to indicate their views to find out whether there has been implementation of climate change adaptation activities by smallholder farmers or not. Accordingly, out of the total respondents of the study, 291 (82.9%) of them indicated that they have carried out various climate changes adaptation activities in their localities, while the remaining 60 respondents (17.1%) of them have not carried out adaptation activities due to several reasons (see determinants of climate change adaption strategies section). Belay *et al.* (2017) has conducted a study on climate change adaptation issues in Arsi Negelle district – central rift valley region of Ethiopia. The study found out that 85% of smallholder farmers were practicing diverse types of climate change adaptation strategies. As Arsi Negelle district is close to Adama district, the proportions of smallholder farmers practicing climate change adaptations strategies are similar with this study. The finding of the current study is also consistent with the observations made by Legesse *et al.* (2013) and Tessema

et al. (2013) who state that the majority of the farming communities have carried out various climate change adaptation strategies in response to climate change impacts. It is possible to conclude that the majority of the farming communities in the study area have understood the role of climate change adaptation activities in minimizing crop damages by practicing adaptation activities. In other words, the majority of the rural communities apply at least one climate change adaptation strategy in their local areas. This *n* clearly concords with the result obtained through key informant interviews and focus group discussions. However, most of the respondents are of the opinion that the ongoing activities are not sufficient for minimizing the effect of climate change on farming activities. This is because most of climate change adaptation strategies being implemented by smallholder farmers are largely characterized by simple adaptation measures.

Moreover, these respondents who practice adaptation activities in response to climate change were again asked to identify the major adaptation strategies they undertake in their farming practices. Accordingly, the respondents identified different adaptation activities which include changing quantity of land under cultivation, shifting livelihood from farming to non-farming activities, diversifying crops, selling off household assets, implementing soil conservation techniques, practicing watershed management campaigns, planting trees, terracing and early planting. Most of the strategies identified by the respondents target physical activities as they are meant for increasing crop production.

Similarly, question regarding the major climate change adaptation strategies being implemented by the local communities were presented to the participants in focus group discussions conducted at various *kebeles* of study area. The data obtained from the participants include growing multiple crops on the same unit of land, conserving soil and water, increasing use of agricultural inputs such as compost and chemical fertilizers, using drought resistant crop varieties, using improved crop varieties and growing early maturing crop varieties. Accordingly, the focus group discussants mainly focused on crop-related activities and soil and water conservation practices as adaptation strategies. In fact, during the field observation it was clearly noted that as a result of huge community mobilizations, several promising works have been carried out. However, some of the climate change adaptation strategies being practiced in the study site are different from the methods identified by Legesse *et al.* (2013) and Tessema *et al.* (2013). This indicates that some adaptation methods are specific to a particular place.

4.3 Determinants of climate change adaptation strategies

To identify the determinants of climate change adaptation strategies, binary logistic regression model was applied and its specification was presented in the methodology part. The omnibus test of model coefficients has a χ^2 value of 156.549 on 9 degrees of freedom, which is significant at $p < 0.001$ suggesting that the model has a strong explanatory power. This indicates that the explanatory variables included have a high joint effect in explaining the condition of undertaking climate change adaptation activities. The model has got predictive efficiency of 82.9%, while 60% of variance in a dependent variable was explained by the model (Nagelkerke R^2 value is 60%). The analysis of the binary logistic regression revealed that marital status, duration of the stay in study area and weather related information were non-significant, while the remaining independent variables were found to be statistically significant to the practices of climate change adaptation activities (Table 5).

The likelihood of adapting to climate change in the study area is higher for male-headed household compared to female-headed household as hypothesized. This is so mainly because cultural and social norms of the community do not equally encourage and recognize

Variables	B	SE	Wald	df	Sig	Exp (B)
Sex of household head	1.637	0.441	13.806	1	0.000*	5.14
Family size of household	2.796	0.836	11.173	1	0.001*	16.375
Age of household head	−2.139	0.858	6.211	1	0.013**	0.118
Marital status of household head	0.159	1.137	0.02	1	0.889 ns	1.172
Education of household head	2.367	0.681	12.087	1	0.001*	10.66
Duration of the stay	−1.005	0.529	3.614	1	0.057 ns	0.366
Training on climate change	1.557	0.729	4.567	1	0.033**	4.745
Weather related information	0.19	0.647	0.087	1	0.769 ns	1.21
Agricultural extension services	3.137	0.5	39.386	1	0.000*	0.043
Constant	−1.976	1.16	2.903	1	0.088	0.139

Note: *Significant at 0.01 and **significant at 0.05 level, while ns represent non-significant
Source: Compiled from household survey data

Table 5.
Binary logistic regression result on determinants of adaptation activities

male and female household heads in physical activities. This finding is in line with Asfaw and Admassie (2004), who found out that female headed households are mostly characterized by small income sources and less likely to meet the requirement for physical activities.

Keeping other factors constant, an increase in family members of the households would increase the probability of practicing climate change adaptation strategies by odds ratio of 16.375. The contributions of large family members to adaptation activities are mainly attributed agricultural activities and adaptation methods that are very labor-intensive works. It is important to note that families with large members develop the work plan either on daily or weekly basis based on their ability to coordinate and facilitate their activities depending on the agricultural calendar. The majority of these families work as a team and they exchange ideas all the time. The result of this regression is concordant with the study of Gebrehiwot and Veen (2013), who found out that family numbers is the significant determinant of adaptation activities. Thus, farmers with large family members have higher probability of practicing adaptation activities.

According to the result of regression model presented in Table 5, a unit increase in the age of a household head would decrease the likelihood of practicing climate change adaptation activities in the study area holding other regressors constant. This is associated to the fact that younger farmers are characterized by their flexibility in decision-making process, in seeking support and information from government and non-governmental institutions and they have higher interest in dealing with the risk as compared to older farmers. During focus group discussion, it was observed that younger farmers are optimistic about the adaptation activities being practiced in their surroundings compared to the older farmers in the area. This could be due to the fact that young farmers do not want to stick to older traditional farming systems. These groups of young farmers would prefer to combine both local knowledge and conventional science to obtain good yields.

As it has been hypothesized, the result indicated that those households that can read and write have higher probability of undertaking climate change adaptation practices as compared to the households that cannot read and write holding other factors constant. Literate farmers are more responsive with regard to their farming technologies and they have better access to the scientific information compared to the

illiterate farmers. This further enables them to have exposure and practice adaptation to climate change in their farming level. The result is consistent or aligned with the findings of (Nhemachena and Hassan, 2007; Deressa *et al.*, 2008; Tazeze *et al.*, 2012) that indicated that education is a significant determinant of climate change adaption practices in rural farming communities.

Access to training on climate change related issues was found to be positive and significantly determine the practices of adaptation strategies. This implies that farmers who are trained on the management of climate change issues would practice more adaptation strategies than those who do not get access to the training (Table 5). As it was hypothesized, access to agricultural extension services also enhances the probability of undertaking climate change adaptation activities. In other words, smallholder farmers who have access to professional advice from extension workers are more likely to practice climate change adaptation strategies compared to those who do not get access to professional advice. Thus, the study revealed that access to the expertise of agricultural extension workers significantly determines the level of climate change adaptation activities of smallholder farmers (Table 5). This finding is in consonance with the studies of Tessema *et al.* (2013) and Belay *et al.* (2017).

5. Conclusions and recommendations

The study identified that planting trees, adjusting planting seasons, using improved crop varieties, practicing watershed management, diversifying crop and practicing terracing are some of the climate change adaptation activities applied by the smallholder farmers of the study area. Hence, from the smallholder farmers of the study area, experts and observations made in the field, it can be concluded that more than few climate change adaptation strategies are being practiced by significant proportions of the farming communities in the study area. The result from the binary logistic regression model also showed that age and sex of household heads, as well as their education, family size, access to agricultural extension services and training on climate change significantly influence the practices of adaptation measures.

To enhance the smallholder farmers' adaptive capacity of climate change, concerted efforts should be made by government institutions, individual farmers, farmers' cooperatives, non-governmental organizations and private investors. These stakeholders need to work hand in hand to enable the smallholder farmers to properly implement appropriate adaptation strategies. It is also suggested that the existing adaptation activities need to be modified in such a way that advanced and technological-based adaptation approach would be introduced. For this action, all the stakeholders should come together by the coordination of the Agriculture and Natural Resources Office of the district.

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