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Impact of Carbon Sequestration Forestry Project on Income of Local Community: A Case Study on Soddo Community Managed Reforestation Project,SNNPR's Ethiopia

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Abstract
The atmospheric concentration of CO_2, which is the principal greenhouse gas, has significantly increased from its 280 ppm, preindustrial level, to 395ppm in 2014. As a result, many physical and biological systems and other key sectors including forest resources and societies in the developing countries are suffering. Multifarious mitigation efforts are being put in place to halt offset this negative outcome. In light of this, Soddo Community Managed Reforestation project is among these mitigation efforts under taken in Ethiopia since 2006. The major objective of this study was then to investigate the income benefit which goes to the local community from participating in this project. The study was carried out in three systematically selected Kebele Administrations (KAs) legally organized into forest Development Cooperatives and one control KA from which non-participant members were selected for the purpose of comparison. From these KAs, a total of 173 sample HHs (125 from participant KA and 48 from Control KA) were selected after matching based on systematic random sampling technique. Propensity Score Matching (PSM) was used to evaluate the impact of project participation. The result indicated there is significant difference in average annual income between the project participants and non-participants. The project participants earned an average annual income of 8806 Birr, which is 61% higher than that of the non- participants, who earned 5472Birr. The probability of participation in the project was positively and significantly determined by sex and distance at 0.1 significance level; educational status and landholding at 0.05 significance level and environmental knowledge at 0.01significance level, whereas age of the households was significant and negatively determined participation at 0.05 significance level. Thus, it has a paramount importance to scale up such projects in other potential areas of the county for the benefit of the community and ecosystem by government, non-governmental organizations and the private sectors into other potential areas of Ethiopia to contribute for its Climate Resilient Green Economy (CRGE) strategy.
Keywords: Climate Change, Reforestation, Propensity Score Matching

1.INTRODUCTION

The issue of climate change has become a growing concern globally. The Intergovernmental Panel on Climate Change (IPCC) clearly indicated the presence of climate change, its magnitude and projected impacts as unequivocal (IPCC, 2007). The report quantitatively highlighted that the atmospheric concentration of CO_2, which is the principal greenhouse gas, significantly increased from preindustrial level, 280 ppm to 395ppm[1] in 2014. As a result, many of physical and biological systems especially functions of ecosystem and other key sectors and societies in the developing countries have been suffering more. The world will face an average temperature rise of 3^0c in this century if GHG emissions continue to rise at the current pace (UNFCCC, 2009). Thus, short and long term policy options such as mitigation and adaptation measures are the key to reduce the impacts of climate change.

It was highlighted in FAO (2006) that deforestation and forest degradation practice has been common in Ethiopia and removed a total of 85.8 million m^3 in 1990 to 111.9 million m^3 in 2005**.** Ethiopia is facing rapid deforestation and degradation of land resources which are reducing the capacity of forests and the land to contribute to food security and to provide other benefits of forest such as fuel wood and fodder (Beshaw B., 2001).

EFAP (1994) indicated that by the early 1950s the forest cover of Ethiopia declined to 16% of the total land area, about 35% of the land area or nearly 40 million ha might once have been covered by high forests .The existing forest resources of Ethiopia however, can store 2.76 billion tons of carbon in the aboveground biomass, which will be released to the atmosphere in 50 years if the deforestation continues at the current pace of about 2% (Yitebitu M. et al., 2010).

Climate change funding mechanisms available currently for financing forestry sector are CDM and REDD. In response to global effort to mitigate climate change and to benefit from this financing opportunity, Ethiopia has made numerous efforts in implementing various natural regeneration projects in some regions of the

[1]For recent GHG concentrations visit: http://cdiac.ornl.gov/pns/current_ghg.html

country. Till 2013G.C, Humbo A/R and Soddo community managed reforestation projects are the only forestry projects certified and registered by UNFCCC as CDM and CFS with huge carbon sequestration potential of 880,296 and 189,183 tCO_2eq respectively through their lifetime (WVE, 2012& 2013).

Forest provides wide ranges of environmental services when it is managed properly. The sector plays a crucial role in mitigating global climate change through carbon sequestration, stabilize natural environment, ensure sustainable ecosystem, biodiversity conservation, and ecotourism promotion. It also contributes to livelihood improvement of the rural poor in ensuring sustainable development through enhanced income from the sale of carbon credit (Takacs, 2010). Moreover, it has an important social impact through creation of green job, promote rural development, and improve food security and other social amenities (Mulenga et al., 2012).

The Soddo Community Managed Reforestation project is the project of interest and was launched in 2006. It is an initiative of the Soddo community and World Vision Ethiopia to restore and protect the montane high-forest on the slopes of Mt Damota, in the highlands of Southern Ethiopia. The aim of the project is to maintain and improve the diversity of native flora and fauna , improving soil conditions to reduce the risk of floods, erosion and to improve agricultural yields and potential livelihood, environmental rehabilitation for carbon sequestration and to support long term sustainable ecosystem regeneration (WVE, 2006).

World Vision Ethiopia (WVE), in collaboration with World Vision Australia (WVA) has invested huge money to support for project implementation and transaction costs. To improve livelihood of the community, diversified sources of income were created to avoid forest encroachment and ensure food security at household level. The project is being managed by legally established five forest development cooperatives. The cooperatives granted land use right along with legal personality to protect and benefit from the project (WVE, 2012). The project also certified after fulfilling all the requirements and has started to generate carbon revenue for the community since 2014 (WVE, 2014).

Despite the fact that the project has been operational in the area for the last eight years and has brought changes both in the lives of community and ecosystem, so far systematic study has not been made to know the impact on socio-economic dimension of the participant community. Thus, this study was initiated to investigate the socio-economic impacts of Soddo Community Managed Reforestation project on local community, which at end determines the project fate for the success or failure.

2. STUDY DESIGN AND METHODOLOGY

2.1. Description of the study area

The survey respondents were selected from a sampling frame of legally organized forest development cooperatives and a control kebele. As per the data obtained from Soddo Area Development Program 2014, there is a total of 4135HHs (2858 HHs in three cooperative and 1277 in non-cooperative KA (control KA). Among these, 991 individuals (35%) are members of the forest development cooperatives and are actively participating in carbon forestry project. Hence, the sampling frames were taken for all members of the forest development cooperatives and households of the control KA. To keep proportionality between participants and non-participants (control) KA, a total of 353 HHs, which is 28% of the total HHs and live within 2-3 kms, were used to draw the sample from the control KA. The assumption here is that those individuals who live closer to the project site better know about the environment than those who live relatively distant and, hence they can provide all necessary information related to the project. Thus, the total population on which the survey sampling was drawn was 1344. 202 HHs (15%) were selected for the survey. The sampling techniques used to draw the representative samples from the sampling frame is systematic random with size to proportion sampling

2.2. Methodology

A range of methodologies exist to estimate program effect. However, each comes with its own limitations. When data permits and there is a baseline information or a panel data set, a before and after comparison will be appropriate. Instrumental variable regression is also an important method through which one can evaluate the effect of a program. However, the difficulty if not a limitation with instrumental variable regression, is identification of instrumental variable/s which takes care of the selectivity bias and still provide consistent and efficient estimates. Another alternative methodology for evaluating program effects is to use matching techniques, appropriate when there is no baseline information or panel data set and the analysis should rely on available cross section dataset. With a cross section data different matching techniques have gained prominence in evaluations of a program effect (Ali and Abdulai, 2010). In matching methods an individual from comparison group is matched with one from the treatment group and difference in outcome variable of interest in the intervention computed (Caliendo and Kopeinig, 2008). A Propensity Score Matching method is useful in the absence of an experiment as there is no need to have a baseline and panel data (Caliendo and Kopeinig, 2008). It compares treatment effects across participants and matched non-participants based on the propensity to participate. A good comparison group should come from the same economic environment and administered the same questionnaire by similarly trained interviewers as the treatment group (Baker, 2000).

In this model households have two choices. The treatment indictor *D* is 1 if a household participated in community carbon sequestration project and 0 otherwise. The potential outcomes can be defined as *Yi* (Di) for each individual *i*. The treatment effect for an individual ***i*** is then:

$$T_i = Y_i(1) - Y_i(0) \dots\dots\dots\dots (1)$$

From equation 1 the counterfactual problem is clear because only one of the potential outcomes is observed for each individual *i*. *Yi* (0) is not observed for community carbon sequestration project participants, whereas *Yi* (1) is not observed for non-participants. Therefore, estimating the individual treatment effect *Ti* is not possible and there is a need to focus on average treatment effects.

The main goal of impact assessment studies is to get rid of selection bias for which Propensity Score Matching (PSM) has become one of the major approaches to estimate causal treatment effects while overcoming the problem of selection bias. To obtain the program effect, the outcomes of participating and non-participating households with similar propensity scores are compared. Households for which no match is found are dropped because they cannot be compared.

Based on a model for the probability of participation in contract farming *D,* conditional on observed characteristics *X,* the propensity score can be obtained by:

$$P(X_i) = \Pr(D_i = 1|X_i) \dots\dots\dots\dots (2)$$

For the matching method to be valid, there are assumptions that should be satisfied. These are Conditional Independence (CIA) and presence of a common support (Khandker et al., 2010). CIA states that given a set of observable covariates *X* that are not affected by treatment; potential outcomes *Y* are independent of treatment assignment *D* (Rosenbaum and Rubin 1983; Khandker et al., 2010). In the this case, this means that the counterfactual income is the same as the income level that would have existed if the household had not participated in contract farming given by:

$$(Y_0), (Y_1) \perp D_i|X_i \dots\dots\dots\dots (3)$$

The common support or overlap condition is the second assumption: $0 < P(D_i = 1|X_i) < 1$.

This condition implies that treatment observations have comparison observations "nearby" in the propensity score distribution (Rosenbaum and Rubin 1983; Khandker et al., 2010).

As these assumption holds, the PSM estimator for ATT can be written in general as;

$$T_{ATT}^{PSM} = E_{P(X_i)|D_i=1}\{E[Y_i(1)|D_i = 1, P(X_i)] - E(Y_i(0)|D_i = 0, P(X_i)]\} \dots\dots\dots (4)$$

In this study, application of PSM uses the probability of participation obtained from a logit model.

Next, the controls were matched to each treatment using a selected matching algorithm. Different matching criteria can be used to assign participants to non-participants on the basis of the propensity score. In this study, participant and non-participant households were, therefore, matched using the, kernel and radius matching methods. Following the data cleaning process, it was possible to maintain 173 households from which number of non- participant households was 48 compared to the participant households which was 125. To avoid loss of sample units, as a result, matching with replacement was conducted during the PSM analysis.

3. RESULTS

3.1. Economic Impacts of Participation in Reforestation Project

The major sources of income in the study area were crop production, livestock rearing, off-farm activities (petty trade, wage, remittance) and sale of environmental products and services like carbon credit. The study indicated that the average annual income obtained from various activities for the area was 7,881 Birr/household. It significantly varies between the project participants and the non-participants (Table 1)

The project participants earned a total annual income of 8806 Birr. Among incomes generated from various sources, income from livestock sale, crop production and off-farm activities constituted a highest share of 41%, 22% and 14% respectively. The share of income from the sale of carbon credit is 7% and will significantly grow and constitute to a highest % age in the coming crediting period of the project until the project sequesters 50000tCO_2eq.

The non-participant of the project obtained a total annual income of 5,472ETB/year, which is 39% less than the total income of the participants (Table 1). Among these incomes generated from various sources, income from livestock sale, off farm activities, and crop production constituted a highest share of 62%, 15% and 14% respectively (Table 1). Thus, in the absence of benefits obtained from environmental services such as carbon credit, the income of the non-project participants mainly relays on livestock rearing, off-farm activities, crop production, and other sources such as planting and sale of Eucalyptus

The income contribution of carbon revenue and related income generating activities contributed 7.3% income increment within a year. Overall, there was a mean difference of 3334 Birr between the project participants and non-participants (Table 1). This much income changes on project participants was not merely the sole efforts of the project intervention though its contribution is significant. Rather it was attributed to the sale of 6,157 tCO_2eq for 41,559.75 USD (831,195 Birr) in 2014 after deducting carbon reversal and monitoring costs. As per the agreement entered with the voluntary credit buyer, participants will continue to receive money

until the project sequesters 50,000 tCO_2eq, from which they will earn additional 394,587USD (7,891,740 Birr) from the sale of 43,843 tCO_2eq. Thus, in the coming few years, the project will bring more impacts on the livelihood the participant community.

Table 1: Income Sources (Birr/year) of sampled households in Soddo Zuria Woreda

Income Sources	Non- participants		Participants		Total	
	Mean	SD	Mean	SD	Mean	SD
Crop production	782	853	1901	1659	1590	1561
Livestock sale	3370	4136	3571	3078	3515	3393
Environmental Services	0	0	81	234	58	202
Off-farm activities	852	1247	1228	1634	1124	1542
Sale of carbon credit	0	0	577	322	417	377
Carbon credit sale and adaptation activities	0	0	611	344	442	401
Others	469	1541	703	1320	638	1384
Total income	5472	4881	8806	4299	7881	4698

3.2. Determinants of Participation in Reforestation Project

The logistic regression estimation result (Table 2) indicated that the probability of participation in reforestation project was significantly and positively determined by sex, educational status, landholding, distance from market center and environmental knowledge at 10%, 5% and 1% probability levels, whereas age of the respondent was significant and influenced participation negatively at 5% probability level. Thus, sex, educational status, landholding, distance from market, and environmental knowledge variables are determinants of participation in the reforestation project.

Table 2: Estimation of Logistic Model Regression for Determinants of Participation

Variables	**Marginal effects**	**Z-Value**
Constant	0.008	1.21
Family Size	0.16	0.48
Head Sex	-0.09	1.85*
Head Age	0.001	-2.24**
Educational level	0.455	2.10**
Land size	0.351	2.53**
TLU	0.016	1.23
Distance from Market Center	0.031	1.86*
Environmental Knowledge	0.125	3.02***
Presence and Interconnectedness of Local institutions	0.177	0.74
Number of obs = 173		
LR $chi^2(10)$ = 45.030		
Prob> chi^2 = 0.000		
Log likelihood = -79.645		
Pseudo R^2 = 0.220		
Source: Own calculation. *, **, *** respectively indicate significance levels at 10, 5 and 1% probability levels.		

3.3. Income effect of participation in the project

Propensity scores for the total observations vary between 0.06 and 0.994(0.72). For participants scores vary between 0.26 and 0.994 (mean= 0.789) and between 0.068 and 0.903 (mean = 0.547) for non-participants of carbon project. Radius and Kernel matching techniques were employed later to evaluate the impact of the project to the communities. However, the large significant difference between the covariates before matching, as it is seen in the following table (Table 3) for all of the variables included in the model, there was no meaningful statistical difference after they were matched. This can be confirmed by the t test values. In addition the Histogram (Figure 1) indicated further that the matching was well combined as there are very small number of observation which stand of support. This is an evidence that every group of the participant has gotten a match to compare to.

Table 3: matching test between covariates.

Variables	Mean		%bias	% Reduction |bias|	P-Value after Matching
	Treated	Control			
Family Size	6.72	6.55	7.00	9.00	0.634
Head Sex	0.76	0.72	9.00	50.00	0.577
Head Age	37.33	36.78	7.00	78.00	0.644
Head Education	3.30	0.99	-8.00	74.00	0.397
Land size	0.38	0.36	7.00	88.00	0.615
TLU	2.54	2.59	-2.00	95.00	0.904
Distance from Market Center	7.16	7.00	9.00	81.00	0.562
Environmental Knowledge	0.89	0.88	1.00	99.00	0.959
Interconnectedness	0.94	0.96	-9.00	59.00	0.512

Source: own calculation.

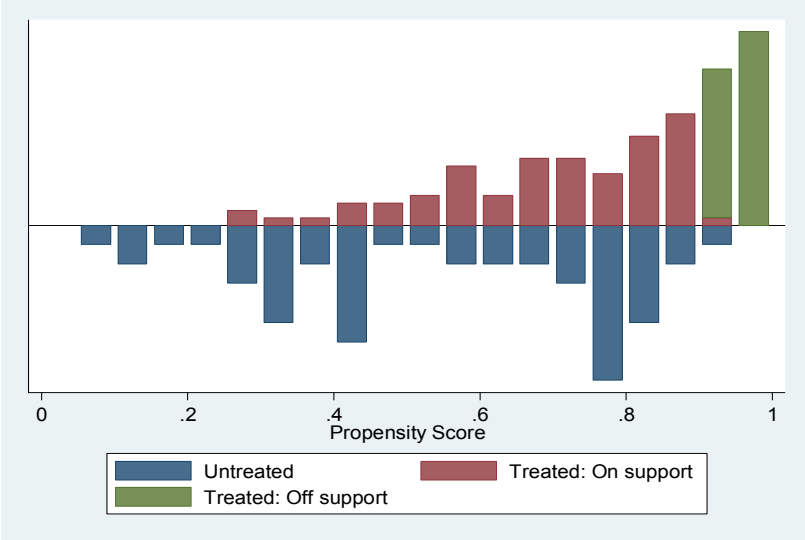

Figure 1: Histogram of propensity score among the treated and non-treated group.

Income benefits going to the project participants were evaluated using two matching techniques, Caliper and kernel matching techniques. The choice was made for simplicity. Besides the robustness of the income benefits from the project was done at different values of Caliper distances and Kernel widths. Table.4. summarizes the result of this analysis. It can been seen that the project had significant income contribution to the project participants and the result was consistent even after it was evaluated using different caliper distances and kernel widths. On average, project participants gained around 3000 to 4500Birr after matching. This difference in income was statistically significant at 5% level of significance.

Table 4. Income benefits based on Kernel and Caliper matching techniques.

Matching Technique	sample	Treated	Controls	Difference	T-stat
Kernel(0.5)	Unmatched	8805.6	5472.4	3333.2	4.39
	ATT	**8805.6**	**5704.8**	**3100.0**	**3.79****
Kernel(0.25)	Unmatched	8805.6	5472.4	3333.2	4.39
	ATT	**8805.6**	**6007.9**	**2797.6**	**3.13****
Kernel(0.1)	Unmatched	8805.6	5472.4	3333.2	4.39
	ATT	**8805.6**	**5822.8**	**2982.8**	**2.96****
Caliper (0.01)	Unmatched	8805.6	5472.4	3333.2	4.39
	ATT	**8732.0**	**4761.1**	**3970**	**3.10****
Caliper (0.03)	Unmatched	8805.6	5472.4	3333.2	4.39
	ATT	**8441.0**	**4495.7**	**3945.2**	**2.71***
Caliper(0.05)	Unmatched	8805.6	5472.4	3333.2	4.39
	ATT	**8756.7**	**4268.1**	**4588.62**	**2.80***

Source own calculation

3.4. Sensitivity tests

The sensitivity test result indicated that the result of this study, difference in income between participants and non-participants of a carbon sequestration project is robust and will not change for unobserved hidden bias even when the propensity scores of being treated differ by as large as 200%((e^{γ}=2.03)

Gamma	Sig+	Sig-	t-hat+	t-hat-	CI+	CI-
1	4.8e-12	4.8e-12	2763.45	2763.45	2031.84	3577.09
1.05	1.0e-10	8.9e-13	2672.43	2872.79	1938.86	3678.21
1.1	2.4e-11	1.6e-13	2586.5	2965.85	1859.28	3770.57
1.15	3.9e-10	3.0e-14	2498.7	3055.8	1774.37	3868.15
1.2	1.3e-09	5.6e-15	2418.84	3125.64	1705.92	3954.45
1.25	4.0e-09	1.0e-15	2351.69	3200.22	1623.19	4048.06
1.3	1.1e-08	2.2e-16	2288.79	3286.89	1561.79	4128.67
1.35	2.9e-08	0	2211.65	3355.19	1491.14	4209.11
1.4	6.9e-08	0	2152.19	3426.76	1429.28	4304.9
1.45	1.6e-07	0	2089.49	3493.42	1363.31	4386.27
1.5	3.3e-07	0	1551.87	3568.31	1298.07	4453.75
1.55	6.7e-07	0	1968.52	3637.07	1226.2	4533.97
1.6	1.3e-06	0	1927.74	3697.59	1168.92	4610.05
1.65	2.4e-06	0	1873.29	3752.36	1118.39	4670.84
1.7	7.5e-06	0	1821.21	3812.67	1066.24	4742.39
1.75	4.3e-06	0	1767.74	3872.92	1015.9	4817.01
1.8	.000012	0	1724.86	3929.85	961.914	4881.08
1.85	.00002	0	1678.22	3987.87	919.608	4957.02
1.9	.000032	0	1628.53	4040.68	870.835	5022.75
1.95	.000049	0	1592.54	4082.13	822.034	5083.42
2	.000074	0	1551.87	4147.51	781.177	5145.49

Source own calculation

4. Conclusion and Recommendation

The results from this analysis shown that participation in the project is influenced by factors such as age, sex, educational status, land holding, distance from major market and environmental Knowledge. This indicated those individuals who are Male headed, with younger and productive age, educated and well acquainted with environmental knowledge are more likely to participate in the project management than their counterparts. The primary reason to this is that the laborious and time demanding nature of carbon forestry activities on which older people and Females can't easily cope with. The econometric analysis result indicated that there is a significant difference in average annual income between the project participants and the non-participants. The result shows that the project participants after matching earned an average annual income of Birr 8806, which is 61% higher than that of the non- participants, who earned 5472 Birr.

In designing and implementation of such reforestation projects and improve incomes of participating households, government and any project proponent should consider age, sex, educational status, landholding, distance from market and the understanding level of community on the environment as determinant factors to ensure project sustainability and improving the livelihood of community. High population number and growth significantly contributed to land shortage. When the population growth continues at this pace, there will be high risk of deforestation by the community. Thus, special training and awareness creation program should be arranged by the government and development partners.

REFERENCES

Ali, A. and Abdulai, A. (2010). The adoption of genetically modified cotton and poverty reduction in Pakistan. *Journal of agricultural economics vol.61, No1, 2010, 175-192*.

Badege Bishaw. (2001). Deforestation and Land Degradation in the Ethiopian Highlands: A strategy for physical Recovery. Oregon University, Corvallis.

Baker. J. (2000). Evaluating the Impact of Development Projects on Poverty A Handbook for Practitioners. The World Bank Washington, D.C.

Caliendo, M. and Kopeinig, S. (2008). Some practical guidance for the implementation of propensity score matching. *Journal of Economic Surveys, Vol. 22, (2008), 31–72*.

Central Statistics Authority (CSA). (2007). Addis Ababa, Ethiopia

EFAP.(1994). The challenge for development. Ministry of Natural Resources Development and Environmental Projection, Final Report. Volume (2).

FAO. (2006). Global Forest Resource Assessment 2005: Progress towards Sustainable Forest Management. Italy, Rome.

IPCC. (2007). An Assessment of the Intergovernmental Panel on Climate Change Synthesis report contained in the Working Group contributions to the Fourth Assessment Report

Mulenga, B.P., Richardson, R.B and Tembo, G. (2012). Non-Timber Forest Products and Rural Poverty Alleviation. Indaba Agricultural Policy Research Institute Lusaka, Report 6.

Rosenbaum, Paul R., and Donald B. Rubin. (1983). "The Central Role of the Propensity Score in Observational Studies for Causal Effects." *Biometrika* 70 (1): 41–55.

Takacs, D. (2010). Forest carbon offsets and international law: a deep equity legal analysis. International Environmental Law Research Centre, International Environmental Law Review 521.

UNFCCC. (2009). Climate change science

WVE. (2006).Soddo Community Managed Reforestation Project; Project Design Document (PDD)

WVE. (2010). Soddo Community Managed Reforestation Project; Project Redesign Document Unpublished

WVE. (2012). Soddo Community Managed Reforestation Project; (Project Terminal Report); Unpublished

WVE. (2013).World Vision Ethiopia Soddo Community Managed Reforestation Project: Community Climate Biodiversity Alliance (CCBA)

WVE. (2014). Soddo Community Managed Reforestation Project; (Project Annual Progress Report); Unpublished

Yitebitu M., Zewdu E., and Sisay N. (2010). Ethiopian Forest Resources: Current Status and Future Management Options in View of Access to Carbon Finances. Addis Ababa, Ethiopia