ADOPTION AND IMPACTS OF NATURAL RESOURCE CONSERVATION IN ARSI ZONE, ETHIOPIA

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ABSTRACT

Land degradation in Ethiopia alone accounts for 8% of the global total degradation. The most serious problem concerning country's land resources, however, is the removal of fertile topsoil by water. Population pressure which results to intensive cultivation, overgrazing deforestation and inappropriate land use practices are the most serious cause of soil erosion in Ethiopia which is more severe in the highlands areas where, 85% of the human and 77% of livestock population are living and agriculture is intensive. To reverse the situation the government of Ethiopia designed policy and programs which are holistic and landscape wide approaches. Based on the strategies, different soil and water management programs have been implemented throughout the country and different practices were introduced to farmers as well for more than ten years. The central questions of this research were, whether farmers adopt these soil and water conservation practices; and if yes, do these soil and water conservation interventions have an impact in improving crop production in value per hectare and gross annual income of participating households? If yes, how much is the impact? Based on above objectives, the research was conducted in Arsi zone and data was collected from 202 respondents in representative districts. Both adopters and counterfactual respondents were included. Educational background of households, farming experiences, size of landholding, slop of plot, degree of vulnerability of the districts and extension contact significantly and positively affect adoption probability while land fragmentation was significant and negatively influencing adoption of soil and water conservation (SWC) activity. Though it was not statistically significant, SWC adoption has positive impact on productivity, gross production and income of the household. The average treatment effect on treated (ATT) was 6358.86 ETB of total household income which could be proxy for farm level productivity and 85.35 quintal of total annual farm production.

Keywords: Soil and water conservation, Ethiopia, Adoption, Impact, Propensity score matching

1. BACKGROUND AND JUSTIFICATION

Reduction or losses of biological or economic productivity of land resulting from land use cover change or processes arise from anthropogenic activities, such as soil erosion caused by long-term deterioration of natural vegetation Mundia and Aniya (2006). This phenomenon of the land is becoming one of the most severe global problems of our times Nanpham et al. (2001) and Kertesz (2009)and this phenomenon affects 33% of the land surface; and has direct or indirect consequences for more than 2.5 billion people "Land Degradation Strategy" (2010). Around 40% of world agricultural land is currently seriously degraded and soil erosion accounts for around 80% of this degradation Angima et al. (2003), Kessler and Stroosnijder (2010). In countries where agriculture and other natural resource bases are the main pillar for their economic development, the continuous depletion of resources is becoming a serious hazard Bruutrup and Zimmermann (2009) of which Sub-Saharan African countries are the most affected Berry et al. (2003).

Tekalign (2008) indicated that land degradation in Ethiopia alone accounts for 8% of the global total degradation which is huge compared to our land size in proportion to global land size. The most serious problem concerning country's land resources, however, is the removal of fertile topsoil by water. Osman and Sauerborn (2001) reported that an increase in population and consequent activities such as intensive cultivation, overgrazing by livestock, deforestation and inappropriate land use practices to satisfy its needs are the fundamental factors that exposed the Ethiopian soil to erosion. This is much more severe in the highlands where, 85% of the human and 77% of livestock population are living and agriculture is intensive Gete (2000). As estimates from national level studies indicate, more than 2 million ha of Ethiopia's highlands have been degraded beyond rehabilitation, and an additional 14 million hectares severely degraded, which is reflected in reduction of cereal yield to less than 1.2 tons per hectare in most of the highlands Fao/Wfp (2005). The comparative analysis report of a decade by Environmental Forest Development on the cost of land degradation also indicated that, the net amount of soil eroded in 1995 was 130 million metric tons and this has increased to 182 million metric tons in 2005 and the nutrient loss from lost soil in terms of phosphorus and nitrogen was 1.1 and 1.3 million metric tons, respectively. The monetary value of productivity loss, due to soil loss, also shows 639 and 766 million Birr in 1995 and 2005, respectively Efd (2010).

As a result of this extensive land degradation, which in turn is caused by various intermingled factors, soil productivity has been negatively affected and agricultural production has not been able to meet the basic food requirements of the growing population Hurni et al. (2016). To improve the situation, governments and development agencies have invested substantial resources in promoting soil conservation practices as part of efforts to improve environmental conditions and ensure sustainable and increased agricultural production Minale (2005), Menale et al. (2011).

Studies conducted in different parts of the country indicted that the level of success in SWC activities was low. This low level was explained by factors like poor performance of the technologies themselves, policy and institutional deficiencies at different levels and other socioeconomic factors Lakew et al. (2005), Mitiku et al. (2006), Bekele et al. (2009), Menale et al. (2011). The interventions were primarily technology oriented and top-down with limited participation of the beneficiaries in decision making Berhanu et al. (2009). Such command-and-control type of interventions that have not been linked to the indigenous land conservation knowledge of the farmers as well as their local institutions, reduced the sense of responsibility over the area conserved Lakew et al. (2005). Most policies, programs and projects for sustainable land management were also designed without making a distinction between proximate and underlying causes which in turn forced the technologies to focus narrowly on structural measures to arrest soil erosion only, without fully considering the underlying causes of low soil productivity, socio-economic factors, and the need for tangible benefits to be attractive to poor farmers Berhanu et al. (2009). According to Mitiku et al. (2006), Berhanu et al. (2009) and others, even though many scholars raised different factors affecting the sustainability of conservation measures, the main shortcomings of conservation efforts in previous periods were largely rooted in a lack of understanding of the important interface between resource conservation and agriculture, and of the factors that motivate farmers to invest in sustainable land management over the long run.

In an effort to address these problems, the basic paradigm and approach to land and water conservation has evolved over time Bekele et al. (2009) and the Ethiopian government has changed its land management policy to more holistic and landscape wide approaches that go beyond resource conservation towards improved land husbandry and water management for beneficial conservation Reddy (2005), Kerr et al. (2007). Given this policy, different soil and water management programs have been implemented throughout the country and different practices were introduced to farmers as well. The central issue is thus, whether farmers adopt these soil and water conservation practices; and if yes, do these soil and water conservation interventions have an impact in improving crop production in value per hectare and gross annual income of participating households? If yes, how much is the impact? Policy makers and development practitioners need to know the empirical output of these questions to decide about their future approaches.

With the above-mentioned context of policy endorsed and its objectives this study was carried out in Arsi Zone of Oromia Regional State, Ethiopia where various conservation programs have been executed to improve the livelihoods of most vulnerable households through value adding and natural resources management (NRM)-based income generation at household level. Therefore, this research was initiated with the following objectives to: 1) assess the impacts of the natural resource conservation practices on yields and farmers' income; 2) assess community participation and gender roles in natural resource conservation activities; 3) assess community

perception towards the ongoing natural resource conservation interventions; and 4) identify constraints and opportunities on SWC practices in the study area.

2. RESEARCH METHODOLOGY

2.1 DESCRIPTION OF STUDY AREAS

This study was conducted in five districts of Arsi zone located in south-east region of Oromia in Ethiopia. Arsi zone lies between 6^0 45' N to 8^0 58'N and 38^0 32 E to 40° 50' E. Arsi is bordered on the south by Bale, on the southwest by the West Arsi Zone, on the northwest by East Shewa, and on the east by West Hararghe. All the three traditionally classified agro-ecologies which are highland (dega/beddaa), mid highlands (wainadega/bede-dere) and lowlands (kola/gammojjii) are found in Arsi zone. Given its diversified agro-ecologies which range from lowest point of up to 805masl in Seru district of Wabe gorge to highest point of altitude 4195masl which is found in Kaka mount (BOFED, 2011), the zone has also diversified production system which can be classified into two broad categories as crop-livestock mixed farming and the pastoral/agro-pastoral farming system. However, as it was indicated in A. Tamrat and Ashebir (2019), there are around seven sub-farming systems which are: barley-root crops, wheat-teff, large seeded cereals maize-sorghum, rain fed coffee-khat (Chat)-tree, irrigation, agro-pastoral and peri-urban sub-clustered farming systems.

According to A. Tamrat and Ashebir (2019), the three dominant soil types in Arsi zone are: the Chromic and Pellic Vertisols having characteristics of water holding and heaviness for plowing during rainy seasons due to high clay content that covers about 30% of the zone's soil type; the Cambisols (accounts for 23% of total soil type) dominantly occur on the steep slopes and are often shallow or have many rock outcrops and those developed on gentler slopes, however, have good base saturation and fertility and can be used for agricultural purposes; the third is Luvisols which is good for agriculture with base saturation and weatherable minerals and dominant on the high land parts covering about 13% area of the zone. The rest of the soil types are Lithosols which is another soil type having good base saturation and fertility status and constituting about 6% of total and Fluvisols, constitutes about 2% of the total soil groups' coverage, and found in the lowland parts of Gololcha, Merti & Ziway-Dugda districts.

The activity of soil and water management is performed every year at the end of main season's agricultural activities i.e., after harvesting the crops grown during main season usually in the month of January for one to two months. This activity is assisted by trained development agents (DAs) which are assigned to each Kebele (PA). Recently, some active farmers (model and can read and write) are also gathered at district level from each PA and practical trainings of trainers (TOT) are being given and the trained farmers are responsible for both training and leading the soil and water conservation activity in their PA in collaboration with DAs.

2.2 SAMPLING TECHNIQUE AND SAMPLE SIZE

A two-stage sampling technique was employed. However, before sampling, the zone was stratified into three based on traditional agro-ecological classification (highland, mid highland and low land). From each stratum, districts which are highly vulnerable to natural calamities specially erosion and landslides were identified after discussion with zonal natural resource conservation team. These districts are known for relatively high intervention of soil and water conservation practices. Then at the first stage from each identified strata a total of five representative sample districts were selected based on above criteria (agro-ecological base and availability of soil and water conservation practices). As a result, Lemu-bilbilo and Inkolo-Wabe were selected from highland districts and Aseko from mid-highlands while Seru and Merti were selected from lowland districts. The sample size from each district was based on proportionality to areas of intervention in soil and water conservation activities. Therefore, at the second stage based on this proportionality, a total of nine peasant associations (PAs) were selected. Accordingly, two PAs from each Seru, Inkolowabe, Merti and Aseko districts and one PA from Lemubilbilo district (total nine) were selected. Finally, 66 respondents from highlands, 44 from mid highlands and 92 from lowland were randomly drawn to make the total sample size of 202.

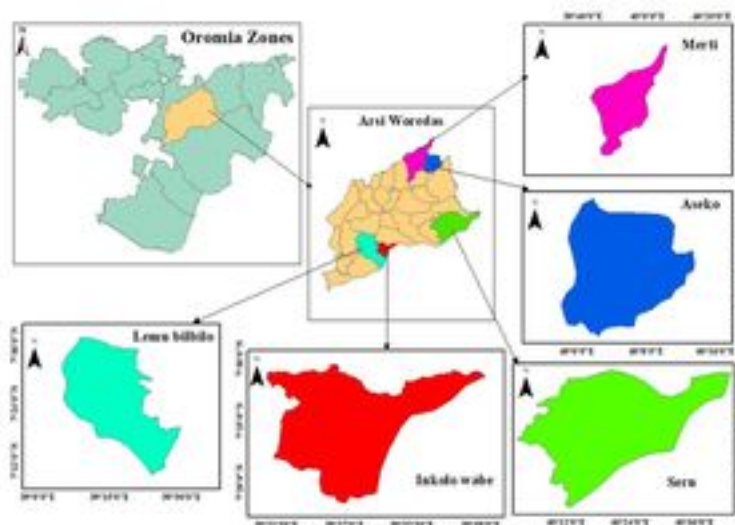**Figure 1** Map of the study districts

2.3 SOURCE AND TYPE OF DATA

Both primary and secondary data were collected from farmers, DAs, districts and zonal level soil and water conservation experts. Both beneficiaries (adopters) of soil and water conservation practices and non-beneficiaries (non-adopters) (technically known as counterfactual) farmers were interviewed using structured questionnaire.

Published and unpublished secondary data were collected from zonal and districts' reports and online sources. Data collected include socio-economic aspects, crop production, soils and land use change and sustainable land management, types of soil and water conservation practices, and land ownership and etc. Survey instrument used for data collection is attached for further reference in appendix part (Appendix V).

2.4 METHODS OF DATA ANALYSIS

Both descriptive and inferential and econometric analyses were employed to meet the specific objectives of this study. Descriptive and inferential statistics like frequency, mean and tabulation were used while from econometric model's propensity score matching (PSM) was used to analyze impact of adoption of soil and water conservation activities on income and yields of selected cereal crops in the study area. The PSM technique enables us to extract from the sample of nonparticipating (non-adopter) households a set of matching households that look like the participating (adopter) households in all relevant pre intervention characteristics. In our study participation in soil and water conservation activities (adoption of one or more of soil and water conservation practices listed) is treatment and those participants are treatment groups while non-participant group members are control groups. This study attempts to estimate the average impact of treatment on treated (ATT). Bryson et al. (2002) indicated that ATT refers to mean impact of the program (adoption) on individuals who actually participated.

2.4.1 ESTIMATION OF PROPENSITY SCORE

The first step in estimating the treatment effect is to estimate the propensity score. In this study logit model was used to estimate propensity scores using a composite of pre-intervention characteristics of the sampled households and matching was 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 practiced soil and water conservation on his/her own plot and 0 otherwise. Mathematically it can be explained as follows:

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

Where, Pi is the probability of participation (adopting soil and water conservation practices),

$$zi \ = ao + \sum_{i=1}^{n} aiXi \tag{2}$$

Where, i = 1, 2, 3, - - -, n
  a_0 = intercept
  a_i = regression coefficients to be estimated

U_i = a disturbance term

1 - Pi $\frac{1}{1+ e^{zi}}$ is the probability of a household belonging to out of the program (probability of non-adopting soil and water conservation practices)

Heckman et al. (1998) states that in social science research where experimental research is difficult due to different reasons, impact evaluation studies are problematic due to the presence of selection bias which could be arise mainly from nonrandom location of the intervention and the nonrandom selection of participant households. Bernard et al. (2010) identifies three sources of potential biases. The first potential source of bias is the observable characteristics of the participants (such as geographic remoteness, or a household's physical and human capital stock) which may significantly differ from nonparticipants at community or household level and this may have direct effect on outcome of the interest (households' income and farm productivity in our cases). Secondly, the difference arises due to unobservable community level characteristic such as the existence of intervention may be in part driven by particularly dynamic local leaders at community level or at the household level, a household's expected benefits, its entrepreneurial spirit, or its relationship with other program/project may significantly influence behavior. Thirdly, externalities (spillover effect) exerted by project/intervention on nonparticipants could be source of bias in a given research activity of impact study.

As a result of one or more of these abovementioned potential sources of bias, the difference between the participants and control group (in our case the difference in households' income and farm productivity between SWC adopters and non-adopter) may either totally or partially, reflect initial differences between the two groups rather than the effects of adopting the SWC practices under consideration.

2.4.2 CHOICE OF MATCHING ALGORITHM

Naturally, estimation of the propensity score not enough to estimate the ATT of interest due to the fact that propensity score is a continuous variable and the probability of observing two units with exactly the same propensity score is zero. To overcome this problem, there are different matching algorithms which have been proposed. Among others, the most widely applied matching estimators are Nearest Neighbor (NN) Matching, Caliper Matching and Kernel matching. As it was explained by Caliendo and Kopeinig (2008), these methods differ from each other with respect to the way they select the control units that are matched to the treated, and with respect to the weights they attribute to the selected controls when estimating the counterfactual outcome of the treated. However, they all provide consistent estimates of the ATT under the CIA and the overlap condition. The choice should be guided in part by what the distribution of scores in the comparison and treatment samples looks like. In this case matching algorithm, which gives larger common supports was selected.

2.4.3 OVERLAP AND COMMON SUPPORT

According to Bryson et al. (2002) imposing a common support condition ensures that any combination of characteristics observed in the treatment group can also be observed among the control group. After identification of common support, it requires deleting all observations out of the overlapping region, whose propensity scores are smaller than the minimum and larger than the maximum, of the treatment and control groups respectively Caliendo and Kopeinig (2008).

2.4.4 TESTING THE MATCHING QUALITY

As it was justified by Caliendo and Kopeinig (2008), since conditioning is not on all covariates but on the propensity score, matching quality has to be checked if the matching procedure is able to balance the distribution of the relevant variables in the control and treatment group. Standard bias, t-test, joint-significance and pseudo-R^2 approaches are applied in covariate balancing (i.e., the equality of the means on the scores and all the covariates) between treated and non-treated individuals.

2.4.5 ESTIMATING THE AVERAGE TREATMENT EFFECT ON THE TREATED (ATET

For random experiments average treatment effect (ATE) which is the difference between the outcome of treated and control groups can be fine but in observational studies, it can be biased if treated and control observations are not similar. Therefore, another option to treat this problem is needed which is the way to find average treatment effect on treated (ATET). ATET is the difference between outcomes of the treated and outcomes of the treated if they had not been treated.

$$ATET = E(\triangle D = 1) = E(Y1X,\ D = 1) - E\ (Y0X,\ D = 1) \qquad (3)$$

The second term is not observable hence need to be estimated and it is why we need the propensity score matching methods. After matching on propensity scores, we can compare the outcomes for treated and control observations. Then the average treatment effect on treated (ATET) will become:

$$ATET = E(\triangle P(X),\ D = 1)\ =\ E(Y1P(X),\ D = 1) - E(Y0P(X),\ D = 0)$$

For this above condition to hold true there are some assumptions as discussed by Heckman et al. (1998):

Partial equilibrium characteristic (no general equilibrium effect) condition which is the assumption that there are no program spillover effects;

Conditional independence assumption: for random experiments, the outcomes are independent of treatment Wooldridge (2002). This is simply an assumption for the treatment variable to be exogenous.

Unconfoundedness Assumption: it is the conditional independence of the control group outcome and treatment and it is the weaker assumption than the conditional independence assumption.

$Y0 \perp D|X$

Matching or overlap assumption: it is an assumption of that for each value of X, there are both treated and control observation. That is for each treated observation; there is a matched control observation with similar x.

$0 < Prob\ (D=1/X) < 1$

Based on Keele (2010), sensitivity analysis should be conducted to check the robustness of the estimation (whether there were hidden biases affected the estimated ATT or not) for an outcome indicator which shows significance. However, in our case, even though "rbounds" bounding approach proposed by Rosenbaum (2002) was proposed, since ATT matched outcome variables estimations did not show significance (t-test for ATT was not significant), sensitivity analysis was not necessary.

On the basis of the various studies reviewed, it was hypothesized that both farmer's participation in the soil and water conservation program and maximization of their crop and gross income and farm output are influenced by the combined effect of a number of factors. Thus, those specific hypotheses set for the selected variables and their prior expectations are described as follows:

1. Sex (dummy 1= male and o otherwise): being male is expected to have positive effect

2. Education (continuous in years of schooling): expected to have positive effect

3. Experience in farming (continuous and measured in year): expected to have positive effect

4. Family labor (continuous and measured in man-equivalent): expected to have positive effect

5. Landholding (continuous and measured in hectare): expected to have positive effect

6. Fragmentation (continuous & measured in number of plots): has expected negative effect

7. TLU continuous and measured in tropical livestock): expected to have positive effect

8. Credit access: (dummy 1=yes) expected to have positive effect

9. Slope category: (categorical plain, gentle ....) sloppier is expected to have positive effect

10. District category (categorical: the more vulnerable expected to have positive effect

11. Cooperative distance (continuous measured in km) expected to negative sign

12. Perceived Erosion (dummy 1=yes if the farmer perceived that his/her parcel is vulnerable to erosion and expected to positive sign)

13. DA contact (continuous number of DA contacts per month) and expected to positive sign

3. RESULT AND DISCUSSION

3.1 DEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS OF THE RESPONDENTS

Result of the survey (Table 1) revealed that around 30 percent of the households' heads were illiterate while around 69 percent were literate. For those literate groups (Table 2) the mean year of schooling was 5.75 years with 2 and 12 years of minimum and maximum values respectively. The mean family size of the household was 7.5 persons with maximum of 35 family members. Each household has about 5 economically active (family member with working age of between 10 years and 64 years) family members. The mean farming experience of household head was around 23 years. The mean age of household head which are in active working group were around 40 years (Table 2). Only 4 percent of the household were female headed while the rest 96 percent were male headed. The man-equivalent family labor was 3.03 and 3.28 for adopters and non-adopters respectively. Soil and water conservation adopter household heads have statistically significant (at 99% and 95% respectively) educational background and farming experience. Similarly, adopters have more extension contact compared to non-adopter groups (t-value significant at 99 percent) while dependency ratio for non-adopters is higher with significant t-value at 95 percent.

Table 1 Household Demographic Characteristics			
Variable Description	**Category**	**N**	**Percent**
Educational background of HHH	Illiterate	60	29.70
	Read and write	2	1.00
	Informal (religious) school	1	0.5
	Literate	139	68.80
Marital status of household head	Single	2	1.00
	Married	197	97.500
	Divorce	1	0.5
	Widowed	2	1.00
Household head Sex	Female headed	8	4.00
	Male headed	194	96.00

Source: own survey data, 2019

Table 2 Summary of continuous socioeconomic variables

Description	Mean		Total	t-values	Sig.
	Adopter	Non-Adopter			
Education	6.0086	3.6744	3.96	5.79***	0.000
Farming experience	24.62	20.02	22.75	2.76***	0.006
Family size	7.39	7.63	7.5	-0.426	0.67
Family labor (man-equ.)	3.04	3.28	3.14	-0.956	0.34
Landholding (ha)	2.71	1.34	1.43	1.76	0.079
Farm frag-mentation	2.60	2.35	2.50	1.22	0.22
Gross production (qt)	114.62	26.38	77.06	0.88	0.379
Yield (qt/ha)	82.43	28.39	75.10	1.07	0.286
Livestock possession (TLU)	5.29	4.61	5.00	1.10	0.272
Total income (ETB)	31772.41	23196.19	28121.15	1.61	0.109
Extension contact	3.28	2.28	0.54	4.39***	0.000
Distance to FTC (km)	2.65	2.37	2.53	0.71	0.481
Distance to main road (km)	3.80	3.23	3.56	0.77	0.443
Distance to cooperative (km)	2.43	2.01	2.25	1.02	0.306

Source: own survey data, 2019

3.2 MAIN ECONOMIC ACTIVITIES AND INCOME SOURCES OF THE HOUSEHOLDS

The main production system of the zone is crop-livestock mixed farming with crop production as the main household income source and the livestock sector is mainly used as draught power sources and supplementary income source G. Tamrat (2018). The survey result revealed that around 95 percent of the respondents responded that grain crop production is the main source of their households' income source followed by vegetable production, khat (chat) and cattle production responded by around 17, 16 and 14 percent of respondents. Major crops produced in the areas are wheat and barley in the highlands and mid-highland areas and maize, teff and sorghum in low-lands and mid highlands. Wheat is among the widely produced crops in the study area being grown by around 44 percent of respondents and followed by maize and

barley each produced by 39.11 and 37.13 percent respectively. The result is also similar with previous research output by A. Tamrat and Ashebir (2019). Livestock possession in tropical livestock unit (TLU), computed based on appendix II, was 5.29 and 4.60 for adopters and non-adopters respectively while on average each respondent possesses around 5(SD of 5) TLU.

3.3 CONSTRAINTS AND FARMERS' PERCEPTION IN SOIL AND WATER CONSERVATION ACTIVITIES

Table 3 **Perceived Erosion and its Causes**

Variable	Description	N	Percent
Perceived erosion as a production problem	Yes	164	81.19
Erosion Severity level	Very severe	37	22.56
	Severe	63	38.41
	Less severe	64	39.02
Cause of erosion	Deforestation	156	95.12
	Poor agricultural practices	135	82.32
	Over cultivation	120	73.17
	Cultivation of steeply sloped lands	157	95.73
	Excessive rainfall	109	66.46
	Soil erosion	164	81.19
	Limited use of fertilizer	116	57.43
	Continuous cultivation	137	67.82
	Lack of conservation practices	165	81.68
	Lack of fallowing	114	56.44
Consequences of erosion:	Decline in land productivity	180	89.11
	Soil fertility decline	174	86.14
	Soil depth reduced	99	49.01
	Change in crop type	94	46.53
	Difficulty in land preparation	80	39.60
	Gully and sandy soil formation	77	38.12
	Soil water holding capacity decline	71	35.15
	Abandonment of land from production	53	26.24

Source: own survey data, 2019

About 81 percent of the farmers in the study area perceived soil erosion as one of the main production constraints (Table 3). Out of those respondents who perceived soil erosion as problem, 29.27 percent of them ranked the problem as very severe, 37.8 percent as severe and 32.93 percent of them ranked it as less severe. Expansion of cultivation to marginalized lands, deforestation and poor agricultural practices were ranked from first to third main causes of soil erosion by the respondents. Lack of conservation practices, soil erosion, continuous cultivation and limited use of chemical fertilizer were mentioned as main cause of loss of soil fertility

in the study area. As it is perceived by the respondent farmers, about 89, 86 and 49 percent of them responded that decline in land productivity, decline in soil fertility and reduced soil depth were the main consequences of soil erosion in the study area. Some 47 percent of the farmers also responded that they changed type of crops they produce due to soil erosion they faced.

3.4 SOIL AND WATER CONSERVATION PRACTICES IN ARSI ZONE

Table 4 **Soil and water conservation Adoption status and conservation types**

Variable description	Categories	N	Percent
Soil and water conservation:	Adopter	116	57.40
	Non-Adopter	86	42.6
Types of SWC practices:	Traditional	38	32.76
	Improved	76	65.52
	Both	2	1.72
Types of SWC practices:	Stone bund	42	36.21
	Soil bund	29	25.00
	Stone faced soil bund	9	7.76
	Fanya juu	9	7.76
	Cut-off drain	5	4.31
	Check-dam	3	2.59
	Terracing	25	21.55
	Contour plowing	17	14.66
	Grass strip	1	0.86

 **traditional type of soil and water conservation (SWC) is type of conservation done by farmers themselves without any training and guidance from development agents or other bodies while improved type is done under training, guidance and supervision from development agents.

According to the result (Table 4) out of total respondents' 57.4 percent were adopter of one or more type of soil and water conservation structures while 42.6 percent were non-adopters. The result also revealed that around 66 percent of the soil and water conservation practices implemented by the respondents are improved while around 33 percent was traditional and some 1.7 percent uses both traditional and improved practices. Majority of adopters which are 36.21, 25.00 and 21.55 percent are using improved types of stone bunds, soil bunds and terracing respectively while the rest of respondents are using contour plowing (14.66%), stone faced bund and fanya-juu (7.76% each), cut-off drain (4.31%), check-dam (2.59%) and grass-strip (0.86). Mean year of adoption (since a respondent started using SWC practices) was 3.30 years with minimum and maximum value of 1 and 10 years respectively. As result from table 5 revealed, the mean area of plots covered by stone bund, soil bund and terraces were 9.05-, 5.94- and 2.60-meter squares. The result shows that stone bund and soil bunds are the most preferred structures (Table 5).

Table 5 **Area of land covered by different types of SWC structures**

Variable description	N	Mean	StD	SE. Mean
Area of stone bund developed in meter square	116	9.05	15.35	1.43
Area of soil bund developed in meter square	116	5.94	13.47	1.25
Area of cut off-drain developed in meter square	116	.47	4.66	0.46
Area of check dam developed in meter square	116	0.09	0.93	0.09
Area of terraces developed in meter square	116	2.60	6.23	0.58
Area of fanayjuu developed in meter square	116	0.35	2.84	0.26
Year of adoption	116	3.30	2.96	0.28

Source: own survey data, 2019

According to the survey result from perception and practical challenges farmers faced in implementing different types of SWC activities, stone bund, terrace and soil bund were mentioned as laborious, difficult in implementation and create difficulties to turn oxen during plowing (Table 6).

Table 6 **SWC practices and their challenges to implement**

Descrip-tion of variable	count of challenges					
Conser-vation type	Not effec-tive	Laborious	Frequent mainte-nance	Implementat difficulty	Waste land	Difficult to turn oxen
Stone bund	1	13	1	6	1	3
Soil bund	2	7	2	2	1	6
Stone faced soil bund	1	3	1	1	-	-
Fan-aju	1	1	-	2	-	-
Cut-off drain	-	1	1	1	-	-
Check-dam	-	1	-	-	-	-
Terracing	1	12	2	2	-	-
Contour plowing	2	-	-	-	-	2
Land slope	Description		Adoption category		Chi-square	Sig.
		Non-Adopter	Adopter	Total		
	Plain	33	24	57	9.14	0.028*
	Gentle slope	26	56	81		
	Step slope	4	6	10		

Continued on next page

Table 6 continued			
Both plain and gentle slope	23	31	54

Source: own survey data, 2019

3.5 COMMUNITY PARTICIPATION AND GENDER ROLE IN SOIL AND WATER CONSERVATION ACTIVITIES

Most of the SWC structures and activities are conducted by community campaign. Out of adopter farmers who have different conservation practices on their own plots, only 23.28 percent have practiced different SWC activities on their own farmlands while the rest of the adopters' of SWC activities were conducted by community campaign.

Table 7 Participation in soil and water conservation practices

Variable	Description	N	Percent
Participate of SWC campaign:	Male	192	98.97
	Female	8	4.00
Participate on project based SWC activities	Yes	42	20.80
Your participation by type of land:	Communal	17	8.40
	Private	93	46.00
	Both	92	45.50
Who participate on SWC campaigns?	Husband	136	67.3
	Wife	3	1.5
	Boys	4	2.00
	Hired labor	1	0.50
	Husband and/or wife	58	28.7
Presence of area closure in your areas	Yes	131	64.9
If it is rehabilitated (Yes)	Yes	126(of131)	96.18
Get water spring due to its rehabilitation	Yes	15(131)	11.45
Use grass for livestock from rehabilitated area	Yes	80(131)	61.10
Beekeeping in area closure	Yes	4	3.05
SWC has impact on your income and productivity	Yes	186	92.10

Source: own survey data, 2019

As it is expected since work of soil and water conservation is a top-down planned campaign from government body, every member of a PA has no choice other than participating in the campaign. Accordingly, almost all respondents have participated on SWC activities campaign by order from the government every year. According

to the result from Table 7 , 20.80 percent of the respondents have participated on project based SWC activities. The projects around are safety net program and Malkawakena watershed development project that initiated by Ethiopian Electric Power Authority in Lemu-bilbilo district to protect electric generating dam. The safety net programs are implemented in the three districts Seru, Aseko and Merti where there was problem of food self-sufficiency due to drought and soil erosion. The inception period of safety net project varies from 1997 to 2010. The Melka Wakena project is a newly initiated project in 2018. In most cases, even though there is beginning of watershed development projects there is problem of materializing the activity on the ground and it is mostly a touch and release activity.

Most of the activities of SWC were done on private (individuals') land and accordingly, 46 percent and 8.40 percent of the respondents have participated on individuals and communal lands respectively while 45.5 percent of them participated in both communal and individuals land conservation activities. In most cases either husbands or wives were involved in SWC activities household level. Result from (Table 7) revealed that 67.3 percent of the respondents answered that only husbands participated while 28.7 percent replied that either husband or wife were involved on the campaign.

3.6 IMPACTS OF SOIL AND WATER CONSERVATION PRACTICES ON YIELDS AND HOUSEHOLDS' INCOME

Around 65 percent of the respondents indicated that there was area closure around them and some started realization of some benefits from the rehabilitated areas. From the assessment on their perception and benefits that are realized so far, 11.45 percent of respondents indicated that they were getting re-developed spring water from area closures, while 61.10 percent were using grass from area closure and 3.05 percent of them were benefiting from beekeeping activity in rehabilitated areas. In general, around 92 percent of the total sample perceived that the activity of SWC had a positive impact on their household income and farm productivity (Table 7).

3.7 CONSTRAINTS AND OPPORTUNITIES IN SOIL AND WATER CONSERVATION PRACTICES IN ARSI ZONE

With all its limitation the government led SWC campaign has great impact in awareness creation about the negative impact of deforestation, mismanagement of farmlands, cultivation of marginal lands and other kinds of misuse in natural resources. Even though some of them were being solved since two to three years (joint planning and training started), during the beginning of the campaign, inadequate training, the non-participatory nature of planning stage and absence of structure construction materials to implement some type of conservation structures like check and seedlings of conservation trees or grasses were the major challenges to implement and sustain the SWC activities (Table 8). About 42 percent of the respondents reported that absence of practical accountability after conservation activities were

done was the main challenge in conservation activity. The free grazing practices of livestock during winter (Ethiopian Summer) season is the remaining problem in devastating all the structures that were constructed by the campaign and it hardly lasts for a year.

Table 8 **Drawbacks of SWC campaigns**

Description	N	Percent
No sufficient training	35	17.30
No material/seedlings to cover the constructed structure	33	16.30
We do not participate on planning	12	5.90
No accountability after work	84	41.60

Source: own survey data, 2019

3.8 RESULTS OF ECONOMETRIC ANALYSIS

Prior to proceeding to estimation using logistic regression model, different tests were conducted to confirm whether the data fits to the model. Among these Hosmer-Lemeshow test was conducted to check if the data fit to our model. The chi-square value of 10.60 which is insignificant (p-value=0. 2253) shows our data fit to logit model. To check for multicollinearity among the variables, variance inflation factor (VIF) was calculated and there is no serious problem found.

Table 9 **Logit estimates of the propensity scores**

Adopt SWC	Coef.	Dy/dx	Std.Err.	Z	t-value
Sex	-.175	-.556	.652	-0.85	0.393
Education	.182	.072	.037	4.87***	0.000
Experience	0.032	0.013	0.011	2.77***	0.006
Family labor	-.108	-.044	.078	-1.40	0.163
Landholding	.327	.128	.122	2.68**	0.007
Fragmentation	-.191	-.070	.100	-1.91*	0.057
TLU	-.054	-.023	.036	-1.49	0.135
Credit access	-.338	-.134	.231	-1.46	0.144
Slope category	.425	.139	.226	1.88*	0.061
District category	1.200	.346	.320	3.76***	0.000
Cooperative distance	0.005	-.001	.041	0.12	0.902
Perceived Erosion	0.140	.046	.276	0.51	0.612
DA contact	0.196	0.026	.065	2.98 ***	0.002
_cons	-1.334		.758	-1.76*	0.079
Number of obs. =202		Prob > chi2 =0.000			
LR chi2 (13) =83.35		Log likelihood =-96.105			
Pseudo R2 =0.303					

Source: own survey data, 2019

3.9 RESULTS OF BINARY LOGIT MODEL AND PROPENSITY SCORE ESTIMATION

Based on matching algorithm result total of thirteen (13) covariates which are used in matching the treated and control were selected and were included in the model and eight of them were found to be significant. The result of logit model on drivers of soil and water conservation practices in Arsi zone was presented as follows (Table 9).

As it is expected education has a positive influence on adoption of soil and water conservation activities and significant at 1 percent. This is because of the fact that education is a base for awareness on positive impact of conservation activities on farm productivity. The result is consistent with that of Tesfaye (2017) of sustainable land management, and Gebru et al. (2019) and Beyene etal. (2017) for agro-forestry adoption study. Asfaw and Neka (2017) and Wordofa et al. (2020) also found that education has positive impact on adoption rate of soil and water conservation.

Farm experience was also an important variable that affect adoption of SWC practices positively as expected and significantly at 1 percent probability. This can be explained by the fact that farmers who have long experience in farming may realize the gradual decline in fertility of their farm plots as a result of erosion, and other factors and will be willing for adoption of SWC practices. Result of other studies like Tigist (2010) and Wordofa et al. (2020) farming experience and by Mengstie (2009) and Beyene et al. (2017) age which can be a proxy for farming experience has positive impact on adoption probability of SWC practices. However, result of Anjulo and Mezgebu (2016) shows that age has a negative impact on adoption probability of SWC practices. In other studies, by Asfaw and Asfaw and Neka (2017) and Wordofa et al. (2020) age of respondents which can be proxy variable for experience in farming was significant.

Landholding by household was another variable which is found to be significant in affecting SWC practices adoption in the study area at 95 percent of significance level. The result depicts that as landholding increases, the probability of adopting SWC practices also increases and the result is also in line with other authors like Tigist (2010) and Wordofa et al. (2020), Tesfaye (2017) on sustainable land management, while the result of research by Gebru et al. (2019) shown that landholding was negatively affecting SWC practices.

Land fragmentation which was expressed in terms of number of land plots possessed per a household was also found to be negatively and significantly affecting the probability of SWC adoption at 90 percent level of significance. Slope of the land parcel was also one of the determinant factors that positively influence the adoption rate of SWC practices positively significantly at 90 percent. The more the slope of the land parcel, the greater possibility of adopting the practices. This is an indication for the level of understanding of the farmers that as the slope of their parcel increases, the more they are required to conserve their plots. Other results by Beyene et al. (2017) and Tesfaye (2017) are also in line with this output.

Another variable which comes out significantly affecting adoption probability was level of vulnerability of districts. Accordingly, districts categorized as vulnerable to different erosion types were found more likely to adopt the practices at 99 percent level of significance. Districts like Inkolowabe which were categorized as severely affected by zonal experts were more adopting relative to others.

Frequency of development agent contacts (visit to DA) was also significant and positive variable in determining adoption probability of SWC and 99 percent level of significance. The result was also similar with other researches like Kassa (2013), Menale et al. (2007), Beyene etal. (2017) and Tesfaye (2017).

3.10 IMPACT OF ADOPTION OF SOIL AND WATER CONSERVATION PRACTICES

Choosing Matching A lgorithm and Results of Impact

Result of matching performance of different estimators (appendix 3) indicated that kernel matching at band width of 0.25 (KBW 0.25) showed best matching quality as it had largest common support which include all sample size, least R-squared (0.092) and reasonably include enough covariates which is 13 out of 16 covariates. In propensity score (pscore) estimation and performing initial balance of the covariate, 6 numbers of blocks were identified that ensured the mean pscore was not different for adopters and non-adopters in each block. The result (appendix 4) also further revealed that before matching, 57.14% of the covariates pscore estimates show significant but after matching all except one become insignificant. Because of this one covariate was excluded from matching algorithm and the model was run by using thirteen covariates. The balancing efficiency of the estimator was determined by considering the reduction of the mean standardized bias (SB) between the matched and unmatched respondents and equality of means (adopters and non-adopters) was tested using t-test. As shown in Appendix 4, fifth column shows the mean BS before and after matching while sixth column shows the total mean SB reduction obtained by the matching procedure.

The result of analysis (Table 10) revealed that the mean impact of adopting SWC practices was positive for all outcome variables. The mean annual gross household income was found to be 6358.86 ETB while yield of major crops (agricultural output per hectare) was 54.81 quintal per hectare. For this particular analysis only major crops of the area which are wheat, barley, maize, sorghum and teff were considered. The mean impact of adoption for soil and water conservation practices on total production (gross production) for abovementioned major crops was 85.35 quintal per annum per households. However, the result also depicted that none of the differences become statistically significant. This can be justified due to the fact that natural resource rehabilitation impact may take some more time to be demonstrated significantly on land productivity. In this regard Abebe and Bekele (2014) and Gatbel et al. (2019) also found the similar result that even though SWC practices have positive impacts on productivity and household income, the differences are not statistically

significant. However, Kedir (2020) from Ethiopia and Abdulai and Huffman (2014) from Ghana found that adoption of SWC practices have positive and significant impact on household income.

Table 10 **Average treatment effect of adoption of SWC practices on treated households**

Variable	Treated	Control	Difference	S.E	t-test
Total Income	31772.41	25413.55	6358.86	10177.86	0.62
Gross yield	82.43	27.62	54.81	49.99	1.10
Total production	114.62	29.27	85.35	87.64	0.97

Source: own authors computation from survey data, 2019

Moreover, the result from propensity score matching algorithm shows that there are high standard errors for ATT which may be one indication for difference in matching covariance or background difference for land productivity in the zone. In general, given the agro-ecological variability among districts within the zone, there is variability of types of major crops between different districts. Therefore, the statistical comparison of total production and yield among different crops (for instance comparing productivity of wheat and maize) is not as such good and feasible and rather the researcher is more interested in gross annual household income from agricultural products for analysis as a right outcome variable. Therefore, based on households' income difference between adopter and counterfactual group (Table 10), one can conclude that adoption of SWC practices can positively influence household income of farmers.

4. CONCLUSION AND RECOMMENDATIONS

4.1 CONCLUSION

The result revealed that almost all households participated in SWC. All genders categories (male, female and youth) have participated on soil and water conservation activities. However, the survey revealed that adult males (husbands) were more responsible and participated in soil and water conservation campaigns in general. The majority of SWC activities done so far are on individual land parcels but most activities are mobilized by campaign that are organized on individuals holdings each year which are identified prior to the commencement of campaign. The campaign is organized each year since almost ten years after end of main agricultural activities for one to two months based on severity of degradation in the areas. Stone bund, soil bund and cut of drain were the most widely practiced soil and water conservation types. Recently, seedlings of different vegetation are also being distributed even though it is not uniform across the zone.

Different demographic, socioeconomic, and institutional and parcel properties are found to be significantly affecting adoption of soil and water conservation activ-

ities in the study area. Accordingly, educational background of households, farming experiences, size of landholding, slop of plot, degree of vulnerability of the districts and extension contact are variables which are found to be significantly and positively affected adoption while land fragmentation was significant and negatively influenced adoption of SWC activity. Though it is not statistically significant, SWC adoption has positive impact on productivity and income of HH.

Sustainability of structures is among the main constraints due to fact that there are still some gaps in making SWC activity participatory at every stage and activity handover problem after the end of the campaign. Free grazing and absence of seedlings are among the main constraints of sustainability of SWC activity. Most respondents are aware of natural resource degradation and its impact on their livelihoods. This will create good opportunity in strengthening SWC activities.

4.2 RECOMMENDATION

Based on the findings of the research, the following activities are recommended for further adoption and sustainability of soil and water conservation activities.

1. Even though farmers perceive that they are benefiting from SWC activities, there is gap in internalizing the cost and benefits of the activity. Therefore, further awareness and training is needed.

2. Farmers believe that whether they maintain the already done structures or not, SWC activity is their year after year duty. Due to this, they don't worry about sustainability of the structures they have done before. Therefore, there must be an exit strategy which gives accountability to a farmer to maintain the structure done on his/her field.

3. According to the result free grazing is one of the major constraints to SWC sustainability. To overcome such problem, there must be mass community awareness creation and training on activities that could reduce free grazing.

4. In most cases, after construction of physical structures to sustain the structure, covering the structure with grass strips and other vegetation is important. Therefore, availing seedlings for biological intervention of constructed structures should be given a due attention.

5. There are districts which are categorized as vulnerable to different man-made and natural calamities like landslide, erosion and others. These districts are mainly found in Arba-gugu and Dida'a areas. Therefore, these vulnerable districts must be given more attention by both zonal and district development practitioners

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1. APPENDIX

Table 1 Conversion factors used to estimate adult equivalent

Age group	Male	Female	Age group 2	Male 3	Female
<10	0	0	17-60	1	0.8
10-13	0.2	0.2	>60	0.7	0.5
14-16	0.5	0.4			

Source: Bekele Hundie(2001)

2. APPENDIX

Table 2 Conversion factors used to estimate TropicalLivestock Unit (TLU)

Types of animals	TLU	Types of animals	TLU	Types of animal 2	TLU3
Cow	1	Heifers	0.75	Donkey	0.5
Ox	1	Calve	0.4	Horse/ mule	0.8
Bull	1	Sheep/ Goat	0.1	Camel	1

Source: (Storck, et al., 1991) and Freeman etal., (1996)

3. APPENDIX

Table 3 Matching performance of different estimators

Matching estimator		performance criteria		
		Balance test*	Pseudo R-square	Matching sample
Radius caliper	0.01	12	0.17	155
	0.02	10	0.165	192
	0.03	8	0.188	202
	0.04	9	0.188	202
	0.05	7	0.188	202
Nearest neighbor	1	7	0.188	202
	3	12	0.133	202
	4	12	0.13	202
	5	14	0.112	202
Kernel band width	0.1	12	2	202
	0.25	14	0.092	202
	0.5	14	0.105	202

Source:Author's computation from survey data

4. APPENDIX

Table 4 Testing of covariates balance for adopters and non-adopters

Variable	Unmatched Matched	Mean Treated	Control	%bias	bias	% reduct t	t-test p>t
Sex	U	.965	.953	6.1		0.43	0.667
	M	.965	.996	-15.5	-155.4	-1.71	0.088
Education	U	6.00	3.67	81.4		5.79*	0.000
	M	6.00	5.73	9.4	88.5	0.67	0.503
Experience	U	24.62	20.02	39.5		2.76*	0.006
	M	24.62	25.94	-11.4	71.2	-0.82	0.415
Family labor	U	3.04	3.28	-3.21		2.71**	0.005
	M	2.84	3.18	-4.3	11.25	1.01	0.98
Landholding	U	2.71	1.3423	26.8		1.76*	0.079
	M	2.71	1.8355	17.1	36	1.3	0.194
No. of Plots	U	2.60	2.34	17.6		1.22	0.223
	M	2.60	2.87	-18.6	-5.7	-1.41	0.159
TLU	U	5.29	4.6	15.4		1.1	0.272
	M	5.29	5.2	2	86.9	0.16	0.871
Credit Access	U	.336	.372	-7.5		-0.53	0.59
	M	.336	.352	-3.4	55.1	-0.26	0.79
District categor	U	.301	.127	43.1		2.96*	0.003
	M	.301	.209	23	46.7	1.62	0.107
Coop_ distance	U	2.43	2	14.8		1.03	0.306
	M	2.43	1.99	15.1	-2.3	1.11	0.269
Perceive Erosion	U	.844	.755	22.3		1.59	0.114
	M	.844	.776	17.2	23	1.33	0.184
Erosion Land	U	.425	.688	-38.7		-2.77*	0.006
	M	.425	.376	7.2	81.5	0.76	0.445
DA_contact	U	3.27	2.27	61.8		4.39*	0
	M	3.27	3.51	-15	75.8	-0.98	0.329
Slope_category	U	.474	.302	35.6		2.49*	0.014
		.474	.414	12.5	65	0.92	0.359

5. APPENDIX

Household Questionnaire for Adoption and Impact of Soil and Water Conservation Practices on Household Income in Arsi zone, Ethiopia

Date of interview: _____

Interviewed by (enumerator's name): _____

Part 1. General Information

1. Name of the district: —————————-; 2. Name of Kebele: ————————————

3. Name of Watershed: —————————; 4. Household head name: ——————-

5. GPS readings of Village: a) Altitude_____; b) Latitude_____; c) Longitude: -_____

Part 2: Socio economic characteristics of household heads/respondents

1. Age of household head/respondent in year: ————————————

2. Sex of household head/respondent 1. Male 0. Female

3. Marital status of household head/respondent:
   1. Single 2. Married 3. Divorced 4. Widowed)

4. Educational status of household head/respondent: ————————————
   1. Illiterate 2. Read and write 3. Informal (religious school)
   4. If literate (put years of schooling/grade) _____

5. Total household size by age and sex

S.N	Sex category	Bellow 10 years	10-14 years	14-64 years	Above 64 yrs	How many of your children are at formal school?
1	Male					
2	Female					
3	Total household size					

6. Experience in farming (years)………………………........

7. Distance to the nearest main market from residence (km)……minutes of walking time……….

8. Average single transport cost (per person) to the main market using a car (Birr/person) ……….

9. Distance to the farmer cooperative from residence (km)……. minutes of walking time………

10. Distance to main road from residence (km)……minutes of walking time……….

11. Distance to the FTC from residence (km)………minutes of walking time……….

12. Main roofing material of main residential house…………… (1. Grass thatch; 2. Iron sheet)

13. What is the major source of your income/livelihood (multiple answer is possible) ————–-?
   1. Crop production
   2. Small ruminants
   3. Cattle production
   4. Fruit and vegetable
   5. Off/non farming activities
   6. Beekeeping
   7. Others—————————

14. Relative importance of different sources of income/livelihood for farmers(rank)

S/n	Major sources of income/livelihood	Participate (1=Yes, 0=No)	Estimated annual income (birr)
1	Grain crop products sales		
2	Vegetable product sales		
3	Khat product sales		
4	Livestock and products sales		
5	Timber product sales		
6	Employed (salaried monthly)		
7	Remittance		
8	Daily labour		
9	Petty trade		
10	Others specify–		

15. Land holding during the 2010/11 E.C cropping year

Land holding	Size (ha)		Size (ha)
Total land holding (own)		Fallowed land	
Total cultivated land (annual crop like wheat, barley)		Covered by trees	
Total cultivated land (permanent crops like chat, coffee)		Land rented in	
Total cultivated land (annual + permanent crops)		Land shared in	
Grazing land		Land rented out	
Homestead land		Land rented out	
		Total land	

16. Number of plots of land owned: —————

17. Types of landscape of your farm land: —————
  1. Plain,
  2. Gentle slope,
  3. steepy slope

18. Cost paid for livestock feed and/or services in 2011 E.C

No.	Product/service used	Quantity	Unit price/cost	Total cost
1	Feed purchased			
2	Supplements (minerals)			
3	Veterinary services (in number)			
4	Bull service			
5	Transport			
6	Others			

Part 4: Access to credit services

1. Have accessed credit for financing your farm activities for two years?
  1. Yes 2.No

2. If yes, amount you received in birr? ——————————

3. If yes, from where do you received the credit? ——————————

       1. Cooperative

       2. Micro Finance

       3. Local money lenders

       4. Others specify: —————–

4. If yes, for what purposes did you received the credit? ——————————–

5. Have you received credit to finance your SWC activity for the last five years?

       1. Yes 2. No

6. If yes, amount you received in birr? —————, and sources———————————–

7. If no, what are your sources of finance to invest on SWC practices?

       1. Own finance

       2. No need to invest on SWC

       3. Others, Specify, —————–

Part 8: Farmers' Perception of the impact of soil erosion/land degradation

1. Do you think soil erosion is a problem for your farmland? (tick)

       1. Yes 2. No

2. If yes, how do you perceive the level of soil erosion in your farm land? (tick)

       1. Very severe

       2. Severe

       3. Less severe

3. If yes, how much of your farm land affected by erosion in hectare? _____

4. If yes, how do you perceive the severity of soil fertility decline of your farm lands?

       1. Very severe

       2. Severe

       3. Less severe

5. What do you think about the major cause of soil erosion for your farm land (rank)?

       1. Deforestation

       2. Overgrazing

       3. Poor agricultural practices

       4. Over cultivation

       5. Cultivation of steep slope lands

       6. Excessive rainfall

6. What do you think about the major cause of **soil fertility decline for** your farm land (tick)?

       1. Soil erosion

       2. Limited use of fertilizers

       3. Land is cultivated continuously

       4. Lack of use conservation practices

       5. Lack of land fallowing

       6. If others (specify): ——-

7. What do you think is the consequence of soil erosion? (Rank)

No.	Consequences of soil erosion/land degradation	1. Yes 0. No	Give rank
1	Land productivity decline		
2	Soil fertility declined		
3	Change in type of crops grown		
4	Abandonment of land from crop production		
5	Land preparation becomes difficult		
6	Reduces farm size		
7	Gully and sandy soil formation		
8	Soil depth decreased		
9	Water holding capacity of land declined		

PART 10: Community Participation on Campaign of SWC practices

1. Do you participate on soil and water conservation campaign organized so far?
    1. Yes 0. No

2. If yes, for how many years? _____

3.If No, why? _____

4. If you participate on SWC activities, is it on project based?
    1. Yes 0. No

5.If it is project based, please name the project. _____

6.When does the project started (year project started) _____?

7.What support does the project give to the SWC activities?
    1. training participants
    2. Financial support
    3. Material support
    4. Provide food to beneficiaries

8. How do you participate on SWC in the watershed? _____.

9. The land on which you conduct SWC activities are:
    1. Communal
    2. Individual's

10. Is there area closure in your area?
    1. Yes 0. No

11. If there is area closure, did it get rehabilitate?
    1. Yes 0. No

12. If it rehabilitated, how did you get benefit from it?
    1. Use water from spring generated
    2. Use cut-carry grass for livestock
    3. Use beekeeping in the area
    4. Use wood for house construction and firewood
    5. Others(specify) _____

13. Do you think that the SWC practices have an impact on your household Income and productivity?
    1. Yes 0. No

14. How do you rate extension services on SWC?

    1. Very poor

    2. Poor

    3. Medium

    4. Good

    5. Very good

15. What are the weaknesses of SWC campaign by the government each year?

    1. No training

    2. No material/seedlings

    3. No participation on planning

    4. No accountability after work

16. What is the productivity five major crops?

No.	List of three major crops grown	Yield per hectare in 2003 E.C (before SWC)	Yield in 2010/11 per hectare (after SWC done)
1.			
2.	…………		

17. What is the income from the following Activities on area closure? (To be filled for both groups)

No.	Sources of income	Estimated Income amount in 2004 E.C (before SWC done)	Estimated Income amount in 2011 E.C (after SWC done)
1	Use water from spring generated		
2	Use cut-carry grass for livestock		
3	Use beekeeping in the area closure		
4	Use wood for house construction and firewood from area closure		
5	Employed as guard for area closure		

Who participate on SWC activities in your household? (Multiple answer possible)

    1. Husband 2. Wife 3. Boys 4. Daughter 5. Hired laborer

Part 5: Crop production and marketing

1. Crop production and income from crops in 2010/11 cropping season

Crop types grown	Cultivated Area (ha)	Total quantity produced(kg)	Quantity consumed kg)	Quantity saved for seed(kg)	Did you sell? 1. Yes 0. No	Quantity sold (kg)	Average selling price (birr/kg	Who sold? 1= Men, 2 = women
Wheat								
Barley								
Maize etc								

Crop production and input use during 2010/11 E.C cropping season for three major crops in terms of land allocation

Major Crop(s) grown	Land size allocated in (ha)	Fertilizer (If not used, put zero)				Seed use			Manure		Pesticides	
		Amount of NPS (Kg)	Total cost (ETB)	Amount of Urea (Kg)	Total cost (ETB)	Amount of non-bought Seed (own saved, gift(kg) used	Bought	Own	Bought		Amount in liters/gm	Total cost (ETB)
						Amo (kg)	Total cost (birr)	kg	kg	Total cost (ETB)		
Wheat												
Barley												
Teff etc												

Part 6: Livestock production and marketing

1. Livestock type, number kept and their values in 2010/11 E.C cropping season

Part 7: Off/non-farm activities

1. Do you or any member of your family have off-farm/non-farm job? 1. Yes 2. No

2. If yes, indicate the type of off/non-farm activities and annual income for the year 2010/11

Livestock type	Number of livestock owned at end of 2011 cropping season (including bought ones)	Number of livestock sold in 2010/11 (enter 0 if none)	If you would sell, how much would you receive from the sale? (ETB) (take average)	Average lactating period	Average daily milk yield per animal (liters)/ honey(kg)(no.)	Total production milk (liters) & honey production per beehive (kg) egg production(number)	Amount earned per annum
Cattle							
1. Indigenous milking cows							
2. Cross-bred milking cows							
3.Exotic milking cows							
4. Non milking cows (mature)							
5. Trained oxen							
6. Bulls							
7. Heifers							
8. Calves							
Goats							
9. Adult male goats							
10.Young male goats							
11.Young female goats							
Sheep							
13. Male sheep							
14. Mature female sheep							
15. Young male sheep							
16. Young female sheep							
Other livestock							
17. Mature trained donkeys							
18. Young donkeys							
19. Horses							
20. Mules							
21. Mature chicken							
22. Local Bee hives							
23.Modern Bee hives							

Part 9: Farmers' Perception of the Impact of Soil and Water Conservation Measures

1. Did you use soil and water conservation practices on your farm land? 1. Yes 2. No

2. If no for the question no.1 please pass to question no. 12

3. If yes for the ques. no. 1 what type of SWC practices used on your farm plots?
1. Traditional 2. Improved 3. Both

4. If improved **SWC technologies** used on your farm land, fill the following table

S/N	Off/non-farm activities	1. Yes 0. No	Payment mode 1. In kind 2. Cash	Total annual income(birr/annual)
1	Livestock trading			
2	Grain trading			
3	Vegetable and fruit trading			

Type of Soil and water conservation (SWC) technologies	what type of improved SWC technologies used on your farm? (1. Yes 0. No)	For how many Years did you use it? (Number of years)	Improved SWC con-structed by**	Which type of improved SWC technologies are easy to implement? (Rank:1,2,3,4,5)	Which type of improved SWC practice is effective in your farm plots? (tick)	Problems in practicing SWC* (Multiple responses are possible)
1. Stone bund						
2. Soil bund						
3. Stone faced soil bund						
4. Fanyajuu						
5. Cut-off drain						
6. Check-dam						
7. Terracing						
8. Contour ploughing						
9. Grass-strip						
10. Farm forestry						
11. Integrated SWC						
11. Others, specify						
12.						

**Problems related to SWC technologies*   **
1. Not effective to reduce erosion   1. Community campaign
2. Labour intensive   2. PSNP/other projects
3. Requires frequent maintenance   3. Farmers themselves
4. Difficult to implement
5. Take land out of production
6. Difficult to turn oxen

5. If improved **SWC practices** used on your farm land, fill the following table

Types of improved SWC practices built in on your farm land	Area of land developed in meter	Number of plots SWC practices built on the farm land	Types of improved SWC practices built in on your farm land	Area of land developed in meter	Number of plots SWC practices built on the farm land
Stone bund			Fanya juu		
Soil bund			Farm forestry		
Cut-off drain			Grass strip		
Check-dam			Others, specify		
Terraces					

6. If you are using improved SWC technologies/practices, what factors do you consider in constructing SWC structures on your farm land?

1. Land size 2. Soil characteristics 3. Labor availability 4. Soil fertility status

5. Steepness of the slope 6. Intensity of rainfall 7. Availability of construction material

8. Others, specify: —————————————————————————–

7. How do you compare the problem of soil erosion in your farm land after intervention of improved SWC technology/practice?

1. Aggravated 2. Reduced 3. No change 4. I do not know

8. Did you have plots where improved SWC structures were built by food for work or by any other community participation in the past? 1. Yes 2. No

9. If yes, what is the present condition of the structures?

1. Partially removed 2. Completely removed 3. Reconstructed 4. Retained

10. Which type of structures did you remove?

1. Soil bund 2. Stone bunds 3. Check-dam 4. Others: ——————————-

11. How do you perceive the importance of SWC technologies?

S.N	Importance of SWC practice	1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree (put the scale)
1	Improving soil fertility	
2	Improving vegetation cover	
3	Improving crop yield	
4	Improving income	
5	Alleviate food shortage	
6	Improving water availability	
7	Soil depth increased	
8	Reducing runoff	

12. If you removed constructed SWC structures from your farmland, why? 1. I think it wastes my farmland 2. I didn't see its advantages 3. It was removed by erosion or … 4. Damaged by others livestock

5. Others (specify) _____.

13. If you use traditional conservation practice used on your farm land, fill the following table

No.	Mention types of traditional conservation measures used on your farm land	Which type of traditional conservation measures are easy to implement? (Rank)	Which type of conservation measure is effective in your farm? (Rank)	What factors do you consider in constructing the structures?
1	....			

PART 10: Community Participation on Campaign of SWC practices

18. Do you participate on soil and water conservation campaign organized so far? 1. Yes 0. No

19 If yes, for how many years? _____

20. If No, why? _____

21. If you participate on SWC activities, is it on project based? 1. Yes 0. No

22. If it is project based, please name the project. _____

23. When does the project started (year project started) _____?

24. What support does the project give to the SWC activities? 1. training partici-pants

2. Financial support 3. Material support 4. Provide food to beneficiaries

25. How do you participate on SWC in the watershed? _____.

26. The land on which you conduct SWC activities are: 1. Communal 2. Individ-ual's

27. Is there area closure in your area? 1. Yes 0. No

28. If there is area closure, did it get rehabilitate? 1. Yes 0. No

29. If it rehabilitated, how did you get benefit from it? 1. Use water from spring generated 2. Use cut-carry grass for livestock 3. Use beekeeping in the area 4. Use wood for house construction and firewood

5. Others(specify) _____

30. Do you think that the SWC practices have an impact on your household Income and productivity?

1. Yes 0. No

31. How do you rate extension services on SWC?

1. Very poor 2. Poor 3. Medium 4. Good 5. Very good

32. What are the weaknesses of SWC campaign by the government each year? 1. No training 2. No material/seedlings 3. We do not participate on planning 4. No accountability after work

33. What is the productivity five major crops?

No.	List of three major crops grown	Yield per hectare in 2003 E.C (before SWC)	Yield in 2010/11 per hectare (after SWC done)
1.			
2.	....		

34. What is the income from the following Activities on area closure? (To be filled for both groups)

No.	Sources of income	Estimated Income amount in 2004 E.C (before SWC done)	Estimated Income amount in 2011 E.C (after SWC done)
1	Use water from spring generated		
2	Use cut-carry grass for livestock		
3	Use beekeeping in the area closure		
4	Use wood for house construction and firewood from area closure		
5	Employed as guard for area closure		

35. Who participate on SWC activities in your household? (Multiple answer possible)

1. Husband 2. Wife 3. Boys 4. Daughter 5. Hired laborer

Part 11: Institutional support

3. Agricultural extension services participation

No.	Description	Response	Remark
1	Frequency of contact with DAs per month		__times
2	Have ever read of extension materials?		1. Yes 0. No
3	Have you ever been model farmer?		1. Yes 0. No
4	Do you listen to radio on agricultural program?		1. Yes 0. No
5	Have you participated on SWC practices?		1. Yes 0. No
6	Have you participated on demonstration on any agricultural matters (crop/livestock)?		1. Yes 0. No
7	Have you participated on Natural resource conservation?		1. Yes 0. No
8	How far is the DA site from your home (-hrs)		Walking hrs