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RESEARCH ARTICLE

FACTORS INFLUENCING THE ADOPTION OF SUSTAINABLE LAND MANAGEMENT PRACTICES AMONG SMALLHOLDER FARMERS: THE CASE OF BOLOSO SORE DISTRICT IN WOLAITA ZONE, SNNPR, ETHIOPIA

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ABSTRACT

Natural resource conservation draws the attention of many development oriented organizations as the problem extended to the available and most productive lands since its implication in food production is adverse. In this context, the adoption of Sustainable Land Management practices is quite crucial to increase agricultural productivity, ensure food security and improve the livelihoods of smallholder farmers in many parts of the world, especially in developing nations, including Ethiopia. A number of soil and water conservation methods were introduced to combat land degradation but adoption of these practices remains below expectations. Therefore, the main objective of this study was the socio-economic, institutional, psychological and biophysical factors that influence adoption of SLM practices among smallholder farmers in Boloso Sore District of Wolaita zone, Ethiopia. Employing multi-stage sampling technique 200 households were interviewed to gather data. Primary quantitative data were collected using interview schedule through face-to-face interview whereas qualitative data were collected through key informant interview and focus group discussion. Descriptive, inferential and econometric analyses were carried out. The computed independent T-test for the mean income difference was statistically highly significance between adopters and non-adopters, suggesting that adopters were in better-off position to improve their livelihood. From the 17 explanatory variables entered into the model, 10 variables were found to be statistically significant in determining adoption of SLM Practices by farmers in the study area at less than 1, 5 to 10% probability levels. These are education level of the household head, , perception of land degradation problems, land tenure certification, credit service access, frequency of development agent contact, member in community organization,Participation in government awareness programand livestock ownership significantly positively affect adoption of land management practices while distance to market, land to labour ratio affects it negatively at less 10% probability levels. Overall results from this study show that Planners should formulate appropriate programs considering the farmers interest, capacity, and limitation in promoting improved soil conservation technology for greater acceptance and the adoption of SLMPs can also be enhanced by increasing farmers' literacy level and encouraging them to participate more in community based organizations.

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INTRODUCTION

On average, one out of every three people on earth is in some way or the other affected by land degradation. Latest estimates indicate that nearly 2 billion hectares of land worldwide are already seriously degraded, some irreversibly (FAO, 2010). In Ethiopia, for example, soil erosion is one of the major threats to agricultural production (Tenge, 2005). Factors such as population growth, deforestation and poor farming techniques have been pointed out as the major causes. Human growth has resulted in increased human activities and land demand, which triggered overgrazing, deforestation and use of inappropriate farming practices (Senkondo, 2009). Land degradation becomes an economic problem when it reduces productivity in individual farm. It is an important contributor to poverty and backwardness of Ethiopia's rural population. Land degradation reduced food production and even created unproductiveness in some parts of the country. Land degradation at the household level has resulted in economic loss (food, pasture, and fuel wood) and it also has social consequence where farmers are forced to migrate to other areas, which would result in displacement of the household member (Addisu *et al*, 2015).

In the most part of the country, water shade in general and Omo Basin watershed in particular are among the watersheds that are severely affected by land degradation. This is because of early settlement and expansion of agriculture, high population and continuous cultivation together with steep terrain and erratic and intense nature of rainfall that caused soil erosion and nutrient depletion to be the major problems. The

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productivity of the area deteriorates year after year and has become very serious. In response to high resource degradation particularly soil erosion, to mitigate the problem and enhance or maintain the production potential of agricultural land, some soil and water conservation measures were undertaken. However, land degradation is still a serious problem due to different socio-economic, political and institutional reasons. The cause for the failures and low adoption of introduced soil conservation practices are also reported to be attributed mainly to non-participatory nature of conservation, inappropriate conservation technologies, discontinuity of incentives like food for-work program, and other institutional and socio-economic problems related to individual land owners. Recognizing the threat of land degradation, the government of Ethiopia has made several Natural Resource Management (NRM) interventions through various programmes such as productive safety net programme (PSFP), Food for Work programme and *MERET* and *MERET PLUS* Programme since mid-1970s and 80s (Aklilu, 2006; Terr Africa, 2006, Tesfaye, 2017). As a result a wide range of land conservation practices, which include stone terraces, stone bunds, area closures, and other soil and water conservation technologies and practices have been introduced into individual and communal lands at massive scales. The concept and definition of sustainability is broad and varies depending on the problems to be addressed. There is a need to give a clear working definition of sustainability in the context of our problem. Solomon (2005), define Sustainable Land Management(SLM) in more specific term as the use of both indigenous and introduced land management practices and technologies for agricultural and other purposes to meet human livelihood needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions. In this regard, SLM is not only the use of physical Soil and Water Conservation measures, which is a common mistake made by almost all actors in the country, but also includes the use of appropriate soil fertility management practices, agricultural water and rain water management, forestry and agroforestry, forage and range land management, and application of these measures in a more integrated way to satisfy community needs while solving ecological problems (Seid, 2009; Bai *et al*., 2008; Lal and Stewart, 2013; Tesfaye., 2017).

A recent survey in the Amhara region also showed that only 30% of the implemented soil and water conservation structures of the past half decades of conservation, work have survived (EPLUA, 2005;Tesfaye, 2017). The above survey results, however, should be seen in time context. Better land and water management and increased use of soil conservation practices could help to reverse soil degradation and boost crop yields, but in many parts of the country, these practices are not widely adopted yet. The adoption and investment in sustainable land management is crucial in reversing and controlling land degradation, rehabilitating degraded lands and ensuring the optimal use of land resources for the benefit of present and future generations (Akhtar-Schuster *et al*., 2011). Despite on-going land degradation and the urgent need for action to prevent and reverse land degradation, the problem has yet to be appropriately addressed and identifying the determinants of SLM adoption is a step towards addressing them. There is an urgent need for evidence-based economic evaluations, using more data and robust economic tools, to identify the determinants of adoption as well as economic returns from SLM (Tesfa and Mekuriaw, (2014); Tesfaye, 2017). Given the situation as cited above research on determinants of land degradation at plot level remains has been scanty. Research on the human induced factors of land degradation (unsuitable land-use and inappropriate land management practices) helps to design appropriate land management policies and strategies that promote wise use of natural resources. Moreover understanding the characteristics of agriculture in the study area and the effect of farming population growth on land resource use is necessary. Policies and strategies addressing the constraints and limitations faced by the farmers and the bio-physical condition of their plots managed are needed in order to use land sustainably in the best interest of the land users for sustainable development.

Available evidence shows that studies on the determinants of adoption of SLM practices among smallholder farmers are a few and far below adequacy. Further research on the adoption of land management practices is needed to build on this understanding of what works, and where. Therefore, this study was conducted in view of bridging this gap. It intends to add to the stock of knowledge on the factors that determine farmer's decision to implement certain sustainable land management practices. The general objective of this study was to assess the determinant of adoption of SLM practices/technologies among smallholder farmers in Boloso Sore in Wolaita zone, Ethiopia. Thus, this study is significant in that the identification of context based determinant factors of adopting sustainable land management practices will inform decision makers to design context-specific socio-economic, biophysical, institutional and demographic context based SLM technologies/ practices and avoids one size fits to all problem of the previous top down approaches. Such knowledge is important to guide policy makers and development agencies in crafting programs and policies that can better and more effectively address land degradation in Ethiopia.

Methodology of the Study

Description of the Study Area

The study was conducted at Boloso Sore district, Wolaita zone, Ethiopia. The area has a bi-modal rainfall pattern with two distinct rainy and cropping seasons. The total number of rural households in the district is 38,935 out of which 89.87% are men and 10.13% are women headed households. The total population of the *district* was estimated to be 196,582 out of which 49.27% were male and 50.73% were female. The population density of the *district* is 636 persons per Km^2. The average household size is 5.1. The total size of the *district* is 24,286 hectares out of which 65.80% is used to grow annual crops, and 13.3% for perennial crops. The rest of the land is used for grazing and a small portion of land for other communal purposes including basic agro-forestry activities. The main rainy season (*meher*), which is also the main cropping season, extends from *June to September*. The short rainy season, known as *belg* rain, usually covers the period from *February to April*. The mean annual rainfall of the area ranges from1201 to 1600 mm. The maximum and minimum temperature of the area ranges from 17.6 to 22.5ºC. Land preparation mainly done by ox-drawn plough. The *district* is predominantly rural, and depends on agriculture. The major economic activity is rain fed farming. Major crops grown in the *district* include cereals, pulses and cash crops like coffee, fruits, and root crops. Wheat and maize are the dominant cereal crops grown. However, the area is known for its low productivity due to land scarcity, land degradation, erratic rainfall and prevalence of pests. As a result, income from non-farm and off-farm activities is the second most important source of livelihood in the *districts*. Apart from trading, income from daily labor and seasonal workforce movement during harvest time is another source of income (WZFED, 2016).

Data Collection Techniques

Data for the study were collected from both primary and secondary sources. Primary data collected by employing household interview schedule survey, focus group discussion, field observation, and key informant interviews to bring the study to realization. Information about personal characteristics of the household head, the knowledge of SLM practices/ technologies, the resource endowment of farmers, farm management practices, cropping patterns, crop yield, role of different institutions to improve farming, and adoption of improved and indigenous soil conservation technologies, such as the construction of check dams, terrace improvement, terrace bunds, hedge management, retention walls, waterways, and mulching, were collected through individual interviews by using a semi- structured interview schedule. Pilot-tests were made by distributing interview schedule to six farmers in each site to assess whether the instruments were appropriate and suited to the study at hand. Necessary adjustments were made based on the comments obtained from pre-test responses from farmers to ensure reliability and validity. Data collectors were trained with respect to the survey techniques and ethical issues. Additional qualitative information, such as changes in soil conservation practices and cropping patterns over time, adoption of indigenous and improved soil conservation technologies, role of local level institutions in the promotion of SLM technologies/practices were collected through four focus group discussions, eight key informant interviews, and through observation of the watershed. Focus group discussions were conducted with 8 to 10 non sample farmers. A secondary data source includes journal articles, research reports and other publications, including internet sources of information.

Sampling Techniques

In the study area, farming households are the main source for making day to day decision on farm activities. Thus, households were the basic sampling units. Three-stage sampling techniques were used to generate the required primary data. At the first stage, *Boloso Sore district* was selected purposively because it is one of the food insecure and Sustainable land management practicing *districts* of the zone. In the second stage, out of 29 *villages* within the *districts,* five *villages* (*Chama Hibecho, Wormuma, Tadisa, Dubo and Dolla*) were selected by purposive sampling technique because for the reason where the adoption of sustainable land management practice was high in comparison to the other villages. From these *villages*, sample size was determined using simplified formula provided by (Yamane, 1967) and 200 households were determined by employing 93 per cent confident interval and 7 per cent margin errors. That is

$$n = \frac{\text{N}}{1+\text{N}(\text{e})2} = \frac{9102}{1+9102(0.07)2} = 200.$$

A probability proportion to size (PPS) was employed to determine sample size from each *village* and finally households were selected by using systematic random sampling techniques (Table 1).

Data Analysis

Descriptive Analysis

Data were analyzed through generation of descriptive statistics and binary logistic regression model. Descriptive static techniques such as percentages, means, standard deviations and frequency counts were generated for general information, t-tests were applied to analyze continuous data to compare the mean differences between adopters and non-adopters, chi-square tests were applied to analyze categorical data, correlation and cross tabulation method were used to identify inter-dependence among various factors influencing the adoption of soil conservation technology.

Table 1. Sample size of the villages

Name of villages	Total households in the village	Sampled households
Chama Hembecho	2344	51
Wormuma	1928	42
Tadisa	1852	41
Dubo	1548	34
Dolla	1436	32
Total	9108	200

Model Specification

A probabilistic model was specified with Determinants of the Adoption of Sustainable Land Management Practices among Smallholder Farmers' in Boloso Sore District, Wolaita Zone, as a function of series of socioeconomic, geographical, institutional and household characteristics. The dependent variable is dummy variable that takes a value of zero or one depending on whether or not SLM practice was adopters. A value of 1 was assigned to all households who adopted at least one improved SLM practices (the adopters) and 0 was assigned to households using only indigenous SLM practices (non-adopters). Here, the main purpose is to determine the probability that an individual with a given set of attribute fall in one choice rather than the alternative, i.e., to all households who adopted at least one improved SLM practices (the adopters) and 0 was assigned to households using only indigenous SLM practices (no adopters). Linear Probability Model (LPM), logit or probit models of regression are generally used to estimate the dependent dichotomous variable. Although linear probability model is the simplest method, it is not logically an attractive model in that it assumes that the conditional probability increases linearly with the value of explanatory variables. Unlike linear probability model, logit model guarantee that the estimated probabilities increase but never step outside the 0 – 1 interval and the relationship between probability (P_i) and explanatory variable (X_i) is nonlinear (Green, 2003 and 2004). Thus, a logistic model was used to identify determinants of the Adoption of Sustainable Land Management Practices among Smallholder Farmers' in Boloso Sore District of Wolaita Zone. Where P_i = is a probability of adopting or non-adopting which ranges from 0 to 1

$$L_{ij}= \text{Ln}\left(\frac{P}{(1-P)}\right) = P_{ij} = \beta_0 + \sum_{i=1}^{j} \beta_i X'_i + U_{ij} \quad i = j = 1, 2\ldots 17 \ldots\ldots\ldots\ldots 1$$

Where L_{ij}= is log of the odds ratio which is equal to Z_{ij}, which is not only linear in X_i but also linear in the parameters. It shows how log odds in favor of SLM practices change as the respective independent variable change by a unit and X_i= vector of relevant explanatory variables; B_i= vector of unknown coefficient; U_i = error term. The parameters were estimated by using maximum livelihood techniques. Hence, the above econometric model was used in this study and was treated against potential variables assumed to affect the farmer decision of soil conservation practices. The parameters of the model were estimated using the iterative maximum likelihood estimation procedure. The later yields unbiased and asymptotically efficient and consistent parameter estimates. Therefore, the above econometric model was used in this part of the study to identify determinant variables that influence adoption practices of Sustainable Land Management in the study area.

Dependent Variable: The dependent variable for the adoption model indicates whether a household has adopted SLM practices. Therefore, in this study adopters are households who adopted at least one SLM practices while non-adopters are those who did not adopt any of these land management practices. SLM technologies/practices include adoption of improved terraces, building *fanyajuu*, construction of check dams, diversified cropping systems (strip cropping and mixed intercropping), stone bund, integrated agro-forestry practices, terrace bunds whereas indigenous technologies include mulching, plantation of shrubs and trees at the edge of farm terraces, crop rotation, mixed cropping, diversion drains and waterways and manure. Improved SLM and indigenous practices were identified based upon the response given by the sampling units the interview schedule and cross checking the responses through field observation and discussion with farmers. In this study, a farmer who has adopted at least one improved SLM technology was defined as adopter. A value of 1 was assigned to all households who adopted at least one improved SLM practices (the adopters) and 0 was assigned to households using only indigenous land management practices (the non- adopters).Whether or not to adopt any SLM practices is determined by personal, social, economic, institutional, and geographical factors. These variables were retreated as explanatory variables in this study.

and institutional factors. T-test and Chi-square test were used, respectively to identify potential continuous and dummy variables differentiating adopters from non- adopters.

Continuous variables differentiating adopters from non-adopters of SLM practice/ technologies

Extension contact (Frequency): Extension is a source of information for many farmers, either directly, through contact with extension agents, or indirectly, through farmers who have prior exposure transmitting information to other farmers. 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 improve its fertility. Therefore, contact between a farmer and development agent and information gained help accelerating the attitude of farmers towards SLM practices positively, and the decision of farmers to invest on SLM Practices on his/her land (Tenge, 2005). In the study area, the most important sources of information cited were through communication with relatives and neighbors, community leaders, and the government's mainstream agricultural extension program. Farmers pointed out the government's extension service as the most important one. In addition, they further revealed that information about input supply and use, land management practices; and soil and water conservation practices are among the aspects covered by the extension services. Access to extension service is very important element of institutional support needed by farmers to enhance the use of agricultural technologies in general and soil and water conservation technologies in particular. Three Development Agents (DA"s) were assigned in each sample kebeles. It was expected that sample farmers in the study area have an access to extension services through the DAs, attending field days and trainings. However, 22% of adopters, 33% of non-adopters have reported that they did not get extension services (visits) in the year 2016. Development agents had visited 66% of sample households from one to three times per month. The average monthly frequency of extension visits was found to be 3.37 and 0.67 for users and non-users with a standard deviation of

Table 2. Independent Variables and their Expected Sign

Variable Code	Description and measurements	sign
EDUC	Discrete Level of education; where 0, illiterate; 1, able to read and write up to elementary; 2, grade attending above elementary. 3. Secondary and above	+
LADLAB	Continuous level, land holding household members	+
FSIZE	Continuous level, number of people in the household	-
AGE	Continuous, age of the households in years	-
SEX	Dummy variable, the sex household heads (1,Male and 0 otherwise	+
CERTFI	Farmers' feeling about the land belongs to him/she will have a positive effect on his/her decision to adopt land management practices; 1 if he/she perceives 0 otherwise	+
PERISK	Dummy variable, Farmers perceives a risk of loss of land in the future(1 factors if he/she perceives, 0 otherwise)	+
ACCRD	Dummy variable, accesses to credit (1= if accessed and 0 otherwise)	+
MEMBER	Dummy variable, membership in local organizations (1 if a farmer is a member and 0 otherwise)	
TRAIN	Dummy variable, whether training on SLM practice received by the farmer (1 if a farmer got training and 0 otherwise)	+
LAND	Dummy variable, farm land size owned by a member in hectares	+
TLU	Continuous variable, total livestock owned by member in TLU	+
EXTVIS	Continuous variable, number of extension visits received	+
DIEX	Continuous level, distance from member home to extension office in Km	-
DMRK	Continuous level, average distance of a plot from homestead, in minutes	-
TOTINC	Continuous level, total income of the households in Birr	+
GAPR	Dummy variable, Participation in government awareness program on climate or environmental variability, land degradation/soil conservation, etc. (Yes=1, No= 0);	+ +

RESULTS AND DISCUSSION

In order to investigate the presences of group mean difference with respect to the hypothesized socio-economic, geographical

0.98 and 0.68, respectively. The mean monthly extension visit difference of the two groups was found to be statistically significance at less than 1% probability level.

Land Size (Hectares): The survey results showed that landholding size of total sample households ranges from 0.125 to 2.50 ha with a mean of 1.75 and standard deviation of 0.65 ha. The average landholding size of adopters and non-adopters were 1.6 and 0.7 ha with a standard deviation of 0.95 and 0.65, respectively. It was significant at less than 1% probability level. There was a slight difference in the mean size of landholding between the two groups. However, the result of t-test showed that the mean landholding size was significantly different between the two groups. Land is one of the most important production factors for agricultural production. In rural households, in the study area land and labor account for the largest share of agricultural inputs. According to (Tesfaye, 2017) revealed that lack of control over resources is one of the major reasons for the degradation of natural resources. It is argued that farmers' decisions to investment on land management activities as well as their choice and implementations of land management practices are affected by tenure security. Some argue that private ownership is vital, because it encourages farmers to invest on and opt for efficient and lasting practices.

Livestock in TLU: Livestock is an important component of the farming system in the study area. A vast majority of the sample households included in this survey owned animals of different kind. Cattle, donkeys, horse sheep, goats and chicken are common domestic animals. Small ruminants and chickens were sold and serve the purpose of immediate cash needs at times of cash shortage. The size of livestock owned indicated the wealth status of the household. The average size of livestock in TLU was found to be 3.49 for total sample households. It was for 5.4 and 3.1 TLU with a standard deviation of 2.2, and 2.3, SLM adopters and non-adopters respectively. The main purpose of keeping livestock is for draught power. Livestock products such as milk and meat have secondary importance to the farmers. Small ruminants are mainly used as income sources as well as for household consumption. The t-test revealed that there is significant difference in the number of oxen owned by farmers who have adopted SLM practices and those who have not at less than 1% probability level.

Income of households in (Birr): This suggests that households who have adopted sustainable land management practices are in better-off position to improve their livelihood than those who have not adopted. As the former can diversify and be able to afford SLM practices expenses, expensive synthetic fertilizers, improved seeds, keeping livestock and thus uphold their livelihood sustainable. This is in agreement with Parwada *et al.,* (2010) who observed the adoption of sustainable land management technologies offer opportunities of improving the quality of the resource poor farmers. The total household income of adopters and non-adopters were 6645 and 3285 Birr with a standard deviation of 3876 and 1120, respectively. The result of t-test showed that the mean total income significant difference between the two groups at less than 5% probability level. The following table describes the measurement testing cited above.

Table 3. Continuous variables differentiating adopters from non-adopters of SLM practice/ technologies among 200 sample households

Variables	Adopters	Non-Adopters	t-value
	Mean(St.dev)	Mean (St. dev.)	
FSIZE	6.2(1.7)	6.6(1.8)	0.125
AGE	48.2(15.6)	47.8(14.8)	0.542
LAND	1.6(0.95)	0.7(0.6)	5.1***
DIEX	61(56)	63(57)	0.98
TLU	5.4(2.2)	3.1(2.3)	4.40***
EXTVIS	(0.67) 3.37	0.98(0.68)	3.98***
TOTINC	6645(3876)	3285(1120)	3.85**

Dummy variables differentiating SLM adopters from non-adopters of SLM practices

Generally, adopters and non-adopters not only vary in terms of quantitative variables but also in terms of qualitative variables. It was, therefore, quite essential to use a method of testing the differences between adopters and non-adopters. From the total 200 sample household heads, 74 (37%) were women and 126(63%) were men respectively (Table 3). The majority of adopters of the SLM Practices (73.6%) were male-headed households while only 26.4 % were female-headed households. Chi-square test results show that there is a statistically significant difference between adopters and non-adopters in terms of sex of the household heads at 1% probability level. From this, only 62.8 % of households adopted SLM practices/ technologies at least in one of their plots. This can imply that perceiving the problem of land degradation problem is cannot always be a guarantee for adoption of SLM practices/ technologies.

In the study area, it was found that only 53 % of the respondents have reported obtaining credit at least once since the last three years. Table 3 revealed that 47 % of respondents have not obtained credit from formal sources. When the data analyzed by disaggregating into adopters of SLM practices and that of non-adopters, it was assured that 81.1% of those who were adopted and continuously practiced SLM practices have obtained credit, but only 20.9% has got credit from those non-adopters. The Chi-square analysis disclosed that there is a significant association between access to credit service and adoption of SLM practices and it is significant at 1% level of significance. This could prove that farmers who have access to credit have a higher probability of adopting and retaining SLM practices/technologies than those with no access. Focus group discussions revealed that more than half of the farmers are cultivating erosion prone areas. According to Key Informant Interview also confirmed that credit sources for purchase of livestock and crop production are not satisfactory. Although credit facilities are available from microfinance institutions such as Omo microfinance, most farmers do not use the services because of fear of risks associated with crop and livestock performance failures that could lead to failure of repayment of the loan. Moreover, the credit services provided by the microfinance institutions are group based; which makes individual farmers accountable for the group members who are unable to pay their loan.

Farmers' perception of resources degradation and conservation motivation

With the intention of understanding the community's perception of natural resource degradation and conservation motivation, they were asked who are the most responsible for natural resource conservation. Ninety five percent of the participants strongly agreed that the responsibility should be only by every community member, 4.55% strongly agree that it should only by landowners, 2.12% strongly agree that it should be only by the government and 88.48% strongly agree it should be by all communities and government.

Table 4. Dummy variables differentiating SLM adopters from non-adopters of SLM practices among 200 sample households

Variables	Scores	Adopters	Non-Adopters	Total	χ^2
SEX	0	30	44	74	9.8***
	1	52	74	126	
PERISK	0	43	92	135	7.2***
	1	32	33	65	
ACCRD	0	72	22	94	7.8***
	1	86	20	106	
MEMBER	0	68	76	144	6.1**
	1	22	34	56	
TRAIN	0	45	78	133	9.2***
	1	42	25	67	
GAPR	0	43	62	105	8.40***
	1	72	23	95	

Households were also crosschecked for their perception of natural resource degradation. Farmer's perception on the existence of land degradation problem on their farm plots, causes of the problems as well as its consequences might make farmers to adopt and continuously implement SLM measures. The majority of the sample household heads (88.2%) have perceived the problem of soil erosion on their farm plots. From this, only 48.8 % of households adopted SLM practices/ technologies at least in one of their plots. This can imply that perceiving the problem of land degradation problem cannot always be a guarantee for adoption of SLM practices/ technologies. Based on their perception, the participants were approached to suggest their views about the importance of conserving natural resources. Thus, 61.8% of them suggested that conserving natural resources is extremely important, 31.2% very important, 5.8% somewhat important, 0.9% not very important, and 0.3% not at all important. Further, a question was forwarded in order to understand how many of them were involved in natural resource conservation. Accordingly, 9.4% were fully involved and 77.0% not. In order to understand the sources of degradation and conservation information households were also asked a question about it. Accordingly, 16.97% has access to information from a radio broadcast, 80% from extension staff, 14% from farmer organizations, and 6 % from friends. This finding on farmers' perception and motivation analysis showed low perception and motivation level of farmers. Although perceptive or not, the majority of the households still suggested that conservation of natural resources was extremely important as compared to small number of the households who suggested that conservation was not important. At the suggested level of perception and importance of conservation, households were clear on the responsibility of natural resource conservation; majority of them believed that both the community and government bodies should be responsible for natural resource conservation activities. One of the reasons behind fewer numbers of household perceptions of natural resource degradation and motivation to natural resource conservation is believed to be the inaccessibly to degradation and conservation information. The majority of the households are found accessing information only through agricultural extension agents.

Land Management Practices in the study area

Any land management practice, to be effective, needs to be economically feasible, socially acceptable and environmentally friendly. The researcher focused on the land management practices, especially introduced and indigenous land management practices. One can understand from Table-5, the most widely implemented indigenous practice was crop rotation (78.5%) followed by animal manure (77%) respondents in the study area. Results of the FGD revealed that low implementation of crop rotation resulted from habitual cultivation of one type of crop on the same plot of land and from low awareness; however, less admission to fallowing was due to large population whereby no land is left fallow. Crop rotation is one of the most important means of improving soil fertility as well as conserving the soils. High application of animal manure was attributed to livestock production by the mixed farmers in the study area. The use of animal dung, ash and household trash to crop land as manure is common practice to improve soil fertility. In the study area, this is well manifested in the homestead gardening or at backyards. Description of indigenous practices of manure shows highest concentration of manure around the homesteads (Habtamu, 2006 and Tesfaye, 2017).

Table 5. Indigenous land management practices

Indigenous land management practices	Frequency(n=200)	Percent
Crop rotation	145	78.5
Crop residue	82	41
Fallowing	63	31.5
Traditional waterway	115	57.5
Mixed cropping	72	36
Animal manure	154	77

Adoption of Introduced SLM practices/ Technologies

Long-term productivity and sustainability of the land resource requires sound land conservation measures in the farming systems that enhance maintenance and/or improvement of soil and land quality in general. This is an important consideration as it influences agricultural productivity and local livelihoods. In many instances, environmental degradation has stimulated a variety of responses and adaptation mechanisms by local communities. This study made an enquiry on whether farmers had undertaken any deliberate efforts to protect their land holdings from soil degradation. Majority of respondents (73.75 %) indicated to have used one or more SLM Practices in their farms as a means of adjusting and adapting to land degradation processes. As discussed by Tesfaye, (2017) and Holden and Shiferaw (2004) construction of bunds is arduous and labor intensive, requiring as much as 100 person days to construct a bund on a small quarter-hectare plot. Furthermore, opportunity costs can be very high, with bunds taking up 10–20 percent of cultivable area and even more on sloped plots. Bunds therefore actually reduce the area under cultivation by a significant percent. If farmers are to be benefited from installing bunds, productivity must not only increase, but must increase by more than is lost by the reductions in cultivation area. The combination of wet conditions and complications associated with small plots where bunds occupy significant portions of cultivable area, and difficulties in plowing appear to drive these results. The reasons behind limited implementation of the modern measures of land management as reported by FGD participants were different. Mulching was implemented by more significant proportion of the sample household heads due to the fact that crop residue disposed on their farm brought about better result in keeping the land protected from evaporation of its moisture and also breaks up heavy rain drops thereby minimizing run off. Fairly more than half 60% of the sample households have developed grass strip. This measure has double advantage; for land management and for animal feeding.

Econometric Analysis of Determinants of Adoption of SLM Practices

Education (EDUC): This variable has positive influence on SLM practice of households and was significant at less than10% probability level. Holding other regressors constant, a change in household head education level by one unit, say one grade, will increase a probability of being more practice on SLM by a factor of 1.267. The possible justification for this finding was that educated farmers tend to use modern agricultural technologies, adopt soil conservation enhancing technologies, use agricultural extension advice and information than illiterate farmers. This result is in agreement with findings of Tesfaye (2017), which stated that educated persons recognize the risk associated with soil erosion and spent more time and money on soil conservation. This in turn increases crop production and make farmers to be more food secure. Amsalu and Graaff (2007) documented positive and significant effect of education on SLM practices.

Number of livestock owned (TLU): The number of TLUs is positively related to the decision of compost/manure investment. This is because animal manure is one of the major inputs for compost/manure production. The positive sign of slope coefficient indicates that when livestock owned increase by one TLU, while the other variables in citrus paribus condition the probability of a household more participate in SLM practices, ceteris paribus, increase by a factor of 1.495. The possible explanation for this result is that as farmers have large number of livestock (ox, cow, heifer, calf, donkey, goat, sheep and chicken) they become in better position to be more the decisive towards compost/manure investment than farmers who have few livestock. On the other hand, livestock (ox) serve as non-human labor, i.e., draft power in land preparation that directly contributes to supply of food grain for a household. This finding is in agreement with Million Taddesse and Belay Kasa. (2007) and Tesfaye, (2017).

Extension contact (EXTVIS): As hypothesized, frequency of extension contact was found to have a significant positive effect on the adoption of SLM Practices at less than 10% probability level. This may be explained by the fact 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 improve its fertility. Therefore, contact between a farmer and development agent and the information gained accelerate the attitude of farmers towards SLM practices positively, and the decision of farmers to invest on SLM Practice on his/her land Taddesse and Belay Kasha (2007). The marginal effect value for extension contact should shows that keeping all factors constant an increase in extension contact by one e increases the probability of SLM Practice adoption by 0.062.

Perception of severity of land degradation as problem (PERISK): The coefficient of this variable supports the proposed hypothesis and it is significance at less than 1 per cent level of probability level. The logit model coefficient estimate for this variable is about 0.44939. The reason for this is that farm households' awareness of the erosion hazard is attached to their perception of the negative consequences of soil erosion and benefits of soil and water conservation. This could be explained by the fact that those farmers who have perceived soil erosion as a serious problem were willing to participate in conservation strategies of land management. Those farmers, who have better perception of soil erosion, will develop good initiations towards land management scheme and become less dependent on external assistance for undertaking land management activities (Tesfaye, 2017).

Land to labor ratio (LADLAB): the independent variable land to labor ratio had significant negative effect on land degradation that indicates an increase in the ratio of the land to labor decrease land degradation. The land holding per economically active person of the family as represented by the land to labor ratio was found to be significant at less than 10% probability level and have negative relationship with land degradation. This finding is consistent with the findings of Wagayehu and Drake (2003) in Eastern Hararghe. For a farmer with high land/labor ratio, spending more time in managing his land is more preferable than working in off-farm activity as opposed to limited land holding. This implies that the investment cost per unit area in terms of human labor invested and area lost to structures make the investment less costly and more rewarding.

Land tenure (PERISK): Farmers' feeling about the land belongs to him/she will have a positive effect on his/her decision to adopt land management practices. The lack of title to land is one important factor affecting adoption of SLM Practices because lack of tenure security means that people are reluctant to invest in new land management practices on a land which they do not formally own. Therefore, farmer's perception that the farmland he/she owns will remain his/hers at least during his/hers lifetime affects the decision on land management practices. For farmers to be able to carry out long or medium term investment, they require the security of tenure. This does not necessarily mean that they have to have individually documented proof of title rather need the feeling of ownership to make sure that the land will be theirs to work for a foreseeable future and not unpredictably taken away and reallocate to somebody else. This variable is found to be significant at less than 5% probability level and positively affect the dependent variable, SLM Practice. This is because to adopt and invest on land management practices, first there should have a sense of ownership so that farmer can take care of his land. When one unit increase in land tenure practices, other variables in citrus paribus, the SLM practices adoption increased by a factor of 0.210. The finding is consistent with (Tesfaye, 2017)

Distance to Development Agent Office (DIEX): plot distance has been found to be negatively related with SLM practices and the relationship is significant at less than 1% probability level. It is in line with the hypothesis that farm plot near to the home had a better chance of getting organic fertilizer and soil conservation technology than those that are away from home. Distance to development office increase by one minute, the probability of a household more participate in SLM practices, ceteris paribus, decrease by a factor of 0.802. The result indicated that distance of plot from the residence demands much time and effort while plots near the residence of the household get frequent supervision, organic fertilizer, traditional and improved soil conservation due to proximity and plots far away from the residences are usually neglected. The decision could perhaps be related to the availability of resource and profitability of the conservation structures. The finding is consistent with Wagayehu and Drake (2003).

Access to Credit (ACCRD): Access to credit was found to be significant and positive relationship with adoption of SLM practices. This indicated that access to credit has impact on the adoption of soil and water conservation practices. This is consistence with the study done in Ethiopia by Mberengwa (2012). The observed positive relationship could be due to the fact that, those who are likely to access credits are more likely in doing farming activities and business unlike those who are unable to access credits they mainly depend on farming as their main livelihood option and hence more likely to adopt SLM practices. The study was consonant with Melese (2016).

Member of CBO (MEMBER): member of farm group has been found to be positively related with land degradation and the relationship is significant at 5% probability level. It is in line with the hypothesis that farm group member had a better chance of can share and disseminate SLM knowledge to each other easily unlike those who are not in a group. The negative sign of slope coefficient indicates that when member in farm group increase by one unit, the probability of a household more participate in SLM practices, ceteris paribus, increase by a factor of 0.321. It was expected that, farmers who are in a group could better practice SLM than those who are not in a group because the former can share and disseminate SLM knowledge to each other easily unlike those who are not in a group. The significance relationship between farming groups and adoption of SLM practices can be explained by the fact that, many of the existed farmer group in the study area is addressing the issues of SLM practices hence the increase of farming groups leads to significance on adoption of SLM practices. The finding is consistent with Tesfaye (2017)

Table 6. The Maximum Likelihood Estimates of the Binary Logit Model

Variable name	Coefficient (B)	Odds ratio	P-value	(St.Error.)
-Constant	-20.702	0.000	0.001***	5.819
EDUC	0.236	1.267	0.054*	0.123
LADLAB	-0.235	1.132	0.099*	-0.360
HHS	-0.306	0.736	0.052	-0.157
AGE	-0.010	1.010	0.785	-0.037
SEX	0.072	1.075	0.915	0.672
PERISK	0.001	1.001	0.007***	0.001
CERTFI	0.042	0.210	0.026**	1.765
CRED	1.028	0.802	0.020**	2.064
MEBER	1.136	0.321	0.062*	0.609
TRAIN	0.836	0.092	0.020	2.034
LAND	2.18	0.042	0.952	0.976
TLU	0.402	1.495	0.086*	0.234
EXVIS	0.865	0.062	0.031*	0.032
PERDE	3.805	0.44939	0.005***	1.346
DIEX	0.096	0.075	0.815	0.572
DMRK	-0.965	0.802	0.096**	-1.096
TOTINC	0.000	1.000	0.001	0.001
Pearson chi-square = 92.7***				
-2 log likelihood = 62.69				
Prediction success (count R2) 91.8[a]				
Sensitivity 82.0[b]				
Specificity 94.7[c]				
Sample Size 200				

***, **, * Indicate significance at 1%, 5% and 10% probability level respectively. a -- Based on a 50% probability classification schemes; b-- Correctly predicted adopters households based on a 50% probability classification; c -- Correctly predicted non-adopters households based on a 50% probability classification.

CONCLUSIONS AND RECOMMENDETIONS

Conclusions

The overall objective of the study was to revisit adoption of sustainable land management technology practices in the study area. Descriptive data analysis showed that only 62.8 % of the HH adopted SLM practices/technologies at least in one of their plots. This can imply that perceiving the problem of land degradation problem cannot always be a guarantee for adoption of SLM practices/ technologies. A range of socio-economic, institutional, demographic and biophysical factors determines adoption of SLM practices in the study area. The result of the binary logistic regression model showed that SLM practices is significantly influenced by education, tenure security, livestock ownership, distance to land to home, credit services access, family labor to land ratio, members in community based organization, frequency in extension agent visit in the study area.

Recommendations

Sustainable land management practices are of great important for their significant positive impacts in our daily life. This has been observed from economic analysis and findings of this study. These results have important policy implications to be recommended. First, Planners and policy makers should formulate appropriate policies and programs considering the farmers' interest, capacity, and limitation in promoting improved soil conservation technology for greater acceptance and adoption by the farmers. In order to achieve the social benefits of natural resource conservation, there is a need for aggressive programmes to tackle the problem of low level of education, poor participation in community organizations and government initiated soil conservation programmes.

Second, for sustainable land management, despite the fact that sustainable land management is multifaceted and seems to require formal knowledge or at least guidance from extension providers to farmers, this call for quality extension staff so that non-adopters would become adopters. For this reason, government and policy makers should focus on improving skill of extension staff in-line with increasing their number and their availability for well-organized and useful dissemination of technologies, and hence a trickle-down effect to farmers. Such practices may have a significant impact for reducing the number of sustainable land management non-adopters, and for this reason farmers might have a considerable produces that could further reduce the burden of low income from the sale of their produces.

Third, there should be either formation or reformation of farmers-group/associations. Shortage and dormant farmer-group/associations was among drawbacks of SLM practices adoption. As seen earlier, majority of the farmers are not members of community based organization despite many advantages for a farmer being in a community based organization. Such advantages are to help to lower the delivery costs of government, NGOs and private-sector agencies supplying development services to small farmer groups, as well as help allied groups in reducing their individual cost of accessing those services and sharing input purchase, production, processing and marketing costs. Moreover, membership in community based organization in the study area would enhance their awareness towards adopting SLM practices, thus get more production to enhance their household income and consumption patterns.

Fourth, allotment of house-site near their landholding would also benefit the farmers so that they would become SLM practice adopters.

Fifth, more educational institutions with continuing education programs might be opened besides adult education centers. This eventually enhances the educational qualification of the farmers in the study area enabling them to become adopters of SLM practices.

Sixth, advancing loans to farmers through microfinance institutions, saving and credit cooperatives, and other banks would have positive impact on SLM practices adoptions.

Seventh, positive awareness creation and changing any negative perception of the farmers on the adoption of SLM practices through FTCs, periodical workshops and seminars and lecturing on the positive of SLM practices during farmers' day celebration would achieve the desired goals with regard to SLM practices adoption. Moreover, policy makers may device a suitable land tenure certification system whereby the farmers are assumed control over their land for a specific long period of tenure. This will enable them to feel the ownership to a greater extent.

Eight, any program and policy aimed at rural development has to give due attention and priority towards increasing the perception levels of farmers through organizing and facilitating experience-sharing programs at different levels.

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