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Determinants of Farmers' Decision to Use Improved Land Management Practice in Gindara Watershed, Southern Ethiopia

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Abstract

The principal environmental problem in Ethiopia is land degradation in the form of severe soil erosion, gully formation and soil fertility loss. To overcome this problem, promoting appropriate land management technologies are best options. However, farmers' decisions to use land management practices are determined by complex factor. Thus, this study was conducted in Gindara watershed with the objective of analyzing the status of farmers' choice of improved land management practices and investigating determinants of farmers' decisions to use improved land management practices. The total of 286 samples household heads were selected using randomly sampling procedure with sample size allocation procedures of probability proportional to size method. Data were gathered through questionnaires, key informant interview, field observation and focus group discussions. Data were analyzed and presented quantitatively using different statistical methods such as percentage, mean, frequency, Chi-square (categorical variables) and (F-test for continuous variables), F-test and Chi-square test were employed to test the variation of the sample respondents towards farmers' decisions to use improved land management practices and also used to describe the patterns of the sample data. The result of multinomial logic model indicated that respondent' level of education, family size, access of credit, off-farm income, farm size and land tenure security of the households were positively and significantly determined farmers' decision to use fanyajuu. The result also revealed that farmers' educational level, family size, access of credit, off-farm income, farm size, extension services and slope of farmland were positively correlated and significantly determined farmers' decision to use stone bund. Based on the finding of the current study, it is recommended that agricultural extension service workers *should give due attention to these variables, which may greatly contributes farmers' decision to use improved land management technologies.*

Keywords: Land management practice, Gindara watershed, fanaya juu,

1. INTRODUCTION

Land degradation is a problem of global dimensions and affects all terrestrial ecosystem services on every continent and it has been recognized for over 100 years in Africa (Kotiaho & Halme, 2018). Land degradation also refers to any reduction or loss in the biological or economic productive capacity of the land caused by human activities, exacerbated by natural processes, and often magnified by the impacts of biodiversity loss (UNCCD, 2013). Similarly, land degradation is the consequence of multiple processes that both directly and indirectly reduce the utility of land and adverse effects on the biodiversity (Ajeye, 2014). It negatively affects the state and the management of the natural resources such as water, soil, vegetation and animals and hence reduces agricultural production (Vlek et al., 2010; Eni, 2012; Pingali et al., 2014).

In other side, land management practices refer to activities on the ground that uses appropriate technologies for the improvement or maintenance of productive capacity of the land. This includes activities such as soil and water conservation, soil fertility management and controlled-grazing. It incorporates the adoption of land use systems through appropriate management practices that enable land users to maximize the economic and social benefits from the land while maintaining the ecological functions of the land resources (FAO, 2009). In addition to this, Sustainable Land Management (SLM) is defined as knowledge-based procedure that helps integrate land, water, biodiversity, and environmental management (including input and output externalities) to meet rising fiber and food demands while sustaining ecosystem services and livelihoods (INTOSAI, 2013; GEF, 2016).

Hence, majority of the population of Ethiopia consists of farmers and their families who reside in rural areas and whose life is almost entirely dependent on agriculture and agricultural products (Megersa, 2011). However, land degradation in the form of soil erosion has been remained the major challenge that is adversely affecting the agricultural performance of the country (Amdihun et al., 2014). Similarly, the productive land in Ethiopia generally and Southern region specifically has been exposed to degradation and threat to productive soil. The proximate drivers of land degradation in the country include forest degradation and soil surface exposure (high removal of vegetative cover); detrimental cultivation practices with emphasis on small seed crops that require a fine tillage and overgrazing (Gebreselassie et al., 2016). It also reduces productivity and increases formation of rills and gullies in both farming and grazing lands through time (Nachtergaele et al., 2010; Heyi & Mberengwa, 2012; Selassie & Amede , 2014). Hence, the call for improved land management practices is the best options.

Accordingly, decisions made on land management practices have also a significant effect on environmental quality, agricultural production and land management conditions. These decisions also can be private decisions made by farm households and collective decisions made by groups of farmers and communities. On the other hand, communities also can influence land management practices through their collective decisions (Pender & Ehui, 2006).

The general objective of this study was to identify determinants of farmers' decisions to use improved land management practices in Gindara watershed. Thus, this study is significant in the identification of contextual based determinant factors of farmers' decisions to use improved land management practices and it will inform decision makers to design context-specific factors such as socio-economic, physical, institutional and household context based on sustainable land management practices.

Hence, farmers land management practices are determined by household and village level factors, among others. Household factors include physical, human and social capital, whereas village level factors include population pressure, access to markets, agricultural potential, local markets, presence of programs and local institutions (Heyi & Mberengwa, 2012). In the same way, farmers make decisions on their farmlands whether to use land management practice or not by considering different factors. Such factors include individual, social, economic, institutional and environmental context (Temu, 2013).

A numbers of studies have been conducted to investigate land degradation and land management activities in different parts of Ethiopia. A study conducted by Gebreselassie *et al*., (2016) indicated that better understanding of households' behavior about land management, policy and institutional factors that affect such decisions are crucial, but usually these factors are underestimated in most measures to address land degradation in the country. In addition, soil erosion is particularly serious in the high and low potential cereal zones of the north-central highlands. Study made by Megersa (2011) focused on traditional land management practices without encompass improved/introduced land management technologies. Meseret (2016) also argue that, land degradation in Amhara region is continuing with increasing rate. This was mainly due to over exploitation and mismanagement of the land resources. Heyi & Mberengwa (2012) also reported that land degradation is increasing with gullies and rills are common features rendering some areas out of use. Heyi & Mberengwa (2012) found that higher soil loss has been estimated at densely populated highlands of Southern Ethiopia.

These studies mainly focused on land degradation and its land management technologies. Most of these studies found that there is high degree of land degradation and land mismanagement practices. Therefore, there is a research gap on considering multivariate variables issue of what personal, social-economic, institutional and natural factors that determine the farmers' decisions to use improved land management practices. In an attempt to contribute in bridging the above stated gap, this study tries to address multivariate variables. It will add to the stock of knowledge on the factors that determine farmers' decision to use improved land management practices and provide information and recommendations to policy makers and others involved in promoting sustainable land management.

2. Materials and methods

2.1. Study Area description

This study was conducted at Gindara watershed which is part of Gibe III watershed in southern part of Loma district in Dawuro Zone, SNNPR of Ethiopia. It is located between 6°34'00" to 6°50'15"N latitude and 37°04'00" to 37°12'00"E longitude (Fig.1). The watershed is located at 540 Km in south west of Addis Ababa, the capital city of Ethiopia, and 340 Km from Hawassa, the capital city of Southern Nations Nationalities and Peoples Region. The watershed covers a total area of 158.22 Km^2 and is inhabited by 11,104 people distributed within the watershed. The crude population density of the watershed was 121 persons per square kilometer. The watershed included Arga bacho and Dissa kebele in upper streams; Wasara Talo kebele in middle stream, and Hala Bacho and Sayki kebele in lower streams (Loma woreda agriculture and rural development office, 2013).

The elevation ranges lie between 1254m – 2428m above sea level. The large part of the watershed was entirely falls into sub-tropical (*Woina-dega*) and tropical (*kola*) agro-climate. The mean annual temperature range is 15.1 to 27.5°C (BoFED, 2014/15). Rainfall ranges from 1401mm-1800mm. The rainfall is a bimodal type in the watershed: the short rainy season is between March and May, and the long rainy season is between June and September. The geology of the study area is abundant with *rhyolites* and *trachy* basalts mainly overlying in the Precambrian basement and tertiary volcanism. Most of the area has dissected and rugged landscape, having well drained and moderately weathered brown soil (*Nitisols*) and *Orthic Acrisols* (Getahun and Bode, 2015). Thus, soil erosion in the area is mainly attributed to the dissected and rugged topography.

Agriculture is mainly composed of crop production and animal husbandry and it is the main source of livelihood of the population in the Watershed. The dominant activities under land use pattern in the study area include cultivation of perennial crops such as enset, banana, coffee, mango, avocado and etc., whereas the annual food crops include cereals (maize, sorghum, teff), pulses (beans, peas), (maize and teff are largest produced), and root crop like potatoes, yams, sweat potatoes and cassavas. Generally, mixed agriculture is the major economic activity in this watershed (Loma woreda agriculture and rural development office, 2013).

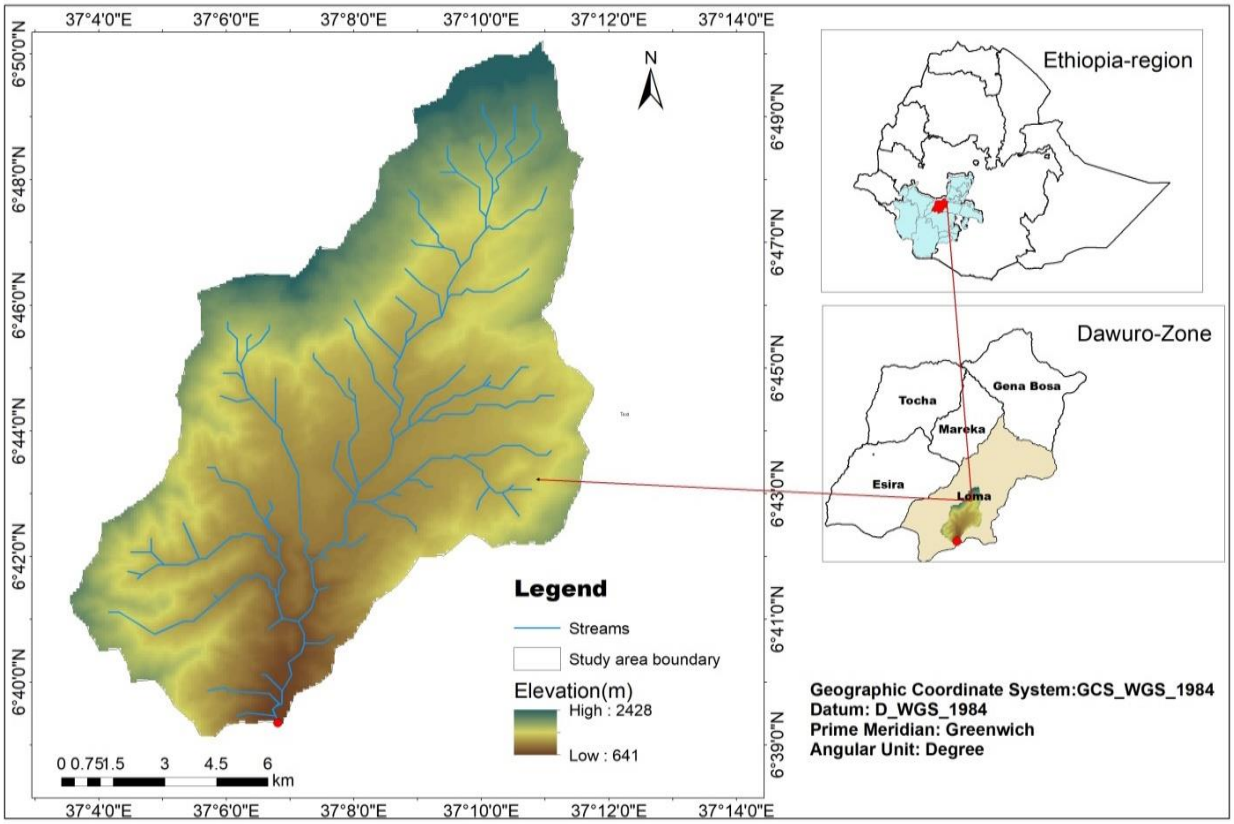

Figure 1 Locational Map of the study area

2.2 Sampling Design

Multi-stage sampling techniques were employed to select sample household farmers for the study from entire watershed. In the first stage, the watershed was purposively classified in to three parts depending on its topography i.e. upper, middle and lower streams of the watershed. In the second stage, the household heads stratified based on their residence in to upper, middle and lower streams of watershed to avoid the bias in generating information.

Finally, a total of 286 sample households were selected randomly from three streams of the watershed on the basis of probability proportional to size (PPS) sampling procedure. These sample farm household heads were determined using the following formula provided by Yamane (1967).

$$n=\frac{N}{1+N(e)^2} \qquad \text{(Eq.1)}$$

Where; n= sample size
N=total population (the total household head)
e= level of precision (margin error) = 0.05

Based on the above formula, the total sample household heads were calculated as follow:

$$n=\frac{1,009}{1+1,009(0.05)^2}=286$$

Table 1 Distributions of household head and determinations of sample size

Categories of Watershed	**Household heads in each stream**		**Total households**	**Sample size**		**Total sample Size**
	Male	Female		Male	Female	
Upper streams	386	23	409	109	7	116
Middle streams	302	15	317	86	4	90
Lower streams	272	11	283	77	3	80
Total	**960**	**49**	**1,009**	**272**	**14**	**286**

2.3 Method of Data Collection

To attain the objective of the study, data were collected from both primary and secondary sources. The primary data were collected through questionnaire, key informant interviews, FGDs and field observations. Close ended and open ended format questions were prepared and distributed to the selected sample farmers' household heads, and interview questions administered through face to face interview to get information about determinants of farmers' decision to use improved land management practices. In addition, three focus group discussions among a small group of six to seven members of the farmers were carried out in the watershed. Moreover, key informant interviews were held with respondents from different sections of the community such as three development agents, two from non-government organizations, four model farmers, and three elderly farmers. Furthermore, secondary data were collected from published and unpublished documents, reports from the study area of different governmental organizations and non-governmental organizations.

2.4 Data Analysis Techniques

Qualitative data (data which were gathered through observation, interview and focus group discussions) were analyzed by using thematic analysis of categorization. Descriptive statistics and multinomial logistic regression model were employed to analyze the quantitative data. Important statistical measures that were used to summarize and categorize the research data were means, percentages, frequencies and standard deviations. These analyses were made by using SPSS version window 20. Comparisons between land management technology user's and non-users were carried out through application of chi-square and F-test. The relative influences of various explanatory variables on the dependent variable were also analyzed.

Specification of the Logistic Model

Multinomial logistic regression is used to predict categorical placement in or the probability of category membership on a dependent variable based on multiple independent variables. The independent variables can be either dichotomous (i.e., binary) or continuous (i.e., interval or ratio in scale). Multinomial logistic regression is a simple extension of binary logistic regression that allows for more than two categories of the dependent or outcome variable (Schwab, 2002).

In the econometric analysis, multinomial logistic model was applied in this study to identify the factors that determine farmers' decision to use improved land management practices such as *fanyajuu* and stone bund. Attempting bivariate modeling excludes useful economic information contained in the interdependent and simultaneous adoption practices (Bekele, and Drake, 2003; Wagayehu, 2003). Multinomial logistic model is more appropriate to treat the determinants of farmers' decision to use land management technologies as a multiple choice decision.

Accordingly, the multinomial logistic model for a multiple choice problem is specified as follows:

$$P\ (y = j) = \frac{e^{Bjxi}}{\sum e^{Bkjxi}} \quad \text{..........}2$$

Probabilities for the j + 1 choice for a decision maker with characteristics *xi*. Before proceeding, we must remove indeterminacy in the model. If we define B*****j= Bj + Z for any vector Z, then the identical sets of probabilities result because the terms involving Z all drop out. A convenient normalization that solves the problems of the probabilities which Bo = 0 are:

$$P\ (y = j) = \frac{e^{Bjxi}}{1+\sum e^{Bkjxi}} \quad \text{..........}3$$

for j= 1, 2……………………………………………………………………..…k

$$Prob\ (y = 0) = \frac{1}{1+\sum e^{Bkjxi}}$$

Preconditions and Adjustment made before Analysis

The existences of multi-collinearity is assessed for continuous explanatory variables by using a technique of variance inflation factor (VIF) and tolerance level (TOL) where each continuous explanatory variable is regressed on all the other continuous explanatory variables and coefficient of determination is computed (Addisu, 2013). Thus, a measure of multi-collinearity associated with variance of inflation factor is defined as:

VIF (Xi) =(1-Ri^2-11)……………………………………………………………...…....…4

Where $R^2$is the coefficient of determination when the variable Xj is regressed on the others explanatory variables.

TOL (Xi) =1-Ri^2……………………………………………………………………………………..5
Where, TOL = Tolerance level of explanatory variable
R^2i=Coefficient of determination of explanatory variable
Therefore, the multinomial logistic model was used to identify the factors that determine farmers' decision to use land management practices, and the goodness of model fit and the result depicts that the model has a value of chi-square at less than one percent level of significance that shows the parameters in the model except the constant are different from zero.

According to Agboola et al. (2015), Also important to note is that in a multinomial logistic model, the marginal probabilities resulting from an item alter in an independent variable must sum up to zero, since the predictable increases in marginal probabilities for certain options persuade a decrease for the other options within a set. In this case, the choice of improved land management practices is then modeled as a function of demographic, socio-economic, institutional and characteristics as well as physical factors. This can be presented as a general form equation:
Zit = f(X_i) …………………………………………………………………………6
Where Zit takes on values 1, 2… k, if individual i chooses alternative j; the MNL model is, however, operationalized empirically with the following equations.

$Z_{ot} = \alpha_o + \beta_{10}X_1 + \beta_{20}X_2 +$ ---------------$+ \beta_n X_n + \epsilon_1$...7

$Z_{1t} = \alpha_1 + \beta_{11}X_1 + \beta_{21}X_2 +$ ---------------$+ \beta_n X_n + \epsilon_1$...8

$Z_{2t} = \alpha_2 + \beta_{12}X_1 + \beta_{22}X_2 +$ ---------------$+ \beta_n X_n + \epsilon_1$...9

X_i…………………X_n represent vector of the explanatory variables where n = 1---------10
β_1……………….. β n represent the parameter or coefficients
ϵ_i represents the independent distributed error term and α_o, α_1, α_2 *and* α_3 shows the intercept or constant term.

3. RESULTS AND DISCUSSION

3.1 The Status of Farmers' Decision to Use Improve Land Management Practices

The status of farmers' decision to use improved land management practices are shown in table below

Table 2 Distribution of respondents by farmers' decision to use improve land management practices

Types of ILMPs	**Farmers' decision category**					
	Used		**Not-used**		**Total**	
	N	**%**	**N**	**%**	**N**	**%**
Fanyajuu	111	38.8	175	61.2	286	100
Stone bund	191	66.8	95	33.2	286	100

Source: own survey data (2018)

Fanyajuu: It is an improved physical land management measures in the study area. It is made by digging a trench and throwing the soil uphill to form an embankment and over time creates sloping bench-like terraces. The result showed that cumulatively, (61.2%) of the farmers did not practice land management technology of *fanyajuu,* while about (38.8%) of farmers used improved land management practices of *fanyjuu*. This implies that *fanyajuu* was not widely used by the farming household heads in their farm plots.

Stone bund: is an improved physical land management technology. It prevents humus of soil fertility and control erosion by shortening the length and minimizing the gradient of the slope. The structures of stone bunds are recommended to be constructed on the farmland with slope ranging between 3% up to 30% (MoARD, 2010). The study further revealed that about (66.8%) of the farmers used stone bund, while about (33.2%) of farmers did not practice improved stone bunds in their farmlands. Its construction length and width depends on topography of the slope.

Results from key informant interview suggested the limitations of stone bund in the farm plots. It takes much labor forces to construct and when sudden destruction happens on a single upslope bund, it causes a serious destruction. Consequently, it results in the destruction of the remaining down slope bund, which in turn results in a huge amount of soil erosion.

3.2 Descriptive Results

This section presents the descriptive statistics results between farmers' decision category for both dummy and continuous variables of improved land management technologies among farming household heads in the study area.

Table 3 Descriptive statistics between farmers' decision category for dummy variables

Explanatory Variables	Farmers' decision category				χ^2
	Used		Not-used		
	N	%	N	%	
Sex of HHs	167	58.4	119	41.6	8.056**
LANDSEC	183	64	103	36	22.378***
LABORG	156	54.5	130	45.5	2.364^{Ns}
SLOPE	206	72	80	28	55.510***

Source: own survey data (2018); ***, ** and Ns significant at 1, 5%, not significant probability level, respectively

As specified by survey result in Table 2 showed majority of household heads (58.4%) used improved land management technologies, whereas only (41.6 %) of household heads did not use improved land management practices. In addition to this, chi-square analysis of these data showed that there is a statistically significant variation between farmers' decision category in terms of sex of the household heads at less than 5% probability level.

On the other hand, majority of sampled respondents (64%) used improved land management technologies and have secured their land, whereas only (36%) of sampled respondents did not use improved land management practices and have not secured their farmlands. Analysis of chi-square test showed that there is a statistically significant difference between farmers' decision category in terms of land security household heads at 1% probability level.

Furthermore, survey results also showed that about majority of respondents (54.5%) had labor force to construct land management technologies, whereas only (45.5 %) of respondents lack labor force to construct land management technologies in their farm plots. Similarly, Tesfaye (2017) found that the number of labor force available in the family is assumed to influence decision of farmers to adopt SLM practices. Families with large household members will be able to supply the extra-labor that could be required for adoption and continuous implementation of SLM activities. During focus group discussions participant recognized that labor is important for physical management practices in mutual cooperation. They also suggested that family labor hire mutual cooperation with community and labor hire with neighbors are the solution to reduce labor shortage for improved land management practices.

Slope of the land determines land degradation in general and soil erosion potential in particular. The result also showed that the large number of farmers (72%) practiced improved land technologies along steep slope areas which need much attention. On the other hand, only (28%) of the farmers did not practice improved land management practices along steep slope areas that need relatively less attention than users for constructing structural land management practice. The chi-square result indicated that the sampled respondents land slope was statistically significant at less than 1% probability level. From this point of view, the farmers who had steep slope farmland practiced improved land management technologies more than gentle slope to reduce the impact of soil erosion and land degradation on their farmlands.

Accordingly, during focus group discussions farmers suggested that as the slope of farmland increases, farmers also strengths structural land management technologies to control soil erosions. Moreover, field observation results revealed that stone bunds are constructed more along sloppy farmlands than flat farm plots because sloppy farm plots are more exposed to land degradation and soil erosion. Similar result has been reported by Miheretu & Yimer (2017). They reported that farmers are more likely to use physical land management practices on sloppy lands that are susceptible to more rapid runoff and soil erosions.

Table 4 Descriptive statistics between farmers' decision category for continuous variables

Explanatory Variables	Farmers' decision category Used	Not-used	F-test

	Mean	SD	Mean	SD	
Age of HHs (in years)	40.96	10.64	43.4	8.83	4.55***
EDUHH (in years)	2.12	1.084	1.33	0.669	7.70***
FAMSIZE(in numbers)	6.92	2.38	6.04	2.28	2.45*
CREDIT (in frequency)	2.05	1.027	1.15	0.925	0.187
OFFINCOM in ETB	616.92	255.4	405.61	182.3	1.50
TLU	2.78	3.09	2.45	2.27	10.20***
FARMSIZE in ha	1.87	1.38	1.3	0.72	4.92***
EXTSERVICE (in frequency)	1.17	0.83	0.67	0.59	2.4*
DISTPLOT in Km	0.29	0.57	0.52	1.09	2.27***

Source: own survey data, 2018 ; ***, * significant at 1, 10% probability level

Survey results indicated continuous variables in Table 4 The mean age of 40.96 with standard deviation of 10.64 of the farmers used improved land management technologies, while the mean age of 43 with standard deviation of 8.83 of the farmers did not use improved land management technologies in their farm plots. This implies that the farmers who are in working age groups have a good understanding of the environmental problems due to access of information and flexibility and they are more interested in land management technologies. Similarly, Tesfu (2012) reported that younger farmers have longer planning horizon and they are more flexible in deciding to use new ideas and technologies. On the other hand, older farmers usually have short planning horizon and the practices of land management declines if there is no person in the family who can contribute labor. The result of one-way ANOVA also indicated that (F=4.55) there is a statistically significant difference between farmers' decision category in terms of age household heads at 1% probability level to practice land management technologies.

Farmers with the mean years of schooling, 2.12 and 1.084with standard deviation used improved land management technologies, whereas farmers with the mean years of schooling 1.33 and 0.665 standard deviation did not practice improved land management technologies in their farm plots. This implies that when farmers' year of schooling increases, their access for information about soil erosion increase which in turn increase land management practices. In addition, the analysis of one way ANOVA revealed that (F=7.70) there is statistically significant difference at 1% probability level. This showed that there is a systematic association between the years of schooling of farmers and their use of land management technologies.

Farmers with the mean family size of 6.92 and 2.38 standard deviation used improved land management technologies, whereas the mean family size of 6.04 with standard deviation of 2.28 of the household heads did not practice improved land management technologies in their farm plots. In addition, information collected from focus group discussants suggested that the existence of large number of family size contributes significant labor hiring for social activities in structural land management technologies. This implies that farmers with a larger numbers of family size and relatives invest more in land management than farmers with small family size. The result of this study is similar to a study conducted in Silt Woreda by Mushir and Kedir (2012). They reported that households with larger family size maintain conservation structures of land management than their counterparts due to availability of laborers. The result of one-way ANOVA also indicated that (F=2.45) there is a statistically significant difference between farmers' decision category in terms of households size at less than 1% probability level to practice land management technologies.

Farmers, who received loans from various institutions for the cultivation of new crops and for livestock farming, significantly involved in continued use of land management technology. This implies that the use of credit motivated farmers to produce more cash crops and get more income which lead to better implementation of land management technologies. The mean yearly frequency of access to credit was found to be 2.05 and 1.15 with standard deviation of 1.025 and 0.925 for land management technology users and no users of land management technologies respectively.

In rural area, off-farm activities are usually considered as significant sources of employment and income for the rural farmers that help to decrease burden on the land and encourages land management practices. The mean off farm incomes of users and non-users of improved land management technologies were 616.92 and 405.61 with a standard deviation of 255.4 and 182.3, respectively.

Livestock are as means of the indicator of wealth or assets and used for food, transport from place to place, cash requirement, credit payment for taxes and farmers kept them for beef farming in the study area. The mean size of livestock in TLU was 2.78 with standard deviation of 3.09 for the sampled farmers who used improved land management technologies, while the mean size of livestock was 2.45 in TLU with standard deviation of 2.27 for sampled farmers who did not use improved land management technologies. This implies that the farmers with more livestock have better availability of manure, and invest more in land management technologies. The analysis of one way ANOVA revealed that (F=10.20) it is statistically significant at 1% probability level. This showed that there is a systematic association between livestock ownership of farmers and decision to practice land management technologies.

As survey result also showed, the mean size of farmland in hectare was 1.87 with standard deviation of 1.38 for the sampled farmers who used improved land management technologies, while the mean farmland size of 1.3 in hectare with standard deviation of 0.72 for the sampled farmers who did not use improved land management technologies. The result of one-way ANOVA also indicated that (F=4.92) there is a statistically difference between farmers' decision category in terms of farm land size at 1% probability level to practice land management technologies. In addition to this, the information from FGDs and key informant interviews indicated that farm size determines fallow period, the farmers who have large farm size increases fallow period to enhances better land management practices and the farmers who have small farm size cultivates in continuous way decreases fallow period leads to decline of soil fertility and productivity. They also suggested that farm size also determines the designing and planning of physical land management technologies.

Accesses to agricultural extension service to farmers are likely to increase their awareness about the effects of land degradation, soil erosion and the understanding about the land management technologies and their benefits. As survey result also depicted, the mean monthly frequency of extension services was found to be 1.17 with standard deviation of 0.83 for farmers who used improved land management technologies, whereas the mean monthly frequency of extension services was 0.67 with standard deviation of 0.59 for non-users of improved land management technologies. The result of one-way ANOVA also indicated that (F=2.4) there is a statistically significant difference between farmers' decision category in terms of mean monthly extension visit at less 10% probability level.

During FGDs, the discussants claimed that access to agricultural extension services is provided experience and information sharing and better understanding about the environmental problems particularly soil erosion. But, Extension trainers most of the time focused on improved seed and artificial fertilizers, but they did not focus on the ways of land management technologies.

Distance from farm plots influence a land management decision for two reasons: the closer supervision and attention it gets from the family. Adoption of labor-intensive land management practices is greater on homestead plots than on rain fed plots away from the homestead. Furthermore, survey result also showed that the mean distance from farmers' plot in kilometer was found to be 0.29 and 0.52 with standard deviation of 0.57 and 1.09 for users and no users of land management technologies respectively. The result of one-way ANOVA also revealed that (F=2.27) there is a statistically significant difference between farmers' decision category in terms of distance from plots and residence at less 1% probability level. This implies that farmers who have farm plots near homestead invest more on their farm plots than far away from their dwellings. In line with this, farmers whose farms are nearer to their residence use application of manure and compost than distance farm plots (Fikru, 2009). Daniel and Mulugeta (2017) also found farmlands far away from homesteads require more time and energy for the conservation of farmlands.

3.3 Causes of Declining Soil Fertility

Soil fertility depletions are considered as main indicators of land degradation (Adimassu & Kessler and Aad, 2012).

Table 5 Major causes of declining soil fertility

No_	Cause of declining soil fertility	Percent
1.	Continuous cultivation	51.0
2.	Deforestation	46.6
3.	Poor agricultural land management	36.0
4.	Soil erosion	21.0

5.	Overgrazing	16.8
6.	Rugged topography	16.4

Note: A multiple response provided was used. Source: Own survey result (2018),

In this study discussants in the FGD have listed six indicators like continuous cultivation, deforestation, poor agricultural land management, soil erosion, rugged topography and over grazing are causes for the decline of soil fertility on the study area. Based on this, 51%,46.6%, 36%, 21%, 16.8% and 16.4% of 16.8% of FGD participants indicated that continuous cultivation, deforestation, poor agricultural land management, soil erosion, overgrazing, and rugged topography as the main causes of declining soil fertility in their area respectively (Table 5). Thus, it is clear that majority of the discussants replied that continuous cultivation, deforestation and poor agricultural land management were the main causes of declining soil fertility in the study area. Moreover, during observation period, some farmers practiced inappropriate design with poorly constructed land management practices on their farm plots.

3.4 Econometric Model Results

3.4.1. Test result for multi-collinearity among specified variables in the model

Before doing the econometric analysis, it was necessary to check for the existence of multicollinearity among the continuous variables and verify the degree of association among discrete variables. Variance Inflation Factors (VIF) and Tolerance (TOL) test show the degree of multicollinearity among the explanatory variables used in this analysis. The result showed that there was no serious multicollinearity problem between the continuous variables. This is because they did not exceed threshold point. For continuous variables, according to Gujarati (2004) if the value of VIF is ten and above, the variables are said to be collinear. Test result also revealed that the VIF has not reached the tenth point mark; on the other hand, the tolerance factor is greater than 0.1 point mark for all the explanatory variables in the model.

3.4.2 Determinants of farmers' decisions to use improved land management practices

The analysis of multinomial logistic regression was used to identify the factors that determine farmers' decision to use improved land management practices in the study area. The results of multinomial logistic regression analysis for improved land management practices indicated in Table 6 below. The dependent variable used in this study improved land management practices were *fanyajuu* and stone bunds.

Data in Table 6 revealed that the maximum log likelihood ratio -294.452 with *Chi square* test value of 252.723 at statistically significant at 1% probability level. These imply that the model is a good fit in this study. The pseudo R square result was 0.812 showed that about 81.2% of the explanatory variable had the variation of in decision to use improved land management technologies.

The total of 13 independent variables was hypothesized to analyze determinants of farmers' decision to use *fanyajuu* and stone bund as improved land management technology in the study area. Thus, only seven explanatory variables (level of education, family size, access of credit, off-farm income, farm size and land security of the households) were positively and significantly determined farmers' decisions to use *fanyajuu as* land management technologies, whereas only eight explanatory variables (level of education, family size, access of credit, off-farm income, farm size, extension services and slope of farmland were positively correlated of farmers' decision to use stone bund improved land management technology. In addition, the age of households was negatively correlated and significantly determined farmers' decisions to use *fanyajuu* and stone bund as land management technologies.

Table 6 Results of logistic regression for *fanyajuu* and stone bund land management technologies

Fanyajuu					**Stone bund**			
Variables	Estimated Coefficient	Standard error	Marginal effect	P-value	Estimated Coefficient	Standard error	Marginal effect	P-value
SEX	.312	.705	1.367	.658	-.233	.677	.792	.730
AGEHH	-.696	.289	.498	.016**	-.855	.278	.425	.002***
EDUHH	.317	.076	.729	.042*	.406	.171	.667	.018**
FAMSIZE	.191	.057	1.210	.001***	.205	.055	1.228	.000***
CREDIT	1.491	.358	.225	.000***	.918	.486	2.503	.0471*
OFFINCOM	2.077	.446	7.980	.000***	1.574	.417	.207	.000***
TLU	.071	.073	1.073	.333	.063	.067	1.065	.344
FARMSIZE	.200	.090	.819	.026**	.416	.128	.660	.001***
EXTSERVICE	-.547	.425	.579	.198	1.948	.441	.143	.000***
LANDSEC	1.629	.379	.196	.000***	-.207	.338	.813	.540
LABORG	.680	.373	1.975	.068	-.377	.380	.686	.321
SLOPE	.044	.214	1.045	.836	.796	.238	2.216	.001***
DISTPLOT	-.294	.274	.745	.283	-.289	.247	.749	.242

***, **, * represents significant at 1%, 5%, 10% probability level, respectively

Age of households: As hypothesized, the model output showed that age of households was found statistically significant at less than 5% and 1% probability level with the expected value and negatively related with farmers' decision to use *fanyajuu* and stone bund as land management technologies respectively. Accordingly, if age of households increases by one unit it decreases the probability to use *fanyjuu* and stone bund improved land management technologies by factor of 0.498 and 0.425 respectively. The result confirmed that adult households more likely decide to use *fanyajuu* and stone bund as land management technologies than households who are older. This finding corroborates study made by Heyi & Mberengwa (2012) and Simon et al. (2013) that reported age of the household affects decision on land management practices and conservation strategies negatively. Miheretu & Yimer (2017), and Tesfaye (2017) also reported that older farmers probably have shorter planning horizons and are physically weaker, more resistant to change, and hence they are not interested in adopting land management technologies, which have long-term effects. On the contrary, study made in Ngaciuma Sub-Catchment in Kenya by Chris et al., (2012) reported that it is true that older farmers were likely to have more farming experience and would therefore be likely to be more receptive to improved land management technologies.

Level of Educational: Level of education was found to be statistically significant at less than 10% and 5% probability level to use *fanyajuu* and stone bund respectively. As hypothesized, the positive coefficient of educational level indicates that one unit of schooling of farmers increase their decisions making and it also increases the probability to practice *fanyajuu* and stone bund improved land management practices by factor of 0.729 and 0.667 respectively. This implies that farmers with more years of schooling decide to use *fanyajuu* and stone bund improved land management technologies. It is in line with previous study made by Gemechisa (2017) that reported that relatively better educated farmers are engaged in the adoption of the newly introduced SWC practices. This finding is also similar to the finding of Gemechisa (2017).

Family Size: The family size influences the decision of farmers to undertake the type of land management activities. The multinomial logistic regression analysis also revealed that family size was found to be statistically significant at 1% probability level to use *fanyajuu* and stone bund. *T*he positive coefficients indicate that a unit increase in family size with the probability to adopt *fanyajuu* and stone bund improved land management technologies by factor of 1.210 and 1.228 respectively. This implies that the labor requirement is substantially increased farmers' decision to use *fanyajuu* and stone bund land management technologies in their farmlands. This study is in line with Berhan et al., (2016) and Heyi and Mberengwa (2012). They reported that households with large family size of members undertake more diverse land management practices as they are more likely to have the labor required to carry out land management activities. However, Agboola et al., (2015) in North central Nigeria reported that the larger households tend to hold smaller farms as a result of pressure on land which brings about land fragmentation and cannot afford to fallow; hence the use of bush fallow as a land management technique might not be feasible.

Access to Credit: The result revealed that access to credit has positively determined farmers' decision to use *fanyajuu* and stone bund improved land management practices. An increased access to credit by a unit increases the probability to adapt *fanyaju* and stone bund improved land management practices by factor of 0.225 and 2.503 at less than l% and 10% significance level respectively. This implies that farmers obtain credit motivated to invest more *fanyajuu* and stone bund land management technologies. The finding of this study is similar to a study made by (Gemechisa, 2017). They reported that the use of credit encouraged farmers to invest in land management practices.

Off-farm Income: The result revealed that off-farm income has positively correlated with farmers' decisions to use *fanyajuu* and stone bund improved land management practices. An increase off-farm income for farmers by a unit increases the probability to adapt *fanyaju* and stone bund improved land management practices by factor of 7.980 and 0.207 respectively at l% significance level. This implies that the farmers with higher yearly off-farm income were more likely to invest on land management technologies. And off-farm income is generating activities compete for labor resource that the household uses as an input in land management activities. This finding contradicts with the findings of Amsalu and deGraaff (2007). They reported that farmers who are involved in off-farm activities may encounter time and labor constraints for investing in land management technologies.

Farm Size: The result showed that farm size for households was found statistically significant at 5% and 1% probability level with the expected value and positively related with farmers' decision to use *fanyajuu* and stone bund as land management technologies respectively. Keeping other factors constant, an increase in farm size for farmers by a unit of hectare increases the probability to adapt *fanyaju* and stone bund improved land management practices by factor of 0.819 and 0.66 respectively. This means that farmers with larger farm sizes are expected to practice better land management practices. Sagni (2015) found similar results that large farm sizes are positive toward land management technologies and farmers more likely invest on it because they have funds to do so, while those who are holding small farm size have negative attitudes towards physical land management measures. On the other hand, Gemechu (2018) reported that land holding size would cause a decrement in farmers` level of perception on soil erosion.

Access to Extension Service: Extension service plays a great role in awareness about environmental problems and the possibility of farmers to practices land management technologies. The result revealed that extension service has positively correlated with farmers' decisions to use stone bund as improved land management practices. All other factors constant, an increase in extension service frequency for farmers by a unit increases the probability to adapt stone bund improved land management practices by factor of 0.143 at l% significance level. This implies that the frequency of extension service increases, it increases the possibility of the farmers to practice improved land management technologies. Similarly, Tesfaye (2017) found that the message/contents that farmer gain from extension agents help them to initiate to use the newly introduced land management practices on their farm to protect their land from erosion and to improve its fertility.

Land Security: As hypothesized, land security has positively correlated with farmers' decisions to use *fanyajuu* as improved land management practices. Keeping other variables constant, an increase land security for farmers by a unit increases the probability to adapt stone bund improved land management practices by factor of 0.196 at less than l% significance level. This implies that farmers who own and secure their land tend to invest in land management practices because as no one can take over the land in the future. Similarly, Ragassa (2005) found that security of land owner ship encourages manure use and construction of structural management practices, but not the use of inorganic fertilizer. Meseret(2014) also reported that farmers own secured land tend to be more conserved than rented or sharecropped plots.

Slope of Farmland: Slope of the land determines farmers' decisions on particular land management technologies. The result showed that slope of farmland was found to be statistically significant at 1% probability level to construct stone bund. *T*he positive coefficient indicates that a unit increase of slope of farmland with the probability to adopt stone bund improved land management technology by factor of 2.216. This implies that on steep slope farmers are more likely construct stone bund because the impact of soil erosion and land degradation would be more visible to the farmers. Kifle et al., (2016) also found similar results. The higher slope category of a plot, the greater will be the severity of soil erosion. On the other hand, Meseret(2014) found, the structures of soil and water conservation take more area of land and it will create inconvenience for farm operation like oxen plough.

4. Conclusions

The study identified determinants of farmers' decision to use improved land management practice in the study area. The study has focused on the major factors that determine farmers' decision to use improved land management practices. These factors are grouped as personal, institutional, socio-economic and physical. Analysis of multinomial logic model reveals that the explanatory variable household heads of educational level, family size, access to credit off-farm income and farm size were identified to have significant positive relationship on farmers' decision to use *fanyajuu* and stone bund improved land management technologies, while age of households was negatively related on farmers' decision to use *fanyajuu* and stone bund improved land management practices. As the result also revealed that extension service and slope of farmland were positively correlated with farmers' decisions to use stone bund, and land security has positive impact on farmers' decision to use *fanyajuu* as improved land management practices. It was concluded the results obtained from FGDs also revealed that continuous cultivation, deforestation, poor agricultural land management, soil erosion and rugged topography were the main causes of declining soil fertility in the study area. Based on finding it is recommended that policy makers and local government leaders should arrange a strategy to focus on enhancing extension delivery to farmers in the study area to appropriate design of *fanyajuu* and stone bund with supporting practices to their farmlands.

Conflict of interest

The authors would like to declare that there is no conflict of interest.

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