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Impact of Soil and Water Conservation on Household Income in West Arsi Zone of Oromia

Beriso Bati Bukul
Department of Agricultural Economics, Adami Tulu Agricultural Research Centre,
Adami Tulu, Ethiopia

Abstract
Land degradation due to soil erosion and nutrient depletion is one of the main problems constraining the development of the agricultural sector in Ethiopia. As part of intervention activities number of soil and water conservation (SWC) practices have been promoted to smallholder farmers living in highly degraded and drought prone areas of the country. This study was conducted to assess the impact of SWC intervention on the livelihood of smallholder farm households in terms household income and productivity. To meet this objective primary data was gathered from 150 sample responds (67 SWC program participants and 83 non-participants). Descriptive and inferential statistics and propensity score matching (PSM) models were used to address the stated objectives. Results of the descriptive statistics showed that before matching there was statistically significant difference between program participants and their counterfactual households in terms of sex, education and farm experience generally in favor of non-program participants whereas access to market information and amount of land allocated for production in favor of program participant in the zone. The analysis of mean difference in outcome variables before matching result indicated that the mean total crop yield for SWC practiced respondent households is higher (22.102quintal per hectare per household) than SWC non-practiced respondent households (17.26quintal per hectare per household) with mean total crop yield difference equivalent to 4.842 quintal per hectare per household in the zone. In the mean-time, even though, the results of the PSM model revealed that SWC intervention did not result in significant difference between program participant and non-participant households in terms of maize productivity and gross crop income total annual crop income of households who participated in SWC program was 10,838.13 birr whereas its 6075.48 birr for non-participant farmers accounting 4762.65birr difference suggesting that on average participant households earned 43.9 percent more crop value per hectare than the control group. Logistic regression model was employed to estimate propensity scores for matching SWC program households with their counterfactuals. Except sex of the household, Market information, amount of land cultivated, Education and farm experience influenced the probability of HH participation in SWC positively and significantly at 10% expect land cultivated at 5% level. The implication could be that farm household participation was more guided by demographic than economics factors (defined by farm size and herd size). Nominal results of analysis of treatment effects indicate that there was a sign of positive impact on both of the variables considered due to SWC program. However, the changes in crop productivity and gross household income could not be statistically justified as there was no statistically significant difference between the two groups in terms of these variables. The possible reason could be that SWC programs are not short-term nature and impacts are to be realized gradually with increased adoption and intensification of activities. Finally it was to be noted that there were positive trends which all together should guide SWC policy makers to identify important factors influencing the contribution of such a program and reconsider the design and implementation of the interventions.
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1. Introduction

The Ethiopian economy is primarily agricultural. In any single year, agricultural production makes up more than 40 percent of the GDP. Much of the foreign currency earnings are derived from it and some 85 percent of the country's population derives their livelihood directly from the sector. Smallholder farmers operating under entirely rain-fed condition dominate the sector. Smallholders account for 95 percent of the total area under crop cultivation. And they contribute more than 96 percent of the total agricultural output (COHEN and ISAKSSON, 1988).

Climate change is already taking place, thus past and present changes help indicate possible future changes. Over the last decades, the temperature in Ethiopia increased at about 0.2° C per decade. Precipitation, on the other hand, remained fairly stable over the last 50 years when averaged over the country. However, the spatial and temporal variability of precipitation is high thus large-scale trends do not necessarily reflect local conditions. Since then many public organizations and NGOs have been involved in addressing the widespread problem of land degradation. The conservation measures were in most of the cases physical structures namely stone or soil bunds. Hundreds and thousands of kilometers of fanya juu and normal bunds were constructed on crop lands.

However, reports indicated that these conservation structures have not been adopted and sustainably used by the farmers (Fisum, et al, 2002; Betru, 2002; Yeraswork, 2000).Farmers that seemed to be adopters at the presence of incentives and forced to behave differently dismantling structures entirely or selectively.

In the central rift valley of Oromia, the conservation works have been carried out through campaign like other areas of the countries. However, the achievements and Impact of natural resource Conservation on Household Economy in West Arsi zone were not clearly known. In addition attempt has been made in the area to determine factors that hinders for low adoption of SWC structures, particularly from cultivated fields (woldeamlak 2003). Due to this limited success of SWC measures farmers are obligated to construct the same structure in the same field every year. These becomes worth for environmental degradation, labor and time losses. The main purpose of this study is to identify the major factors that influence the adoption behavior of SWC measures which help to conserve natural resources sustainability and draw conclusion for future generation of the area.

Therefore, to overcome such problem in the future, this investigation will hopefully provide an empirical explanation and give available information as to which Impact of natural resource Conservation on Household Economy in West Arsi zone.

1.1. Objectives of the Study

- To assess the impacts of the soil and water conservation on yields and farmers' income.
- To assess community participation and gender roles soil and water conservation activities
- To identify constraints and opportunities on SWC practices in the study area

2. Research Methodology

2.1. Description of study area

The study was carried out in purposively selected areas of west Arsi zone of Oromia regional state, In which most of the Zone are mid altitude and highland agro climate and characterized by agro-pastoral farming system. The district was purposefully selected due to the fact that in the area there are large amount of soil erosion problems.

2.2. Sampling procedure

Initially micro water sheds with respect to each sustainable land management and participatory work farmers are listed forming three separate groups within each PA. Then proportional samples will be drawn from each group to make the total sample size.

A two stage random sampling technique will be used to select the sample households in the study area. Both purposive and multi-stage stratified sampling techniques will be used to collect primary data. Considering the objective of the study and representativeness of the sample, out of the three selected districts in the zone, three micro-water shades was selected (upper, middle and lower micro-watersheds).

Two-stage sampling technique was applied to select sample households for this study.

1st stage, SWC technology adopting districts were identified with zone level experts of bureau of agriculture. Then two intervention districts and two counterfactual districts were selected randomly based on similarity with the randomly selected districts in terms of land degradation, cropping system, soil type and topography using ranking method. 2nd stage, a total of 150 (67 SWC program participants and 83 non-participants) households were selected randomly.

2.3. Data types, sources and methods of data collection

Both primary and secondary data collected from selected district will be used. Primary data will be collected from sample households who benefited from watershed through structured questionnaire. Secondary data from concerned line offices such as agricultural office, education offices and from administration office of the district (KII).

The questionnaire covered information on household demographic and farm characteristics, crop and livestock production, household income and ownership of farm inputs. Both male headed and female headed households in the sample PAs was interviewed. A pre-testing of the questionnaire was conducted before actual data collection made. The interviews were conducted by enumerators who trained on the subject matter of the questionnaire.

Primary data was generated through interview of individual farmers who are beneficiaries from the particular program. The information pertaining to adoption and attitude evaluation with respect to each program especially socio-economic variables like labour availability, crops grown and purpose, source of income, level of education, age, land availability and use, and other factors, which are explanatory, are included. Secondary data, basically to fill the information gap and to gain the picture of sustainability of activities with respect to each program so far exercised is used. The sources include periodic reports and interview of agricultural and other line departments and administrative bodies (KII).

Method to collect the data was based on a field pre-tested questionnaire focusing on socio economic characters (age, farming experience, sex and others), agro ecologic and production characters related to sustainable land management of practice from a particular micro-water sheds (upper, middle and lower micro-watershed).

2.4. Methods of data analysis

Both descriptive and econometric analyses was employ to meet the specific objectives of the study. Descriptive and inferential statistics were used to describe sampled households and draw relevant conclusions about them in terms of the deferent demographic, economic and institutional characteristics and the SWC technologies that have been made available to farmers.

A number of econometric methods have been used elsewhere to study impact of programs (Pender and Gebremedhin, 2006) and as each of them had their own limitations there was no superior method. However, the propensity score matching (PSM) has become a popular approach to estimate causal treatment effects and is being increasingly applied in policy program evaluations (Heinrich *et al*., 2010) mainly because it is based on comparable observations which reduces the selection problem when there are two categories of response. This study used PSM to analyze the impact of SWC practices on small holder farmers' livelihood defined by crop productivity and income using pre-intervention cross sectional data.

2.4.1. Estimation of Propensity Score

The PSM framework

Considering the dichotomous nature of the response variable, participation and non-participation in SWC taking 0–1 value, and the simplicity of the model for interpretation of results the logit model (Gujarati and Porter, 2009) was chosen to estimate propensity scores using a composite of pre-intervention characteristics of the sampled households (Rosenbaum and Robin, 1983). In estimating the logit model, the dependent variable was SWC program participation status, which takes the value of 1 if a household participated in the SWC program and 0 otherwise.

The first step in estimating the treatment effect is to estimate the propensity score. To get this propensity scores any standard probability model can be used. As the propensity to participate is unknown, the first task in matching is to estimate this propensity scores. Matching can be performed conditioning on P(X) alone rather than on X, where P(X) Prob (D=1|X) is the probability of participating in the program conditional on X. If outcomes without the intervention are independent of participation given X, then they are also independent of participation given P(X). This reduces a multidimensional matching problem to a single dimensional problem

In this study logit model will be used to estimate propensity scores using a composite of pre- intervention characteristics of the sampled households and matching will be performed using propensity scores of each observation. In estimating the logit model, the dependent variable for participation, which takes the value of 1 if a household, participated in the program and 0 otherwise. It will be mathematically as follows:

$$pi = \frac{e^{zi}}{1+e^{zi}}$$

Where, Pi is the probability of participation,

$$zi = ao + \sum_{i=1}^{n} \text{aixi} \quad + \text{ui}$$

$$1 - \text{Pi} \frac{1}{1+e^{zi}}$$

Where, i = 1, 2, 3, - - -, n

a_0 = intercept

a_i = regression coefficients to be estimated

U_i= a disturbance term

2.4.2. Sustainability measures

The level of sustainability of physical structures, which approximate the efficiency of the activities or the level of acceptance by the farmer towards conservation measures, is seen to have three distinct categories. The categories are (i) extremely lower performance, expressed by observation of less hectares of conserved plots at present than the originally covered by structures (ii) maintaining almost what has been constructed and (iii) those who tried to extend the original structures by adding more structures in to the already sustained. So these all can tell the degree of adoption of physical structures by each farmer categorized under different programs. The above ordered categories lead us to use the ordinal logit model as in Sheferaw, (1998).

The model is represented as:

$Y^*_{i = \beta xi + ui}$

Y* is the dependent variable which expresses the efficiency of activities (EFF),

X_i's represent a vector of independent variables, $\mathbf{u_i}$ is the error term and βi's represent the respective coefficients for the independent variables.

Y* tells the level of use of the conservation structures under each farm plot by the respective farmer which could assume ordinal categories in such a way that, it's

- Value = 0...if.....EFF $\leq \theta$
- Value = 1...if..... θ…. < EFF $\leq$ 1…and
- Value = 2...if.....EFF > 1

The category (θ) is selected and they are to be estimated as each coefficient in such a way that each extreme from them indicates the deviation from the unity ratio of sustainability, which explains the maintenance of what has been already constructed. The probability of each efficiency category is then given by

P (Y=0) = P (Y* ≤ 0) = P (β*xi+u≤0) =F (-β*xi)

P (Y=1) = F (θ -β*xi) - F (-β*xi)

P (Y=2) = 1-F (θ -β*xi) where: F stands for cumulative density function

2.4.3. Overlap and Common Support

Imposing a common support condition ensures that any combination of characteristics observed in the treatment group (most benefited from soil and water conservation) can also be observed among the control group(households haven't any relation with micro-water sheds). It requires deleting all observations out of the overlapping micro-water shades, whose propensity scores are smaller than the minimum and larger than the maximum, of the treatment and control groups respectively.

2.4.4. Conservation index

This dependent variable is introduced to express the proportion of the land, which has conservation structures out of the total holding by each farm household. The difference from the previous sustainability measure is that it does not take in to account the amount of the original structure constructed; rather it purely concerns itself with present condition of the plot. The dependent variable is expressed as

$$\textbf{\textit{CONIND}} = \frac{\textbf{\textit{TA}}-\textbf{\textit{Conserved}}}{\textbf{\textit{TA}}-\textbf{\textit{Cultivated}}} \, X \, \textbf{\textit{100}}$$

Then this conservation indicator is regressed in to a multiple of explanatory variables defined as in the previous model specification in a simple linear form. That is:

CONIND = βi xi+ ui

2.4.5. Estimation Technique

The popular estimation techniques, method of maximum likelihood for the ordinal logit model and, Ordinary Least Square Technique (OLS) for estimation of the multiple regression equation was used.

3. Result and Discussion

3.1. Descriptive Analysis

Results of the descriptive and inferential analyses show that there were statistically significant differences between SWC program households and their counterparts before intervention with regard to demographic and economic characteristics. The groups differ in terms of sex, farming experience, distance of land from SWC, market information and farm size in the zone (Table 1). Therefore, it can be inferred that, compared to their counterfactuals, SWC program participants had relatively better position considering these characteristics before SWC program intervention. There was no statistically significant difference between the two groups in terms of education status, age, family size, and Off/non-farm income. Generally male and literate households dominate in the sampled households.

Regarding farm size of the two groups, analysis result revealed that households who participated in SWC program have mean land holding size of 0.905 hectare per household while households who don't participated in SWC program have 0.737 hectare per household in West Arsi. Farm sizes have positive and significant influence on SWC adoption at 10% significant level. This indicated that households who participated in SWC program have larger farm size than non-practiced households suggesting that households who have larger farm size adopt SWC than non-participant households.

Table1: Demographic and economic characteristics of sample households in W/Arsi zone

Pre-intervention Variables	Total Sample (n=150)		Participant in the program (n=67)		Non-participant in the program (n=83)		χ2/t-value
	Mean	STD	Mean	STD	Mean	STD	
Sex (% female)	19.33	-	9	-	20	-	2.703*
Education (% illiterate)	31	-	16	-	15	-	0.7628
Age household head	39.4	12.41	37.76	12.347	40.72	12.38	1.458
Farming experience	21.13	11.13	19.388	10.03	22.54	11.815	1.737*
Family size	8.0866	4.098	7.627	3.805	8.458	4.306	1.238
Farm size/land cultivated	0.812	0.632	0.905	0.709	0.737	0.555	-1.62*
Off/non-farm income	1348.63	1693.98	1401.32	1752.84	1297.042	1651.23	-0.2985
Distance of land from SWC	1.873	1.203	0.847	0.274	2.699	1.009	14.585***
Market information (%)	94	-	37	-	57	-	2.867*

*, **and *** means significant at 1% 5% and 10% probability levels, respectively and STD: Standard Deviation

3.2. Current state of soil and water conservation in West Arsi Zone

According to Hurni et al. (2016), SWC measures are recommended to be implemented based on agro-ecology and land use type. All SWC measures are classified into physical, agronomic and vegetative type and their implementation is agro-ecological and land use type specific. Thus, based on Hurni et al. (2016) the study watershed could be classified as wet kolla agro-ecology (wet lowland) with its altitude ranges from 500-1000m above sea level (m.a.s.l) and average annual rainfall range of 1600-2100 mm (USAID, 2009).

Different types of physical soil and water conservation measures were introduced to the study area with the objectives of conserving, developing and rehabilitating degraded agricultural lands and increasing food security through increased productivity. The soil and water conservation measures introduced to the area include soil bund, check dam, Area closures, and diversion of water way. Table 2 indicates that most of the SWC program farmers adopted soil bund, and check dam on (n=148) in West Arsi zone, on their farms. Diversion of water way was the least adopted of all technologies availed to the program households in both zones.

Table 2: Length of soil and water conservation structures on farm in meter/number

SWC technologies	West Arsi zone
Soil bund	148
Check dam	148
Diversion of water way	110
Area closures	120

Source: Survey result

3.3. Household income and crop productivity

Table 3 shows the mean difference in outcome variables before matching. Program and non-program households did not have statistically significant difference in terms of all outcome crop variables considered gross crop income and crop productivity (ton/ha) yield except income obtained from wheat and its productivity. However, this descriptive result cannot tell us whether the observed difference is exclusively because of the program; as comparisons are not yet restricted to households who have similar characteristics. Hence, further analyses were performed using propensity score matching techniques to address this issue.

Income source is linked to livelihood strategy; therefore households who derived greater proportion of their income from crop production are more likely to engage in soil and water conservation in order to increase their agricultural production and consequently acquired their required income. Rural communities who pursue agriculture as source of their livelihood are highly probable to implement conservation measures in their farmlands as intensification of agriculture is the survival option and they should work hard to improve crops production.

Above table shows the mean difference in outcome variables before matching. Program and non-program households did not have statistically significant difference in terms of all outcome crop variables considered gross crop income and crop productivity (quintal/ha) yield. The analysis result indicated that the mean total crop yield for SWC practiced respondent households is higher (22.102quintal per hectare per household) than SWC non-practiced respondent households (17.26quintal per hectare per household) with mean total crop yield difference equivalent to 4.842 quintal per hectare per household.

In line with this finding, Abebe (2015) found an improvement in crop yield of adopter households as compared to non-adopter in Adwa and Amba Alagie district in Tigray region. Yenealem (2013) also indicated that there is additional crop production value equal to 1,510.42 birr for adopter households than non-adopter in west Harareghe, Oromia region. Another finding from Hadush (2015) revealed that crop production increase to

0.673ton/ha in smallholder farms who adopted SWC measures in Adwa district, Tigray region. higher crop yields from plots with stone terraces (an average yield increase of 23%). Another study conducted by Tugizimana (2015) in Nyamasheke District, Rwanda has shown that SWC measure has significantly improved a bean yield. According to Menale (2007), there was high positive additional mean crop production value of 412 ETB as a result of SWC measures adoption in low rainfall area of Tigray.

In the meantime total annual crop income of households who participated in SWC program was 10,838.13 birr whereas its 6075.48 birr for non-participant farmers accounting 4762.65 birr difference. **However,** this descriptive result cannot tell us whether the observed difference is exclusively because of the program; as comparisons are not yet restricted to households who have similar characteristics. **Hence,** further analyses were performed using propensity score matching techniques to address this issue. In addition, Yenealem (2013) found that gross annual income of households who implemented SWC measures increase to 4,288.29 ETB than non-adopter households in west Harareghe, Oromia region. However, another study by Yitayal and Adam (2014) in Adama district of Oromia region found that SWC practices resulted in less significant positive impact on gross household income because of short duration of the practices. Moreover, a study conducted by Meaza (2015) in Adwa district, Tigray region indicated that the total average household income increase from 3990ETB to 7313.5ETB after adoption of SWC practices. These are the empirical findings which indicate the financial implication of SWC measures adoption at the household level across the country

Table 3: Comparison of program participants and their counterfactuals in terms of household income and crop productivity

Income from crop	Total sample		Participant-program		Non-participant-program		t-value
	Mean	STD	Mean	STD	Mean	STD	
Gross income from crop	8202.80	2663.40	10838.13	3449.38	6075.48	9437.14	-1.088
Productivity of maize (qt/ha)	19.54	16.465	22.102	20.245	17.26	11.897	-1.505

3.4. Econometric Model Outputs

3.4.1. Estimation of propensity score

The first step taken to evaluate impact of SWC program on crop income and crop productivity was estimation of propensity scores based on the selected covariates. Logistic regression model was employed to estimate propensity scores for matching SWC program households with their counterfactuals. The dependent variable in this model was a dummy variable indicating whether a given household has participated in the SWC program taking a value of 1 or 0 otherwise.

Therefore, before matching, results of logit estimation showed that SWC program participation status has been significantly influenced by five variables (Table 4). Sex of household head, education, farming experience, market information and amount of land cultivated were found to affect the probability of adopting SWC technology significantly. Market information and amount of land cultivated influenced the probability of SWC participation positively and significantly at <10%. On the other hand Sex of household head, education, and farming experience affected participation negatively at <5% significance level. The implication could be that farm household participation was more guided by demographic than economics factors (defined by farm size and herd size).

Estimation of logit model was followed by series of activities involving defining region of common support, matching and testing the balance for matching program and non-program households for isolating causal effects of SWC program.

Table 4: Results of logit estimation household program participation

		Number of observation = 150
		LR chi2(10) = 20.21
		Prob > chi2 =0.0273
Log likelihood	= -93.01221	Pseudo R^2 =0.0980

Variables	Coefficient	Std. Err.	Z	P>|z|
Sex	0.117**	.5094265	-2.19	0.028
Age	.0056	.0271623	0.21	0.837
Education	.0863*	.0473489	-1.82	0.068
Experience	.0519*	.0302296	-1.72	0.086
Family size	-.0584	.0572778	-1.02	0.308
Extension	.2182	.6433275	0.34	0.735
Information	.7397*	.3910169	1.89	0.059
Credit	.1579	.3856474	0.41	0.682
Land amount	.7585**	.3419021	2.22	0.027
Crop revenue	.0014	.0426085	0.03	0.974
_cons	.7372	1.327428	0.56	0.579

***, ** and* means significant at the 1%, 5% and 10% probability level respectively.

3.4.2. Defining region of common support

Identification of common support or overlap condition for program and non-program households was done in order to estimate causal treatment effects (in this case, SWC outcome) since violation of the common support condition is a major source of selection bias (Heckman *et al.,* 1997). We used the estimated propensity scores us to define the common support region and results of data analysis are depicted in Table 4. Our common support region according to Caliendo and Kopeining, (2008) would lie between 0.193 and 0.897.

3.4.3. Matching Program and Non-program Households

Nearest neighbor, Caliper and Kernel matching estimators were used in matching the program and non-program households in the already defined common support region. The final choice of a matching estimator was guided by three criteria; namely, the equal mean test (balancing test), pseudo-$R2$ and matched sample size (Caliendo and Kopeining, 2008). In general, a matching estimator which balances all explanatory variables, bears a low pseudo-R^2 value and also results in large matched sample size is preferable. Therefore, caliper matching with tolerance level of 0.25 was found to be the best matching algorithm for the data we have 140 matched observations.

3.4.4. Testing the Balance of Propensity Score & Covariates

The balancing test involves a test of equality of means of covariates; i.e., observations with the same propensity score must have the same distribution of observable (and unobservable) characteristics independently of the treatment status (Becker and Ichino, 2002). The results on Table 5 below show that SWC program and non-program households had no statistically significant difference in terms of all of the covariates after matching, indicating similarities between the two groups.

Table 5: Propensity score and covariate balance

Variable	Before Matching (N=150)		t-value	After Matching (N=140)		t-value
	Program (N=67)	Non-program (N=83)		Program (N=60)	Non-program (N=80)	
Sex	1.117		-2.19**	-.6878		-2.24**
age	.0056		0.21	.00326		0.20
education	.0863		-1.82*	-.0530		-1.85*
experience	.0519		-1.72*	-.03219		-1.76*
Family size	-.0584		-1.02	-.0360		-1.04
extension	.2182		0.34	.14148		0.36
information	.7397		1.89*	.46051		1.92*
credit	.1579		0.41	.09179		0.39
Land amount	.7585		2.22	.47445		2.34**
Lnincome crop	.0014		0.03**	.000084		0.00
_cons	.7372		0.56	.461088		0.57

Source: Survey result

3.5. Impacts of SWC program

This part indicates whether or not the soil and water conservation program has brought significant changes on the livelihood of the beneficiaries. After controlling for other characteristics, the propensity score matching model using the kernel matching estimator result (band width 0.5) indicates the existence of a positive Additional crop production value premium of birr 4,762.65 per hectare in west Arsi zone. Annual gross income of birr 4,995.57 for program groups compared to non-program groups suggesting that on average participant households earned 43.9 percent and 42.26 percent more crop value per hectare and gross household income than the control groups, respectively. Nominal results of analysis of treatment effects indicate that there was a sign of positive impact on both of the variables considered due to SWC program.

However, the changes in crop productivity and gross household income could not be statistically justified as there was no statistically significant difference between the two groups in terms of these variables. The possible reason could be that SWC programs are not short-term nature and impacts are to be realized gradually with increased adoption and intensification of activities.

The study provides evidence about the contribution of the SWC program in considering crop productivity and household income. Nominal results of analysis of treatment effects indicate that there was a sign of positive impact on majority of the variables considered due to SWC program (Table 6). However, the changes in crop productivity and gross household income could not be statistically justified as there was no statistically significant difference between the two groups in terms of these variables. The possible reason could be that SWC programs are not short-term nature and impacts are to be realized gradually with increased adoption and intensification of activities.

Table 6: ATT for outcome variables of interest

Outcome variable	ATT on Treated	ATT on Control	Difference	S.E.	*t-value*
Gross crop income	8,838.13	4,075.482	4,762.65	4815.218	0.989
Productivity of maize (qt/ha)	20.102	15.26	4.838	2.797	1.730

3.6. Opportunity and Constraints of SWC

❖ **Opportunity for SWC**

- Government focus
- Willingness of people construct dam
- Availability of degraded area and
- Availability of NGOs supports conservation.

❖ **Constraints for SWC**

- Destroy by animals,
- Lack of sustainability in management and
- Lack of punished rule on destroying conserved area

4. Conclusion and Recommendation

This paper examined the impact of soil and water conservation interventions on crop production value per hectare and gross income of smallholder farm households in West Arsi Zone of Oromia Regional State, Ethiopia. This study was conducted to assess the impact of SWC intervention on the livelihood of smallholder farm households in terms household income and productivity. To meet these objectives primary data was collected from 150 sample households, consisting 67 soil and water conservation program and 83 non-program participants sample respondents.

The study empirically demonstrated that soil and water land management program have a significant contribution in increasing crop productivity and hence, increase income to reduce food insecurity of smallholder farmers. These estimated performances of the program also show considerable variability by agro-ecological type of the sampled kebeles. Therefore, it can be concluded that in agriculture dependent country like Ethiopia, soil and water conservation is crucial in improving the livelihoods of the rural farm households. This sends an encouraging signal for program designers, implementers, and funding agents. Thus, to realize the intended outcomes, future development strategies should consider on how to link such interventions with natural resource management based income generating activities that can provide farmers with short term benefits. These estimated performances of the program also show considerable variability by agro ecological type of the sampled kebeles.

Though impact study of a given intervention encompasses the spillover effects on production, income, environment, and on social welfare in general, and soil and water conservation measures have both on-site and off-site effects on society at large. This study limited its scope with the direct effects of the interventions on value of crop production and household income of small holder farmers. Therefore, taking the other livelihood indicators in to consideration is necessary to extend the research work to the other onsite effects and off-site effects of the projects too. In realizing sustainable land management by providing farmers with short-term benefits, the projects linked with natural resources management based income generation at household level. Thus, assessment of major constraints and determinants of such income diversification will have immense contribution to scale up the interventions, and hence it is one potential area for research and development. The collectives and the institutional arrangements under each water shade also require the attention of researchers.

Results of the descriptive statistics showed that before matching there was statistically significant difference between program participants and their counterfactual households in terms of sex, generally in favor of non-program participants whereas access to market information, education, farm experience and amount of land allocated for production in favor of program participant. Even though, the results of the PSM model revealed that SWC intervention did not result in significant difference between program participant and non-participant households in terms of maize crop and household income, the result indicates the existence of a positive impact on maize and households crop income for program groups compared to non-program groups. The possible reason could be that SWC programs are not short-term nature and impacts are to be realized gradually with increased adoption and intensification of activities.

However it was to be noted that there were positive trends which all together should guide SWC policy makers to identify important factors influencing the contribution of such a program and reconsider the design and implementation of the interventions. Therefore, taking the other livelihood indicators in to consideration is necessary to extend the research work to the other onsite effects and off-site effects of the projects too. In realizing sustainable land management by providing farmers with short-term benefits, the projects linked with natural resources management based income generation at household level. Thus, assessment of major constraints and determinants of such income diversification will have immense contribution to scale up the interventions, and hence it is one potential area for research and development.

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