Journal of Sustainable Development; Vol. 8, No. 2; 2015
ISSN 1913-9063 E-ISSN 1913-9071
Published by Canadian Center of Science and Education

Determinants of Land Conservation Technologies Adoption among Arable Crop Farmers in Nigeria: A Multinomial Logit Approach

P. T. Owombo[1] & F. O. Idumah[1]

[1] Moist Forest Research Station, Forestry Research Institute of Nigeria, Benin City, Nigeria

Correspondence: P. T. Owombo, Moist Forest Research Station, Forestry Research Institute of Nigeria, Benin City, Nigeria. E-mail: owombopaul@gmail.com

Received: October 30, 2014 Accepted: November 23, 2014 Online Published: March 30, 2015

doi:10.5539/jsd.v8n2p220 URL: http://dx.doi.org/10.5539/jsd.v8n2p220

Abstract

As parts of the efforts to reduce land degradation and hence improve farm productivity, farmers in the area were introduced to various land conservation technologies. The study was thus conducted to investigate the determinants of land conservation technologies in the area. Data collected through a multi-stage sampling procedure were analysed with the aid of descriptive statistics and multinomial logit model. Findings revealed significant difference between socio-economic characteristics of the respondents such as age ($p \leq 0.01$), household size ($p \leq 0.01$), farm size ($p \leq 0.01$), value of livestock ($p \leq 0.01$) and off-farm income ($p \leq 0.01$). Findings further revealed that level of education, extension contact and land ownership significantly influenced farmers adoption of mulching, cover cropping and tree planting respectively. On the other hand, while age of respondents reduced farmers' adoption of mulching and tree planting, membership of association increased the adoption of cover cropping. Government through her agencies and other development organizations should therefore put in place policy framework that would educate the farmers through regular extension contact and also carry out a review of land ownership rights in the study area. This would enhance farmers' adoption of conservation options and hence, sustainable production.

Keywords: multinomial logit, mulching, cover cropping, tree planting

1. Introduction

Land degradation is a major factor militating against agricultural productivity in Africa. This poses a great threat to livelihood of farm families in Africa, Nigeria inclusive. Mugonola *et al*. (2013) revealed that restoring agricultural productivity requires the promotion and adoption of farm-level conservation technologies that are meant to reduce soil degradation. Various agricultural and non-agricultural processes and practices are known to cause different forms of soil degradation, among which are soil erosion, soil toxicity, soil pollution, poor land use regime such as bush burning (Mugonola *et al*., 2013; Iheke & Onyenorah, 2012). Soil erosion is a worldwide problem, particularly in the tropics where rainfall is high and intense. It has been recognized for a long time as a serious problem in Nigeria (Kabubo–Mariara *et al*., 2010). There are various conservation technologies which farmers can adopt in order to reduce the severity of poor productivity and poverty. Conservation techniques can be mainly runoff management techniques or fertility sustaining techniques. Kabubo–Mariara *et al*., (2010) stressed that land conservation entails fertility management which involves the use of such techniques as mulching, cover cropping, tree planting, among others. The adoption of these technologies which usually involves risk among the farmers may be influenced by a number of factors.

Bekele and Mekonnen (2010) in their work in Ethiopia revealed that land and non-land factors affect farmers' decision at household plot-level to adopt conservation technologies. The land factors include farm size and tenure arrangement among others while the non-land factors are asset holdings (e.g. livestock) and income level. They added that institutional factors such as access to extension and, membership of association affect farmers' decision to adopt land conservation measures.

Land conservation technologies are known to play an important role in improving farm incomes. For this reason, substantial investments have been made in research to improve agricultural technologies in various parts of the world, from the development of new crop varieties to new practices of land management (Kabubo-Mariara, 2006; Sheferaw & Holden, 2001).

Despite the identified benefits of land conservation technologies on income, environment and the livelihood of the farmers and family, a substantial number of farmers in Nigeria do not adopt these technologies. In order to ensure conservation, sustainable utilization and management of agricultural lands, studies on determinants of adoption of conservation technologies with emphasis on socio-economic characteristics of respondents become priority. Therefore, it is important to empirically determine the specific effects these factors have in the willingness or otherwise of farmers to adopt land conservation technologies. This study thus addressed the following pertinent questions: what are the socioeconomic characteristics of the respondents? What are the land conservation techniques adopted by farmers in the study area? Which factors determine farmers' adoption of conservation technologies? The objective of the study was to investigate the factors influencing farmers' decisions to adopt land conservation techniques in the study area.

2. Research Methodology

2.1 Theoretical Model

Land conservation option appears as a discrete choice set rather than a continuous one. When the dependent variable takes more than one value, the multinomial logit model is often appropriate (Akinola *et al*., 2011). The multinomial logit model was employed to package the various categories of land conservation practices into a three-model scenario. The model was employed instead of Tobit, logit or probit model because they assume that non-adopter of a given practice does not adopt any other as they only allow zero or one dependent variables. This is because when there is more than one practice to choose from, that the farmer does not pick one does not mean he is a non-adopter. Hence, non-adoption of one technology or practice does not necessarily puts the farmer in non-adopter category. This supports the model appropriateness for the various conservation options.

The model was specified as

$$U_i = \beta_i X_i + \varepsilon_i$$

Which implies that the utility, U_i, of choosing a particular practice is a stochastic linear function of farm, farmers and practice specific attributes (X_i). In this Multinomial logit, the probability,

$$\text{Prob(choice } j\text{)} = \frac{\exp(\beta_j X)}{\sum_j^n \exp(\beta_j X)}$$

of choosing a given practice, j is equal to the probability that the utility of that particular technology is greater than or equal to the utilities of all other soil fertility technology in the model. The dependent variable in this model was a discrete variable taking the value 0, 1, 2, and 3, for cases of no-adoption, mulching adoption, cover cropping adoption and tree planting, respectively.

2.2 Study Site

The study was conducted in Ondo State, Nigeria. The state was purposively selected for the study owing to relative incidence of land degradation. It lies between Longitude $4^0 30^1$ and $6^0 00$ east of the Greenwich Meridian and Latitude $4^0 45^1$ and $8^0 15^1$ north of equator. The state is located on tropical coastal wetland with mean annual rainfall of about 2800mm, and mean number of rainy days of about 170. The mean relative humidity falls between 70-80%, mean annual temperature is about 27.8°C.The land area is about 14,798.8 square kilometres with varying physical features like hills, lowland, rivers, creeks and water bodies. The predominant occupation in the area is farming which is characterised by smallholder farmers, cultivating both permanent and arable (such as yam, cassava, maize and cocoyam) crops for family consumption, market and cash. Farming activities are usually carried out using simple farm tools with limited application of modern implements. The total population and the population density of the state are 3,460,877 and 233.9, respectively (Ondo State Ministry of Economic Planning and Budget, 2010).

2.3 Sampling Procedure and Data

Multi-stage sampling technique was used in selecting respondents for the study. In the first stage, Ondo state was stratified into two agro-ecological zones based on the state's Agricultural Development Programme (ADP) classification. These are Ondo and Owo zones. Ondo zone consists of coastal forest and mangrove swamp forest while Owo zone consists of moist lowland forest, and forest savannah. The second stage involved the purposive selection of three local government areas (LGAs) from each of the zones based on the past records of land degradation. These are Irele, Odigbo and Okitipupa in the Ondo zone and Akoko South West, Ose and Owo in

Owo zone. The third stage involved a random selection of 2 villages from each of the LGAs. In the final stage, 20 respondents per village were randomly selected making a total of 240 respondents. Primary data were used for the study and were collected using structured questionnaires. Information elicited from the respondents include their socio-economic and institutional characteristics. Data collected were analysed with the aid of Statistical Package for Social Sciences (SPSS) version 16.0 and LIMDEP version 7.0.

2.4 Empirical Model

Farmers' decision to adopt or not to adopt a technology is assumed to be the outcome of a

complex set of factors related to the farmers' objectives and constraints. In other words, there are certain factors –social and institutional factors that affect the likelihood that farmers will adopt a technology. Thus if each farmer and each technology can be classified based on a core set of variables, then it is possible that the probability of a farmer adopting that technology could be estimated (Amare, 2012). Data collected from the survey were analysed using descriptive statistics and econometric model (Multinomial Logit). In this study, the dependent variable is the land conservation technologies adopted by the respondents. The estimated model is specified as follows:

$$Y_i = \beta_0 + \beta_1 AGERES + \beta_2 HHSIZE + \beta_3 FARMEXP + \beta_4 EDULEV + \beta_5 FARMSIZ + \beta_6 EXTENSN + \beta_7 OFFINCOM + \beta_8 CREDIT + \beta_9 VALSTOCK + \beta_{10} ASSOC + \beta_{11} LANDOWSP + \beta_{12} PLOTAGE + \varepsilon_i$$

Table1. Description of explanatory variables

Variables	Description	Units of measurement
AGERES	Age of respondents in	Years
HHSIZE	Number of people living under the same roof	
FARMEXP	Number of year since farmers has been farming	Year
EDULEV	Number of years of formal education a respondent had	Year
FARMSIZ	Total farm size	Hectares
EXTENSN	Number of extension contact a respondent had	
OFFINCOM	Income in naira earned from off-farm activities	₦
CREDIT	Access to credit measured by the farmer's access to source of credit such as co-operative society at a reasonable cost. 1 if there was access, 0 otherwise	
VALSTOCK	Money value of livestock owned by respondents in naira	₦
ASSOC	Membership of association 1 if you belong to association, 0 otherwise	
LANDOWSP	Farmers' ownership of land on which he or she operates. 1 owned, 0 otherwise	
PLOTAGE	Year since land has been in used by respondents	Year
ε_i	Error term	

₦ = Nigerian currency; ₦ 1= $0.006

The multi-areas explanatory variables included in this study were those variables, which were believed to have influence on investment decisions on land conservation technologies. These included households, farm and institutional characteristics, tenure related factors, poverty related variables and market access factors. The rationale for the inclusion of these variables was based on a priori expectation of agricultural technology adoption.

Previous studies revealed that ages of individuals affect their mental attitude to a new technology and hence influence adoption in a number ways. Young farmers have been found to be more knowledgeable about new practices and may be more willing to take the risk and adopt or invest than the older farmers. This implies that farmer's age and technology adoption are inversely related (Dereje, 2006; Akinola *et al*., 2010).. Therefore, it is hypothesized that farmer's age and investment decisions are expected to relate negatively. Household size (*HHSIZE*) is the number of persons that live under the same roof. A large household size working on the farm reduces the farms' external labour requirements and is hence assumed to positively affect adoption of land conservation technologies (Bekele & Mekonnen, 2010; Akinola & Owombo, 2012). Farming experience (*FARMEXPR*) is measured in number of years, that is, the year a respondent started farming on his own. Experience of the farmer is likely to have a range of influences on adoption. Experience will improve the farmer's skill in production operations. Farmers with higher experience appear to have often full information and better knowledge and are able to evaluate the advantage of the technology (Godoy *et al*., 2001; Clay *et al*., 2002). Education (*EDUCATN*) measures the literacy level of individual farmer. The study hypothesized that it will positively influence adoption of investment in soil conserving technologies since it enhances the ability to obtain, process, use new information and thus increase the ability of farmers to use their resources efficiently. Several studies (Bamire *et al*., 2002; Dereje, 2006) indicated a positive relationship between education and technological adoption. Total farm size (*FARMSIZ*) holding may serve as a good proxy for wealth, status and income levels. This variable is likely to have a positive effect on adoption of most practices, meaning that the larger the farm size the greater the likelihood that a farmer will invest in land conservation technologies. This is possible as a farmer who has relatively large plot of land can rent out part of his land to earn income and run his production activity. Therefore, the size of the land will positively affect level of investment in conservation practices (Akinola *et al*., 2010, 2011). Extension visits (*EXTENSN*) refer to the number of contacts farmer had with extension agent to take advice in last cropping season. Therefore, extension contact is expected to have a positive influence on farmer's investment decision on soil conservation technologies. It is believed that frequent contacts will enhance the exposure of farmers to improved production package (Owombo *et al*., 2011; Kidane, 2001).

Wealth related factors included were value of livestock (*VALSTOK*), Off-farm income (*OFFINCOM*) and credit access (*CREDACCS*). Measures of wealth comprising value of livestock, off-farm income and credit access are hypothesized to positively influence adoption of land conservation technologies. They are generally considered to be capital that could be used either in the production process or exchanged for cash or other productive assets. They are expected to influence the adoption of land conservation positively (Shiferaw and Holden, 1998; Holden *et al*., 1998; Zeller *et al*., 1998; Negatu and Parikh, 1999; Holden and Shiferaw, 2002; Owombo *et al*., 2011). *VALSTOK* increases the availability of capital which makes investment in land conservation technologies feasible. Off-farm income has the same effect on conservation adoption. Credit access takes cognizance of farmers' access to sources of credit to finance the expenses relating to adoption of innovation. Access boosts farmers' readiness to invest in technological innovations. It is hypothesized that the variable has a positive influence on the profitability of technology adoption (Oluoch-Kosura *et al*., 2001; Gebremedhin and Swinton, 2003; Hagos and Holden, 2006; Kipsat *et al*., 2007; Jungel *et al*., 2009; Akinola *et al*., 2012). It was measured as a dichotomous variable with access being one, and zero for no access.

Tenure related factors included in the study were land ownership (*LNDOWSIP*) and plot age (*PLOTAGE*). *LNDOWSIP* measured as dummy (1, if owned and 0, otherwise) is a measure of the rights individual farm operator has over his or her plots. It is hypothesized that those who own plot have greater confidence in taking investment risks on farm (Bekele and Mekonnen, 2010). PLOTAGEE measures the length in years since land has been held. Some studies (Bekele and Mekonnen, 2010; Kabubo-Mariara, 2010) had established positive relationship between investment decision and plot age. This study hypothesized that if the farmers are confident of using a plot for at least five years, the greater the tendency that they would adopt conservation investment. Membership of association such as cooperatives has been found to influence the interaction and exchange of ideas among farmers (Bamire *et al*., 2002, Akinola *et al*, 2010). Farmers who are not members of associations are expected to have lower probabilities of adoption and low level of adoption of conservation technologies.

3. Results and Discussion

Socio-economic characteristics of the respondents

Results of the survey revealed that there were variations in the demographic and socio-economic characteristics of the respondents' categories. The mean age of the non-adopters of any technology was 50.3 years which was higher than that of adopters. The mean age of the adopters ranged from 43.3 years to 46.1 years. F-test reveals a significant difference between the means of the respondents ($p \leq 0.01$). The average year of schooling was 2 years among the non-adopters which was the least among the respondents' categories. The years of education ranged from 4 to 13 years among the adopters though the mean age was 13 years which was the highest among the groups. The mean farm size was 6 which was the least among the respondents' categories. The house hold size was 8 each of non-adopters and adopters mulching respectively and 7 among the adopters of cover cropping. The mean farm size was 2.8 hectare and ranged from 3.2 hectare to 3.9 hectare among the adopters. It was highest (3.9 hectare) among the tree planting adopters. There was significant difference between the means of the respondents' farm size ($p \leq 0.01$). The value of livestock in naira among the non-adopters was ₦7,740 which is the least among the respondent categories. The value of livestock in naira ranged from 11,980 to 26,902 among the adopters. F-value showed significant difference between the means of the livestock income ($p \leq 0.01$). The number of extension contact was also least (3) among the non-adopters. The contact ranged from 7 to 13 among the adopters. The least number of contacts among the non-adopters could be traced to the farmers' membership of cooperative society. The farmers in the area are well experienced. The non-adopters have an average of 28 years of farming experience, which is the highest among the respondents' categories while it ranged from 17.7 years to 21.4 years among the adopters. The higher experience among the non-adopters could be traced to two factors, viz; age and the fact that most were born into farming. Farmers in the area engage in activities other than farming. The non-adopters recorded an average of ₦1, 445 as off-farm income in the area. The off-farm income in the area ranged from ₦9, 899 to ₦38,662 among the adopters. The off-farm income was highest among the adopters of tree planting. The higher off-farm income among the adopters might be the reason for the technology adoption as posited by Bamire *et al*., 2002; Akinola *et al*.2010; Owombo *et al*.2011 and Akinola and Owombo, (2012). F-value showed a significant difference between the means of the farmers' off-farm income ($p \leq 0.01$).

The results also revealed that each of the respondents' group has used the plots for over one decade. The plot age among the non-adopters was 22 years. The age ranged from 12 years to 17 years among the adopters. The higher plot age among the non-adopters could be traced to factors such as age and land inheritance among the rural households. Analyses further revealed that while only 1.3 percent of the respondents had access to credit, 14.1 percent of mulching adopters, 14.9 percent of cover cropping adopters and 21.2 percent of the tree planting adopters had access to credit, respectively. This could be traced to respondents' membership of association in the study area. Membership of association was least among the non-adopters as 28 percent of them belonged to one association or the other. Ownership of land was fairly reasonable in the area. While 54.6 percent of the respondents owned the land on which they operate, 56.6 percent of the mulching adopters, 59.4 percent of the cover cropping adopters and 73.4 percent of the tree planting adopters owned the plots on which they operate. The higher proportion of tree planting adopters who owned land could be the reason for tree planting adoption because of permanent investment nature of tree planting technology.

Table2. Demographic and socio-economic characteristics of the respondents

Variables	Non-adopters N=62	Mulching adopters N=99 Mean	Cover cropping adopters N=53	Tree planting adopters N=26	F
Age	50.3	46.1	44.4	43.3	21***
Level of education	2	4	9	13	0.4
Household size	8	8	7	6	0.3***
Farm size	2.8	3.2	3.4	3.9	4.1***
Value of (₦) livestock	7,740	11,980	13,886	26,902	7.2***
Number extension contacts	3	7	7	12	0.6
Farming experience	28	21	21.4	17.7	0.7
Off-farm income (₦)	1,445	9,899	19,233	38,662	13***
Plot age	22	12	13	17	0.7
		%			
Access to credit	1.3	14.1	14.9	21.2	
Membership of association	28	53	56	61	
Land ownership	54.6	56.6	59.4	73.4	

Source: Field survey, 2013 ₦=Nigerian currency; ₦1=$006

3.1 Adoption Typology of the Respondents

Figure 1 reveals the adoption typology of the respondents. The results in the figure revealed that while 26 percent of the respondents did not adopt any conservation technology, 41 percent, 22 percent and 11 percent of the respondents adopted mulching, cover cropping and tree planting, respectively. The wide adoption of mulching technology over the cover cropping and tree planting could be traced to factors such as low cost of adoption (Jungel *et al.*, 2009) and non-permanent nature of mulching technology (Bekele & Mekonnen, 2010).

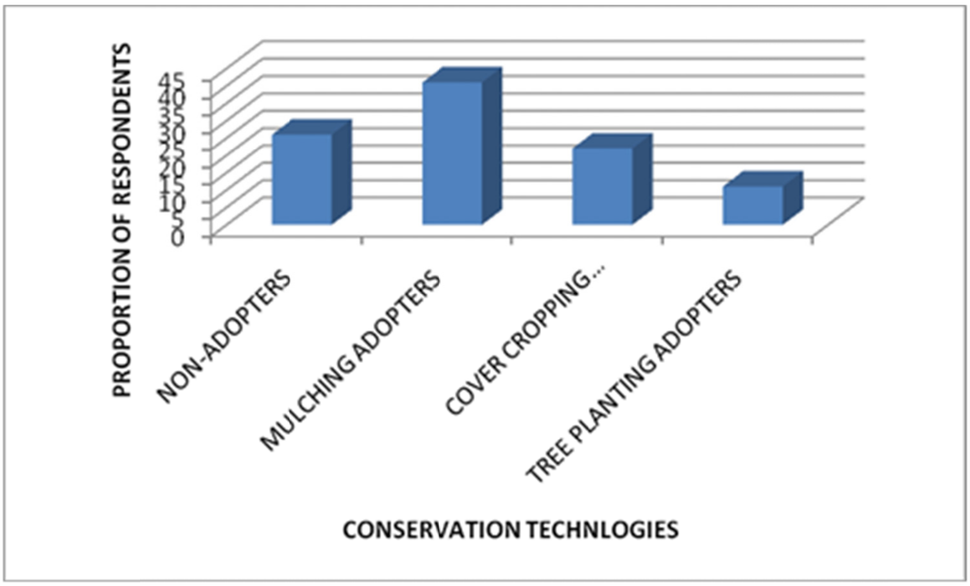

Figure 1. Adoption typology

3.2 Multinomial Logit Model Results

The results of the determinants of land conservation technologies among the respondents are presented in Table 3. The results in the table showed that the Log likelihood function, Restricted Log likelihood function and Chi-squared values were -81.0811, -118.8223 and 92.0882, respectively. These values show the fitness of the entire model and are significant at 1 percent level of probability. The results in the table furthers revealed that the coefficients of level of education, number of extension contact and land ownership were positive and significantly influenced the farmers adoption of mulching, cover cropping and tree planting technologies, respectively. This implies that an increase in the years of education of respondents by 1 year would increase farmers of adoption mulching, cover cropping and tree planting technologies by 2.1 percent, 1.2 percent and 4 percent respectively. This is in agreement with previous studies such as Bamire *et al*. (2002) and Akinola *et al*. (2012). An increase in the number of extension contact by 1 would increase farmers' adoption of mulching, cover cropping and tree planting technologies by 0.5 percent, 5.4 percent and 3.2 percent, respectively. Also, increase in the ownership of land would increase respondents' adoption of the technologies. Household size was positive and significantly influenced mulching and tree planting technologies adoption in the study area. An increase in the household size by 1 would increase probability of adopting by mulching and tree planting technologies by 5.5 percent and 1.7 percent, respectively. This agrees with the a priori expectation of the study and in addition conforms with Akinola *et al*. (2010) and Akinola *et al*. (2012). The coefficient of farm size was positive and significantly influenced mulching technology adoption. An increase in the farm size by 1 hectare would increase the probability of adopting mulching by 7 percent. This conforms to the a priori expectation of the study and in agreement with Akinola *et al*. (2010). The coefficient of plot age was positive and significantly influenced tree planting technology adoption. This shows that an increase in the plot age by 1 year would increase probability of adoption by 21 percent. This is in agreement with the a priori expectation of the study and in addition conforms to Bekele and Mekonne (2010) that plot age influences conservation technologies with permanent investment like tree planting and stone terracing. On the other hand, while the coefficient of age of respondents was negative and significantly influenced the adoption of mulching and tree planting technologies, off-farm income was negative and significantly influenced tree planting. This implies that an increase in the age of the respondents by 1 year would decrease the probability of adoption by 2.3 percent and 5 percent, respectively. This is in agreement with the expectation of the study that age and technology adoption are inversely related and conforms to the previous studies such as (Dereje, 2006; Nkoya, *et al*., 1997; Akinola *et al*., 2010). The coefficient of age was negative and does not significantly influence cover cropping technology adoption. The sign is in agreement with the expectation of the study. An increase in the off-farm income by 1 naira would decrease the probability of adoption by 7.6 percent. This implies that the increase in the off-farm income was diverted to activities other than farming. This does not conform to the expectation of the study but in agreement with Bekele and Mekonnen (2010) that an increase in the income of farmers may be diverted to activities other than farming.

Table3. Average partial estimates of multinomial logit model for land conservation technologies adoption

Variables	Mulching Probability	Cover cropping	Tree planting
AGERES	-0.0234 (0.0114)	-0.0017 (0.0012)	-0.0502**(0.0311)
HHSIZE	0.0551*(0.3541)	0.0062(0.0015)	0.0172*(0.0223)
FARMEXP	0.0033(0.0041)	0.0054(0.0012)	0.0177(0.0117)
++EDULEV	0.0211***(0.0144)	0.0119**(0.1110)	0.0400**(0.0221)
FARMSIZ	0.0698**(0.0341)	0.0071(0.054)	0.0054(0.0023)
++EXTENSN	0.0051**(0.0115)	0.0543*(0.0333)	0.0323**(0.0018)
OFFINCOM	0.2231(0.2100)	0.0211(0.0112)	-0.0762*(0.0321)
CREDIT	0.0018(0.0013)	0.0872(0.0277)	0.0073(0.0062)
VALSTOCK	0.0991(0.0348)	0.0477(0.0238)	0.03216(0.0245)
ASSOC	0.0188(0.0332))	0.0211*(0.0671)	0.0432(0.0223)
++LANDOWSP	0.0667*(0.0043)	0.0277**(0.0123)	0.0432**(0.0244)
PLOTAGE	0.0255(0.0143)	0.0134(0.0119)	0.2100***(0.0149)
Log likelihood	-81.0811		
Restricted Log likelihood	104.8234		
Significance level	0.0000		

Source: Data analysis, 2013

Note: ***= significant at 1 percent, **=significant at 5 percent and *=significant at 10 percent ++= significantly influence the three technology.

4. Conclusion

Land degradation is a major factor causing poor yield among rural farmers which has resulted in poverty among the rural farmers. The study thus investigated the determinants of land conservation technologies adoption among arable crop farmers in the study area. Data which were from primary source were analysed with the aid of descriptive statistics and multinomial logit model. Results from analysis revealed that adoption of conservation technologies was influenced by farmers' level of education, extension contact and land ownership among others. Therefore, government through her agencies and others development organizations should encourage farmers on the need for conservation technologies' adoption and put in place policy thrust that would educate farmers, improve extension services as well as review ownership rights to land.

References

Akinola, A. A., Alene, A. D., & Adeyemo, R. (2011). Determinants of adoption of balanced nutrient management systems technologies in the Northern Guinea Savanna of Nigeria: A multinomial logit approach. *International Journal of Agricultural Economics & Rural Development, 4*(2), 29-36.

Akinola, A. A., Alene, A. D., Adeyemo, R., Sanogo, D., Olanrewaju, A. S., Nwoke, C., Nziguheba, G., & Diels, J. (2010). Determinants of Adoption and Intensity of use of Balanced Nutrient Management Systems Technology in the Northern Guinea Savanna of Nigeria. *Quarterly Journal of International Agriculture, 49*(1), 25-45.

Akinola, A., & Owombo, P. (2012). Economic analysis of adoption of mulching technology in yam production in Osun State, Nigeria. *International Journal of Agriculture and Forestry, 2*(1), 1-6. http://dx.doi.org/10.5923/j.ijaf.20120201.01

Amare, M., Asfaw, S., & Shiferaw, B. (2012). Welfare impacts of maize–pigeonpea intensification in Tanzania. *Agricultural Economics, 1,* 1-17. http://dx.doi.org/10.1111/j.1574-0862.2011.00563.x

Bamire, A. S., Fabiyi, Y. L., & Manyong, V. M. (2002). Adoption pattern of fertilizer technology among farmers in the ecological zones of South-western Nigeria: A Tobit analysis. *Australian Journal of Agricultural research, 53*, 901-910. http://dx.doi.org/10.1071/AR01095

Bekele, G., & Mekonnen, A. (2010). Investment in Land Conservation in Ethiopia Highlands: A Household

Plot-Level Analysis of the Roles of Poverty, Tenure Security, and Market Incentives. *Environment for Development Discussion paper series*, 10-09.

Clay, C. D., & Reardon, T. (1994). Determinants of farm level conservation investments in Rwanda. International Institute of Agricultural Economics Conference Paper. August, 1994, Harare.146-153.

Clay, D. C., Kelly, V., Mpyisi, E., & Reardon, T. (2002). Input use and conservation investments among farm households in Rwanda: Patterns and determinants. In C. B. Barret, F. Place, & A. A. A Solid (Eds.), *National resources management in Africa agriculture: Understanding and improving current practices.* Willingford, Oxfordshires, UK: (AB). http://dx.doi.org/10.1079/9780851995847.0103

Dereje, H. (2006). Assessment of farmers' evaluation criteria and adoption of improved bread wheat varieties in Akaki, central Ethiopia. M.Sc. Thesis (Unpublished) Presented To School of Graduate Studies of Alemaya University, Ethiopia.

Gebremedhin, B., & Swinton, S. M. (2003). Investment in soil conservation in northern Ethiopia: the role of land tenure security and public programs. *Agricultural Economics, 29*, 69-84. http://dx.doi.org/10.1111/j.1574-0862.2003.tb00148.x

Godoy, R., Kirby, K., & Wikkie, D. (2001). Tenure Security, Private time Preference, and Use of Natural Resources among Lowland Bolivian Ameridians. *Ecological Economics, 38*, 105-118. http://dx.doi.org/10.1016/S0921-8009(01)00144-6

Hagos, F., & Holden, S. (2006). Tenure security, resource poverty, public programs and household plot-level conservation investment in the highlands of northern Ethiopia. *Agricultural Economics, 34*(2), 183-196. http://dx.doi.org/10.1111/j.1574-0864.2006.00117.x

Holden, S., & Shiferaw, B. (2002). Poverty and land degradation: peasants' willingness to pay to sustain land productivity. In C. B. Barret, F. Place, & A. A. Abound (Eds.), *National resources management in Africa agriculture: Understanding and improving current practices* (pp. 91-102). Willingford, Oxfordshire, UK: CAB.

Holden, S., Shiferaw, B., & Wik, M. (1998). Poverty, market imperfections and time preference: Of reverence to environmental policy. *Environment and Development Economics, 3*, 105-130. http://dx.doi.org/10.1017/S1355770X98000060

Iheke, O. R., & Onyenorah, C. O. (2012). Awareness, Preferences and Adoption of soil conservation Practices among farmers in Ohafia agricultural zone of Abia State, Nigeria. *Journal of sustainable Agriculture and Environment, 13*(1), 1-12.

Junge, B., Deji, O., Arabio, R., Sikoye, B., & Spahr, K. (2009). Farmers adoption of soil conservation technology: A case study of Osun State, Nigeria. *Journal of Agricultural Education and Extension, 15*(3), 257-274. http://dx.doi.org/10.1080/13892240903069769

Kabubo-Mariaura, J., Linderhof, V., & Kruseman, G. (2010). Does land tenure security matter for investment in soil and water conservation? Evidence from Kenya. *African Journal of Agricultural Resource and Economics, 4*(2), 123-139.

Kabubo-Mariaura, J., Mwabu, G., & Kimuyu, P. (2006). Farm productivity and poverty in Kenya: The effect of soil conservation. *Journal of Food, Agriculture and Environment, 4*(2), 23-36.

Kidane, G. (2001). Factors influencing the adoption of new wheat and maize varieties in Tigray, Ethiopia: The Case of Hawzien Woreda. M.S.C. Thesis Presented to School of Graduate Studies of Alemaya University, Ethiopia. 140p.

Kipsat, M. J., Okalebo, J. R., Nyangweso, P. M., Korir, M. K., Serem, A. K., Maritim, H. K., & Kanule, B. J. (2007). Factors affecting farmers' decisions to abandon soil conservation once external support cease: the case of Kericho District, Kenya. *African Crop Science Proceedings, 8*, 1377-1381.

Mugonla, B., Deckersa, J., Poesen, J., Isabrye, M., & Mthijs, E. (2013). Adoption of soil and water conservation technologies in the Rwizi catchment of Southwestern, Uganda.

Negatu, W., & Parikh, A. (1999). The impact of perception and other factors on the adoptin of agricultural technologies in the Moret and Jiru Woreda (district) Ethiopia. *Agricultural Economics, 21*, 219-229. http://dx.doi.org/10.1016/S0169-5150(99)00020-1

Oluoch- Kosura, W. A., Marenya, P. P., & Nzuma, M. J. (2001). Soil fertility management in maize based production system in Kenya. Current options and the future strategies. *Paper submitted at the seventh*

Eastern and Southern Africa regional maize conference, Nairobi. 350-355.

Owombo, P. T., Akinola, A. A., Ayodele, O. O., & Koledoye, G. F. (2011). Economic Impact of Agricultural Mechanization Adoption: Evidence from Maize Farmers in Ondo State, Nigeria. *Journal of Agriculture and Biodiversity Research, 1*(2), 25-32.

Shiferaw, B., & Holden, S. (2001). Farm-level benefits to investment for mitigating land degradation. Empirical evidence from Ethiopia. *Environment and Economics, 6*, 335-358. http://dx.doi.org/10.1017/S1355770X01000195

Shiferaw, B., & Holden, S. T. (1998). Resource degradation and the adoption of land conservation technologies in the Ethiopian highlands. A case study in Andit Tid, North Shewa. *Agricultural Economics, 21*, 241-256. http://dx.doi.org/10.1016/S0169-5150(98)00036-X

Zeller, M., Diagne, A., & Mataya, C. (1998). Market access by smallholder farmers in Malawi: Implication for technology adoption, agricultural productivity\ and crop income. *Agricultural Economics, 19*, 219-229. http://dx.doi.org/10.1016/S0169-5150(98)00027-9