Article

Determinants of soil and water conservation practices choice in Dale Sadi District, South-Western Ethiopia

Habtamu Rufe Gurmu[1], **Gebre Gidey Weldeabzgi**[2]

[1]Department of Agricultural Economics, Dambi Dollo University, Ethiopia

[2]Department of Natural Resource Management, Dambi Dollo University, Ethiopia

E-mail: gebregidey09@gmail.com

Received 25 November 2022; Accepted 31 December 2022; Published online 20 January 2023; Published 1 March 2023

Abstract

The study aimed to examine choice of farmer's to promote SWC (Soil and Water Conservation) activities, assess their choice on soil and water conservation activities and examine the determinant factors of choice. Structured survey questionnaire, field observation and group discussion were used to obtain primary information and secondary data gathered to supplement primary data. The result finding shows that majority of sample household participated in SWC practice and majority of respondents understood as soil erosion might be controlled with practice of such soil and water conservation activities. The survey result revealed that about 66%, 37% and 49.3% of the farmers have chosen improved structures; namely stone bund, soil bund and biological conservation practices respectively. Multivariate probit model was applied to analyze determinant of factors affecting farmer's choice to SWC structures. Multivariate probit model result demonstrated that level of education, extension contact, land holding size, farm experience, land ownership, land slope, area cultivated and off-farm activity variables were significantly affecting choice. This implies that the requirement of enhancing continuous training for farmers on area and identifying conservations type and relationship with appropriate type of SWC practice could be focus on production capacity, type of cultivation and off-farm income activities to maintain soil water conservation.

Keywords determinants; conservation practices; farmer's choice; land degradation; multivariate probit; Dale Sedi.

Proceedings of the International Academy of Ecology and Environmental Sciences
ISSN 2220-8860
URL: http://www.iaees.org/publications/journals/piaees/online-version.asp
RSS: http://www.iaees.org/publications/journals/piaees/rss.xml
E-mail: piaees@iaees.org
Editor-in-Chief: WenJun Zhang
Publisher: International Academy of Ecology and Environmental Sciences

1 Introduction

Ethiopia economy is mainly based on rain-fed agriculture and its main source of food of the country (CSA, 2016). Therefore, progressive soil erosion completely threatens people's livelihoods; especially in drought prone highland parts of the country. Small holders are still poor and food insecurity is a great problem of not giving attention to SWC practice. Soil in the highlands is now mostly eroded to the extent, which is not economically productive again in the expected future. The capacity of the farming communities to sustain

production is under serious pressure (Olana, 2014). Among developing countries; Ethiopia has heavily relied on its environmental and agricultural base for the past decades. According to Gebremariam (2012), Ethiopia for the for past three decade fail in food insecurity because of large-scale deforestation and soil erosion from essence of improper farming practices. This resulted in a hindering production of agricultural commodity, Reduction of water and hydrological conditions which resulted to poverty and food insecurity in Ethiopia.

Land degradation problem is revealed mainly in the form of soil erosion, through loss of soil fertility & crops productivity reduction. Productive soil loss and fertility depletion is a major problem in Ethiopia due to its negative impacts on food security, animal and crop production, natural resource conservation and productivity (Laekemariam et al., 2016; Erkossa et al., 2018). Major cause of this problem might be improper land resources use and rapid population growth which accelerate soil fertility problem (Laekemariam et al., 2016). The wellbeing future generations depends on the fertility of soil. Human activities fasten soil degradation that needs immediate solution to sustain productivity of cropland and livestock production. Population around rural area those their life directly depend on soil resource was accelerated from time to time & greater food product was needed to continue their life. However, the size of the land that devoted to this all population is decreasing and the productiveness of the land decreasing too and this forced the rural population to use intensively thereby increase mineral depletion of soil (Tekalign, 2011). In Ethiopia, it is evident that agricultural sector is the main economic source. However, this agriculture is known by under potential that is recommended per hectare due to severe soil erosion. By identifying land and soil degradation as the most important environmental problem that leads to socio-economic deprivation, the Ethiopian government has made several interventions after the famines and droughts of 1973/74. Yet, the realizations have gotten a little success. The country still loses great amount of fertile top soil and the threat of soil degradation is increasing at alarm rate (Gebre and Weldemariam, 2013; Tesfaye et al., 2014).

Land degradation is a serious problem in Dale Sedi district Kellem Wolega Zone of Oromia Regional State. Despite the introduction of various soil & SWC practices in the area, about 2634 ha of farm lands are more damaged annually which eventually led to low production and poor living condition of the smallholders (Sugiyama et al., 2006). This study is designed to answer question concerning what were the SWC practice available & enhance to answer what are the determinants of SWC practice choice in the study area. Moreover, it is designated to assess factors affecting the choice and uptake of the practices in the study area. Apart from contributing to the this literature on the choice of SWC practices, finding of the study can serve as an input for generating and disseminating demand driven soil and water conservation practices which considers the prevailing environmental and socioeconomic situation, ultimately contributing to easy adoption and utilization of the conservation technology. Therefore, strategy suggestions drawn from some of the above empirical works may not agree in designing area exact policies to be well-matched with its socio economic as well as agro-ecologic conditions and the results of some studies may not allow making relative analysis of farmers' competence across Kebeles. Thus, this study expected to fill this information and knowledge gaps by adding recent evidence concerning with choice of soil with soil water protection practices in specific study area.

2 Study Area and Methodology

2.1 Study site

Dale Sedi district is found in KellemWellega zone, and located between $35^{0}06^{'}34.5^{"}$E and $35^{0}11^{'}15^{"}$ E longitudes and $8^{0}43'35''$N and $9^{0}07'15^{''}$N latitudes. It is located 532 km away from Addis Ababa, the capital city of Ethiopia (Fig. 2). It has a total area of 68419 ha with 27 rural and 3 urban kebeles totally 30 kebeles. The soil types in the area were black (43%), Red (37%) and Brown (mixed) (25%). The district also characterized mixed farming system which was crop production & livestock rising. The total land of woreda is about 69418

ha. Soil resource in Dale Sedi district has different soil depth and texture, the steep slope mountains have very shallow depth and sandy texture, semi mountains /hills/ have better depth and fine particles of the soils easy for erosion, moderate slopes have moderate depth soils with clay and loam texture and the remain flat land has a good or best soil depth and black clay soil (ANRODSD, 2020).

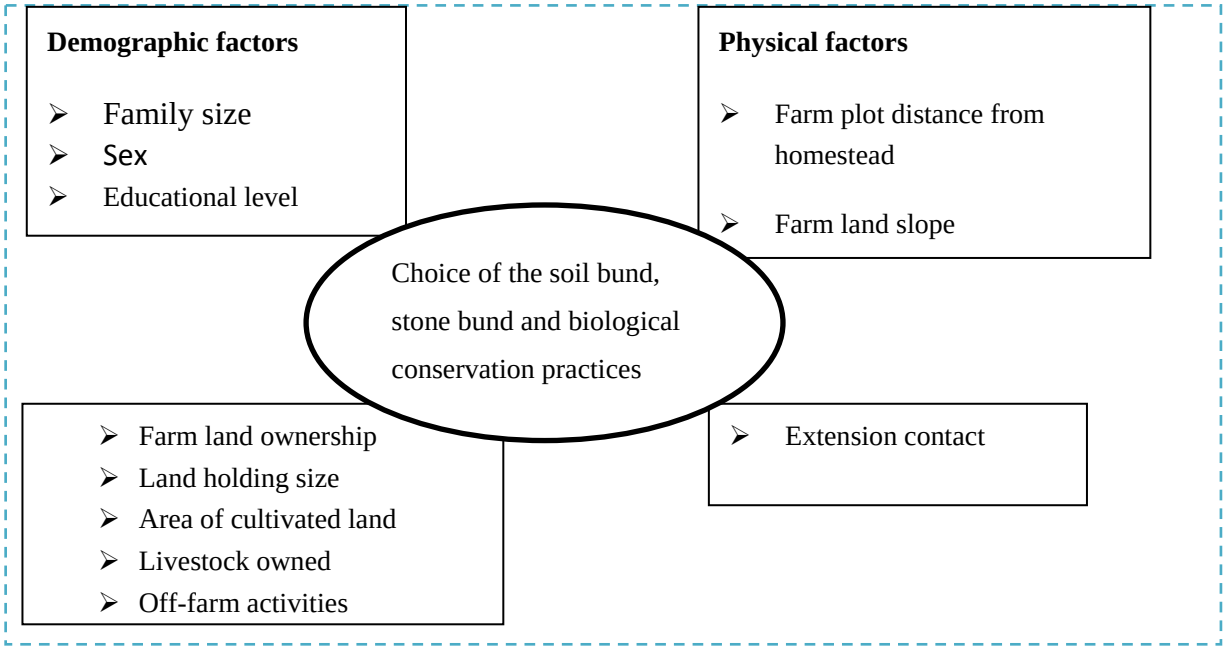

Fig. 1 Conceptual framework**.**

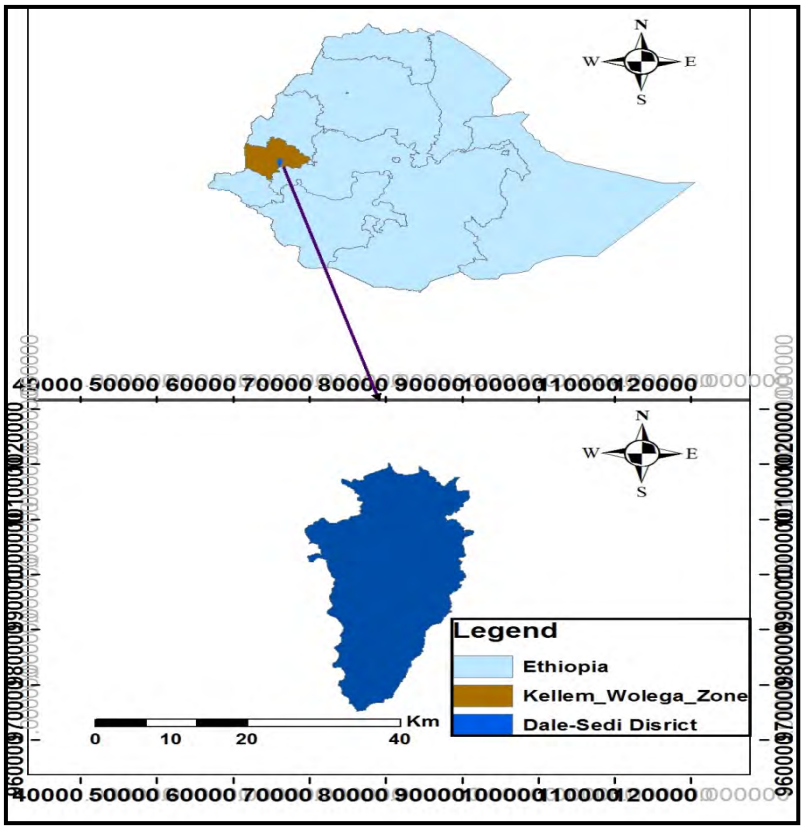

Fig. 2 Map of the study area.

2.2 Types and sources of data

The research is accomplished using primary and secondary data types. Primary data which was necessary to achieve the designed objectives were obtained from sample households through semi-structured interview and key informants interview. Secondary data were collected from articles, journals, scientific reports, Zonal and district annual reports which were relevant to the study.

2.3 Sampling techniques

Sampling techniques used for this study was two stage sampling technique. At 1st stage, to identify sample kebeles a purposive sampling technique was used. From the total of 27 rural kebeles, three kebeles (Lalo Kera, Arere Gebi and Cammo) were selected purposively by considering topography, severity of soil erosion problem, and agro-ecology. At the 2nd stage, 160 sample households were selected using simple random sampling technique based on probability proportional to the size of sample household head. Sample size determination was made by using formula provided by Yamane (1967):

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

where n = sample households head, N = total farmers in the study area and e = accepted error term,

$$n = \frac{1270}{1+1270\ (0.08)^2}\ 1270/7.9 = 160$$

where N = 1270 and e = 5%.

The above formula gives 160 respondents were randomly selected for this study. Proportionate to sampling size was employed to select 160 from three selected Kebeles.

$$ni = \frac{Ni*n}{N} \quad (2)$$

where, ni = number of the household head selected from the i^{th} kebele, Ni = summation of farmers in participate in SWC practices the i^{th} kebele, n = sample size, N = the total farmers participating on SWC practices in three selected Kebeles.

Table 1 Sample household in selected Kebeles.

Kebeles	Total population			Desired sample size			% of proportion
	Male	female	Total	Male	Female	Total	**SS**
Lalo Kera	310	22	332	40	4	44	27.5
Arere Gabi	420	40	460	50	6	56	35
Cammo	428	50	478	52	8	60	37.5
Total	**1158**	**112**	**1270**	**142**	**18**	**160**	

2.4 Method of data analysis

To address the objective of this study, both descriptive statistics and econometrics methods of the data analysis were employed. Descriptive statistics such as mean, minimum, maximum, percentages and frequencies were applied to describe characteristics of household regarding soil and water conservation practice in the study area. Standard deviation- was used to measure the amount by which every value within a data set varies from the mean.

The most popular econometric analysis used for such problem is the multivariate probit model which has been widely used in applied work in identifying determinants of soil and water conservation practice; different econometric models were used. The determinants of choice decision of SWC were analyzed using multivariate probit model (Cappellari and Jenkins, 2006).

Before operating econometrics model, all the hypothesized explanatory variables were checked for the existence of multicollinearity problem, using two measures approach.

$$\mathrm{VIF}\ (X_i) = \frac{1}{1-R^2}$$

VIF can be calculated as

$$CC = \sqrt{\frac{x^2}{n+x^2}}$$

Similarly, if CC is greater than 75% there is multicollinearity problem. CC is contingency coefficient, x^2=chi^2 value and n = total sample size (Maddala, 1992).

2.5 Hypothesis and definition of variables

Choices of soil and water conservation practices (CSWCP): it is categorical dependent variables that were measured by the probability of farmers' choice either of the alternatives of soil and water conservation practices. It was represented in the model as Y_1 for those farmers choose biological conservation practices, Y_2 for those farmers choose soil bund and Y_3 for those farmers choose stone bund (Table 2).

Table 2 Summary of variables hypothesis.

List of Variables	Values	Category	Expected sign	Supportive studies
Dependent Variables				
Biological	Y1=biological conservation	Categorical		
soil bund	Y_2=soil bund	Categorical		
stone bund	Y3=stone bund	Categorical		
Independent variables				
Sex	1, if male; 0, otherwise	Dummy	+/_	Kifle et al., 2017
Education	0=illiterate; grade1, 2...	Continuo	+	Habtamu and Krishna, 2021
Livestock owned	Measured in number	Continuo	+	Habtamu and Krishna, 2021
Family size	number of family size	Contin	+	Habtamu and Krishna, 2021
Area of cultivated land	Measured in hectare	Contin	+	Amsalu and Graaff, 2006
Off-farm activities	1 if participate, and 0, otherwise	Dummy	+/_	Bezabih et al., 2013
Landholding size	Landholding, hectares	Contin	_	Asfewu et al., 2019
Farmland slope	1, if flat; 0, otherwise	Dummy	+	Gebremedhin, et al., 2003
Farm plot distance	Measured in minute	Contin	_	Chala and Chalchisa 2017
Farm experience	Measured in years	Contin	+/_	Habtamu and Krishna, 2021
Extension contact	Contact frequently, weeks	Contin	+	Shiferaw and Holden, 1998
Land ownership type	1, if own land; 0, otherwise	Dummy	+	

3 Results and Discussion

3.1 Descriptive statistical results

This section briefly summarizes the type of various soil and conservation practices used in the area and the demographic characteristics of sample respondents.

3.1.1 Type of soil and water conservation practices

The study result pointed out that there are about three main categories of SWC currently used by actors. These are biological conservation, soil bund and stone bund. The result in table 3 illustrates that stone bund is largely preferred and used by the majority of the respondents (66%) compared with soil bund and biological conservation. The fact that, stone bund is more important to reduce run off water, not break easily and stay long period of time than both biological and soil bund types of SWC practice.. Therefore, stone bund is more appropriate type of SWC practice to reduce soil erosion as a result of soil degradation.

Generally, biological conservation is very important to reduce soil erosion. But, according to the study area it occurs in summer season. So, in summer season farmers may not focus this practices, instead they participate on sowing seed. Because of this, less than half percent of sampled household (49.3%) were selected biological conservation practice. Stone bunds were found in very large areas where stone is abundant. Greater than half percent of sampled household (66%) were selected stone bund of soil and water conservation practice. Soil bunds were the 3rddominant & widely practiced SWC technique next to biological and stone bund in the area. 37% of sampled household were selected soil bund practice.

Table 3 Types and usage of soil conservation practices in the area.

Types of SWC	Number of sample	Percent (%)
Biological conservation	72	49.3
Soil bund	54	37.0
Stone bund	96	66

3.1.2 Demographic characteristics of sample households

As statistical results shows that, about 11.5% of the sample households were female headed and the rest 88.5% were male. It was understood that female headed households in rural areas in Ethiopia face more challenges in participating on soil and water conservation practices when compared with their male headed counterparts. This is partly due to cultural barriers and their busy schedules as they are engaged in domestic, reproductive and community roles. Additionally, education can be used as measurement to improve the quality of labor for resource management skill. The average years of schooling in the study area was 1.5, with a minimum of 0 year (illiterate) and maximum of 12 year of schooling (Table 4). Farm experience can captured by years of farming farmers spent in soil and water conservation practices or accumulated through years of practice. The more experienced the farmer is the more participating on choice of SWC practices he/she might be. From the survey result, the mean, minimum and maximum on soil and water conservation practice experience of the study area was 11.5, 4 and 25 years respectively and shows that, farmers in this area having a good experience regard to soil and water conservation practices.

Table 4 Demographic characteristics of the sampled households.

Variable Description	Observed	Mean	Std. Dev.	Min	Max
Sex	160	0.84	0.36	0	1
Educational status	160	1.49	1.96	0	12
Family size	160	3.32	1.29	0	12
Farm experience	160	11.5	4.66	4	18

3.1.3 Institution and physical characteristics

Extension work focuses on the provision of general advisory services on choice of such as biological conservation, soil bund and stone bund. Development agents have been giving extension services in their respective field of specializations. They are required to advice and follow up their farmer's field. Hence, the survey result showed that frequency of extension contact in 2019/20 at season of SWC year was on average about 1.80 with the maximum contact of like 6 times and minimum 0 times per year (Table 5). Distance is the time span required to reach the field of SWC practices from home of the farmer and is essential variable in explaining the capacity to apply SWC. The survey result showed that distance from farm plot in man walking minute was on average 29.37 with the maximum 58 minutes and minimum 10 minutes. The slope of a farm land was the shapes of land that farmers hold. As the slope of the plot increase the distance between two consecutive conservation structures would decrease and this creates difficulties to undertake conservation practice. The survey result showed that the slope of farm plot was average 0.67 with the maximum 1 and minimum 0 (Table 5).

Table 5 Descriptive statistics of institution and physical variables

Variable description	Observed	Mean	Std. Dev.	Min	Max
Extension Contact	160	1.808	1.420	0	6
Farm plot distance from homestead	160	29.376	13.353	10	58
Farmland slope	160	0.671	0.471	0	1

3.1.4 Socioeconomic characteristics of the sampled household

In the study area mixed farming system is common and livestock has overbearing role to farmer's food security and income. The type of livestock kept by sample farmers includes cow, oxen, bull, horse, mule, donkey, calf, goat, sheep, heifer and chicken. Among others, oxen power is the major input in conservation practices as a source of draft power. An average total livestock holding in the study area was 19.89 TLU per household. Descriptive statistics analysis shows that an average landholding size of the sample was 2.720 ha. The minimum and maximum landholding sizes were 0.3 ha and 5 ha respectively. In the study area farmers who have more land size were less participated on soil and water conservation practice actively when compared with farmers who have less land size (Table 6). The average cultivated land of households was about 1.78 ha, the standard deviation of this variable was 0.59 ha and also minimum and maximum area cultivated by this household head was 0.3 & 3.5 hectare.

The average of off-farm activities of respondent was 0.16 and also the standard deviation of household was 0.36 as well as minimum and maximum 0 and 1.

The information obtained from focus group discussion tells that, soil water conservation practices was used to improve soil fertility of their farmland, increased water holding ability of the soil, reduce runoff and erosion and also increased land productivity. In the study area responsive SWC practice were hindered by of feed plants, agro-forestry and fruit production in the garden. The ideas of focus group discussion indicated the positive effects of this practice on common lands used for grazing which improved forage biomass quantity and increased rates of water filtration. As the information from FGD there are some sources of soil erosion that decreases soil fertility and productivity; Such as overgrazing, strong rainfall, and no construction of appropriate SWC structure on farmland are some causes of soil erosion. Among those causes rainfall is more damage the farmland and as a result decreases soil fertility and productivity of farmers. As the information

from FGD, improved soil and water conservation practices like biological conservation, soil bund, stone bund and others are very increased their farmland fertility and productivity from declared as government strategy.

Table 6 Socio-economic characteristics of the sampled households.

Variable	Observed	Mean	Std. Dev.	Min	Max
Land holding size	160	2.72	0.933	0.3	5
Farmland ownership	160	0.678	0.468	0	1
Area of cultivated land	160	1.783	0.597	0.3	3.5
Off-farm activities	160	0.157	0.365	0	1

3.2 Econometrics model results

The choice of soil and water conservation activities which was available to the sampled household's includes biological conservation practices, such as stone bund; cut off drain and soil bund types. The expected multivariate interdependence of choice of particular practice of biological conservation practices, soil bund, and stone bund were accounted by employing the multivariate probit model (Table 7).

3.2.1 Sex of the household head (SEX)

The result model analysis indicated that male smallholder farmer was more participate than female smallholder farmer on both types of soil and water conservation on average by 0.52 & 0.53. The fact that male headed households are more likely to use stone and soil bund compared to the female headed ones can be attributed to factors related with labor, access to resources and information compared to female headed households.

3.2.2 Educational level of household (EDUC)

The result of the study implies that increase in education status by one class resulted to increase the choice of SWC practice that is biological conservation by 0.27, higher level of education is directly with higher productivity and conservation practice (Table 7).

3.2.3 Frequency of extension contact (EXTCON)

The probability to choose soil and stone bund were influenced by frequency of extension contact positively at 1% and 5% probability level. Implies that household regularly contact with DA's could improve knowledge and skill resource protection thus increase their soil fertility and productivity and also increase the probability to choose soil bund as well as stone bund types of practice. The results of model analysis indicated that, an increase in frequency of extension contact by one increases the probability of choosing soil & stone bund system of conservation by 0.31 and 0.20 probability levels, respectively. This implies that more frequency of extension contact to household increases the choosing soil and stone bund of soil and water conservation practices than those of less contact (Table 7).

3.2.4 Land holding Size (LAHS)

The effect of size of land was negative and significant on the choice of SWC which were biological conservation practices and stone bund. The result of the study indicate that increase in size of land by one hectare leads to decrease choice of biological conservation and stone bund by 0.45 and 0.48 respectively.

3.2.5 Farm experience (FAEXP)

Experience significantly and positively affected stone bund of the sampled households at 5% level of significance, which is in line with the hypothesis made. The possible reason is that having more experience and knowledge on management of natural resources would increase the likelihood of stone bund by smallholder farmers in agriculture. In this specific area, farmers' experience in soil and water conservation practices plays a great role in choice of stone bund of SWC practices in order to increase production. Moreover,

the result shows that, a one year increase of experience in soil and water conservation practices increase the probability of a farmers being choosing stone bund by 0.05 (Table 7).

3.2.6 Farmland ownership (FLOSH)

Farmland ownership of influence the likelihood of stone bund SWC practice at 5% probability level.

3.2.7 Area of cultivated land (ACULA)

Among the economic factors, size cultivated land influence to the choice of soil bund and stone bund positively and significantly by 5% and 1% significance level respectively (table 7). This might be as result of large farms land required for biological and stone bund while on farmers having small land used for crop production only.

3.2.8 Off-farm activities (OFFAc)

The result of multivariate probit model show that off-farm activities had a negatively and significantly effect at 5%. Therefore, an increase the off-farm activities of household one unit decrease the choice of both types of SWC practice those were soil bund and stone bund conservation practice by 0.89 and 0.73.However, off-farm activities could be positively and significantly determined biological conservation practices at 10% probability level. The survey result showed that, an increase the off-farm activities of household increase biological soil and water conservation practices by 0.68. Implies that it help smallholder farmers a source of income and might encourage investment in farming and other conservation practices (Table 7).

Table 7 Multivariate Probit result for choice of soil and water conservation practices.

Variables	**Biological Conservation**		**Soil Bund**		**Stone Bund**	
	Coffie.	Std. Err.	Coffi.	Std. Err.	Coffi.	Std. Err.
Sex	-0.921**	0.369	0.517*	0.296	0.531*	0.304
Educational level	0.273***	0.077	-0.133**	0.066	-0.152**	0.065
Family Size	-0.106	0.120	0.085	0.094	0.086	0.096
Extension Contact	0.172	0.109	0.315***	0.101	0.204**	0.100
Land Holding Size	-0.455*	0.266	-0.378	0.272	-0.483*	0.283
Farm Experience	-0.078**	0.030	0.029	0.028	0.054**	0.027
Farmland ownership	-0.113	0.276	0.164	0.251	0.542**	0.257
Distance from Home	-0.012	0.008	0.003	0.007	-0.002	0.008
Land Slope	-0.108	0.263	0.440*	0.231	-0.133	0.237
Area Cultivated	0.847**	0.411	0.238	0.395	0.676*	0.388
Livestock ownership	0.003	0.070	-0.015	0.069	-0.057	0.067
Off-farm activity	0.679*	0.347	-0.889**	0.356	-0.726**	0.298
_cons	1.474*	0.776	-1.512**	0.693	-0.780	0.685
ρ_{21}	1					
ρ31	-0.0746		1			
ρ32	-0.1254**		-0.1347**		1	
Predict probability to choice	0.49		0.37		0.66	
Joint probability (success)=0.088			Joint probability (failure) = 0.069			

N = 160, Wald chi2 (36) = 97.50, Prob > chi2 = 0.0000, Likelihood = -233.41, $\rho_{21} = \rho_{31} = \rho_{32} = 0$
Draw number=5
where, Y_1, Y_2, Y_3, stands for biological conservation, soil bund and stone bund respectively
and ***, **,*, represents 1%, 5%, and 10% level of significance respectively.

4 Conclusion and Recommendation

4.1 Conclusion

At present, Ethiopia is facing greater natural resource weakening is extremely serious and widespread in Ethiopia including the study area. The study conducted out in Dale Sedi woreda Kellem Wollega Zone Oromia,

Ethiopia. The objectives of the study were to describe the available soil and water conservation Practices undertaken in the study area and to identify determinants of SWC practices choice. The 2nd stage concerned with household head level data collection using a structured questionnaire. The total sample sizes of the survey were 146 households; out of which choosing of 72 household head 49.3% were choice and 74 household head 50.7% are not choice of biological conservation practices, 54 household head 37% were choice and 92 household head 63% were not choice of soil bund and 96 household head 65.8% were choice and 50 household head 34.2% were not choice of stone bund of soil and water conservation practices. From this study stone bund is more appropriate for more than 50% of household head.

Descriptive statistics and multivariate probit model analysis was carried out to interpret data collected. The main choice of SWC structures implemented on individual farmlands are biological conservation, soil bunds, and stone bunds The multivariate probit analysis was used to estimate the effects of the independent variables on the likelihoods sample households to choice soil & water conservation measures. Choice of SWC structures differed in some demographic, socio-economic, physical and institutional variables; such as family size, farm experience, labor availability, farm size, extension contacts, total livestock, educational level, distance between farmland and home, slope, off-farm activities, area cultivated land, sex of household head and land ownership household, which imply the differences in their soil and water conservation practices choice behaviors.

Among twelve independent variable included in the analysis, sex, educational level, farm experience, extension contact, slope, landholding size, area cultivated land, land ownership and off-farm activities are variables which indicate soil erosion as a problem and involvement in statistically significantly related to choice of soil and water conservation practices by the farmers. On the other hand, the coefficients of the variables such as distance of farm land of the household, family size, and the total livestock unit are not significantly related at conservative level of probability. From a total of 12 variables were fitted in the multivariate probit model. Among these, sex, educational level, farm experience, extension contact, slope, landholding size, area cultivated land, land ownership and off-farm activities are variables which indicate soil erosion as a problem and involvement in statistically significantly related to choice the conservation practices by the farmers. However, distance of farm land of the household, family size, and the total livestock unit are not significantly related at conservative level of probability.

4.2 Recommendation

- To promote SWC practices, concerning body should enhance smallholder to participate in farmer organizations so that they could divide farming information.
- Additionally result of the study recommends that, actors/farmers should also be linked conveniently with extension worker and extension worker should enhance farmer to actively participate in each type of SWC practice to manage removal resource.
- Concurrently, the findings result recommends that since off-farm income provides an alternative means of financing farm operations. Therefor concerning body should engage smallholder farmers in off-farm income generating efforts.
- Finally, Government and NGO should promote smallholder farmers to incorporate SWC practices to have great effect on food security status.

Acknowledgment

The authors would like to thank the farmers in the study area for their interesting support in the study season.

References

Amsalu A, de Graaff J. 2006. Farmers' views of soil erosion problems and their conservation knowledge at Beressa watershed, central highlands of Ethiopia. Agriculture and Human Values, 23(1): 99-108

ANRODSD (Agriculture and Natural Resource Office of Dale Sedi District), 2020. Dale Sedi Agricultural office Annual Report. Ethiopia

Asfaw D, Workineh G. 2019. Quantitative analysis of morphometry on Ribb and Gumara watersheds: Implications for soil and water conservation. International Soil and Water Conservation Research, 7(2): 150-157

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(3): 437-451

Bezabih M, Beyene AD, Gebreegziabher Z, Borga L. 2013. Social Capital, Climate Change and Soil Conservation Investment: Panel Data Evidence From the Highlands of Ethiopia (Vol. 135). Grantham Research Institute on Climate Change and the Environment, Ethiopia

Cappellari L, Jenkins S. 2006. MVProbit: Stata module to calculate multivariate probit regression using simulated maximum likelihood. Statistical Software Components, Boston College Department of Economics, USA

CSA (Central Statistics Authority). 2016. Agricultural sample survey 1999/2000. Report on area and production for major crops (private peasant holdings, main season). Statistical Bulletin 1. Addis Ababa, Ethiopia

Erkossa T, Williams TO, Laekemariam F. 2018. Integrated soil, water and agronomic management effects on crop productivity and selected soil properties in Western Ethiopia. International Soil and Water Conservation Research, 6(4): 305-316

Ervin CA, Ervin DE. 1982. Factors affecting the use of soil conservation practices: hypotheses, evidence, and policy implications. Land Economics, 58(3): 277-292

Gebre T, Weldemariam D. 2013. Farmers' perceptions' and participation on Mechanical soil and water conservation techniques in Kembata Tembaro Zone: the Case of Kachabirra Woreda, Ethiopia. International Journal of Advanced Structures and Geotechnical Engineering, 2(04): 2319-5347

Gebremariam GG, Edriss AK. 2012. Valuation of soil conservation practices in Adwa Woreda, Ethiopia: A contingent valuation study. Journal of Economics and Sustainable Development, 3(13): 97-107

Gurmu, H.R. (2020). Impact of foreign aid on economic development: A review. International Journal of Economics & Business, 7(1): 43-48

Habtamu RG, Naidu K. 2021. Determinants of decision to use herbicides by smallholder farmers: The case of Dale Sadi District Kelem Wolega Zone, Oromia, Ethiopia. Journal of Economics and Sustainable Development, 12(13): 5-11

Kifle E, Mateos X, de Aldana JRV, Ródenas A, Loiko P, Choi SY, et al. 2017. Femtosecond-laser-written Tm: KLu (WO 4) 2 waveguide lasers. Optics Letters, 42(6): 1169-1172

Laekemariam F, Kibret K, Mamo T Karltun E, Gebrekidan H. 2016. Physiographic characteristics of agricultural lands and farmers' soil fertility management practices in Wolaita zone, Southern Ethiopia. Environmental Systems Research, 5(1): 24.

Maddala GS. 1992. Estimation and specification analysis of models of dividend behavior based on censored panel data. In: Panel Data Analysis. 111-124, Physica-Verlag, HD

Olana H. 2014. Challenges of Soil and Water Conservation Practices and Measure to be Undertaken the Case of Wuchale District North Shewa Zone, Oromia Regional State, Ethiopia. Doctoral dissertation, Addis Ababa University, Ethiopia

Shiferaw, Holden, 1998. Resource degradation and adoption of land conservation technologies in the Ethiopia highland: A case study in Andittid, north Shewa. Agricultural Economics, 18: 233-247

Sugiyama M, Dejene FB, Kinoshita A, Fukaya M, Maru Y, Nakagawa T, Chichibu SF. 2006. The use of diethyl selenide as a less-hazardous source in CuInGaSe2 photoabsorbing alloy formation by selenization of metal precursors premixed with Se. Journal of Crystal Growth, 294(2): 214-217

Tesfaye A, Deneke TT, Selassie YG. 2014. Determinants of maintenance decision of introduced soil and water conservation practices in Fagita Lekoma District, North West Highlands of Ethiopia. Ethiopian Journal of Applied Science and Technology, 5(1): 1-17

Wagayehu B, 2003. Economics of soil and water conservation: Theory and empirical application to subsistence farming in the eastern Ethiopian highlands. Doctoral thesis, Swedish University of Agricultural Sciences, Uppsala, Sweden

Yamane T. 1967. Statistics: An Introductory Analysis (2nd edn). Harper and Row, New York, USA

Yitayal A. 2004. Determinants of use of soil conservation measures by small holder farmers. Gimma Zone, Dedo District. 65-82, MSc. Thesis Presented to the School of Graduate Studies of Alemaya University, Ethiopia