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Author's details:

Submitting Author	*Zerihun Yohannes Amare*
Position	*Ph.D student in Environmental Management*
Department, Institution	Department of Environmental management, Pan-African University, Life and Earth Sciences Institute (**PAULESI**)(Including Health and Agriculture), University of Ibadan, Ibadan, Nigeria.
Address	*University of Ibadan, Ibadan, Nigeria.*
Country	*Nigeria.*
Email	*zerihun.yohannes19@gmail.com/zamare0109@stu.edu.ng*
Phone	*+2348057332400*
Gender	*Male*

Title: BARRIERS TO AND DETERMINANTS OF THE CHOICE OF CROP MANAGEMENT STRATEGIES TO COMBAT CLIMATE CHANGE IN DEJEN DISTRICT, NILE BASIN OF ETHIOPIA

Zerihun Amare [1], Johnson Ayoade[2], Ibidun Adelekan[2], Menberu Teshome Zeleke[3]

[1]*Affiliation, Institution:* [1]ZA, Ph.D student ,in Environmental management, Department of Environmental Management, Pan-African University, Life and Earth Sciences Institute (**PAULESI**)(Including Health and Agriculture), University of Ibadan, Ibadan, Nigeria.

E-mail: zerihun.yohannes19@gmail.com

[2]*Affiliation, Institution:* [2]JA, Professor (Ph.D), IA, associate professor (Ph.D), Faculty of the Social Sciences, University of Ibadan, Ibadan, Nigeria. Email: ayoadejo@yahoo.com, ibiadelekan@yahoo.com

[3]*Affiliation, Institution:* [3]MZ, Assistant professor (Ph.D), Department of Geography and Environmental Studies, DebreTabor University, Debre Tabor, Ethiopia. Email: menberuteshome@gmail.com

Abstract

Climate change without adaptation is projected to impact strongly the livelihoods of the rural communities. Adaptation to climate change is crucial for developing country like Ethiopia due to high population and dependency on agriculture. Hence, this study was initiated to examine the barriers to and determinants of the choice of crop management strategies to combat climate change. The Intergovernmental Panel on Climate change (IPCC) concepts of climate change adaptation provided the framework. Stratified and snowball sampling techniques were employed to select a sample of 398 households. The household survey was employed to collect data on current adaptation strategies. Logistic regression was used to analyse the determinants of choice of adaptation strategies. Logistic regression analyses were carried out at $p \leq 0.05$. Small farmland size, agro-ecology, farmland location, financial constraints, and lack of skills were the major barriers to adoption of crop management strategies. Age, farming experience, income, family size, government experts' extension services, agro-ecology, and crop failure history of households were significantly related to the choice of most of the crop management strategies. Socio-economic and institutional factors determined rural communities' ability and willingness to choose effective adaptation strategies. Policy priority should be given based on agro-ecology and households demand of policy intervention such as providing extension services and subsidizing the least adopted strategies due to financial constraints.

Keywords: Climate change; adaptation; crop management; Blue Nile of Ethiopia

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1. Introduction

The scope of the study was limited to barriers to and determinants of the choice of crop management strategies to combat climate change in Dejen district, Nile basin of ethiopia The rural communities were included those who were engaged in farming and off-farm activities like livestock rearing and bee keeping among others who reside in the rural areas. According to Food and Agricultural Organization (FAO 2010), due to climate change and variability almost one billion people experienced hunger in 2010 globally.

There are many reasons or convincing arguments for a more comprehensive consideration of adaptation as a response measure to climate change. Firstly, given the amount of past greenhouse gas emissions and the inertia of the climate system, we are already bound to some level of climate change, which can no longer be prevented even by the most ambitious emission reductions (Füssel and Klein 2006). Second, the effect of emission reductions takes several decades to fully manifest, whereas most adaptation measures have more immediate and sustainable benefits (Rahman 2013).

Third, adaptations can be effectively implemented on a local or regional scale such that its efficiency is less dependent on the actions of others, whereas mitigation of climate change requires international cooperation. Fourth, most adaptations to climate change also reduce the risks associated with current climate variability, which is a significant hazard in many world regions. According to (Gbetibouo 2009), there are two adaptation assessment approaches namely, top-down and bottom-up assessment approaches. The top-down approach starts with climate change scenarios, and estimates impact through scenario analysis, based on which possible adaptation practices are identified. Most of the top-down adaptations represent possible or potential measures, rather than those that have been used (Gbetibouo 2009).

Most studies, eg.(Segele and Lamb 2005, NMA 2007, You and Ringler 2010) carried out in Ethiopia and Africa using top-down approach predicted the impact of climate change on the agricultural sector with adverse effects on crop yields. The bottom-up approach takes a vulnerability perspective where adaptation strategies are considered more as a process involving the socio-economic, and policy environments, and elements of decision-making (Gbetibouo 2009). In line with this notion (Schröter, Polsky, and Patt 2005) argue that in choosing adaptation options to climate change and developing policies to implement these possibilities the affected community should actively participate. This study adopts the bottom-up approach that seeks to identify actual adaptations at the local level and the factors that appear to be driving them in the case of Dejen district, Nile Basin of Ethiopia.

Small farmland size, agro-ecology, farmland location, financial constraints, and lack of skills were the major barriers to adoption of crop management strategies. Age, farming experience, income, family size, government experts' extension services, agro-ecology, and crop failure history of households were significantly related to the choice of most of the crop management strategies.

2. Methods

The study employed cross-sectional research design with both quantitative and qualitative research methods. This study used a multi-stage sampling technique to select the agro-ecology, Kebeles (the lower administrative unit next to district), and households. At the first stage, Dejen District of the Nile Basin was selected purposely due to its highly undulated topography and frequent susceptibility to extreme events and representativeness of the three agro-ecological zones such as highland, midland, and lowland. In the second stage, six kebeles (two from each agro-ecological zone) were selected purposely based on the above-listed district selection criteria. Climate change affects the rural communities differently in different agro-ecological zones. As a result, communities' knowledge and skill to adapt to the climate change impacts varies from place to place or agro-ecological settings. In the third stage, stratified sampling was employed to select households. Under the stratified sampling, the population was divided into male and female-headed households, and then the sample was selected from each male and female-headed household to constitute a representative sample. The sample size was determined proportionately. In Ethiopia, in some of the rural communities, disclosing of the marital status of older females is culturally not allowed or not feeling comfort them. Thus, to get female-headed households, snowball sampling was employed. Based on the formula provided by (Yamane 1967) at the 95 % confidence interval and 5%, level of precision. 398 households were selected at the six kebeles of the district.

The study used both primary and secondary data sources. The primary and secondary data sources were both quantitative and qualitative. The study used two main data sources to analyse the barriers and determinants of

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the adoption of crop management strategies to climate change. The data was collected by the trained data collectors under close supervision of the author in the period March to October 2016. To assess whether the instruments were suited and appropriate to the study, the pretest of questionnaires to 10% of the sampled households from the three agro-ecological zones was done

Methods of data analysis

Both descriptive statistics and inferential statistics were used for analysing the quantitative data collected from primary and secondary sources. SPSS (Statistical package for social science version20) was used to perform data entry and statistical analysis. The descriptive statistics used in this study were percentage, mean, maximum, minimum, and frequencies to summarise and categorize the information gathered. The inferential statistics used in this study was binary logistic regression. The logistic regression was used to analyse determinants of the choice of crop management strategies.

Test of Goodness-of-Fit and Multicollinearity

The fitness of the logistic regression model to the data was measured by applying the SPSS classification table (crosstabs), and the Hosmer-Lemeshow test. Collinearity among predictor variables was checked using multicollinearity statistics. The Hosmer-Lemeshow test used 95% confidence interval (CI) and asymptotically follows a X^2 distribution to assess whether or not the observed event rates match expected event rates in subgroups of the logistic regression model. Empty cells or small frequency were checked by doing crosstabs between categorical predictor variables and the outcome variables. When the cell has very few cases, the model becomes unstable. The Hosmer-Lemeshow statistics indicate a poor fit if the significance value is less than 0.05(Kothari 2014, SPSS Version20). Techniques to remedy these problems were by using; 1), re-categorized and 2), dropping the least theoretically important predictor variables that contribute to the model a poor fit to the data. Multicollinearity was assessed by examining tolerance and variance inflation factors (VIF). The variance inflation factor (VIF) quantifies how much the variance is inflated. The tolerance is the percentage of the variance in a given predictor that cannot be explained by the other predictors. When VIF>5, X(the explanatory variable) is highly correlated with the other explanatory variables (Kothari 2014, SPSS Version20).

3. Results

Barriers to adaptation strategies

Implementation of adaptation strategies used by the rural communities varied among households. The study identified a number of constraints faced by the households to adopt crop management strategies to combat climate change.

Crop-diversification: The major constraints identified by respondents to not to adopt crop diversification were: small land size(57%) followed by soil fertility decreasement (25.3%), shortage of money to buy some expensive crop varieties (1.3%), shortage of labour (2.5%) to implement some labour intensive farming practices and they prefer the easiest crop type, lack of skill (3.8%) to sow different crops and stick to one types of crop, topography of farmland location (2.5%) which permits only some crop types, and the remaining (2.5%) do not/have small land size. The majority (58%) of rural communities have less than 1.2 hectares. As a result, small land size/ no land at all consequences as barriers to the choice of decision to adopt adaptation strategies. On the other hand, rural communities who are located in the lowlands of the undulated topography encountered farm soil fertility decreasement. Due to this reason, farmers were obliged to leave their farmland (fallowing) for some periods instead of diversifying different crops as an adaptation strategy to climate change.

Improved seeds: The study communities adopt improved seeds (84.4%). However, the remaining households did not use improved seeds for one or another reason. Financial constraints (42.6%), lack of skills (18%) on how to use, compatibility problems with their farmland (16.4), small/no land at all (13.1%) and lack of information (9.8%). Rural communities need all the support they can get to fight the adverse impacts of climate change and extreme weather events. Improved seed varieties developed by research institutes offer higher yields and stronger resistance to challenges related to climate change such as drought. Improved seed tolerates weeds and other climate change-related diseases.

Changing planting dates: Planting dates are growing season during which the rainfall and temperature allow plants to grow. Of the households interviewed, 78.9% used changing planting dates whilst others do not use this method. Among those who did not use changing planting dates, 87.6% of the respondents attributed lack of skills as a barrier to adaptation methods while 12.3% have not/small land size.

Replanting damaged crops: Weather events such as flooding, hailstorms, disease outbreaks can damage previously planted crops in all or a portion of farm fields. This requires technical assistance for decision making in replanting. The majority (92.5%) of respondents replant their failed crops. However, among those who did not use, the majority (63%) of households indicated lack of skills about future weather forecast and economic return of the replanting, suitability of land and cropping season (7.4%) and small land size/no land (29.6%) contributes for not using replanting damaged crops.

Determinants of choice of crop Management strategies

Changing crop management practice is one of the adaptation practices to climate change impacts. For this study using crop diversification, improved seeds, changing planting date and replanting failed crops were selected in the context of the study sites. The applications of these strategies have been determined by a number of socio-economic, biophysical, and institutional factors (see Table 1).

Crop diversification

The logistic regression model results indicated that age of household head (36-55), the income of households (10,000-30000, 30,001-50, 000,>50,000), agro-ecology (midland), access to government experts extension services, and farmland size has a significant effect on adoption of crop diversification.

Age: Adult age headed households have a significant (Sig. =0.010) effect on adopting crop diversification. This means adult, (age36-55) are 3.506 times more likely to use crop diversification than young headed households (age 18-35

Income: Income has a positive and significant(Sig=0.000) effect on adopting crop diversification. Exp (B) of income (10,001-30,00)8.481times,income(30001-50,000)17.510times,andincome (>50,000)18.539times more likely diversify crops than low- income groups (<10,000).

Access to government experts' extension services: This formal extension service from government experts has significant (Sig=0.003) effect on adopting crop diversification to combat climate change impacts. The beta coefficient shows an inverse relation (-1.306) in adopting adaptation strategies. This indicates households who did not get extension service; there is a decrease in the log of odd of diversifying crops by 1.306. The Exp (B) of 0.271 indicates that households who did not get formal extension service were only 0.271 times (i.e., much less) likely to diversify crops than households who have got extension service during 12 months of the year.

Agro-ecology: Significant variation in the adoption of crop diversification was observed across agro-ecological zones (midland, Sig=0.036). For example, higher crop diversification was identified in the midland than highland and lowland agro-ecological zones. The Exp (B) of 4.082 indicates households who live in the midland 4.082 times more likely to use crop diversification than highland households. The Exp (B) of 0.496 indicates the lowland households are only 0.496 times much less likely diversifying crops than highlands. This means highland households are 2.016times more likely diversify crops than lowland households (i.e., invert, 1/0.496=2.016).

Farmland size: Farmland is the most significant (Sig=0.001) factor to diversify crops in the study communities. The beta coefficient of households having farm size of >1.2hectare has a positive relation to diversify crops. This implies there is an increase in the log of odds in diversifying crops by 1.455. The Exp (B) of 4.286 means households having farmland size >1.2 hectares are 4.286 times more likely diversify crops than households with <1.2hectare farmland.

Improved seeds

In the context of this study, improved seeds include high yielding varieties, drought tolerant, short maturing, pest and disease resistant species either induced or indigenous. The logistic regression model result indicated that; age, farming experience, income, and agro-ecology have a significant effect on explaining the adoption of improved seeds by households (See Table1).

Age: Adult age headed households (36 to 55) have a significant (Sig. =0.010) effect on adopting improved seeds (Sig. =0.011). The beta coefficient (+1.415) shows positive relationships in explaining adopting improved seeds. This indicates there is an increase in the log of odds of using improved seeds by 1.415 in adult headed households (HHH1). Exp (B) of 4.115indicates, adult age headed households are 4.115 times more likely to use improved seeds than young and old age headed households.

Farming experience: Farmers in the range of farming experience 10-20 years (HHH1) has a significant effect on adopting improved seeds (Sig. =0.000). The beta coefficient indicates positive relationships in adopting improved seeds. This implies there is an increase in the log of odds by 2.319 in using improved seeds. The EXP (B) of 10.166, indicates farmers having farming experience of 10-20(HHH2) are 10.166times more likely adopt improved seeds than households having farming experience of fewer than 10 years (HHH), 21-30 years(HHH2) and >30 years(HHH3).

Table 1. Determinants of choice of crop management strategies

Predictor variables	Crop diversification		Improved seed		Changing planting date		Replanting	
	Sig	Exp(B)	Sig	Exp(B)	Sig	Exp(B)	Sig	Exp(B)
Sex_HHH(1)	.170	1.850	.983	.991	.055	.376	.104	.332
Age_HHH	.035		.039		.102		.008	
Age_HHH(1)	**.010***	3.506	**.011***	4.115	.092	2.360	**.005***	5.416
Age_HHH(2)	.110	3.662	.111	3.886	**.038***	5.985	**.014***	32.143
Edu_HHH(1)	.731	1.149	.226	1.690	.725	.867	.456	1.513
Farm_exp_HHH	.233		.004		.046		.603	
Farm_exp_HHH(1)	.108	2.384	**.000***	10.166	.120	.428	.261	2.246
Farm_exp_HHH(2)	.884	.917	.238	2.100	**.007***	.209	.496	1.796
Farm_exp_HHH(3)	.533	.636	.078	3.943	**.018***	.190	880	.864
Income_HHs	.000		.013		.097		.697	
Income_HHs(1)	**.000***	8.481	**.012***	3.408	.639	1.378	.558	1.490
Income_HHs(2)	**.000***	17.510	**.029***	3.632	.051	4.163	.241	2.701
Income_HHs(3)	**.000***	18.539	**.002***	9.064	.281	2.275	.444	1.998
Family_size_HHs(1)	.820	.902	**N/C**	**N/C**	.416	1.490	**.002***	.101
Weather_inf_HHH(1)	.364	.668	.182	.526	.102	.533	.774	.848
Farmer to farmer extension (1)	.809	1.118	.424	1.455	.658	.806	.093	3.286
Government experts extension(1)	**.003***	.271	.635	.815	.124	.520	.064	.290
Agro_ecol_HHs	.005		.000		.000		.022	
Agro_ecol_HHs(1)	**.036***	4.082	.055	5.446	**.002***	5.412	.200	2.922
Agro_ecol_HHs(2)	.093	.496	**.002***	.218	**.000***	145.815	**.006***	11.247
Farmlandsize(1)	**.001***	4.286	.865	.931	**.000***	.150	**.02***	4.570
Crop failure	**N/C**	**N/C**	.205	1.656	**.044***	.345	.211	0.146
Constant	.121	.245	.305	.347	.002	23.795	.894	1.196

Source: Computed from household survey, March-October (2016), "**N/C**" stands for not computed, "HHH", stands for household head and "HHs" stands for households

Income: Income of households has a positive (Beta, +1.226, +1.290, and +2.204) and significant (Sig. =0.012, 0.029, and 0.002) effect on adopting improved seeds. This indicates there is an increase in the log of odds by 1.226, 1.290, and 2.204 in adopting improved seeds as an adaptation strategy. The EXP (B) of income (HHs1) 3.408 times, income(HHs2)3.632 times, and income (HHs3) 9.064 times more likely adopt improved seeds than low-income households(<10,000).

Agro-ecology: The lowland agro-ecology with an inverse beta value (-1.552) has a significant effect (Sig. =0.002) on adopting improved seeds. This indicates a decreasing (1.522) in the log of odds on adopting improved seeds in the lowland agro-ecology zones. The EXP (B) of 0.218 indicates the lowland households are only 0.218 times (much less) likely use improved seeds than highland households. This indicates highland households are 4.587 times (much more) likely use improved seeds than lowland households (inverse of 1/0.218=4.587).

Changing planting date

Age: Old headed households have a significant (Sig. =0.038) effect on adopting changing planting date age (>55years) (HHH2), Exp (B) of 5.985 indicates 5.985 times more likely to adopt changing planting date than age (18-35). This indicates, as age increases, the probability of adopting changing planting date as adaptation strategy increased.

Farming experience: The farming experience of 21-30 years and >30 years has a significant effect (Sig. =0.007 and 0.018) on adopting changing planting date. 21-30years (HHH2, Beta=-1.567), >30 years (HHH3, Beta=-

1.659) indicates there is a decrease in the log of odds by 1.567 and 1.659(inverse relationships). The Exp (B) of 0.209 and 0.190 indicates farming experience of (HHH2) only 0.209 times and (HHH3), only 0.190 times (much less) likely to adopt changing planting date.

Agro-ecology: The midland and lowland agro-ecoloies have a significant effect on changing cropping date (Sig. =0.002 and Sig.=0.000) respectively. The coefficient of beta (+1.689midland (HHs1) (+4.982lowland (HHs2) indicates there is an increase in the log of odds by 1.689 and 4.982 on adopting changing planting date. The Exp (B) of 5.412 indicates households who reside in the midland are 5.412 times much more likely changed their cropping date than highland households.

Farmland size: Farmland size (>1.2 hectares) of households has an inverse (beta,-1.898) and significant (Sig. =0.000) effect on adopting changing planting date. This indicates a decrease (inverse relationships) in the log of odds by 1.898 in changing planting date. The Exp (B) of 0.150 indicates households having farmland size >1.2 hectares are only 0.150 times changed their planting date. Households having small land size <1.2hectare is 6.76 times more likely use changing planting date.

Crop failure: Crop failure has a significant (Sig. = 0.044) effect on adopting changing planting date. Households who never faced crop failure in the past ten years has an inverse relationship (Beta=-1.064) in employing changing planting date. The Exp (B) of 0.345 indicates households who never faced crop failure in the past ten years are only 0.345 times adopting changing planting date. The invert of Exp (B) of 0.345 is 2.8986 which indicate households who faced crop failure are 2.8986 times more likely used changing planting date. This implies most farmers learn only when they faced problems.

Replanting failed crops

Replanting of failed crops is significantly determined by age, family size, agro-ecology, and farmland size (See Table1).

Age: Adult and old headed of households has a significant (Sig. =0.005; 0.014) power in explaining replanting failed crops. Age shows positive relationship (Beta = HHH1, +1.689 and HHH2, +3.470). This indicates there is an increase in the log of odds by 1.689 and 3.470. Adult headed households (HHH1) Exp (B) of 5.416 times more likely and old headed households (HHH2) Exp (B) of 32.143 times much more likely to use replanting their failed crops than young headed households (18-35years). The possible explanation is that age of household head increases the possibility of pursuing replanting failed crops as an adaptation strategy to climate change impact.

Family size: Family size has a significant (Sig. =0.002) effect on adopting replanting failed crops. Family size has an inverse (Beta = -2.297) in the log of odds by 2.297. The Exp (B) of 0.101 indicates households having family size >4, only 0.101 times (much less) likely to replant failed crops. The inverse of Exp (B) of 0.101 indicates small family sizes (<4) 9.91 times (much more) likely to replant failed crops than large family sizes.

Agro-ecology: The mid and lowland agro-ecologies have a significant (Sig. =0.006; 0.020) effect on adopting replanting failed crops. There is an increase (Beta =+1.072 midland (HHs2) and +2.420lowland (HHs2) in the log of odds by 1.072 and 2.420. The Exp (B) of 2.922 indicates households who live in the midland agro-ecologies are 2.922 times more likely use replanting than highland households. The Exp (B) of 11.247 indicates the lowland households are 11.247 times (much more) likely replant their failed crops.

Farmland size: Farmland size has a positive relationship (Beta, +1.519) with no significant effect on adopting replanting failed crops. There is an increase in the log of odds by 1.519. The exp (B) of 4.570 indicates farmers having >1.2-hectare land are 4.2570 times more likely to replant failed crops than households with <1.2 hectares.

4. Discussion

The rural communities of Dejen district adopt crop management strategies to combat climate change impacts. However, the key barriers identified in the study district of Nile Basin of Ethiopia were shortage of money, lack of access to information, and small land size. Previous studies (eg. (Bryan et al. 2009, Kithiia 2011, Peterson 2013) stated that financial barriers are one of the barriers that restrict implementation of adaptation strategies. This implies every form of adaptation requires some direct or indirect costs. For instance, the use of improved varieties of crops has been reported as one of the key adaptation strategies for farmers in Dejen district, Nile basin of Ethiopia where this study confirmed. When improved seeds varieties are available, their price may be prohibiting making it difficult for many rural households to access. Thus, framers have often sought to use their own saved seeds. One of the possible causes of financial barriers in the study area could be due to lack of credit facilities to rural communities.

Access to information on climate change characteristics is an important tool that can be used to enhance the adaptation and implementation of adaptation strategies by rural communities of the study area. Access to information is particularly important for Africa (IPCC 2007) and Ethiopia in particular, where there are few climate projections due to lack of appropriate climate data. This is crucially important considering that most farming systems in Dejen District depend on rain-fed agricultural systems. Hence lack of appropriate climate information could be crucial for rural communities' food security.

Age of households head significantly determined crop diversification, improved seeds and changing planting date, and replanting failed crops. Crop diversification and replanting of the failed crops requires more energy and experience. Thus, adult household heads are more matured and active in sowing different crops than old and young household heads. The probable reason for the positive and significant association is due to the fact that age is the proxy indicator that may likely to endow the farmers with the requisite experience that enables them to make a better decision in the choice of climate change impact adaptation strategies. This is in line with studies by (Deressa et al. 2009) which found that an increase in age does mean an increase in farming experience which would increase rural communities' local knowledge to respond to hazards resulted in climate change and variability.
Farming experience is one of the significant variables that affect the rural communities' choice of adaptation strategies. Farming experience is a proxy indicator of age. Like crop diversification, the middle age farmers have ability and willingness to adopt improved seeds to adjust climate change impacts. This implies as one become more experienced in farming, the probability of one to use improved seeds increases more than a farmer with less farming experience. On the other hand, farming experience has an inverse relationship with changing planting date. The reason for an inverse relationship might be that experienced farmers will have access to irrigation and water harvesting for their agricultural activities and plant their seeds without changing the planting date. This implies a farmer with more experience would know when climate variability is occurring in the area and which method of adaptation strategies works well in that specific agro-ecology zone.

As expected, income is positively and significantly associated with the household decision to pursue crop diversification and improved seeds. This means crop diversification and purchasing of improved varieties of seeds requires money. This implies the rate of using crop diversification and improved seeds is increased as income of households increased.
The logistic regression model result revealed that family size is negatively and significantly associated with the households' decision to pursue replanting failed crops. This finding is in contrary to previous studies. Households who have large family size are supposed to have an opportunity of pursuing various adaptation options in the face of clime change and variability. This argument is raised by many studies (Deressa et al. 2009, Zeleke and Aberra 2014) who argued that large family size is associated with higher labor endowment which would enable a household to accomplish various agricultural tasks. The possible reason for an inverse relationship might be due to the fact that community's expectation of the gains of using adaptation strategy. In this regard, (Barungi and Maonga 2011) based on the rational choice theory; argue that the behavior of human beings is motivated by the possibility of gaining benefit. The possible explanation could be households who have large family size have the possibility to engage in off-farm activities, and they will ignore the failed crops to replant. Therefore, communities are rationale consumers of new technologies, and they will only adopt technology as they foresee it will result in increased productivity.
Access to government extension services has a negative and significant association with the likelihood of choosing crop diversification to combat climate change impacts. This result is in contrary with previous studies (Maddison 2007, Nhemachena and Hassan 2007) who noted that farmers who obtain agricultural extension services through extension workers are more likely informed about the climatic situation and the responses followed. The contributing factors for this inverse relationship could be barriers to adopting crop diversification such as inadequate extension services, constraints of money, labor, skills, and farmland locations.
The midland and highland agro-ecologies have a significant and positive effect on adoption of crop diversification. This is because the suitability of highland agro-ecology to sow different types of crops and access to government extension services due to proximity to the administration. For instance, in this study finding, the midland agro-ecology has got more access to extension services(77%) than the lowland agro-ecology (47%) communities by the government extension experts in the past cropping season.

The lowland agro-ecology has a negative and significant effect on adoption of improved seed varieties. The possible explanation is that lowland households did not use improved seeds because of suitability problem of the lowland agro-ecology and topography to use improved seeds to their farmland. This was confirmed by households report on the barriers to adopting adaptation strategies. On the other hand, the lowland agro-ecology has a positive and significant effect on pursuing changing planting date to combat climate change impacts. This is due to lowland agro-ecologies are characterized by erratic rainfall and other extreme events that led households to change their planting date. The mid and lowland agro-ecologies have a significant effect on employing replanting failed crops as climate change adaptation measures. This is due to the fact that, the midland and lowland households are characterized by climate variabilities such as erratic rainfall than the highland agro-ecology zones. The exposure of climatic variability led them more experienced in adopting replanting their failed crops than highland households.

As expected, farm size has a significant and positive effect on adopting crop diversification to combat climate change impacts. Households with larger farm sizes are more probably to diversify their crops. On the other hand, larger farmland size has a negative and significant effect on using changing planting date as climate change adaptation measures. This means households having small land size <1.2hectare is more likely use changing planting date. This reminds us" a hunter who has only one arrow does not shoot with careless aim." This implies households who have small land size took care of their farmland and changed their planting date when there is a change in weather conditions. Even if farmland size has no significant effect on changing failed crops, it shows a positive effect on using changing failed crops. The possible explanation could be the more farmland plot they have; the more is the probability of having failed croplands that could lead them to replant their failed crops.

5. Conclusions

Rural communities have tremendous ideas to mitigate for current and future climate change impacts with a strong motivation to move out of poverty. However, the mere willingness to adopt climate change adaptation strategies was not enough. Their ability to adapt is constrained by many internal and external factors. Rural communities who did not employ adaptation strategies gave many reasons for their failure to adopt. These includes; poor access to water sources, limited knowledge, and skill, shortage of labour, lack of and/or shortage of land, lack of money, lack of information, lack of agricultural extension services, and other institutional factors.

The most significant determinants of adopting crop management strategies were age, farming experience, income, agro-ecology, and farmland size. Agro-ecology has a significant effect on all adaptation strategies. Due to the soil characteristics, the lowland agro-ecology zones were not suitable for adopting improved seeds. However, the government bodies in the office of agriculture did not realize the problems. This implies, in the process of diffusion of adaptation strategies, adaptation process should require close collaboration and active participation of climate change researchers, decision makers, policy analysts, the community, and partners. Government policies should strengthen the current adaptation strategies practiced by rural community households and support the adoption of adaptation strategies. Besides, the less adopted adaptation strategies due to financial constraints should be subsidized by government and aid organizations. This study contributes to the academic discourse on climate change impact adaptations by providing empirical evidence to deepen understanding of the barriers and determinants that confronts rural communities in their attempt to implement adaptation strategies to manage the negative impacts of climate change and variability.

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