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Impact of Soil and Water Conservation on Household Income in East Shoa Zone of Oromia

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Abstract

This study was conducted to assess the impact of Soil and Water Conservation (SWC) intervention on the livelihood of smallholder farm households in terms household income and productivity. To meet this objective primary data was gathered in 2010 from 120 sample respondents (50 SWC program participants and 70 non-participants). Descriptive and inferential statistics (Logistic regression) and propensity score matching (PSM) models were used to address the stated objectives. The analysis of mean difference in outcome variables before matching result indicated that the mean total crop yield for SWC practiced respondent households is 29.10 and 27.80 quintal/ha having 1.30 quintal difference in the study. In the meantime total annual crop income of households who participated in SWC program was 33,903 and 33,808.40 birr. 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. 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.

Keywords: Impacts, Income, participant, non- participant, household, PSM

1. Introduction

1.1 Background and Justification

Degradation of the Earth's surface (*i.e.* land degradation) is one of the most severe global problems of our times which affect 33% of the land surface; with consequences for more than 2.5 billion people. About 40% of the world's agricultural land is seriously degraded, where 80% of this degradation is caused by soil erosion. This worldwide depletion of land resources continues to be a serious hazard, particularly, in the least developing countries, where agriculture is the main pillar of their economy. Perhaps nowhere have these effects been deeper or have they created greater hardship than the farm population of Sub-Saharan African (SSA) countries. Land degradation in Ethiopia accounts for 8% of the global total. The most serious problem concerning country's land resources, however, is the removal of fertile topsoil by water. This is much more severe in the highlands where, 85% of the human and 77% of livestock population is living and agriculture is intensive. 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 cereal yield reduction averaging less than 1.2 tons per hectare in most of the highlands.

More than 90 percent of Oromia people are engaged in agricultural and pastoral activities for their livelihood. With little access to irrigation, these predominantly smallholding farmers depend on rainfall to cultivate their crops. Poverty, lack of access to improved technology, subsistence agriculture, deforestation, soil erosion and over-population are some of the problems that increase the vulnerability of the people to climate-related disasters.The need to better understand the relationship between natural resource conservation policies and local poverty and the lack of information on impacts has led to repeated calls for the adoption of rigorous impact evaluation methods. Measuring impacts is also necessary during implementation to ensure that interventions do not negatively affect local people. Whether PAs benefit or impose costs on local people depends upon the underlying relationship between local poverty and natural resource conservation.

External drivers, the rules and regulations imposed by the PA and the extent to which these are implemented. The natural resource conservation relationship is dynamic and may be different for different groups of people, implying that social impact assessment needs to consider who gains or losses, and when. Natural resource conservation may contribute to local livelihoods through a needs-driven natural resource dependence, whereby local poor people depend on low value natural resources to some extent for their livelihoods.

The effects of combine more than six years Ethiopian government attention for natural resource conservation some area of degraded land but the impact of technology on house hold income still unknown. There is also need to identify sustainable mechanisms for promoting evaluated and proven natural resource conservation techniques as current extension methodologies driven initiatives in West Arsi and East Shoa zones have to increase uptake and sustained implementation of such techniques.

Exploring farmer-led knowledge sharing platforms should be explored for scaling up proven technologies in activities. However, after this work it needed to establish the key socio-economic conditions affecting the performance and scaling out of *natural resource conservation* technologies. This will help in refining recommendations for their use and improve farmer's capacity to adapt to climate change.

Also its important for to identify and pace of impact of each indicators for ultimate answer regarding either the level of deficiency and income inequality in area or the trends of deficiency rather it concentrated on depicting the implication of the natural resource conservation alone.

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 East Shoa zone.

1.2 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. Methodology

2.1 Description of the Study Area

The study will be carried out in purposively selected areas of west Arsi& east shoe zones of Oromia regional state, In which most of East shoa are found in lowland that are 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 Technique and Sample Size

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 were drawn from each group to make the total sample size.

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

1st stage, SWC technology adopting districts were identified with both zones 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 120 (50 SWC program participants and 70 non-participants) sample respondents randomly selected.

2.3 Source and Type of Data

Both primary and secondary data were collected from selected districts. Primary data was collected from sample households who benefited from watershed through structured questionnaire. Secondary data was collected 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 were interviewed. A pre testing of the questionnaire was conducted before actual data collection was made.

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).

2.4 Methods of Data Analysis

Both descriptive and econometric analyses were 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 & 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.

2.5 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 were 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, participated in the program and 0 otherwise. It is mathematically as follows:

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

Where, Pi is the probability of participation,

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

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

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

a_0 = intercept

a_i = regression coefficients to be estimated

U_i= a disturbance term

2.5.1 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, **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

$P(Y=0) = P(Y^* \leq 0) = P(\beta^*xi+u \leq 0) = F(-\beta^*xi)$

$P(Y=1) = F(\theta - \beta^*xi) - F(-\beta^*xi)$

$P(Y=2) = 1-F(\theta - \beta^*xi)$ where: F stands for cumulative density function

2.5.2 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

2.5.3 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

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

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:

$$CONIND = \beta i\ xi + ui$$

2.6 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 were used.

3. Results and Discussion

3.1 Descriptive and Inferential Analysis

Household income and crop productivity

Table 1 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 29.10 and 27.80 quintal/ha having 1.30 quintal difference.

Table 1. 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	34,331.10	34,331.10	33,903	29,941.7	33,808.4	35,321.80	0.02
Productivity of teff (qt/ha)	28.90	18.30	29.10	17.60	27.80	19.0	0.08

3.2 Econometric Model Outputs

3.2.1 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 2). 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 2. Results of logit estimation household program participation

			Number of observation = 120	
			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*	.03022	-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.

3.2.2 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 3. Our common support region according to Caliendo and Kopeining, (2008) would lie between 0.193 and 0.897.

3.2.3 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 0.25was found to be the best matching algorithm for the data we have on 100 matched observations.

3.2.4 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 6 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 3. Propensity score and covariate balance

Variable	Before Matching (N=120)		t-value	After Matching (N=100)		t-value
	Program (N=50)	Non-program (N=70)		Program (N=50)	Non-program (N=50)	
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

3.2.5 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 91.93 per hectare. 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 5). 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 4. ATT for outcome variables of interest

Outcome variable	ATT on Treated	ATT on Control	Difference	S.E.	*t-value*
Gross crop income	27,508.7	27,416.8	91.93	5220.8	0.02
Crop productivity of teff (qt/ha)	26.99	24.89	2.11	6.04	0.35

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 and East Shewa Zones 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 this objective primary data was collected from 120 sample respondents, consisting 50 soil and water conservation program and 70 non-program participants.

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 and teff crop and household income, the result indicates the existence of a positive impact on both maize and teff 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.

References

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science (Land and Water Management) in the School of Agriculture and Enterprise Development, Kenyatta University.

Abebe, Y., & Bekele, A. (2014). The impact of soil and water conservation program on the income and productivity of farm households in Adama District, Ethiopia. *Science, Technology and Arts Research Journal*, *3*(3), 198-203. https://doi.org/10.4314/star.v3i3.32

Aliye, H., & Geremew, E. (1998). *Oromiya Agricultural Research Annual Report, 1996/97, Finfinne*, Ethiopia.

Alshi, M. R., Kumar, P., & Mathur, V. C. (1983). Technological change and factor shares in cotton production: a case study of Akola cotton farms. *Indian journal of agricultural economics*, *38*(902-2018-1960), 407-415.

Anandajayasekeram, P., Martella, D. R., & Rukuni, M. (1996). *A Training Manual on Research Evaluation and Impact Assessment of Investment in Agricultural and Natural Resource Research*. SADC-SACCAR, Gaborone, Botswana.

Assefa, A. (2007). *Impact of terrace development and management on soil properties in Anieniarea west Gojjim* (Master's thesis, Addis Ababa University, Ethiopia).

Badal, P. S., & Singh, R. P. (2001). Technological change in maize production: A case study of Bihar. *Indian Journal of Agricultural Economics*, *56*(2), 211-219.

Bisaliah, S. (1977). Decomposition analysis of output change under new production technology in wheat farming: Some implications to returns on research investment. *Indian Journal of Agricultural Economics*, *32*(902-2018-1394), 193-201.

Boehlje, M. D., & Eidman, V. R. (1984). *Farm Management*. John Wiley & Sons, Inc. New York.

Booker, T. (2009). *Ttropical soil manual: A handbook for soil and agricultural land conservation in tropics and sub tropics*. New York. Longman scientific and technical publishers.

CIMMYT. (1993). *The Adoption of Agricultural Technology: A Guide for Survey Design*. CIMMYT Economics Program, Mexico, D.F.: CIMMYT.

Eticha, G., Geleto, T., & Husen, A. (1998). A decade of research experience: Sinana Agricultural Research Center 1988-1997. *OADB Bulletin (Ethiopia)*.

Fitsum, S. (2002). Contribution of fanyajuu and normal bund for crop production in Ethiopia. *Addis Ababa, Ethiopia*, 83-84.

Gaddi, G. M., & Kunnal, L. B. (1996). Sources of output growth in new milk production technology and some implications to returns on research investment. *Indian Journal of Agricultural Economics*, *51*(3), 389-395.

Geremaw, S. (2005). Improve soil and water conservation on farm land on high land of

Ethiopia”. *Addis Ababa, Ethiopia*, 83-84.

Gujarati, D. N., & Porter, D.C. (2009). *Basic econometrics* (5th Ed., pp. 553-555). New York: McGraw-Hill.

Hadush M (2015). The Role of Community Based Watershed Management for Rural Livelihood in Wereda Adwa, Central Tigray Zone. *International Journal of Weather, Climate Change and Conservation Research, 2*(1), 22-46.

Herweg, K., & Ludi, E. (1999). The performance of selected soil and water conservation measures—case studies from Ethiopia and Eritrea. *Catena*, *36*(1-2), 99-114. https://doi.org/10.1016/S0341-8162(99)00004-1

Horton, D., Ballantyne, P., Peterson, W., Uribe, B., Gapasin, D., & Sheridan, K. (1993). *Monitoring and evaluating agricultural research: a sourcebook*. Cab International.

Kassa, Y., Beyene, F., Haji, J., & Legesse, B. (2013). Impact of integrated soil and water conservation program on crop production and income in West Harerghe Zone, Ethiopia. *Studies*, *14*, 15. https://doi.org/10.11648/j.ijema.20130104.11

Kerr, J. M., & Sanghi, N. K. (1992). *Indigenous soil and water conservation in India's semi-arid tropics*. London, UK: IIED International Institute for Environment and Development, Sustainable Agriculture Programme. https://doi.org/10.1016/S0169-5150(98)00026-7

Marasas, C., Anandajayasekeram, P., Tolmay, V., Purchase, J., Rooyen, J. V., Martella, D., & Prinsloo, G. (1999). The socio-economic impact of the russian wheat aphid integrated control program. In *CIMMYT.2000*. The Tenth Regional Wheat Workshop for Eastern, Central and Southern Africa. Addis Ababa, Ethiopia: CIMMYT.

Mengistu, K., Aseffa, S., Paulos, A., & Bekele, H. (2002). Profitability Study of Some Major Crops in Selected Woredas of Bale Highlands. Paper Presented on *Workshop Prepared by Socio-economics Department of EARO*, August 6-7, 2002, Addis Ababa.

Merewa. (2002). Bale Mountains-stronghold of Unique Wildlife. Merewa, A Quarterly magazine Prepared by Press and Audiovisual Department of The Ministry of Information, September, 2002

Mitiku, H., Herweg, K. G., & Stillhardt, B. (2006). Sustainable land management: a new approach to soil and water conservation in Ethiopia.

MOA. Ministry of agriculture, Annual report Retrieved on December 2015.

Mulinge, W. M., Thome, J. N., & Murithi, F. M. Impacts of long- term soil and water conservation on agricultural productivity in Katiti catchment, Kenya.In Mati B. (Ed). Agricultural water management intervention bearing returns on investment in eastern and southern Africa.Imawesa, Working paper 17 Nairobi, Kenya: Improved management of agricultural water in Eastern and Southern Africa. 2010.

Mushir, A., & Kedru, S. (2012). Soil and water conservation management through indigenous and traditional practices in Ethiopia: A case study. *Ethiopian Journal of Environmental Studies* *and Management*, *5*(4), 343-355.

Robert. *Sustainable agriculture, social, environmental and economies priorities*. IOWA state university press, USA. In Dave and Ketewa.S. Environmental and Ecological development; Addis Ababa, Ethiopia. 2008;402-405

Sankhayan, P. L. (1988). Introduction to Economics of Agricultural Production. Prentice-Hall of India, New Delhi, India. *Agricultural Economics, 32*(3), 202-207.

Shiferaw, B., & Holden, S. T. (1998). Resource degradation and adoption of land conservation technologies in the Ethiopian highlands: a case study in Andit Tid, North Shewa. *Agricultural economics*, *18*(3), 233-247. https://doi.org/10.1016/S0169-5150(98)00036-X

Shiferaw, B., & Holden, S. T. (1998). Resource degradation and adoption of land conservation technologies in the Ethiopian highlands: a case study in Andit Tid, North Shewa. *Agricultural economics*, *18*(3), 233-247. https://doi.org/10.1016/S0169-5150(98)00036-X

Woldeamlak B. (2003). *Land Degradation and Farmers' Acceptance and Adoption of Conservation Technologies in the Digil Watershed, Northwestern WORLD BANK. 1995*. World development report, Washington, D.C., USA

Workneh, N. (1998). Impact of improved Wheat Production Technology on Food Status of Farm Households in Two Woredas (Districts) of Ethiopia: A Preliminary Assessment. In: *CIMMYT.2000*. The Tenth Regional Wheat Workshop for Eastern, Central and Southern Africa. Addis Ababa, Ethiopia: CIMMYT.