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Determinants of the Adoption of Sustainable Land Management Practices among Smallholder Farmers' in Jeldu District, West Shewa Zone, Oromia Region, Ethiopia

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Abstract
Land degradation is a major cause of Ethiopia's low and declining agricultural productivity, continuing food insecurity, and abject rural poverty. The productivity of agricultural economy, which is the backbone of the country's economy, is being seriously eroded by unsustainable land management practices both in areas of food crops and in grazing. Low land productivity due to land degradation in form of soil erosion is one of the leading challenges to improving the performance of the smallholder farming system sector in Ethiopia. In this context, the adoption of Sustainable Land Management practices/ technologies is quite crucial to increase agricultural productivity, ensure food security and improve the livelihoods of smallholder farmers. Farmers recommend various SLM practices/technologies for sustainable implementation, but adoption of such agricultural land management practices/ technologies is still very low. There is no clear understanding of the problems encountered by farmers in the adoption of recommended SLM practices/ technologies. Therefore, the main purpose of this study was to assess the socio-economic, institutional, psychological and biophysical determinant factors that influence adoption of SLM practices/technologies among smallholder farmers in Jeldu district in West Shewa zone. Primary data were collected through household questionnaires surveys, focus group discussions, key informants interviews and personal observations while secondary data were collected from relevant local authority reports and records. A total of 224 households were interviewed. Both Descriptive statistics and binary logistic regression model were used to analyze the data. 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 18 explanatory variables entered into the model, 14 variables were found to be statistically significant in determining adoption of SLM Practices by farmers in the study area at less than 5 to 10% probability levels. These are education level of the household head, farm size, perception of land degradation ,effectiveness of SLM practices, credit service access, frequency of development agent contact and livestock ownership significantly positively affect adoption of land management practices while distance to market affects it negatively at less 10% probability levels. 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 farmer.
Keywords: Sustainable Land Management Practices, Adoption, Smallholder Farmers'

INTRODUCTION

Background and Justification of the study

To feed the world's growing population which is projected to exceed 9.2 billion by 2050 (World Bank, 2009; FAO, 2013; Nkonya *et al*, 2011.), it will be compulsory to boost the production of food. However, land degradation is extensively increasing, covering approximately 23% of the globe's terrestrial area, increasing at an annual rate of 5-10 million hectares, and affecting about 1.5 billion people globally (Gnacadja, 2012). Processes of land degradation occur in all climatic regions, with 'land' interpreted to include soils, vegetation, and water, and with the concept of 'degradation' implying adverse consequences for humanity and ecological systems (Conacher, 2009; Vlek *et al*., 2010; Braun *et al*., 2012; Pingali *et al*., 2014). Land consists of not only the soil but also the associated natural resources such as water, vegetation, landscape, and microclimate that are components of a larger ecosystem(Thompson *et al.,* 2009; Chasek *et al.,* 2011; Reed *et al.,* 2011).As the land is inter-connected with other natural resources such as the air, water, fauna and flora, managing land well, in addition to guaranteeing food supplies, poverty reduction and socio-economic protect environment and natural resources and to provide ecological functions and services in a sustainable manner(World Bank, 2003; Bridges and Oldeman, 1999; Berry *et al*., 2003; Jones *et al*., 2003; Stringer and Reed, 2007; Bai *et al*. 2008; Stoosnijder, 2007; Nachtergaele *et al*. 2010; Lal and Stewart, 2013; Zucca*et al.,* 2014) .Land degradation often results from immediate causes such as biophysical causes and unsustainable resource management practices, or with underlying causes including population density, poverty, institutional set up, land tenure and access to agriculture extension, infrastructure, opportunities and constraints created by market access as well as policies and general government effectiveness (Nkonya*et al*., 2011; Lambin *et al*., 2001).

Ethiopia's economy has its foundation in the smallholder agriculture. Land degradation is a major cause of Ethiopia's low and declining agricultural productivity, continuing food insecurity, and abject rural poverty (Pender and Hazell, 2000; IFAD, 2001; Shiferaw and Bantilan, 2004; (FAO, 2012). Soil erosion is a major problem with substantial costs to agriculture in the Ethiopian highlands, amounting annually to a minimum of 2-3 percent of agricultural gross domestic product (World Bank, 2007). The productivity of agricultural economy, which is the backbone of the country's economy, is being seriously eroded by unsustainable land management practices both in areas of food crops and in grazing lands **(**Leonard, 2003; Shiferaw and Holden 1998**).** At present extent and speed of land degradation, particularly due to soil erosion is distinguished as a serious threat to the viability of the subsistence agriculture in the country (Lakew*et al*., 2000; Le *et al*., 2014). Its severity is explained by a decline in productivity, formation of rills and gullies in both farming and grazing lands through time (Stringer and Reed, 2007; Bai *et al*., 2008; Nachtergaele*et al*., 2010; Lal and Stewart, 2013; Zucca*et al.,* 2014).Although the country endowed with enormous biophysical potential, it has been affected by the interlinked and reinforcing problems of land degradation and extreme poverty (Teshome *et al*., 2014). This is further aggravated by high population pressure, climatic variability, top-down planning systems, lack of appropriate and/or poor implementation of polices and strategies, limited use of sustainable land management practices, limited capacity of planners, land users as well as frequent organizational restructuring (Tesfaye *et al*., 2013; Kassie *et al*., 2009; Tiwari *et al*., 2008; Bewket, 2007; Shiferaw and Holden 1998). There is evidence that these problems are getting worse in many parts of the country, particularly in the highlands (areas >1500m above sea level). Furthermore, climate change anticipated to accelerate land degradation in Ethiopia (Pender and Gebremedhin, 2007). Nearly 85 percent of Ethiopia's population, 95 percent of its cultivated land, and 80 percent its 35 million cattle are found in the highlands. The considerable diversity of Ethiopia's highland areas means that many factors influencing the adoption of land management inputs and investments are highly sensitive to the local biophysical and socioeconomic context.

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;Shiferaw and Holden, 1998). As a result a 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. In 2008, Ethiopia launched Sustainable Land Management Programme (SLMP) in 36 woreda defined as the process of enhancing agricultural yields with minimal environmental impact and without expanding the existing agricultural land base (Tesfaye et al. 2013; Kassie et al. 2009; Tiwari *et al*., 2008; Bewket, 2007**)**.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. WOCAT (2005), define Sustainable Land Management 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 SWC 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 (Bridges and Oldeman, 1999; Berry *et al*., 2003; Jones *et al*., 2003; Stringer and Reed, 2007; Bai *et al*., 2008; Stoosnijder, 2007; Lal & Stewart, 2013; Zucca*et al.,* 2014; Gete*et al*., 2006). SLM is a combination of technologies, policies and activities integrating socio-economic and environmental concerns in order to reach simultaneously environmentally friendly, economic viable and socially acceptable production goals (Smyth and Dumanski, 1993; Hurni, 2000).

The downward spiral of land degradation and poverty cannot be reversed in a sustained fashion unless farmers adopt profitable and sustainable land management practices or pursue livelihood strategies that are less demanding of the land resource than current agricultural strategies (Berry *et al*., 2003; Jones *et al*., 2003; Stringer and Reed, 2007; Bai *et al*. 2008; Stoosnijder, 2007; Nachtergaele*et al*., 2010; Lal and Stewart, 2013; Zucca*et al.,* 2014). Adoption of sustainable land management (SLM) practices plays a critical role in achieving food security, household income and poverty reduction through reducing soil erosionand improving soil fertility. However, studies reveals that farmers adoption of SLM practices/ technologies at lower rate and more often they dis-adopt them (Aklilu and de Graaff, 2007 (Thompson *et al.,* 2009; Chasek*et al.,* 2011; Akhtar-Schuster *et al.,* 2011; Reed *et al.,* 2011; ELD Initiative, 2013). In most places, implemented SWCStructure was either totally or partially destroyed by farmers (Tesfaye *et al*. 2013; Kassie *et al*., 2009 and Tiwari *et al*., 2008 and Bewket, 2007). For instance, of the total conservation measures implemented between 1976 and 1990, only 30% of soil bunds, 25% of stone bunds, 60% of hillside terraces, 22% of the planted trees, and 7% of the reserve areas survived (TGE, 1994; Nurhussen, 1995). A recent survey in the Amhara region also showed that only 30% of the implemented soil and water conservation structures of the past two and half decades of conservation, work has survived (EPLUA, 2005). The above two 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 yet widely adopted. 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. Identifying the determinants of SLM adoption is a step towards addressing them (Braun, *et al*., 2012). 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 (Tesfaye *et al*. 2013; Kassie *et al*. 2009; Tiwari *et al*.,2008; Bewket, 2007). Given this state of conditions, analysis of the issue of what specifically determines the decision taken by farmers to adopt SLM practices/technologies is very important and relevant to formulate policy options and support systems that could accelerate use of soil conservation technologies (Stoosnijder, 2007; Lal &Stewart, 2013; Zucca *et al.,* 2014). To ensure sustainable adoption and implementation of SLM practices and beneficial impacts on productivity and other outcomes, rigorous empirical research needed on where particular SLM interventions are likely to be successful(Brown *et al*., 2006; Fensholt and Proud, 2012; Beck *et al*., 2011). For a better understanding of the barriers faced by households when deciding to adopt SLM practices more detail context specific household-level studies focusing on the barriers of SLM practices adoption by farmers needed (Carthy, 2011; Tesfaye *et al*. 2013; Kassie et al., 2009; Tiwari *et al*.,2008; Bewket 2007; Shiferaw and Holden, 1998). An available evidence shows that studies on the determinants of adoption of SLM practices among smallholder farmers are few and far below adequacy. Further research on the adoption of land management practices is needed to build onthis understanding of what works, and where. Therefore, this study conducted in view of bridging this gap. It intends to add to the stock of knowledge on the factors that determine farmers' 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 Jeldu district in West Shewa zone of Oromia regional state, Ethiopia. So, 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.

2. Theoretical Framework of the Study

There are many perspectives involved in understanding farmers' views as to how and why they make decisions on whether or not to adopt the improved technology for soil conservation(). There are many complexities and regional variations in biophysical and socio-cultural factors so that conclusions drawn based on the condition of one area cannot necessarily be replicated in another area (ICIMOD, 1995; Thompson and Warburton, 1985). Adoption of agricultural technologies is affected by various factors, usually categorized into; farm specific characteristics, technology specific attributes, and farmer's socioeconomic characteristics. Examples of such variables that have been found to influence technology adoption include: farm size, farmer's age, education, social networks (e.g. membership of association), dependency ratio, gender, access to agricultural advice and information, land tenure security, soil fertility, soil type, income, input availability, access to markets, risk aversion behavior, technology awareness, farming experience, adequacy of farm tools, technical and economic feasibility of using the technology, agro-ecological conditions, access to credit and presence of enabling policies(Feder *et al*., 1985; Boyd and Turton, 2000; Olwande *et al*., 2009). Some of these factors increase adoption; others reduce adoption; while others have mixed effects,

Adoption of conservation technology should not be regarded as an end in itself, but rather as a continuous decision-making process. Individuals pass through various learning and experimenting stages from awareness of the problem and its potential solutions and finally deciding whether to adopt or reject the given technology. Adoption of new technology normally passes through four different stages, which include awareness, interest, evaluation, and finally adoption (Rogers and Shoemaker 1971). At each stage, there are various constraints (social, economic, physical, or logistical) for different groups of farmers. In Ethiopia, the adoption of improved soil conservation technology has been very low at farm level and it is apparent that there is gaps between what technicians see as necessary and what the farmers are prepared to do in the field (Paudel and Thapa 2001). Adoption behavior is complex and often requires a blend of income, profit, and institutional support (Ervin and Ervin 1982; Feder and Umali, 1993). Farmers' adoption of SLM Practices is determined by interactive effects of household socio economic characteristics, resource availability, physical characteristics of the land and institutional support provided by the public or NGO sector (Garcia 2001; Mbaga-Semgalawe and Folmer, 2000; Paudel and Thapa, 2004). It is important to understand the relationship between these factors and the process of adoption of new technology to improve farm production and sustainable land management. It is assumed that the farmers will compare the advantages and appropriateness of different soil conservation technologies, based on the available resources at their disposal and their opportunity for profit. Therefore, the conceptual framework of the adoption of SLM practices in this article is based on the principal of absolute and comparative advantage to farmers in combination with some influence of the personal, socio-economical, institutional, and biophysical factors. The empirical binary logistic regression model used in this study explains the factors that influence the decision of farmers to adopt or not adopt improved soil conservation technologies.

3. Methodology of the Study

3.1. Description of the Study Area

The study was conducted at Jeldu district, West Shewa zone, Central Ethiopia, which is delineated by Meta Robi, Dendi and Ejere *Woredas* in East, Gindeberet *Woreda* in West, Abuna Gindeberet *Woreda* in North and Eliphata *Woreda* in South. The total population of the District is 202,655 (out of which 102,796 are female and 99,859 are males). The average household size is 7 persons in the District. From this, the Watershed has total area of 9260 ha, with variable agro ecology of high lands (80%), midlands (15%) and lowlands (5%). According to the Bureau of agriculture and rural development of the district, the average land holding in the area has a bi-modal rainfall pattern with two distinct rainy and cropping seasons. 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 from1800 to 2200 mm. The maximum and minimum temperature of the area ranges from 17 to 22ºC. The farming system of the area is mainly rain-fed. The soil type is characteristic of clay and clay-loam type, but the riverbed has a loam and sandy-loam type of soil (Dereje, 2010). Eucalyptus (*Eucalyptus globules)* is the main tree planted in the area while there is almost no natural forest except some remnants of very few scattered trees of forest in the crop land and scattered vegetation around the steep slopes and gorge of Meja River. According to Birhanu (2011), 20-30 years go the area was fully covered by natural forest. *Hagenia abyssinica*, *Dombeya torrida*, *Buddleja polystachya* and *Chamaecytisus palmensis* (tree Lucerne) are among the fodder trees and shrubs species that are considered important contributors to grazing animal nutrition in the highlands of Galessa and Jeldu areas.. It has an area of 139, 389 hectares. Undulating slopes divided by V-shaped valleys of seasonal and/or relatively permanent streams characterize the topography of the study area. Steep slopes are found along the valley sides, where slopes greater than30% is very common. The district is characterized as a mixed crop livestock production system. Land preparation mainly done by ox-drawn plough. The main crops grown in the study areas include wheat (*Triticumaestivum*), teff (*Eragrostistef*), broad bean (*Viciafaba*), barley (*Hordeum vulgare*) and potato (*Solanum tuberosum*).Soil erosion in the area is mainly attributed to the steep slopes, population pressure, deforestation, poor farming methods and vulnerable soils. However, the major factor fuelling soil erosion on the steep slopes is that farmers are increasingly destroying contour bunds on terraces to pave way for more farmland. As a result, soil erosion has been accelerated which in periods of heavy rainfall results in silting and flooding of the valley-bottom fields and landslides are becoming very common.

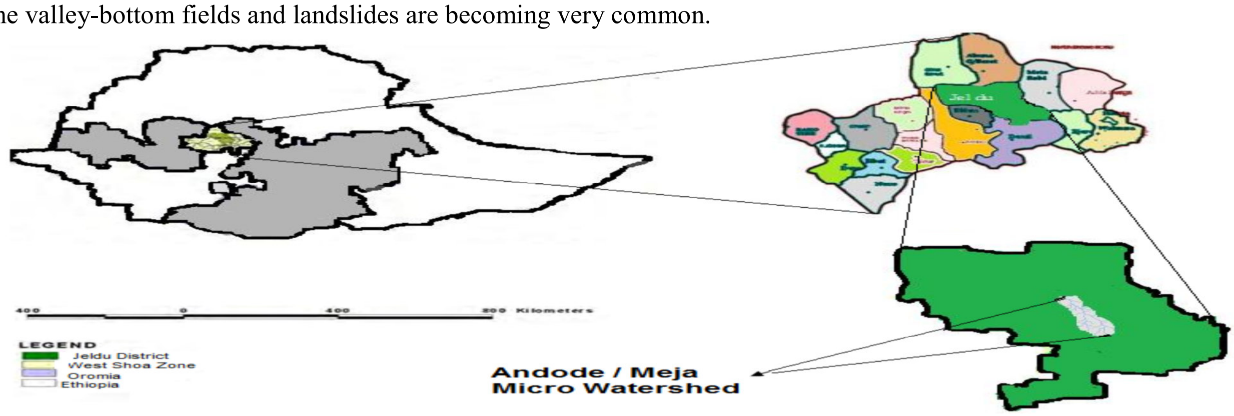

Figure1: Map of the Study Area

3.2. Sampling Design of the Study

In this study, a multi-stage sampling procedure employed. First, Jeldu district was purposively selected because the district is one of severely affected by land degradation (Brihanu, 2011).The district is highly vulnerable to land degradation in particular soil compaction, deforestation and environmental degradation. Second, four *kebele (Edensa Galan, Seriti, KoluGalal and Chillanko)* were randomly selected from the existing 38 *kebeles (lowest administrative unit in Ethiopia)*. Thirdly, the sample respondent households were selected by simple random technique. The sample size of the study determined by using Gujarati sample size determination formula (Gujarati, 2004). Accordingly, 224 sample households from the selected *kebeles* drew using simple random sampling technique for the household questionnaire survey. The random selection of households based on the list of household heads found in each kebeles and proportional to the size population.

3.3. Data Collection Techniques and Instruments

Data for the study was collected from both primary and secondary sources. Primary data collected by employing household questionnaire survey, focus group discussion, field observation, and key informant interview 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 questionnaire. Pilot-tests of questionnaires were made by distributing questionnaire to fifteen 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 confidentiality 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 six focus group discussions, 12 key informant interviews, and through observation of the watershed. Focus group discussions were conducted with 8 to 10 farmers in each group. Audiocassettes were used to record the focus group discussions and key informant interviews.

3.4. Methods of Data Analysis

3.4.1 Descriptive Analysis *Techniques*

Data were analyzed through generation of descriptive statistics and binary regression model. Descriptive static techniques such as percentages, means, standard deviations and frequency counts, tables were generated for general information, t-tests were applied 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. T-test was run to see if there is statistically significant difference in continuous variables of farm characteristics of household who have adopted introduced soil and water conservation practices and those have not done so. The chi- square was used to see if there is systematic association between decision on the use of introduced soil and water conservation practices and with some of the independent variables, for categorical data.

3.4.2. Binary Logistic Regression

Binary logistic regression model was developed to assess the personal, social, economic, institutional, and bio-physical cal factors influencing the adoption of SLM practices in this study (Agresti, 1996). The Binary Logit Model was applied in this study to assists in estimating the probability of decision on the use of introduced soil and water conservation practices that can take one or more of practices or do not practiced the technologies. In the study area farmers practice improved and traditional physical soil and water conservation structures. There are also non-adopters of these improved soil and water conservation measures. A logistic regression mode was developed to explore the personal/social, economic, institutional, and geographical factors influencing the adoption of SLM in this study. A regression model, and its binary outcomes, helps the researcher to explore how each explanatory variable affects the probability of the occurrence of events (Long andFreese, 2006). This model helps to explore the degree and direction of the relationship between dependent and independent variables in the adoption of improved soil conservation technology at the household level. The logistic regression model is an appropriate statistical tool to determine the influence of independent variable son dependent variables when the dependent variable has only two groups. In the logistic model, the coefficients are compared with the probability of an event occurring or not occurring and bounded between 0 and 1 (Sheikh, 2003). The dependent variable becomes the natural logarithm of the odds when a positive choice is made. The odds ratio and predicted probability of the independent variables indicate the influence of these variables on the likelihood of adoption of improved technology if other variables remain the same. Hence, if the estimated values of these variables are positive and significant, it implies that the farmers with higher values for these variables are more likely to adopt improved soil conservation technology

$$P_i = \frac{1}{1+e^{-Z_i}} \qquad (1)$$

Where P (i) is a probability of adopting a given practice for ith farmer and Z (i) is a function of m explanatory variables (Xi), and is expressed as:

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + --- + \beta_m X_m \qquad (2)$$

Where,

B_0Is the intercept and βiare the slope parameters in the model.The slope tells how the Log-odds in favor of adopting soil conservation practices change as independent variables change by a unit. Since the conditional distribution of the outcome variable follows a binomial distribution with a probability given by the conditional mean P_i, interpretation of the coefficient will be understandable if the logistic model can be rewritten in terms of the odds and log of the odds (Hosmer and Lemeshew, 1989.)Since the conditional distribution of the outcome variable follows a binomial distribution with a probability given by the conditional mean P_i, interpretation of the coefficient will be understandable if the logistic model can be rewritten in terms of the odds and log of the odds. The odds to be used can be defined as the ratio of the probability that a farmer uses or adopts the practice P_i to the probability that he or she will not P*i-1*

But,

$$1 - P_i = \frac{1}{1+e^{-Z_i}} \qquad (3)$$

Therefore,

$$\frac{P_i}{1-P_i} = \frac{1+e^{Z(i)}}{1+e^{-Z_i}} = e^{Z_i} \qquad (4)$$

And

$$\frac{P_i}{1-P_i} = \frac{1+e^{Z(i)}}{1+e^{-Z_i}} = e^{\beta_0} + \sum_{i=1}^{M} \beta_i X_i \qquad (5)$$

Taking the natural logarithm of the odds ratio of equation (5) will result in what is known as the logit model as indicated below:

$$L_n\left[\frac{P_i}{1-P_i}\right] = L_n\left[e^{\beta_0 + \sum_{i=1}^{M} \beta_0 X_i}\right] = Z_i \qquad (6)$$

If the disturbance term Ui is taken in to account the log it model becomes:

$$Z_i = \beta_0 + \sum \beta_0 X_i + U_i \qquad (7)$$

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 land management in the study area.

Definition of Variables and Working Hypothesis

1. **Dependent Variable**: The dependent variable for the adoption model indicates whether a household has adopted SLM practices (‘‘adopt’’ versus ‘‘not-adopt’’). 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, hedge plantation, construction of check dams and terrace bunds, whereas indigenous technologies include mulching, slope terraces, retention walls, plantation of shrubs and trees at the edge of farm terraces, diversion drains, and waterways. Improved and indigenous SLM practices were identified based upon field observation and discussion with farmers. In this study, a farmer who has adopted at least one improved soil conservation technology, either as recommended by extension workers or with some modification, 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 SLM practices (the ‘‘no adopters’’).Whether or not to adopt any SLM practices is determined by personal, social, economic, institutional, and geographical factors. These variables we retreated as explanatory variables in this study.
2. **Selection of Explanatory Variables and Expected Impact on Adoption:** Adoption of SLM practices/technologies in the study area is a complicated process similar to the other research in agriculture technology adoption (Doss 2006; McDonald and Brown 2000) that may be influenced by a

set of interrelated personal, social, economical, institutional, and biophysical factors (Table 1).

Table1: Definition of all the explanatory variables used in the model

Variable		Description
Adoption		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 (the ''no adopters'').
Demographic factors	AGE	Age of the household head in years
	HHSIZE	Number of people in the household
	EDUCTION	Literacy of the household head; 1if literate and 0 otherwise
	SEX	Gender of the household head; 1if male and 0 otherwise
	Family-labour	Potentially available family labour force
Institutional factors	TENURE	Whether a farmer perceives a risk of loss of land in the future; 1 if he/she perceives 0 otherwise
	MEMBSHIP	Membership in local organizations; 1if a farmer is a member and 0 otherwise
	TRAINING	Whether training about SLM practice received by the farmer; 1 if a farmer got training and 0 otherwise
	CREDIT ACCESS	Whether a farmer needed credit and was able to get it; 1 if he/she accessed 0 otherwise
	EXTENSION VISITS	Number of extension visits received
Physical Factors	FMSIZE	The size of the farm, in hectares
	DISTANCE	Average distance of a plot from homestead, in minutes
	SLOPE	Slope of the plot; 1 if steep and 0 otherwise
Economic Factors	OFFINCOM	Whether a farmer engaged in off-farm employment, 1 if a farmer has off-farm employment and 0 otherwise
	TOTAL INCOME	Estimated average income earned annually
	LIVESTOCK	Number of livestock's in TLU[1]
Attitudinal Factors	PERCEPTDEGRADATION	whether a farmer perceives land degradation as a problem; 1 if farmer had perceived land degradation as a problem and 0 otherwise
	PERCEPTSLM	whether a farmer anticipates introduced structures effective in retaining soil from erosion; 1 if a farmer anticipates soil retention due to structures and 0 otherwise

RESULT AND DISCUSSION

4.1 Descriptive Statistics

In order to investigate the presence of group means difference with respect to the hypothesized socio-economic, biophysical and institutional factors uni-variate tests were used. Student's t-test and Chi-square test were used, respectively to identify potential continuous and dummy variables differentiating adopters from non- adopters. Adopters and non-adopters significantly different in three of the nine hypothesized continuous socio-economic variables (Table 2).The survey results showed that landholding size of total sample households ranges from 0.125 to 4.00 ha with a mean of 1.29 and standard deviation of 0.79 ha. The average landholding size of adopters and non-adopters were 1.54 and 1.27 ha with a standard deviation of 0.99 and 1.05, respectively. 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 difference between the two groups was significant. 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. Hence, the quality and quantity of land available for farm households largely determine the amount of production. When land holdings are intensively fragmented and scattered much time and energy are lost in moving from one plot to another and make difficulty in application of organic manure. Therefore it is possible to conclude that plots of land located relatively closer to one another and to homes of land users get the opportunity to be more conserved as compared to those located farther apart and fragmented. Land ownership system has its own impact on the way farmers adopt land management practices. Evidence from many parts of the world suggests 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 (Belay, 2000).

Table2. Continuous variables differentiating adopters from non-adopters of SLM practice/ technologies among 224 sample households

Variables	**Adopters**		**Non-adopters**		*t-value*
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**	
Household Size (in number)	6.4	1.7	6.7	1.8	0.232
Age of household head (in years)	51.5	14.4	49.05	13.76	-0.36
Education status of household head (in years)	3.1	1.06	3	0.99	3.46**
Land holding size (in hectares)	1.54	0.99	1.27	1.05	2.251**
Farming Experience (in years)	27	13.42	24	11.87	0.232
Distance of plots from residence (in Kms)	0.57	0.221	0.68	0.46	0.96
Off-farm income (in ETB)	452.5	123.67	376.42	99.56	0.87
Livestock holdings (in TLU)	3.45	1.02	3.04	1.20	2.86**
Extension contact(in number)	1.02	0.76	0.98	0.78	1.98*
Size of labour force	3.02	1.66	2.96	1.54	3.65**

***indicates significant at 10%and 5% probability level respectively.* One TLU is equivalent to a 250-kilogram animal in terms of feed requirements.

Livestock is an important component of the farming system in the study area. A vast majority of the sample households included in this survey own 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 indicates the wealth status of the household. The average size of livestock in TLU was found to be 3.45, 3.79 and 3.04 for total sample households, SLM adopters and non-adopters with a standard deviation of 1.02, and 1.2, respectively. About 33% of total sample household heads has more than five TLU sizes of livestock. . 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 livestock production system commonly found in the villages is an extensive system where open grazing is the main style of feeding. 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.

The number of labour 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-labour that could be required for adoption and continuous implementation SLM activities. Family labour is the main source of farm labour except for potato production for which farmers commonly use hired labour. Labour is highly demanded during planting and harvesting seasons in the study area. Due to shortage of agricultural land in the area, some farmers may also leave their village looking for employment in other places during the months of September to December. In addition, the result of t-test revealed that there was significant difference in the mean size of labour force between adopters and non-adopters. The average available labour was calculated to be 2.95person per day for total sample households, 3.02person per day for adopters and 2.96 person per days for non-adopters, with a standard deviation of 1.68, 1.66, and 1.54, respectively.

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 governments' 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, about 22% of adopters, 43% of non-adopters have reported that they did not get extension services (visits) in the year 2015/016. Development agents had visited about 56% of sample households from one to three times per month. The average monthly frequency of extension visits was found to be 0.97 and 0.70 for users and non-users with a standard deviation of 0.80 and 0.83, respectively. The mean monthly extension visit difference of the two groups was found to be statistically significance.

4.2. Descriptive Statistics of Categorical Variables

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 224 sample household heads, 84 (37.5%) were men's and 140(62.5%) were women's respectively (Table 3). The majority of adopters of the SLM Practices (63.36%) were male-headed households while only 36.63 % 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 10% probability level. Overwhelming majority of farmers disclosed that their land productivity is declining with each passing year due to soil erosion. Farmer's perception about 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 (78.12%) have perceived the problem of soil erosion on their farm plots. From this, only 58.28 % 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. The difference between the two groups with respect to perceiving the existence of land degradation on farm plots was statistically significant.

Table 3: Dummy variables differentiating SLM adopters from non-adopters of SLM practices among 224 sample households

Variable	Score	Adopter	Non-adopter	Total	X^2
Sex	0	37	47	84	8.65***
	1	64	76	140	
	0	17	32	49	6.25***
Perception	1	102	73	175	
Degree of slope of the plot	0	34	52	85	1.34
	1	77	62	139	
Access to credit service	0	87	22	109	7.05***
	1	88	27	115	
Land certification	0	33	37	70	9.63***
	1	98	56	154	
Prior public conservation campaign	0	56	62	118	
	1	72	34	106	1.02

******: significant at <1 probability level***.

In the study area, it was found that only 51.34 % of the respondents have reported obtaining credit at least once since the last five years. Whereas, 48.66 % 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 79.81% of those who were adopted and continuously practiced SLM practices have obtained credit, but only 20.18% 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 10% 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. It was revealed that there are some steep slope areas that shouldn't be under cultivation due to their nature, but are now coming under cultivation due to population pressure. This is a major challenge that seems to exacerbate land degradation. Key Informant Interview also confirmed that the slope of the farm land is highly related to the degree of involvement in management activities. Farmers living on steep slope are involved more in the continued use of management measures than those who own flat or gently sloping farm lands Credit sources for purchase of livestock and crop production are not satisfactory. Although credit facilities are available from microfinance institutions such as Oromia Saving and Credit Share Company and *Busa Gonofa* 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. As survey result shows (table2) only 13.3% of the respondents used microfinance service. Moreover, the credit services provided by the micro-finance institutions are group based; which makes individual farmers accountable for the group members who are unable to pay their loan. It was also indicated that the service provision is limited to only once per year so that it may not be available when it is needed most.

4.3. Causes of land Degradation in the Study Area.

The contributing factors for land degradation are multifaceted and miscellaneous. It is the result of complex interaction between physical, biological and socioeconomic issues. Response to the inquiry on whether the study area households perceived land degradation as a problem in their farm lands have shown (table 4) that 72% of the surveyed respondents perceived land degradation as being a serious problem in their farming and grazing plots. As indicated (*table 4*), the major cause of land degradation mentioned by 98 % farmers was lack of conservation structures. The farmers' perceived various causes of land degradation in their farmland and surrounding landscapes. Overwhelming majority of farmers' in the study areas were aware that land degradation in various forms and levels was happening on their farm lands as well as in the surrounding landscapes. Table 4 presents the locally perceived land degradation causes that were mentioned by the respondents as being the contribution of the farming practices to the observed land/soil degradation in the study areas. About 35 % of the respondents associated land degradation to low adoption and sustained implementation of soil and water conservation measures used in their farmlands while 32.5%, 30.83%, 28.33%, 27.5%, 25.83% and 18.33% considered Cultivation of marginal areas and steep slopes; overgrazing and continuous cropping; torrential rains (high intensity rainfalls); expansion of eucalyptus trees; deforestation and clearing of vegetation and soil erosion vulnerable soil type reported to be responsible for the land degradation and soil erosion proms respectively. This finding clearly corroborates with Bekele and Holden (1998) report which elucidates those vast areas of the highlands of Ethiopia could be classified as suffering from severe to moderate soil degradation. Increasing intensification and continuous cultivation on sloping lands without supplementary use of soil amendments and conservation practices poses a serious threat to sustainable land use. In addition, Brown and Wolf (1984) stated that the apparent increase of soil erosion over the past generation is not the result of a decline in the skills of farmers but rather the result of the pressures on farmers to produce more. Hence, farmers of the study area were aware of soil erosion but they are forced to intensify and produce more food crops for their basic livelihood.

Table4: Farmers' Perception on Land Degradation and soil erosion in the study area

Farmers' perceived causes land degradation	**Frequency (n=120)**	**Percentages**
Overgrazing and continuous cropping	37	30.83
Deforestation clearing of Vegetation	31	25.83
Cultivation of marginal and steep slope areas	39	32.5
Low adoption of conservation measures and practices	42	35
Torrential rains/high intensity of rainfall (extreme weather events)	34	28.33
Erosion vulnerable soil type	22	18.33
Expansion of Eucalyptus Trees	33	27.5

* *Note: A multiple response frame was used. Hence, total count is more than the number of respondents*

4.4. 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

4.4.1 Adoption of Indigenous SLM Practices/ technologies

For generations farmers in different parts of the country used to apply their own indigenous SLM practices to halt land degradation, improve soil productivity and woody biomass production. Some of their indigenous practices were effective, despite some limitations. Farmers were asked to explain indigenous land management measures which were implemented on their farm and the surrounding land. Their answers were summarized in the table5 below.

Table-5: Indigenous Land Management Practices

Indigenous land management practices	Frequency (n=224)	Percentage
Crop rotation	157	70
Crop residue	102	45.53
Fallowing	91	40.62
Traditional waterway	134	59.82
Mixed cropping	67	29.91
Animal manure	138	61.6
Furrow	149	66.51

As one can understand from Table-5, the most widely implemented indigenous were crop rotation (70%) followed by furrow (66.51%) of the respondents. 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. It is a system by which nitrogen restoration is attained by alternating different types of crops on the same cultivated land. This practice is considered to be very effective in maintaining the nitrogen status of the soils where leguminous plants are included in the rotation (Belay, 2000). Similarly, a study conducted in Tigray region indicated that farmers were choosing which crops to grow in rotation according to how they adapt to the soil and the rainfall pattern as well as economic consideration such as the price of the crops to be chosen (Corbeels et al 2000). Crop rotation, one of the most widely applied soil fertility enhancing measures has a number of functions as well as benefits to the farmer. According to Belay (2000), crop rotation improves the soil fertility and controls the spread of weeds and insects.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 manuring shows highest concentration of manure around the homesteads (Herweg, 2002).

4.4.2. Adoption of Introduced SLM practices/ Technologies

The introduction of SLM practices in the country has dated back many hundred years. However, the most recent attempts, which are more focused and extensive, started after the 1973-74 droughts in parts of the country. 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 (63.75 %) indicated to have used one or more SLM Practices in their farms as a means of adjusting and adapting to land degradation processes. Graph2 presents the various SLM practices as mentioned by the interviewed farmers.

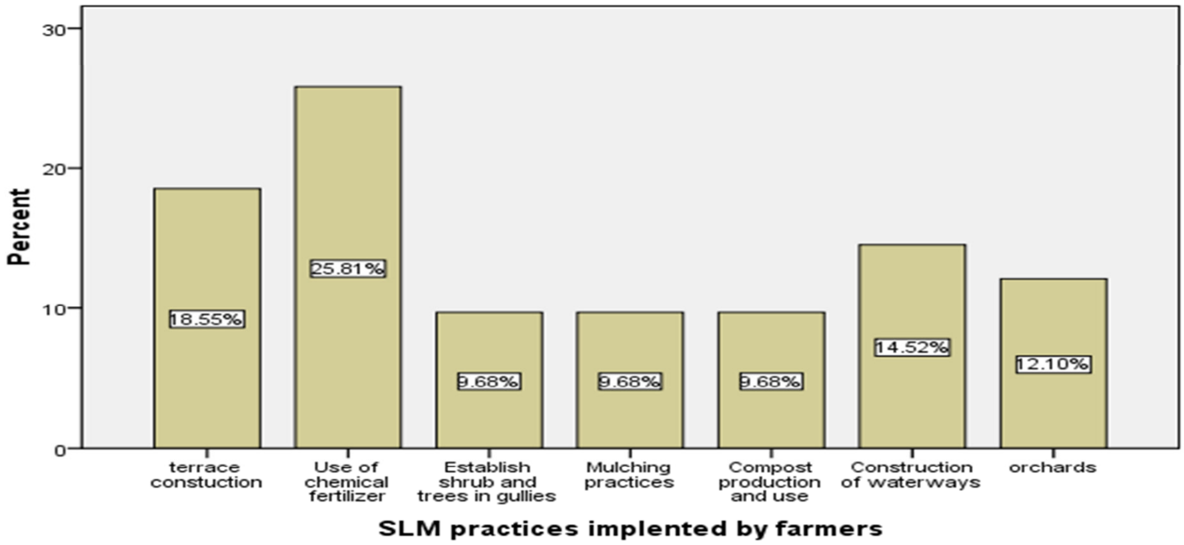

Figure 2: Adoption introduced of SLM practices implemented by farmers in the study area.

As discussed by Shiferaw and Holden (1998), 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. As found by Kassie, (2005), drier areas offer higher returns to bunds than wetter ones. 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

4.5. Constraints to Community Participation in Sustainable Land Management (SLM) Practices

Community participation in sustainable land management practices is of great importance as it seeks to guarantee access and control over resources by the communities living in them, but who depend on these resources to satisfy their various needs (ecological, economic, social, cultural and spiritual needs). Community participation ensures more commitment in ensuring that resources are more sustainably managed, where apart from communities depending on these resources for a living and conserving them, they at the same time become their guardians (Arega and Hassan, 2003; Tesfaye, 2003; Lakew et al., 2000; Yilkal, 2007; Habtamu, 2006).The active participation of various stakeholders in decision making is crucial for ensuring the long term sustainability of community-based resource management initiatives. In several occasions however, sustainable land management has not received the expected involvement of local communities. Some of the reasons that have influenced the local people's participation SLM practices in the study area are discussed here.

Table 6: Constraints to Community Participation in Sustainable Land Management (SLM) Practices

Constraints to adoption of SLM practices	Frequency(n=224)	Percentage (%)
Lack of incentives	72	32.14
Labour intensiveness	66	29.46
Land shortage	69	30.8
Financial constraint(Poverty)	109	48.67
Complexity Conservation measures	76	33.93

***Note: n is frequency of responses (multiple) for each measure**

A financial constraint (poverty) was the main reason reported for not being able to implement SLM practices (mentioned by 48.67% of people as presented in table 7). Artificial fertilizer, ranked most highly in terms of their capacity to improve the soil is also the most expensive measures. It does not follow however that is the poorest that degrade the land most (or that it is the wealthiest who invest most in the land, as shown above). The poorest are often eager to sell their labor, as they are desperate for cash income to buy necessities. In so doing they are rarely able to cultivate all their own fields and so these fields benefit from more regular fallowing than those belonging to wealthier people. This defenses Dejene *et al* (1997) findings that the poor face financial and socio-economic constraints which seriously impede management practices and innovations. Lack of adequate incentive was the main reason that people cited for being unable to implement SLM Practices (reported by 32.14% of people as presented in table 7). Land quality is important variable affecting incentives in this area. The FGD data reveals that that 'the more productive or profitable the land use the more farmers will be willing to maintain and invest in better land management and erosion control practices. Relatively flat, irrigable land suitable for vegetable production generates greater returns to labor and capital, and therefore a stronger incentive to invest. Thus it receives much more attention than steeply sloping fields given to maize and beans.

Land shortage was the main reason that people cited for being unable to implement erosion prevention methods (30.8%) as trees and terraces both absorb land and trees further shade crops. It was also cited as a constraint to improving fertility by 37% of people (referring to the desire for longer and more frequent fallows). Thus population pressure, (as it lowers per capita land availability), could be regarded as a factor contributing to degradation in Study areas but other factors affect whether this results in intensification with soil improvement or degradation. Local people will not convert their ladder terraces into more permanent terraces because they say they would be too labor intensive to maintain (it would involve digging residues into the soil twice annually rather than pulling soil down slope to bury them). With significant rates of out-migration, labor can hardly be said to be a constraining variable to land improvement— thus returns to labor, as outlined above, must be regarded as more significant. The survey result also revealed conservation measures are so complex that they do not understand exactly how to go about their implementation (noted by 33.93 % of people). This arises due to lack of consultation with the community in enacting the policies. This point is consistent with the view of Rogers (Reed and Dougill, 2009; Reed et al, 2006), that innovations which are difficult to understand and implement are less likely to be adopted than technically simple ill innovations, although the scientifically rigorous indicators used in the top-down paradigm may be quite objective, they may also be difficult for local people to use. It was reiterated that some of these measures require financial investment which they do not have, and therefore they are unable to implement them.. This lowers the productivity and income of the poor and reinforces the "vicious cycle" of poverty and natural resource degradation. This means that if land degradation is to be managed sustainably, and then the communities need to be involved in the planning process and resourced to implement projects introduced by authorities

Also the others the reasons elucidated was the taking too lightly the severity of the land degradation risk by many people in the area. Where the tenure system is not guaranteed individual farmers may not be concerned with problems of land degradation regardless of their holdings being at risk as such land degradation is considered as a general community problem. Such attitudes may result in no action being taken against land degradation even when there are no clear hindrances. The implication of the foregoing is that effective conservation is likely to be achieved when land tenure systems are properly secured and articulated. Thus efforts are needed to ensure integrated community-level planning that could promote individual farmers efforts without undermining community interests. Adoption and/or practicing certain SLM measures are much influenced by the farmer's economic situation, including resource endowments. For instance, farmers with sufficient land holdings can afford to conserve by fallowing and constructing various physical SWC structures, while land constrained farmers may not. Similar experiences would be the case for other conservation measures that require heavy investment by the farmer, for example making of soil erosion control structures that may need additional labour, and using fertilizers and/or manure.

From the in-depth interviews held with FGDs participants on management, institutional barriers were identified as another challenge of community involvement. Poor coordination between farmers, traditional/local authorities and NGOs was seen as a major barrier to land management in the area. Reasons assigned for the lack of coordination were conflict of interest among stakeholders, especially concerning resource use and control, the seemingly entrenched stance of some traditional or local authorities on issues relating to land and its use, and the difficulty in convening meetings of all stakeholders to identify priority projects to be undertaken. The lack of coordination among stakeholders (farmers, traditional authorities, governmental agencies, NGOs, etc) sometimes results in duplication of efforts in some areas whereas other places receive little or no attention at all. Furthermore, lack of genuine involvement between local communities, NGOs and governmental agencies who undertake conservation projects is holding back sustainable land management in the in the study area. This situation often results in a top-down approach to planning. For example, authorities design conservation plans with the scientific knowledge available and then take them to the people for execution, a process which usually leads to inappropriate execution or to the failure of some conservation efforts. Also, a top-down approach may result in the location of projects at sites that may not be fitting to the inhabitants. The household survey reveals that most projects which did not involve the local people at certain levels of planning failed. 79% of the interviewed farmers held the view that their knowledge is very relevant to any intervention exercise and therefore should be sought before any plan is implemented, whereas 21% held a opposing view. Those who saw the relevance of local participation in land management stated that local people should not only be viewed as a labour pool for conservation projects but as people whose experience in the area as land users has given them enough knowledge to share.

Conservation practices are adopted when local communities have satisfied basic needs. Besides population pressure, other factors also need to be evaluated, such as the support of public institutions and sufficient cohesion of local communities, especially a strong community organization. The combination of these factors will result in the decision and the capacity of land users to invest time and resources in land conservation. Decision-making about land management and land degradation should encompasses, among others, factors that may be biophysical (agro-ecological conditions, location), economic (access to credit and markets, non-farm incomes, availability of technologies), social (organizational structure, labor availability, land tenure), historical (environmental history and that of land tenure) and cultural (traditional knowledge, environmental awareness, and gender). Socioeconomic and cultural factors should receive crucial attention in policy decision-making. For instance at a time, the attitude of local communities may be more critical than the availability of technology; the latter, although an important issue, may only be a tool to achieve goals in a social context.

4.5. Econometric Analysis of Determinants of Adoption of SLM Practices

Logistic regression model was used to address the second objective of the study. That is to identify the factors that affect adoption of the introduced land management practices in the study area. The likelihood ratio test statistic exceeds the chi-square critical value with 12degrees of freedom. The result is significant at less than 1% probability level indicating that the hypothesis that all the coefficients except the intercept are equal to zero is not acceptable. Likewise, the log likelihood value was significant at 1% level of significance. Another measure of goodness of fit used in logistic regression analysis is the Count-R^2, which indicates the number of sample observations correctly predicted by the model. TheCount-R^2 is based on the principle that if the estimated probability of the event is less than0.5, the event will not occur and if it is greater than 0.5 the event will occur. In other words, the i^{th} observation is grouped as non-adopters if the computed probability is greater than or equal to 0.5, and as adopter otherwise. The discussion about the significant variables is given below.

Age of the Household Head: This result suggests that older farmers are less likely to adopt SLM practices. This could be explained by the fact that older farmers have a short planning horizon compared with younger colleagues. This is in line with the findings of Anley et al. (2007) and Shiferaw& Holden (1998).

Off- Farm Activities: Adoption of SLM practices also found to be negatively influenced by off-farm activities. This is because farmers who are involved in off-farm activities may encounter time and labour constraints for investing in bunds. This is in line with other findings (Tenge *et al*., 2004; Amsalu and deGraaff, 2007).

Number of livestock owned: 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. As hypothesized, this variable affected adoption of SLM practices s positively and significantly at 5% probability level. The marginal effect for this variable shows that keeping all factors constant an increase in livestock ownership by one TLU increases the probability of SLM Practices adoption by 0.031.

Extension contact: As hypothesized, frequency of extension contact is found to have a significant positive effect on the adoption of SLM Practices s at 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 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 (Tesfaye 2006). Many other case studies too revealed that low adoption of rainwater harvesting technology were due to lack of extension services (Nasr, 1999; Kihara, 2002; Mitiku and Sorsa, 2002; Ngigi, 2003). The marginal effect value for farm size shows that keeping all factors constant an increase in extension contact by one e increases the probability of SLM Practice adoption by 0.032.

Farmers' perception on effectiveness of introduced land management practices: This variable is hypothesized to influence land management practices adoption either positively or negatively. The model results show that this variable has a significant positive impact on land management practices. The variable is significant at less than 5% probability level. As hypothesized, farmers' perception of effectiveness of SLM measures influence households' decision to invest on introduced land management practices positively.

Table4: Analysis of Determinants Using Binary Logistic Regression Model result for perception of the effects of land degradation risks

Variable	β	SE	Z	Sig	Odd Ratio
__AGE	2.142**	0.562	0.862	0.0671	0.025
HHSIZE	0.235	1.320	1.230	0.215	0.0670
EDUCATION	0.072*	1.892	2.290	0.021	0.201
SEX	0.040**	3.536	0.968	0.091	0.056
FAMILY-LABOUR	0.235*	0.360	0.386	0.026	0.024
TENURE	0.042**	1.765	0.564	0.086	0.210
MEMBERSHIP	0.246	1.156	1.961	0.534	0.056
TRAINING	0.836*	2.034	0.862	0.020	0.092
EXTENSION VISIT	0.865*	0.458	1.926	0.031	0.032
FRMSIZE	2.280	0.985	0.862	0.915	0.042
LIVESTOCK	0.965*	2.045	1.926	0.020	0.031
TOTAL INCOME	1.626	1.963	0.034	0.234	0.023
OFFINCOME	-0.025*	2.094	2.026	0.0251	0.031
DISATANCE	-0.965**	1.096	0.648	0.096	0.802
CREDIT ACESS	1.028*	2.064	1.025	0.020	0.035
SLOPE	2.860**	2.021	1.806	0.091	0.020
PERCEPDEGRADATION	0.689*	1.091	0.962	0.031	0.380
PERCEPTSLM	1.096**	2.026	0.863	0.062	0.031
Constant					

Model Chi-square 102.280
Log likelihood function 92.165
Nagelkerke (R^2) 0.75
Number of observation 224

***, * Significant at 0.1 and 0.05 probability levels, respectively*

Perception of severity of land degradation: This variable indicates the severity of soil erosion as perceived by the farm households. The variable positively influenced the adoption of SLM practices/ technologies at less than 1 percent level of significance. 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 management scheme and become less dependent on external assistance for undertaking land management activities.

Educational level of sampled household head: As hypothesized, education of the HH head was found to be positive and having a significant influence on the adoption of improved soil conservation technology. This implies that longer schooling of the HH head increased their ability to access information, and strengthened his/her analytical capabilities with new technology. Furthermore, a longer education leads to a better understanding of the new technology when reviewing the different extension materials, which enhanced adoption of improved technology. Many authors report that education has a positive impact in the adoption of improved soil conservation technology (Lapar and Ehui2004; Mbaga-Semgalawe and Folmer2000;). The findings of this study on the effect of education were close to that of other studies conducted previously. Adoption of a given technology is a behavioral change process, which is the result of a decision to apply that particular innovation. Farmers need enough information about the technology to make the right decision. Education enhances the capacity of individuals to obtain, process, and utilize information disseminated by different sources. This implies that literate farmers are in a better position to get information and use it in such a way that it contributes in their adoption of SLM Practices. As hypothesized, educational level of household heads was found to be a significant at less than five percent probability level. This may be explained by the fact that those farmers who were more educated are likely to use introduced land management than the non-educated farmers in the study area. This is because, educated farmers were more opt in understanding the problem of land degradation and could easily decide to take part in conservation strategies of land management practices . This is attributable to the fact that education reflects acquired knowledge of environmental amenities and educated farmers tend to spend more time and money on land management practices. The marginal effect value for education shows that keeping all factors constant an increase in education by one year increases the probability of adoption of SLM Practices by 0.201.

Land tenure: Farmer's 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, farmers' perception that the farmland he/she owns will remain his/her owns at least during his/her lifetime affects the decision on land management practices. For farmers' to be able to carry out long or medium term investment, they require 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 in the foreseeable future, and not unpredictably taken away and reallocate to somebody else. This variable is found to significantly and positively affect the independent 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.

Slope of the farm plots (SLOP): This variable positively influenced the adoption of SLM practices/ technologies at less than 1 percent level of significance. The significant positive terms in adoption of conservation practices indicate that farmers are inclined to invest in conservation practices where their farm plots are located on higher slopes. The slope of a plot also affects the adoption of land management structures because the steeper the slope, the more likely the land will be exposed to degradation. Hence, it is believed that adoption of physical land structures tends to be likely on steeper slopesThis goes with the perception that those plots can only be productive if protected by conservation structures. On the other hand, Berhanu and Swinton (2003) have stated that an increase in the slope of the plots may create a disincentive to invest in soil conservation practices as the slope of the plot increase the distance between two consecutive terraces will decrease because the structures of SLM measures occupy more area of land and will create inconvenience for farm operation. Slope is an indicator of the likelihood of degradation on the land. But, Lapar (1999) in the Philippines found that the slope of a plot to be one of the factors significantly influencing the adoption of land management. Their results suggest that a farmer who operates a field with steeper slope is more likely to adopt the land management technology.

4.6. Conclusion and Policy Implication

The findings of this study have important policy implications for promoting sustainable land management practices and technologies in the study area. Descriptive data analysis showed that only 63.75 % of the HH adopted SLM practices. Farmers reported that the improved terraces are effective in reducing soil erosion, though they were not common due to high labor cost and inconveniency for ploughing with oxen. A range of socio-economic, institutional, personal 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, perception of severity of land degradation, perception of effectiveness of SLM measures, off-farm activities, credit services access, age of households, slop of the plot ant etc. 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. Any future land management efforts should give a due attention to genuinely involve farmers in entire process of any land management interventions from technology generation to final monitoring and evaluation. Generally, this study recommends that decision-making about land management and land degradation should encompasses factors that may be biophysical (agro-ecological conditions, location), economic (access to credit and markets, non-farm incomes, availability of technologies), social (organizational structure, labor availability, land tenure), historical (environmental history and that of land tenure) and cultural (traditional knowledge, environmental awareness, and gender.

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References

Aklilu, A. (2006). Caring for the Land Best Practices in Soil and Water Conservation in Beressa Watershed, Highlands of Ethiopia. Tropical Resource Management Papers, No. 76.

Amsalu, A. and de Graaff, J. (2007), Determinants of adoption and continued use of stone terraces for soil and water conservation in an Ethiopian highland watershed. Ecological Economics 6:294-302

Amsalu, A. and de Graaff, J. (2007), Determinants of adoption and continued use of stone terraces for soil and water conservation in an Ethiopian highland watershed. Ecological Economics 6:294-302

Assefa D. 2009. Assessment of Upland Erosion Processes and Farmer's Perception of Land Conservation inDebre-Mewi Watershed, Near Lake Tana, Ethiopia. A Thesis Presented to the Faculty of Graduate School ofCornell University in Partial Fulfillment of the Requirements for the Degree of Masters of ProfessionalStudies.104p.

Beddington, J. (2010). Food security: Contributions from science to a new and greener revolution.

Bekele S, Okello J, Ratna VR. 2009. Adoption and Adaptation of Natural Resource Management Innovations inSmallholder Agriculture: Reflections on Key Lessons and Best Practices. Environment, Development andSustainability, 11: 601-619.

Bekele, W. & Drake, L. (2003). Soil and Water Conservation Decision Behavior of Subsistence Farmers in the Eastern Highlands of Ethiopia: a case study of the Hunde-Lafto Area. Ecological Economics 46:437-451.

Bekele, W. and Drake, L. (2003). Soil and water conservation decision behavior of subsistence farmers in the Eastern Highlands of Ethiopia: a case study of the Hunde-Lafto area. Ecological Economics 46 (2003) 437_/451

Bekele, W. and Drake, L. (2003). Soil and water conservation decision behavior of subsistence farmers in the Eastern Highlands of Ethiopia: a case study of the Hunde-Lafto area. Ecological Economics 46 (2003) 437_/451

Belay, M. &Bewket, W. (2013). Farmers' livelihood assets and adoption of sustainable land management practices in north-western highlands of Ethiopia. International journal of environmental studies, 70(2), 284-301.

Betru, N. (2003). Soil and Water Conservation Program in the Amhara National Regional

California Press.

Carucci, V. 2006. Sustainable Land Management as Key enabling Element to End Poverty in Ethiopia: gaps, dichotomies and opportunities. (A paper for dialogue). WFP, Addis Ababa, Ethiopia.

Dejene, A. (Ed.). (1997). Land degradation in Tanzania: perception from the village (Vol. 370). World Bank Publications.

Desta, L. Carucci, V., AsratWondem-Agegnehu and YitayewAbebe (eds). 2005. Community Based Participatory Watershed Development: A Guideline. Ministry of Gariculture and Rural Development, Addis Ababa, Ethiopia.

EEA/EEPRI (2004/05). Report on the Ethiopian Economy: Transformation of The Ethiopian Agriculture: Potential, Constraints, and Suggested Intervention Measures, Vol. IV, Addis Ababa.

ELD Initiative. (2013). The rewards of investing in sustainable land management. Interim Report for the Economics of Land Degradation Initiative: A global strategy for sustainable land management. accessed in September 1, 2015 Available at: www.eld-initiative.org/

EPA, 1997. The Federal Democratic Republic of Ethiopia Environmental Policy. Environmental Protection Agency (EPA), Addis Ababa, Ethiopia.

EPA, 2001. National Action Programme (NAP): Executive Summary, June 2001. Addis Ababa.

EPA, 2005. Concept Note: Sustainable Land Management Country Framework, PDF-A. Addis Ababa, Ethiopia.

EPLAUA, 2004. The State of Soil and Water Conservation Measures in Amhara National Regional State. Bahirdar, Ethiopia.

Ethiopian Economic Association/Ethiopian Economic Policy and Research Institute (EEA/EEPRI) (2002). A Research Report on Land Tenure and AgriculturalDevelopment in Ethiopia, Addis Ababa.

Eyasu, E. (2002). Farmers' Perception of Soil Fertility Change and Management, Institute for Sustainable Development and SOS Sahel International (UK), AddisAbaba.

FAO (2011). Sustainable Land Management in Practice Guidelines and Best Practices for Sub-Saharan Africa. Rome, 2011.

FAO (UN Food and Agriculture Organization). 1996. World Food Summit: Rome declaration on world food security and world food summit plan of action. Rome, Italy: FAO.

FAO 2011. Sustainable Land Management in Practice Guidelines and Best Practices for Sub-Saharan Africa. Rome, 2011.

FAO. (2007). Paying Farmers for Environmental Services, State of Food and Agriculture 2007, Rome: FAO. Rome, Italy.

FAO. (2009). Country support tool for scaling-up Sustainable Land Management in Sub-Saharan Africa. Version 1.0. A TerrAfrica partnership publication.

FAO. (2012). FAO publication - Combating Micronutrient Deficiencies: Food-based Approaches. Rome, Italy.

FAO. 2006. Preparation of a Global Report on the State of Land and Water Resources, SoLAW. Land and Water Development Division, FAO, Rome, 2006. In-progress Draft Report – Version 01.

FAO. 2007. Conservation agriculture in Tanzania: a case study. Rome, Food and Agriculture Organization of the

United Nations.
FAO. 2009. Country support tool for scaling-up Sustainable Land Management in Sub-Saharan Africa. Version 1.0. A TerrAfrica partnership publication.
FAO. 2010. Investment Centre Database of Projects. Rome, Food and Agriculture Organization of the United Nations.
FAO/WOCAT. 2009. SLM in Practice. promoting Knowledge on Sustainable Land Management for Action in Sub-Saharan Africa Roma, Food and Agriculture Organization of the United Nations.
Gebremedhin B. and Swinton S. M. (2003). Investment in soil conservation in Northern Ethiopia: the role of land tenure security and public programs. AgriculturalEconomics 29: 69–84.
Gebremedhin, B. 1998. "The Economics of Soil Conservation Investments in the Tigray Region of Ethiopia". Unpublished PhD Dissertation, Michigan State University, Department of Agricultural Economics, East Lansing, USA.
Gebremedhin, B. and S. Swinton. 2002. Sustainable management of private and communal lands in northern Ethiopia. In: C.B. Barrett, F. Place and A.A. Aboud (eds.), Natural Resources Management in African Agriculture. International Centre for Research in Agroforestry, CABI Publishing, New York.
Gebremedhin, B., J. Pender, and G. Tesfaye. 2003. Community resource management: The case of woodlots in northern Ethiopia. Environment andDevelopment Economics 8: 129-148.
Gerber, N., Nkonya, E., & von Braun, J. (2014). Land Degradation, Poverty and Marginality. In Marginality (pp. 181-202). Springer Netherlands.
Gerber, N., Nkonya, E., & von Braun, J. (2014). Land Degradation, Poverty and Marginality. In Marginality (pp. 181-202). Springer Netherlands.
Getahun, A. (1991). Agricultural growth and sustainability: Conditions for their compatibility in the tropical East Africa highlands. In: S. Vosti, T. Reardon, and
GeteZeleke, Menale Kassie, John Pender & Mahmud Yesuf 2006 Stakeholder Analysis for Sustainable Land Management (SLM) in Ethiopia: Assessment of Opportunities, Strategic Constraints, Information Needs, and Knowledge Gaps
GeteZeleke. 2000. Landscape Dynamics and Soil Erosion Process Modelling in the North-western Ethiopian Highlands. African Study Series A 16, GeographicaBernensia, Berne, Switzerland
GeteZeleke. 2003. Concept Note on Prtnership for Rural Livilihoods Improvement as a First Step Towards Implimenting UNDAF: Touching the Ground. World Food Programme. Addis Ababa, Ethiopia.
GeteZeleke. 2005 (forthcoming): Integrated Watershed Management Experiences in ECA Countries: Lessons from Ethiopia. ICRISAT, Nairobi Kenya.
GeteZeleke. and Hurni H. 2001. Implication of Land Use and Land Cover Dynamics for Mountain Resource Degradation in the North-western Ethiopian Highlands. Journal of Mountain Research and Development. Vol. 21, No. 2. University of Bern, Switzerland.
Global Environmental Facility (2003), Operational Program 15 on Sustainable Land Management.
Global Environmental Facility (2003), Operational Program 15 on Sustainable Land Management.
Godfray HCJ, Beddington JR, Crute IR, et al. 2010. Food security: the challenge of feeding 9 billion people. Science 327: 812 18.
Green, W. H. (2003). Econometric Analysis, 2nd Edition, New York, Macmillan.
Greene, H. W. (2003). Econometric Analysis: Pearson Education Inc. New York University.
Greene, W. H. (2000). Econometric analysis (International edition). New York University.
Greene, W.H. (2012). Econometric Analysis, 7th edition. Prentice Hall, Boston, USA.
Grepperud, S. (1996) Population pressure and land degradation: The case of Ethiopia. Journal of Environmental Economics and Management 30:18-33.
Gujarati, D.N. (2004). Basic Econometrics, 4th ed. McGraw-Hill, New York, 2007
Habtamu, E. (2006). Adoption of Physical Soil and Water Conservation Structures in Anna Watershed, Hadiya Zone, Ethiopia. (Masters ThesisAddis Ababa University, 2006).
Holden, S. T. and Shiferaw, B. 2002. Poverty and Land Degradation: Peasants' Willingness to Pay to Sustain Land Productivity. In C. B. Barrett, F. M. Place, and A.
Holden, S. T. and Shiferaw, B. 2004. Land Degradation, Drought and Food Security in a Less-favoured Area in the Ethiopian Highlands: A Bio-economic Model with Market Imperfections. Agricultural Economics 30 (1): 31-49.
Holden, S., B. Shiferaw, and J. Pender. 2005. Policy analysis for sustainable land management and food security: a bio-economic model with market imperfections. International Food Policy Research Institute Research Report No. 140. Washington,D.C.
Holden, S., S. Benin, B. Shiferaw, and J. Pender. 2003. Tree planting for poverty reduction in less-favoured areas of the Ethiopian highlands. Small-scale Forest Economics, Management and Policy 2(1), 63-80.
Hosmer, D., and S. Lemeshew, 1989. Applied Logistic Regression. A Wiley-Inter Science Publication. New

York
Hurni, H. 1988. Degradation and conservation of the resources in the Ethiopian highlands. Mountain research and development, vol. 8, Nos. 2/3, 1988, pp. 123-130,. University of Bern, Switzerland.
Hurni, H.,.1996. with the assitance of an international group of contributers,. Precious Earth: From Soil and Water Conservation to Sustainable Land Management. International Soil Conservation Organization (ISCO), and Center for Development and Environment (CDE), Berne, Switzerland.
IFAD. 2011. Rural poverty report. New realities, new challenges: new opportunities for tomorrow's generation. Rome, International Fund for Agricultural Development.
IPCC**.** 2007. Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Chapter 8-Agriculture. Climate Change 2007:Mitigation. Cambridge, United Kingdom and New York, NY, USA Cambridge University Press.
Kassie, M., & Holden, S. (2007). Sharecropping efficiency in Ethiopia: threats of eviction and kinship. Agricultural Economics, 37(2 - 3), 179-188.
Kassie, M., Jaleta, M., Shiferaw, B., Mmbando, F., &Mekuria, M. (2013). Adoption of interrelated sustainable agricultural practices in smallholder systems: evidence from rural Tanzania. Technological forecasting and social change, 80(3), 525-540.
Kassie, M., Shiferaw, B., &Muricho, G. (2011). Agricultural technology, crop income, and poverty alleviation in Uganda. World Development, 39(10), 1784-1795
Kidane G. 2001. Factors Influencing the Adoption of New Wheat Verities, in Tigray, Ethiopia: the Case ofHawizen District. An MSc Thesis Presented to the School of Graduate Studies of Alemaya University.164p.
Kidane T. 2008. Determinants of Physical Soil and Water Conservation Practices: The Case of Bati District, Oromyia Zone, Amhara Reion, Ethiopia. M.Sc. Thesis Presented to the School of Graduates of AlemayaUniversity, Alemaya. 162p.
Kirubel M, Gebreyesus B. 2011. Impact assessment of soil and water conservation measures at Medegowatershed in Tigray, northern Ethiopia. Maejo International Journal of Science and Technology. 5(03): 312-330.
Lal, R., & Stewart, B. A. (Eds.). (2013). Principles of Sustainable Soil Management in Agroecosystems (Vol. 20). CRC PressILlc.
Lal, R., Safriel, U., & Boer, B. (2012). Zero Net Land Degradation: A New Sustainable Development Goal for Rio+ 20. [A report prepared for the Secretariat of the United Nations Convention to Combat Desertification].
Mahmud Yesuf and J. Pender. 2005. Determinants and Impacts of Land Management Technologies in the Ethiopian Highlands: A Litreature Review. EDRI/EEPFE. Addis Ababa, Ethiopia.
Mahmud Yesuf, AlemuMekonnen, Menale Kassie, and J. Pender. 2005. Cost of Land Degradtion in Ethiopia: A Critical review of Past Studies. EDRI/EEPFE. Addis Ababa, Ethiopia.
Million Alemayehu. 1992. The Effect of Traditional Ditches on Soil erosion and Production. Research Report 22. Soil Conservation Research Project. University of Bern. Bern, Switzerland.
Million Alemayehu. 2003. Characterization of Indegenous Stone Bunding(Kab) and its Effect on Crop Yield and Soil Productivity at Mosobit-Gedeba, Sorth Shewa Zone of Amhara Region. MSc Thesis. Alemaya University. Alemaya, Ethiopia.
Million T, Belay K. 2004. Factors influencing adoption of soil conservation measures in southern Ethiopia: TheCase of Gununo Area. Journal of Agriculture and Rural Development in the Tropics and Subtropics, 105 (1): 49-62
Million Taddesse and Belay Kassa. (2007). Factors influencing adoption of soil conservation measures in southern Ethiopia: The Case of Gununo Area. Journal of Agriculture and Rural Development in the Tropics and Subtropics 105(1): 49-62
Nkonya E. (2002). Soil conservation practices and non-agricultural Land use in the south western highlands of Uganda. A Contribution to the Strategic Criteria for Rural Investments in Productivity (SCRIP) Program of the USAID Uganda Mission.
Nkonya E., D, Phillip, E. Kato, B. Ahmed, A. Daramola, S. B., Ingawa, I. Luby, E.A. Lufadeju, M. Madukwe, and A.G. Shettima. 2012. Medium-term impact of Fadama III project. IFPRI mimeo.
Nkonya E., P. J., Kaizzi C., Kato Edward K., Mugarura S., 2005. Policy options for increasing crop productivity and reducing soil nutrient depletion and poverty in Uganda. Submitted to EPTID to be considered as Discussion Paper Publication
Nkonya, E. M., Pender, J. L., Kaizzi, K. C., Kato, E., Mugarura, S., Ssali, H., &Muwonge, J. 2008. Linkages between land management, land degradation, and poverty in Sub-Saharan Africa: The case of Uganda (No. 159). International Food Policy Research Institute (IFPRI).
Nkonya, E., Gerber N, Baumgartner P, von Braun J, De Pinto A, Graw V, Kato E, Kloos J, Walter T. 2011. The

Economics of Land Degradation: toward an integrated global assessment, Development Economics and Policy Series vol. 66, Heidhues F, von Braun J and Zeller M (eds), Frankfurt A.M., Peter Lang GmbH.

Nkonya, E., J. Pender, D. Sserunkuuma, and P. Jagger. (2002). Development Pathways and Land Management in Uganda. In Policies for Sustainable Land Managementin the East African Highlands, edited by S. Benin, J. Pender and S. Ehui. Washington, D.C. and Nairobi, Kenya: International Food Policy Research Institute and International Livestock Research Institute.

Nkonya, E., Von Braun, J., Mirzabaev, A., Le, Q. B., Kwon, H. Y., &Kirui, O. (2013). Economics of Land Degradation Initiative: Methods and Approach for Global and National Assessments (No. 158663).

Pender J. (2002). Overview of Findings and Implications. In Policies for Sustainable Land. Washington, D.C. and Nairobi, Kenya: International Food Policy Research Institute and International Livestock Research Institute.

Pender, J. 2004. "Development pathways for hillsides and highlands: some lessons from Central America and East Africa". Food Policy. 29: 339-367.

Pender, J. and B. Gebremedhin. 2004. Impacts of policies and technologies in dryland agriculture: evidence from northern Ethiopia. In: S.C. Rao (Ed.), Challengesand Strategies for Dryland Agriculture, American Society of Agronomy and Crop Science Society of America, CSSA Special Publication 32, Madison, WI.

Pender, J. and B. Gebremedhin. 2006. Land management, crop production and household income in the highlands of Tigray, northern Ethiopia. In: Pender, J.,Place, F., and Ehui, S. (eds.), Strategies for Sustainable Land Management in the East African Highlands. IFPRI, Washington, D.C. In press.

Pender, J., B. Gebremedhin, S. Benin and S. Ehui. 2001. "Strategies for sustainable development in the Ethiopian highlands". American Journal of Agricultural Economics. 83(5): 1231-40.

Pender, J., B. Gebremedhin, S. Benin and S. Ehui. 2001. Strategies for sustainable development in the Ethiopian highlands. American Journal of Agricultural Economics 83(5): 1231-40.

Pender, J., E. Nkonya, P. Jagger, D. Sserunkuuma, and H. Ssali. 2004b. "Strategies to increase agricultural productivity and reduce land degradation: evidence from Uganda". Agricultural Economics. 31(2-3): 181-195.

Pender, J., P. Jagger, E. Nkonya and D. Sserunkuuma. 2004. "Development pathways and land management in Uganda". World Development. 32(5): 767-792. Philosophical Transactions of the Royal Society B: Biological Sciences, 365 (1537), 61 – 71.

Pretty J, Toulmin C, and Williams S. 2011. Sustainable intensification in African agriculture. Int J Agr Sustain **9**: 5–24. Pretty JN. 1997. The sustainable intensification of agriculture. NatResour Forum **21**: 247–56.

Seid H. 2009. Determinants of Physical Soil and Water Conservation Practices: The Case of Bati District,Oromyia Zone, Amhara Reion, Ethiopia. M.Sc. Thesis Presented to the School of Graduates of AlemayaUniversity, Alemaya. 162p.

Sonneveld, B. G. J. S. 2002. Land Under pressure: The Impact of Water Erosion on Food Production in Ethiopia. Shaker Publishing (PhD disertation). Netherlands. State. In: TilahunAmede (ed.) Proceeding of a Conference on Natural Resource Degradation and Environmental Concerns in the Amhara National Regional State: Impact on Food Security. P. 109-125, Bahir Dar, Ethiopia.

Sutcliffe, J. P. 1993. Economic assessment of land degradation in the Ethiopian highlands: a case study. Addis Ababa: National Conservation Strategy Secretariat, Ministry of Planning and Economic Development, Transitional Government of Ethiopia.

Tamene L, Park SJ, Dikau R, Vlek PLG (2006). Reservoir siltation in the semi-arid highlands of northern Ethiopia: sediment yield-catchment area relationship and a semi-quantitative approach for predicting sediment yield. Earth Surface Process. Landforms 31(11):1364-1383.

Tenge, A. J., De Graaff, J. and Hella, J. P. (2004). Social and Economic Factors Affecting the Adoption of Soil and Water Conservation in West Usambara Highlands, Tanzania. Land Degradation and Development, 15: 99–114

TerrAfrica. (2006). Assessment of the Nature and Extent of Barriers and Bottlenecks to Scaling Sustainable Land Management Investments throughout Sub-Saharan Africa. Unpublished TerrAfrica report.

TerrAfrica. 2006. Assessment of the Nature and Extent of Barriers and Bottlenecks to Scaling Sustainable Land Management Investments throughout Sub-Saharan Africa. Unpublished TerrAfrica report.

Tesfa, A., &Mekuriaw, S. (2014). The Effect of Land Degradation on Farm Size Dynamics and Crop-Livestock Farming System in Ethiopia: A Review. Open Journal of Soil Science, 4, 1.

Teshome A, Rolker D, de Graaff J (2012). Financial viability of soil and water conservation technologies in northwestern Ethiopian highlands. Appl. Geogr. 37:139 -49

Troeh FR, Hobbs AJ, Danahue RL (1980). Soil and water conservation for productivity and environmental protection. Prentice-hall, Inc., Englewood Cliffs. pp.718.

Wagayehu B, Drake L (2003). Soil and water conservation decision behavior of subsistence farmers in the Eastern Highlands of Ethiopia: a case study of the Hunde-Lafto area. Ecol. Econ. 46 (3):437-451.

WOCAT. 2011. “Database on SLM Technologies.” Retrieved August, 2016, from http://www.wocat.net/.

Woldeamlak B (2006). Soil and water conservation intervention with conventional technologies in northwestern highlands of Ethiopia: acceptance and adoption by farmers’. Land Use Policy 24(2):404-416.

Woldeamlak B, Sterk G (2003). Assessment of soil erosion in cultivated fields using a survey methodology for rills in the Chemoga watershed, Ethiopia. Agric. Ecosyst. Environ. 97:81-93.

Woldeamlak, B. (2003). Land Degradation and Farmers’ Acceptance and Adoptionof Conservation Technologies in the Degil Watershed, Northwestern Highlands of Ethiopia, Social Science Research Report Series no.29, OSSREA, Addis Ababa.

Woodfine, A. 2009. The Potential of Sustainable Land Management Practices for Climate Change Mitigation and Adaptation in Sub-Saharan Africa. Rome, Food and Agriculture Organization of the United Nations.

World Bank (2007). Ethiopia: Accelerating Equitable Growth Country Economic Memorandum Part II: Thematic Chapters. Poverty Reduction and EconomicManagement Unit; Report No. 38662-ET

World Bank (WB). 2012. Managing land in a changing climate: an operational perspective for Sub- Saharan Africa. Draft version Report No.: 54134-AFR. WB, Washington D.C.

World Bank. (2010). Managing land in a changing climate: an operational perspective for Sub- Saharan Africa. Draft version Report No.: 54134-AFR. WB, Washington D.C.