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ECONOMICS OF SUSTAINABLE LAND MANAGEMENT IN NORTH EASTERN ETHIOPIA

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ABSTRACT

Soil and water conservation efforts can only be productive if their economic feasibility and social acceptability dimensions are considered as great determining factors as its ecological importance. The study examines the impact of sustainable land resource management on household income in North Eastern, Ethiopia. For this study, descriptive statistics and econometrical analysis had been applied to analyze the collected data. First the status of sample households SLM activities had been described through GIZ SLM standards of sustainability of land resource management activities on household plot in descriptive way by comparing means and variations. The logit model result indicates that age of the household, marital status of the household, household's education status, total livestock unit of the household, land size, the distance of resident from land, membership of watershed user association are significant factors that affect farmers' decision to practice sustainable land resource management. To capture the impact of sustainable land resource management on households' income through Endogenous switching regressions model, the indicator was household total income evaluated at the market price of the survey period 2019. The result shows that the positive and significant impact of participation in sustainable land resource management had increased participant households' income as compared to non-participant households. This shows how the significant role of sustainable land resource management is in improving the income condition of poor farmers in the study area. The results indicate that land resource management activities have a profound effect on household income improvement. Hence, such activities need to be encouraged and scaled up to other areas and involve more households.

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INTRODUCTION

In developing countries, the land is a primary means of production, to the country's economy, and generates a livelihood for a large proportion of the population. Accordingly, land issues in developing countries in general, and Ethiopia in particular is becoming a central focus and a concern of many scholars and policymakers. The land question of the 1960s in Ethiopia, was the exploitation of peasants by a few landlords and the ruling aristocrats came to an end in 1975, which nationalized all land and provided usufruct rights to the farming population. Similarly, the EPRDF government that took power from the Derg has also maintained the landholding system as it was. But to avoid the previous

limitations the current government has introduced certain modifications on the problems related to efficiency, tenure insecurity, reducing farm size focusing on agricultural productivity through the provision of some agricultural packages. However, despite all these efforts the problem faced by the rural community and agriculturalists persists, and current land policy is becoming a debatable issue. Up to now, the arguments are revolving around two main streams. While some tried to stick to the political and economic passion, support the present landholding system (public ownership) presuming that the existing land policy is a special precondition to maintain sustainable land management procedures and have rural social security. The second groups are criticizers of the existing land policy stating: the present landholding system and its impact on the economic, environmental, social and political process remains negligible- instead it leads to unsustainable use of resources {Gebregziabher, 2016 #57}.

In Ethiopia, the soil and water conservation efforts are mainly aimed at conserving the remaining soil and rehabilitating the degraded land resources. Experience has shown that soil and water conservation efforts can only be productive if its economic feasibility and social acceptability dimensions are considered as great determining factors as its ecological importance. This situation is calling for a new move "Sustainable Land Management", an approach that will enable the farmer to intensify agricultural productivity and production by making use of the available land resources without compromising the benefits of the future generation. (Molla, 2016). This new approach is come to work through government and non-government organizations in Ethiopia.

Studies showed that poverty had many dimensions and many determinants. Lack of agricultural productivity is one of the causes of food shortage and income poverty for the rural society of northern Ethiopia. Land degradation, lack of technology and lack of extension service, and lack of financial institutions are among a lot of causes of low agricultural productivity (Gebremedhin, 2003).In the study area, land resource management has been done mainly through the coordination of the district Rural Development and agriculture Office. Since the zone is one of the poor areas in the Amhara region population is supported by the Productive Safety Net Program (PSNP) and other non-government organizations such as SLMP, Action Aid, and UNICEF. Based on those facts and others; sustainable land resource management is one of the remedies to alleviate rural income or economic poverty. In addition to the government's effort to sustainable land resource management programs, NGOs work by taking some kebeles of the district by the holistic approach of SLMP. Despite the programs run in the district, the impacts of the program on household income are not well studied in the area. So that this paper identified and examine the extent of the impact of sustainable land resource management programs on target rural households' income by taking the main interventions focuses of the program which is soil and water conservation While there is a bulk of information regarding the adoption of SWC technologies little information is documented on the impact of the various long-term SWC measures implemented in the country (Yitayal 2014). Therefore, this study tried to answer whether soil and water conservation had an impact on rural household income or not, and also it would answer about the status of sustainable land resource management and its determinants.

METHODOLOGY

Description Area of the Study Area

The study was conducted in South Wollo Zone, Amhara National Regional State, Ethiopia. According to the 2015 projections, the total population of the South Wollo Zone is around 2,980,912 (1,505,387 females and 1,475,523 males). The Zone is divided into twenty rural administrative woredas and has four major towns (kombolcha, Dessie, Haik and Mekoneselam). Dessie town is the zonal capital city and is located about 401 km north of Addis Ababa and 510 km from the regional capital city of Bihardar. The altitude of the South wollo zone ranges from 1500 to more than 4000 meters above sea level (SWZFEDO, 2016). The average temperature varies from 100 to 24OC. The average annual rainfall in the highlands of South wollo ranges from 800 to 1200 mm with a seasonal variation. The main rainy season, which accounts for approximately 60% of the annual precipitation, covers the period between the beginning of June and the end of September, while the short rainy season is from March to May (SWZADO, 2016).

Data Types, Sources, and Methods of Data Collection

A Community-based cross-sectional study design using

both quantitative and qualitative research methods was employed. Primary data was collected from sample respondents through a structured questionnaire, via face-to-face interview. The primary data was collected on the demographic, social, institutional, economic, awareness, and willingness to pay for soil conservation practices. Prior to data collection training was given to the enumerators on method of data collection and interviewing techniques. Discussions with stockholders were also the sources of primary data. Continuous supervision was made by the principal researcher to correct possible errors on the spot. Secondary data was obtained from various sources such as reports of Ministry of Agriculture and Rural Development (MOARD), South Wollo Zone Agriculture and Rural Development Office (AWARDO), Sample Woredas of Agricultural office, Journal articles, and so on.

Primary data had been collected through semi-structured questionnaires most of which was too structured but for some descriptive results there had been unstructured open-ended questionnaires namely schedule method. According to Kothari (2004), the schedule method of data collection is very much like the collection of data through questionnaire, with little difference which lies in the fact that schedules (Performa containing a set of questions) are being filled in by the enumerators who are specially appointed for the purpose. These enumerators along with schedules go to respondents, put to them the questions from the Performa in the order the questions are listed, and record the replies in the space meant for the same in the Performa. So in general the data for this study was collected through questionnaires using enumerators the researcher himself.

Sampling Technique and Sample Size

According to the National Oceanic and Atmospheric Administration (NOAA) panel report regarding CVM guidelines, the probability sampling technique is essential for a survey used for environmental valuation. Besides, for such quantitative research, the probability sampling technique is appropriate as compared to the non-probability sampling technique since the results are going to be statistically interpreted. Using this as a reference, the current study also employed probability sampling techniques. The sample respondents were selected using a multi-stage sampling technique. In the first stage, from the total Woredas of the Zone, five Woredas were selected randomly. In the second stage, the total Kebeles of the sample Woredas were stratified in to dega, woyna dega and kola agro-ecological zones. Agro-ecology-based stratification was done with the expectation of that; there might be a difference in the rate of communal land degradation, the method of soil and water conservation strategies and also their WTP for the proposed improved communal land conservation program. In the third stage, from the three agro-ecological zones, 10 Kebeles were selected using simple random sampling proportional to each stratum. In the last step, representative numbers of respondents were selected by probability proportional to size (PPS) techniques of the number of households in each selected kebeles. The sample size was determined by Yamane (1967) formula. Among 396 sample respondents 198 respondents are participants and the remaining 198 respondents are non- participants of SLM were selected through simple random sampling technique.

$$n = \frac{N}{1+N\,(e^2)}$$

$$n = \frac{142352}{1+142352\,(0.05^2)} = 398.8 \approx 399$$

Where: n = sample size;

N = Total number of Households of Sample Woredas (142,352)

e = level of significance (5%)

Based on the formula the total sample size of the study was 400 households

Method of Data Analysis

For this study, descriptive statistics and econometrical analysis had been applied to analyze the collected data. First the status of sample households SLM activities had been described through GIZ SLM standards of sustainability of land resource management activities on household plot in descriptive way by comparing means and variations. The standards are simply by taking counts of land users adopting three sustainable and climate-smart/resilient land management practices on individual land Practiced for more than five years since the positive effects of soil and water conservation (SWC) may occur through time and adoption of SWC agricultural technologies depends on the ability of the technologies to improve agricultural land productivity and income, and risk decisions facing individual households both in the short and long term (Yitayal et al. 2014).

The second objective which focuses on the determinants of farmers' participation and practice of those SLM activities had been analyzed through logistic regression econometric model which is binary logit model.

Descriptive statistics like mean and percentages were used to examine and understand the socio-economic situations of the sample households. Moreover, t-test and chi-square tests were used to compare users and non-users in terms of different explanatory variables. While econometric analysis (logit model) was used to identify the determinants of participation of SLM activities. The endogenous switching regression (ESR) model was used to analyze the impact of participating in SLM activities on farmers' income. For this study, the income of households (evaluated at market price of survey period) was used to measure their livelihood status.

Econometric Analysis

This paper pursued to examine the impact of land resource management activities on farmers' livelihood by examining the income of respondents using the Endogenous switching regressions model in the study area.

Endogenous switching regressions model: In the study area, the interventions of SLMP were not randomly distributed and the decision to participate in SLM activities is voluntary. Therefore, it should be emphasized that smallholder farmers may self-select themselves as the SLM activities participant. In this regard, they use SLM activities, if they perceive that SLM activities will provide them with more income and assets than non-participants. Hence, it is not possible to directly compare the income of the participants and non-participants households because of selection bias. This selection bias may result from both observed (observed to the researcher) and unobserved (observed to the respondent but not the researcher) characteristics. According to (Alene & Manyong, 2007) self-selection into an intervention utilization would be the source of endogeneity, and failure to account for this bias would obscure the true impact of the intervention.

The major econometric problem in evaluating project impacts is selection bias (Maddala, 1983). Instrumental variables or statistical control methods, in which one uses one or more variables which matter to participation, but not to outcomes given participation. This identifies the exogenous variation in outcomes attributable to the program recognizing that its placement is not random but purposive. Measuring the impact of the program when treatment has not been randomly assigned is by using the instrumental variable (IV) method. The IV estimation regards the treatment variable as endogenous. The idea is to find an observable exogenous variable or variables (instruments) that influence the participation or selection variable but do not influence the outcome of the program if participating (Khandker et al., 2010).

Selection bias arises from the fact that treated individuals may differ from the non-treated for reasons other than treatment status. SLM activities participants usually purposively target the dwellers of some specific watersheds or kebeles, which are more likely to be poor. It is expected that participants would have had far less income in the absence of the project.

Selection bias could be as a result of selection on observables or unobservable. Selection of observables can be controlled by including all the variables in the model. Selection on unobservable is difficult to control by adding these variables as these variables are difficult tocapture and not observed. Variables such as managerial ability, motivation, propensity to bear risks, etc., are some examples of variables that are hard to capture.

Selection bias can be overcome in three ways: using instrumental variables, using panel data, or assuming normality in the error distribution of the outcome variable before the treatment happens (Moffitt, 1991). Furthermore, Holvoet (2005) recommended minimizing selection bias by gaining a good understanding of the subject under study and potential selection processes, which can help identify the persistent matching characteristics of participants and nonparticipants and control of other differences statistically. As a result, we looked at characteristics related to households, such as socioeconomic status and whether the household is participants or not, and whether program placement strategies is non-random or random. In this study, the endogenous switching regression model is used to minimize the problems of self-selection bias and unobserved characteristics.

ESR designs account for both endogeneity and sample selection bias by estimating a simultaneous equations model using full information maximum likelihood method (Lokshin & Sajaia, 2004). Moreover accounting for selection bias arising from unobserved factors that

potentially affect both the decision to use SLM activities and the outcomes, it controls for structural differences between the participants and non-participants regarding the outcome functions (Alene & Manyong, 2007).

Therefore, the main significance of ESR is that it allowed us to control both selection and unobserved heterogeneity issues that may arise onwards doing the basic estimation procedure (Lokshin & Sajaia, 2004). Previous empirical studies have employed the framework to study the impact of an intervention on household livelihood and poverty (e.g. Owusu et al., 2011; Kuwornu and Owusu, 2012; Kidanemariam et al., 2017).

Following (Lokshin & Sajaia, 2004), in this approach, there are two stages, first the decision to use SLM activities (selection equation) is modeled by standard limited dependent variable models, and second the outcome variables are then estimated separately for each group (as SLM activities participants and non-participants), conditional on having the selection equation. Therefore, the selection equation is a dichotomous choice, where a smallholder farmer decides to participate SLM activities when there is a positive perceived difference between having participation and not having participation. Consider a farm household **i** that faces a decision on whether or not to participate. Let the indicator variable be **Si** taking a value of 1 for households who decided to participate and 0 otherwise.

This leads to two possible states of the world: a decision to participate in SLM activities (**Si**=1) and not to participate (Si=0), and two population units: SLM activities participants and nonparticipants.

Let's denote the benefits to the household of participating SLM activities (U1) and the benefits of the household not participating SLM activities (U0). Under a non-random utility framework, a rational farm household will choose to use SLM activities if the benefit of participation is positive i.e. **U1**>**U0** or **U1**−**U0**>**0**.The net benefit (**U**∗ = **U1**−**U0**) is represented by a latent variable. Conditional on households' decision to use SLM activities denoted by a selection function (**Si**), there are two potential outcomes to the two population units: the outcome of the participants ($\mathbf{L_1}$) and the outcome of the non-participants ($\mathbf{L_0}$). This can be put in a potential outcome framework as:

$Li = (1 - Si)L_0i + SiL_1i$

$Li = (\{L_1i \text{ if } Si = 1\ L_0i \text{ if } Si = 0\})$

The gain from the intervention is provided as L1 − L0. Hence, taking a simple difference and averaging cannot give the effect of the intervention, causing a 'missing data' problem (Heckman et al., 2001). Therefore, following Lokshin & Sajaia (2004) the selection equation as latent variable framework can be expressed as:

$Si* = \beta Zi + vi$ ..... (2)

$Si = \{1 \text{ if } Si * > 0; 0 \text{ if } Si * \leq 0\}$

Conditional on selection, the outcomes are represented as follows:

$L1i = \{Y1iF1i = \alpha 1\chi 1i + \varepsilon 1 \text{ if } Si = 1$ ..... (3)

Where Z are vectors of observed characteristics that determine the selection equation (includes household, demographic, socioeconomic and farm characteristics); χ1i and χ2i are vectors of explanatory variables assumed to be weakly exogenous and determine the outcomes of participants and non-participants. Although, Z and X can overlap, but there must be at least one variable in Z is required not to be included in X to properly identify the outcome equations and α1, α2 and β are vector of unknown parameters to be estimated. The L1i is income indicator (outcome variable), in this case, income is an outcome variable. According to this study, income (Y) Y1i represents income of the SLM activities participants. whereas, Y2i is income of the non-participants respectively. The error terms of the continuous outcome equations (ε1) and selection equation(vi).

Following Foltz (2004), this paper, first assume that the unobserved residual effects of the selection equation are independent of unobserved residual effects of the outcome equations. That is

$E[\varepsilon 1i \mid si = 1] = E[\varepsilon 2i \mid Si = 0] = 0$

$cov(vi, \varepsilon i) = 0$

This implies that sample partitioning between the participants and non-participants is entirely exogenous to their behavior so that an exogenous switching structure results. The unconditional expectation of these models can be expressed by Applying ordinary least squares to give consistent estimate of the α.

$E(L1i|\chi 1i) = \alpha 1\chi 1i$ ..... (4)

$E(L2i|\chi 2i) = \alpha 2\chi 2i$..... (5)

However, there is a high likelihood that uncontrolled factors (for example, expectation of yield gain from practicing SLM activities, risk-taking ability, managerial skills, and/or motivation) simultaneously influencing the selection equation and the level of outcomes, so that cov (vi, εi) ≠ 0. Under this scenario sample separation between the SLM activities participants and non-

participant households become endogenous to their behavior and governed by the selection equation regime.Here, the paper assumed a trivariate normal distribution of error terms, with zero mean and a covariance matrix represented by Σ i.e. (v, ε1,) ~ (0, Σ). Further justification, the error term v of selection equation is correlated with the error terms ε1 of outcome equations. Accordingly, the expected values of ε1 would be non-zero conditional upon the selection equation. This makes ordinary least square estimates to be more biased. The covariance matrix Σ is expressed as follows:

cov (v**i**,**ε1**) = {**σ**v **2σ1**v **σ2**v**σ1**v **σ12** .**σ2**v . **σ22**}

xlWhere var (vi) = σv 2 is the variance of the error term in the selection Eq. (1), var (ε1) = σ1 2 and var (ε2) = σ2 2, are the variances of the error terms in the outcome functions Eq. (2) and (3) respectively, and cov (ε1 ,vi) = σ1v, cov (ε2 ,vi = σ2v). Whereas, the cov (ε1,ε2) is not defined, as L1 and L2 are never observed simultaneously (Lokshin & Sajaia, 2004) . σv 2=1, because β is estimable up to a scalar factor (Maddala, 1983).

The endogeneity can be tested with estimates of the covariance terms. If σ1v = σ2v = 0, one has a model with an exogenous switching; on the other hand, if either σ1v or σ2v is non-zero, one has a model with an endogenous switching (Maddala ,1986). Consequently, significance of the correlation coefficients between ε1 and (**vρε1**v = **σε1**v **2 /σε1σ**v) and between ε2 and v (ρε2v = σε2v 2 /σε2σv) needs to be tested (Lokshin & Sajaia, 2004).

Not that; in line with standard statically arguments, ρε1v and ρε2v must lie between -1 and 1, and σ1v and σ2v must be always positive/Based on the argument on the distribution of disturbance terms, the logarithmic likelihood function can be formulated following the procedure by (Lokshin & Sajaia, 2004) whom they depend their derivation on (Maddala, 1983).

$\ln L = \sum$(Siiwi[ln[

lnL = ∑ (**Sii**w**i** [**ln**{**F**(η**1i**}+**ln**{$f(x) = a_0 + \sum_{n=1}^{\infty}\left(a_n \cos\frac{n\pi x}{L} + b_n \sin\frac{n\pi x}{L}\right)$**f**(**ε1iσ1σ1**}] + (**1 − Si**)w**i** [**ln**{**1 − F**(η**2i**)}+**ln**{**f**(**ε2iσ2σ2**}]

Where F (x) is a cumulative normal distribution function, f (w) is a normal density distribution function w**i** is an optional weight for observation i, and

η**ji** = (**βZi**+ (**ρjεJi /σj**) √**1**−**ρj2** Where j =1, 2

In addition to the endogeneity test, **ρε1**v and **ρε2**v provide economic interpretation depending on their signs. If **ρε1**v and **ρε2**v have opposite signs, households decide whether to have participation or not based on a comparative advantage (Fuglie & Bosch, 1995; Maddala, 1983).That is, participants enjoy above average income once having participation whereas, non-participants enjoy above income when not participate. Alternatively, if **ρε1**v and **ρε2**v have the same signs, it demonstrates "hierarchical sorting" (Fuglie & Bosch, 1995), suggesting that the participants income is above the average level whether or not they have participated but get better off having than not having. Similarly, the non participating's income is below the average level in either case but get better off choosing not having participation. Moreover, the coefficient **ρε1**v and **ρε2**v can give evidence for model consistency under a condition **ρε1**v <**ρε2**v (Trost, 1981). This implies that participants enjoys more income level than they would if they did not have participation.

The key issue in controlling for the endogeneity of the selection equation is identification of instrumental variables. It is necessary of finding instrumental variables that could be strongly correlated with the selection equation (Eq. 1) but not the outcome (income) equations (Eq.2 and 3). From the variables in our data set, this study uses distance from household's residence to the farm land and social participation that is being memember of watershed users association as instrumental variables are properly identify the model. In developing countries, social networks, peasant and cooperative association, friends are the main source of information and confidence in the process of technology or new practice. Hence the existence of social participation (farmer –to- farmer contact) is expected to influence to practice SLM activities. but not the income of households. Following (Di Falco et al;2011), the validity of the selection instruments was tested. According to his argument, a variable is a valid selection instrument, if it will significantly affect the selectionvariable but it will not affect the income households that did not participate in SLM activities.

The average treatment effect on the treated (ATT) and untreated (ATU) were computed by comparing the expected values of the outcome of the participants and non-participant households in actual and counterfactual scenarios. The estimates from endogenous switching regression allow for the computing of the expected

values in the real and hypothetical scenarios: Following model estimation, Stata allows calculation of the following conditional expectations (Lokshin & Sajaia, 2004).

Actual expected outcome: SLM participants

$E(L1i|S = 1,\chi 1i) = \alpha 1\chi 1i + \sigma 1\rho 1f(\beta)/F(\beta Zi)$ ..... (5)

Counterfactual expected outcome: SLM participants

$E(L1i|S = 0,\chi 1i) = \alpha 2\chi 1i - \sigma 1\rho 1f(\beta Zi)/\{1 - F(\beta Zi)\}$ ... (7)

Counterfactual expected outcome: SLM non-participants

$E(L2i|S = 1,\chi 2i) = \alpha 1\chi 2i + \sigma 2\rho 2f(\beta Zi)/F(\beta Zi)$ ..... (8)

Actual expected outcome: non-participants

$E(L2i|S = 0,\chi 2i) = \alpha 2\chi 2i - \sigma 2\rho 2f(\beta Zi)/\{1 - F(\beta Zi)\}$..... (9)

Equation (Eq. 5) and (Eq. 8) represent the actual expectations observed from the sample, while (Eq. 6) and (Eq. 7) are the counterfactual expected outcomes. Given the above formulation, the following mean outcome difference can be calculated and compared. The expected change of SLM participants that means the effect of treatment on the treated (ATT) is computed as the difference between Eq. (5) and (6):

$ATT = E(L1i|S = 1,\chi 1i) - E(L1i|S = 0,\chi 1i)$ ..... (10)

Similarly, the expected change in the non-participants, the effect of the treatment on the untreated (ATU) is the difference between Eq. (6) and (8):

$ATU = E(L2i|S = 1,\chi 2i) - E(L2i|S = 0,\chi 2i)$ ..... (11)

The treatment effects can be differentiated from the heterogeneity effect because the presence of unobservable characteristics. Therefore, "the effect of base heterogeneity" (BHu) for the group of households that decided to use SLM activities is defined as the difference between (Eq.5) and (Eq.6):

$BHu = E(L1i|S = 1,\chi 1i) - E(L1i|S = 0,\chi 1i)$ ..... (12)

Similarly, "the effect of base heterogeneity" (BHN) for the group of households that decided to not to use SLM activities is defined as the difference between (Eq.7) and (Eq.8)

$BH_N = E(L_{2i}|S = 1,\chi_{2i}) - E(L_{2i}|S = 0,\chi_{2i})$ ..... (13)

Finally, the effect called "transitional heterogeneity" (TH), estimates whether the effect of working SLM activities in thier own land is larger or smaller for households that use SLM activities or for the households that did not use in the counterfactual case that they did use. It is the difference between (Eq.9) and (Eq.10), i.e. (ATT) minus (ATU):

$TH = ATT - ATU$..... (14)

The conditional expectations, treatment and heterogeneity effects also presentd on table 1.

Table 1. Conditional expectations, treatment and heterogeneity effects.

Sub-samples	Decision stage		Treatment effect
	To participate in SLM activities	Not to participate	
HHs participated in SLM	(a)E(L1i|Si = 1)	(c)E(L2i|Si = 1)	ATT
HHs not participated	(d)E(L1i|Si = 0)	(b)E(L2i|Si = 0)	ATU
Heterogeneity effects	Bhu	BH_N	TH

Note :(a) and (b) represents observed expected income of participants and non-participants ;(c) and (d) represents counterfactual of participants of SLM activities.

RESULTS AND DISCUSSION

Descriptive Analysis

The status of sustainable land management practices in the North Eastern Ethiopia

The overall status of sustainable land management practices are discussed in the type of practices, land sizes, age of the household, adult equivalent, age of the household, marital status of the household, household size, household education, iqub (Rotating saving and Credit Association), watershed users association, participation in cooperatives, saving and credit, households ownership of oxen, , household live stalk income, household crop income, estimated annual non-farm income of the house hold, frequency of extension services delivered to the households.

As per table 2, there are about 9 different soil and water conservation; and soil fertility management activities practiced in the study area. The study is conducted for farmers who practiced those management activities for all plots. The first four activities are the physical and biological soil and water conservation activities. The other 4 activities are a type of land resource management mainly for soil fertility management. 70.96%, 58.84%, 50.00%, 48.74%, 50.76%, 67.93%, 59.34%, 42.17% and 12.88% respondents were practice soil bund, stone faced soil bund, biological treatment on

bunds and terraces, terracing plus water collection trench, manure application, artificial fertilizer, crop rotation practice, fallowing and other (ridges) respectively.

Table 2. Sustainable land management activities practiced in the study area.

Land management activities practiced	f	%
Soil bund	281	70.96
Stone faced soil bund	233	58.84
Biological treatment in bunds and terraces	198	50
Terracing plus water collection trench	193	48.74
Manure application	233	50.76
Artificial fertilizer	269	67.93
Crop rotation practice	235	59.34
Fallowing	167	42.17
Other (ridges)	7	12.88

Table 3. Mean estimation of household income over sustainable land resource management participation.

Income type	Mean (ETB)	Std. Dev.	Min (ETB)	Max (ETB)
Crop income (396)	41312.61	47366.3	1900	154369
Participants (198)	81336.91	3383.211		
Non participants (198)	11159.22	1220.911		
Live stalk income (396)	20246.58	20831.56	0	230425
Participants s (198)	27095.75	1421.447		
Non participants (198)	4818.636	735.3638		
Nonfarm income (396)	10944.53	4726.691	0	32967
Participants (198)	10885.13.54	4533.385		
Non participants (198)	11003.93	388.2		
Total income 396	91052.61	63659.95	2545	398366
Participants (198)	104246.7	3120.823		
Non participants (198)	77858.5	6211.514		

Source: own survey 2019 Number of observations = 322

Mean estimation of household income over sustainable land resource management

The average total annual income of the household is 91052.61 with a standard deviation of 63659.95. When we compared sustainable land resource management participants and non-participants, participants' average total annual income is 104246.7 and the non-participants were 77858.5 with the standard deviation of 3120 and 6211 respectively (Table 3).

Econometrics analysis result

Determinants of participating in SLM activities of farmers in their land

The output of the binary logit model showed that six variables were identified as significant variables out of the thirteen hypothesized variables that affect the household participation decision in the land resource management in the study area. These are age of the household (AGEHH), marital status of the household (HHEDUCA), total livestock unit of the household (TLU), land size, the distance of resident from land (DSFLD), membership of watershed user association (WUA) (Table 4).

Age of the household

The sign of this variable is consistent with the prior expectation that means negatively and significantly influenced the probability of household heads to participate in SLM activities at 1 % significance level. This may be because participating in SLM is labor intensive and exhaustive work that the older household heads cannot tolerate this challenge. In another way the negative sign indicates that younger farmers more participated in SLM activities than the older farmers. (Phoebe et al., 2000) also found that the older the household head the less inclined to adopt new

technology. The marginal effect also confirms that age of the household head increases by 1 year to certain level, the probability of participation in SLM activities would be decreased by 0.9%, other variables in the model remain constant (Table 4).

Distance from residents' home to the farm land

The model result shows that distance from resident's home to the farmland significantly affected household's participation decision at 5% significance level. As the distance is far from the homestead of households, incur transportation cost and labor intensive. The households might choose to practice soil and water conservation and some other land management activities in nearby farmlands to their home. The marginal value of this variable suggests that for one-kilometer distance from farmland a household resides the possibility of partaking in land resource management decreases by 3.6%. Therefore, households that are far apart from the farmland are discouraged to participate in SLM activities. This result is in line with other studies conducted by (De Haan, 2012; FekaduAbdissa*et al;* 2017; Sikhulumile*et al*; 2014; 50 WoldegebrialZeweld*et al*; 2017).

Table 4. Marginal effects from logit estimation for determinants of participation in SLM activities.

Variables	Marginal Effects	Std. Err	Z	P>z
AGEHH	-0.0094158	0.0030419	-3.10	0.002**
HHsize	-0.0005235	0.0282048	-0.02	0.985
ADULTEQUI	-0.0213285	0.0264381	-0.81	0.420
HHEDUCA	-0.0104346	0.0179144	-0.58	0.560
MARHH	0.0994793	0.045695	2.18	0.029*
SAVCRE	0.0659322	0.0480729	1.37	0.170
LANDSIZE	0.1838398	0.0890291	2.06	0.039*
TLU	0.0836099	0.0262333	3.19	0.001**
FRQEXT	0.0189251	0.0309877	0.61	0.541
DSTMRKT	0.0077441	0.006508	1.19	0.234
PLMAP	0.0471847	0.0404929	1.17	0.244
DSFLD	-0.0366448	0.0110024	-3.33	0.001**
WUA	0.1606536	0.0418122	3.84	0.000***

***, ** and * represents 1%, 5% and 10% significant level

Marital status of the house hold

The model result shows that the marital status of the household that is whether the household head is married or single significantly affected household's participation decision at 5% significance level. As the household head is married, there is a possibility of participating in SLM activities.

The marginal value of this variable suggests that if a house hold head is married the possibility of partaking in land resource management increases by 9.9%. Therefore, households with a married head would encourage participating in SLM activities. This result is in line with other studies conducted by Meshesha et al (2018) of in his study getting the household head married is advantageous to share information among members about the SWCP and who found the majority of the respondents participated in SWCP measures (Table 4).

Total livestock unit

The model result shows that the households' ownership of TLU significantly affected household's participation decision at 1% significance level. As the household head had more TLU, there is a possibility of participating in SLM activities. The marginal value of this variable suggests that if households had 1 more TLU the possibility of partaking in land resource management increases by 8.3%. This result is in line with other studies conducted by (W. Bekele et al 2003). Livestock is generally considered to be an asset that could be used either in the production process or be exchanged for cash or other productive assets.

It is hypothesized that the livestock holding of a household will affect the conservation decision positively. First of all livestock is considered as a measure of wealth and increased availability of capital which makes investment in conservation more feasible (Norris and Batie, 1987 cited in W.Bekele et al 2003). Secondly, livestock, particularly oxen, are used as working assets to perform farm operations, including conservation, which increases the possibility for timeliness effects (Table 4).

Table 5. Endogenous switching regression model parameter estimates.

Variables	Income		Effects on participation
	Participant	Non participant	
AGEHH	0.0004	0.0021	-0.0534***
	(0.0041)	(0.0053)	(0.0182)
HHsize	0.0219	0.0821	0.0071
	(0.0376)	(0.0586)	(0.1680)
ADULTEQUI	0.0406	0.0941	-0.1563
	(0.0365)	(0.0586)	(0.1555)
HHEDUCA	-0.1355***	-0.0308	-0.0740
	(0.0350)	(0.0271)	(0.1133)
MARHH	0.0343	-0.1701**	0.6186**
	(0.0843)	(0.0737)	(0.2727)
SAVCRE	0.1535*	0.1207	0.4314
	(0.0834)	(0.0836)	(0.2917)
LANDSIZE	0.5841***	0.8358***	1.0674**
	(0.1111)	(0.1561)	(0.5173)
TLU	0.0917***	-0.0294	0.4593***
	(0.0320)	(0.0606)	(0.1574)
FRQEXT	0.1563***	-0.0879*	0.0952
	(0.0470)	(0.0492)	(0.1796)
DSTMRKT	0.0081	-0.0319***	0.0358
	(0.0098)	(0.0107)	(0.0404)
PLMAP	0.0644	-0.1125	0.2239
	(0.0515)	(0.0973)	(0.2482)
DSFLD			-0.2310***
			(0.0633)
WUA			1.0542***
			(0.2644)
Constant	10.7575***	9.9288***	0.0835
	(0.2561)	(0.2761)	(0.9808)
Observations	322	322	322
σ	.26	.38	
ρ	-.47	-37	

LR test of indep. eqns.:	ESR
$chi^2(1)$ 5.11* **	$chi^2(12)$ 2.88*
Wald chi2(11) 410.34***	Wald $chi^2(12)$ 1648***
Log likelihood -170.90	Number of observations 322

***, ** and * represents 1%, 5% and 10% significant level

Land size

The model result shows that the households' ownership of more hectares of farm land significantly affected the household's participation decision at 5% significance level. As the household head had more farmland, there is a possibility of participating in SLM activities. The marginal value of this variable suggests that if households had an additional 1 hectare of his farm land the possibility of practicing in land resource management increases by 18.3%.

This result is in line with other studies conducted by (W.Bekele etal, 2003). The size of a given plot is

expected to influence the conservation decision positively. This is because conservation structures will take proportionally more space on small plots and the benefit from conservation on such plots will not be enough to compensate for the decline in production due to the loss in the area devoted to conservation structures (Table 4).

Membership of watershed users' association

The model result shows that the households' membership of watershed users association significantly affected the household's participation decision at 1% significance level. As the household head had been membership of the watershed user's association, there is a possibility of participating in SLM activities. The marginal value of this variable suggests that if households had participated and were member of the watershed user's association; the possibility of practicing in land resource management increases by 16.06% (Table 4).

Impacts of SLM activities on rural household income

Distance from residents to the farmland was negative and significant for SLM activities participants` income at 1% significance level. The negative sign indicates that households far from the farmland incur high transportation costs and time-consuming while households' labor utilization. The households might choose to participate SLM activities in near and around residents' farmlands. The same result was found by Bekele (2003) according to bekele`s finding studied in the eastern highlands of Ethiopia distance from the farm dwelling is influence conservation decision negatively for two reasons. The closer the plot is to the farm dwelling area the closer supervision and attention it will get from the family. The other argument is derived from the land tenure policy in Ethiopia. Land in Ethiopia is the property of the state and farmers only have the right to use the land. Any form of exchange of land is prohibited and land redistributions by the regional states and local authorities are frequent. In cases where a family has more land than the average of the village, the family may fear a loss of plots to land redistribution especially the . distant plots. Length or duration of use of a plot is expected to influence conservation decisions positively because a longer period of control will give the farmer a sense of tenure security and as a result, encourage him to have a longer planning horizon. In addition, a longer period of use will give the farmer the chance to observe and recognize the yield-reducing effects of soil erosion, i.e. learn from experience. The other research conducted by Schmidt and Fanaye (2012); remoteness of the farmland has a significant but small negative correlation with the household probability of adopting sustainable land and water management.

Households' membership in watershed users' association; it is an instrumental variable; positively and significant for SLM activities participation of participants of SLM activities at 1% significance level (Table 5). The positive sign indicates that households which are members to watershed users' association are more likely to adopt and practice SLM activities due to knowledge, skill and new information sharing among members and since they are abide by the associations by law to participate in watershed management activities in both private and communal lands. The watershed user's association is a legal association, registered and had legal basis based on the ANRS watershed users' association establishment proclamation number 204/2005.

Table 6. Test of predicted outcomes with endogenous switching regression model.

Outcome variable	Household type and treatment effects	Decision stage		Treatment effect
		Participants	Non-participants	
Income (Y)	SLM participants	(a) 110555	(c) 118235.9	ATT_y= -7680.873**
	Non-participants	(d) 149499.9	(b) 69034.18	ATU_y= 80465.73***
	Het effects	BH_{1y}= -38944.9	BH_{2y}=49201.72	TH_y = -88146.603

***, ** and * represents 1%, 5% and 10% significant level Source: own survey calculation (2019)

An important question is whether farmers that practice or participated in SLM activities in their own land improve their livelihood status in terms of income. The results, obtained using equations (1 up to 5), are presented in (Table 6). In other words, to evaluate the impacts of SLM activities on farmers' income; the conditionally expected income by the

participants E (Y1i=1) are compared with what they would have enjoyed the non-participants E (Y2i=0). As shown from (Table 5), the observed difference in income between the participants and non-participants (ATE) were ETB 41520 (a)–(b). However, this simple comparison is misleading because unobserved factors that may impacted of both outcome variables was not accounted.

Hence, following Carter &Milo (2005), the base heterogeneity due to the potential unobservable effect on the livelihood outcome variables was included to get the true impact estimate. BH (referred as base heterogeneity). Within the counterfactual condition, that SLM participants placed in the non-participants status (BH1Y) in (Table 6) households would be expected to earn, an average of, ETB 38944.9 less income, the counterfactual condition that the non-participants placed in the participants status (BH**2Y**), would expect to earn , an average of, ETB 49201.72 earn more income.

Therefore, from the outcomes (income) counterfactual conditions, the non-participants under the status of participating in SLM activities were performing better than the participants. These results participating effects are larger for the counterfactual non-participant's households and less for participants, resulting in a negative transitional heterogeneity effect of outcome variable TH_Y (ETB 88146.603 less income).

The survey result revealed that the actual expected income of the participants E (Y1i |S = 1) was approximately ETB 110555, while the expected income that the same participants would have enjoyed if they did not participate in SLM activities (counterfactual of the SLM participants) E(Y2 |S = 1) was approximately ETB 118235.9. Therefore, the observed income gap (ATT) was found to be ETB -7680.873 due to SLM activities. Similarly, the counterfactual of the non-participants (if non-participants decided to participate in SLM) (ATU) was ETB 80465.73 higher income than their counterpart. Both results were statically significant at less than 1% significance level. The results are in agreement with other studies that report a positive link between SLM participation and income (Kidanemariam G. Gebrehiwot et al., 2017; Woldegebrial et al., 2015). It is also the same to {Owusu, 2011 #69}(Owusu et al., 2011), the study conducted in northern Ghana.

CONCLUSSION

This study analyzes the economics of SLM activities on farmers' or households' income in North-Eastern Ethiopia, Southern Ethiopia. This study revealed that, even though, SLM practices participants and non-participants had the same demographic patterns, the income of the participants was found to be better than that of non-participants. This study applied Logit and ESR model to determine the participation decision and examine the impact of SLM activities on farmer's income. The output of the binary logit model showed that six variables were identified as significant variable out of the thirteen hypothesized variables that affect the household participation decision in the land resource management in the study area. These are age of the household, marital status of the household, household's education status, total live stalk unit of the household, land size, distance of resident from land, membership of watershed user association. The age of the household is consistent with the prior expectation that means negatively and significantly influenced the probability of household heads to participate in SLM activities at 1 % significance level. This may be because participating in SLM is labor intensive and exhaustive work that the older household heads cannot tolerate this challenge. Distance from resident's home to the farmland significantly affected household's participation decision at 5% significance level. As the distance far from the homestead of households, incur transportation cost and labor intensive. The households might choose to practice soil and water conservation and some other land management activities in nearby farmlands to their home. The marginal value of this variable suggests that for one-kilometer distance from farmland a household resides the possibility of partaking in land resource management decreases by 3.6%. Marital status of the household of the house hold that is whether the household head is married or single significantly affected household's participation decision at 5% significance level. As the household head is married, there is a possibility of participating in SLM activities. The marginal value of this variable suggests that if a household head is married, the possibility of partaking in land resource management increases by 9.9%. Households' ownership of TLU significantly affected the household's participation decision at 1% significance level. As the household head had more TLU, there is a possibility of participating in SLM activities. The marginal value of this variable suggests that if households had 1 more TLU the possibility of partaking in land

resource management increases by 8.3%. Households' ownership of more hectares of farm land significantly affected the household's participation decision at 5% significance level. As the household head had more farm land, there is a possibility of participating in SLM activities. The marginal value of this variable suggests that if households had an additional 1 hectare of his farm land the possibility of practicing in land resource management increases by 18.3%. Households' membership of watershed users' association significantly affected household's participation decision at 1% significance level. As the household head had been membership of the watershed user's association, there is a possibility of participating in SLM activities. The marginal value of this variable suggests that if households had participated and member of watershed users' association. The impact of sustainable land resource management on households' income were analyzed through endogenous switching regression model. The result revealed that; the conditional expected income by the participants is compared with what they would have enjoyed the non-participants; the observed difference in income between the participants and non-participants or an average treatment effect were ETB 41520. However, this simple comparison is misleading because unobserved factors that may impact both outcome variables was not accounted. So, to avoid misleading the base heterogeneity due to the potential unobservable effect on the livelihood outcome variables was included to get the true impact estimate. Within the counterfactual condition, that SLM participants placed in the non-participants status households would be expected to earn, an average of, ETB 38944.9 less income, the counterfactual condition that the non-participants placed in the participants status, would expect to earn, an average of, ETB 49201.72earn more income. Therefore, from the outcomes variable (income) counterfactual conditions, the non-participants under the status of participating in SLM activities were performing better than the participants. These results participating effects is larger for the counterfactual non-participants' households and less for participants, resulting in a negative transitional heterogeneity effect of outcome variable TH_Y (ETB 88146.603less income). The survey result revealed that, the actual expected income of the participants was approximately ETB 110555, while the expected income that the same SLM activities participants would have enjoyed if they did not participate (counterfactual of the SLM activities participants) was approximately ETB 118235.9. Therefore, the observed income gap (ATT) was found to be ETB -7680.873 due to SLM activities. Similarly, the counterfactual of the non-participants (if non-participants decided to participate in SLM) (ATU) was ETB 80465.73 higher income than their counterpart. Both results were statistically significant at less than 1% significance level.

RECOMENDETIONS

The results indicate that land resource management activities have a profound effect on household income improvement. Hence, such activities need to be encouraged and scaled up to other areas and involve more households. Based on the findings of this study the following general recommendations are given.

- Households' ownership of TLU significantly affected household's participation decision. As the household head had more TLU, there is a possibility of participating in SLM activities. So, government intervention in these regards; enabling farmers to have live stalk based on the agro-ecological variability and farmers experiences as well as accessing animal health facilities.
- Households' ownership of more hectares of farmland significantly affected household's participation decisions. As the household head had more farmland, there is a possibility of participating in SLM activities. Working on land tenure security and ways of having additional farm land of the household through different farm land transferring systems is essential because if the farmers have less farmland, there is a need for alternative livelihood strategies other than farming and less attention to devote on land resource management activities.
- Households' membership of watershed users' association significantly affected household's participation decision. As the household head had been membership of the watershed user's association, there is a possibility of participating in SLM activities. the agricultural sectors started farmers to be a member of watershed users association and it had legal grounds in Amhara region, but the implication of those legal instruments had still in question, so promoting these activity and members to be members WUA would positively influence farmers decision to participate in their land management activities. Finally participating

in SLM activities had positive impacts on households' income; but as per this research paper the counterfactual non participants would have to more income than participants if they had been participated; so, the government intervention should have inclusive policy to the marginalized and less extension contacted farmers to avail all farmers livelihood in a better manner.

REFERENCES

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