Impacts of Smallholder Tree Plantation in Amhara Region of Ethiopia: The Case of Lay Gayint and Fagta Locuma Districts[1]

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Abstract

This study analyzes the impacts of smallholder plantation on the households' total cash income, modern agricultural input use, education and health care spending of 300 sampled households in Lay Gayint and Fagta Locuma district's of the Amhara Region, Ethiopia. A propensity score matching (PSM) analytical model has been used to examine the impacts of smallholder plantation on total cash income, improved agricultural input use, educational and health care expenditure. The PSM tool confirmed that, participation in to tree plantation had a significant impact on farm households total cash income, education and health expenditure outcome. However, it does not have a significant impact on the use of modern agricultural inputs. The findings of this study calls for the scale up of best practices of smallholder plantation in Amhara region and in Ethiopia at large. In addition, concerns have to be given in improving land productivity, educational level of farm households, and increasing market access and linkages, value addition of plantation products, expansion of infrastructures especially road and telecommunication networks in the rural parts to raise participation in plantation.

Key words: plantation, propensity score matching, planter, non-planter, impact analysis
JEL Classification: Q23, C99, DO2, C91, C18

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1. Introduction

Forests have an important role to play in alleviating poverty worldwide in two senses. First, they serve as a vital safety net function, helping rural people avoid poverty, or helping those who are poor to mitigate their plight. Second, forests have untapped potential to actually lift some rural people out of poverty (Sunderlin *et al.*, 2004). However, the actual and potential contribution of forests and trees to food security and sustainable livelihoods tends to be overlooked by decision and policy makers. The reason is due to a predominance of information on crops and livestock in the agriculture sector and/or a narrow vision on the role of forestry sector (FAO, n.d). This implies that, the contribution of forests to poor households is largely unrecorded in national statistics, most of it being for subsistence or for trade in local markets. In addition, the lion's share of wealth from timber goes to better-off segments of the society while some aspects of timber resources actually inhibit their potential to assist marginalized people.

Farm forest plantation has now been seen by many households as socially acceptable due to its ability to ensure the sustainability of the resource base and improve their socio economic wellbeing. Small scale forest plantations provide a range of benefits to rural communities, including fuel wood, fodder and wood for building and daily uses, as well as environmental and amenity benefits (FRA, 2010; Nawir *et al.,* 2007). Yet small scale producers and poor households still reap only a small portion of the commercial benefits from plantation derived wood and processed wood products, even though plantations in developing countries produce billions of dollars' worth of these products annually. There has been also a consistent bias against smallholder forestry in most developing countries with regard to technical support, market structure and government policies (Byron, 2001).

In Ethiopia, forest resources play a vital role in income generation especially for the poorest population. However, the economic contribution of forest resources to the national development of Ethiopia as well as to household livelihood is not adequately captured. A variety of forest products and services that constitute a major source of livelihood for rural households are not formally traded or not monetary valued. Therefore, forestry's contribution is underestimated to the national economy (EPA, 2007).

Ethiopia has a long history of tree planting activities. According to historical records, afforestation started in the early 1400s by the order of King Zera-Yakob (1434-1468). Modern tree planting using introduced tree species (mainly Australian *Eucalyptus*) started in 1895 when Emperor Menelik II (1888-1892) looked into solutions for alleviating shortage of firewood and construction wood in the capital city, Addis Ababa (Nawir *et al.,* 2007). Forest plantation practices in Ethiopia are mainly of exotic tree species with *Eucalyptus* covering the largest area of hardwood plantations (EPA, 2007).

Amhara region has wide biodiversity composition of flora and fauna species (BoA, 2012). Plantation forests are mainly found in Awi, North Shewa, South Gonder, South Wollo, East and West Gojam zones of the region. These plantation forests are ranging from large scale to woodlots and homesteads. *Eucalyptus species*, *Acacia decurrence and Cupressus lusitanica* are the most common tree species widely planted in community woodlots and private tree investments in Amhara region.

Studies have been done on smallholder plantation in Ethiopia and Amhara region especially on *eucalyptus* plantation. Such studies were mainly focused more on the environmental and hydrological effects and impacts of *eucalyptus* and on value chain analysis (Example: Sirawdink *et al.,* 2011; Tilashwork *et al.,* 2013). However, there is no empirical evidence on whether or not participation in plantation improves the livelihoods of the participant households; that is, there is no study that has been done to examine the socioeconomic impacts of smallholder plantation in the study area. Hence, this study attempts to provide empirical evidence on the impact of smallholder plantation (*Acacia decurrens and Eucalyptus)* on household cash income, improved agricultural input use, education and health care service in the study districts.

The overall objective of this study is to examine the socioeconomic impacts of smallholder plantation forests in the study area. Specifically it evaluates the impact of smallholder plantation on:

- The economic benefits (total cash income and use of improved agricultural input) of the participant households.
- The social wellbeing (education and healthcare services) of the participant households.

2. The Conceptual Framework

2.1 Impact Evaluation Approaches

The main confront of an impact evaluation is to determine what would have happened to the beneficiaries if the program had not existed (Khandker, Koolwal, and Samad, 2010). A beneficiary's outcome in the absence of the intervention would be its *counterfactual*. However, the counterfactual is not observed. So the challenge is to create a convincing and reasonable comparison group for beneficiaries in light of this missing data. Ideally, one would like to compare how the same household or individual would have fared with and without an intervention or "treatment." But one cannot do so because at a given point in time a household or an individual cannot have two simultaneous existences. Therefore, finding an appropriate counterfactual is the main concerns of an impact evaluation. There are two methods to solve this problem: experimental and non-experimental approaches (Diaz and Handa, 2004).

2.1.1 The Experimental Approach

Experimental designs, also known as randomization, are generally considered the most robust of the evaluation methodologies. By randomly allocating the intervention among eligible beneficiaries, the assignment process itself creates comparable treatment and control groups that are statistically equivalent to one another, given appropriate sample sizes (Baker, 2000). If the assignment is properly carried out, random assignment creates a control group comprising individuals with identical distributions of observable and unobservable characteristics to those in the treatment group (within sampling variation). Hence, the selection problem is overcome because participation is randomly determined (Bryson, Dorsett, and Purdon, 2002).

2.1.2 Non experimental (Quasi-experimental) Approach

Non-random methods can be used to carry out an evaluation when it is not possible to construct treatment and comparison groups through experimental design. These techniques generate comparison groups that resemble the treatment group, at least in observed characteristics, through econometric methodologies, which includes propensity score matching, double difference methods, instrumental variables methods, and reflexive comparisons (Baker, 2000). These techniques require imposing assumptions which are non-testable, although many of their implications might be, and may or may not be tenable in actual data (Diaz and Handa, 2004). The choice of best approach is determined in large part by practicalities. Specifically, the characteristics of the program and the nature and quality of available data are key factors (Bryson *et al.,* 2002).

2.1.2.1 Propensity Score Matching Analysis

Propensity score matching analysis is a relatively recent statistical innovation that is useful in the analysis of data from quasi-experiments (Luellen, Shadish and Clark, 2005). The notion in propensity score matching is to develop a counterfactual that is as similar to the treatment group as possible in terms of *observed* characteristics. Each participant is matched with an observationally similar nonparticipant, and then the average difference in outcomes across the two groups is compared to get the program treatment effect (Khandker *et al.,* 2010). This method is very appealing to evaluators with time constraints and working without the benefit of baseline data given that it can be used with a single cross section of data (Baker, 2000).

Propensity score matching method have many advantages over other methodologies. First, it does not necessarily require a baseline or panel survey (Khandker *et al.,* 2010). Second, it allows matching subjects on a single number, no matter how many covariates are existed (Luellen *et al.,* 2005). Third, it avoids the ethical considerations which arise when a potentially beneficial treatment is denied to those randomly assigned out. Fourth, data generation may be less costly than in the case of an experiment since the latter involves substantial monitoring to secure the random allocation (Bryson *et al.*, 2002).

This study adopts propensity score matching (PSM) technique, which is generally considered as a second best alternative to experimental design for such setting where there is no baseline or panel survey (Khandker *et al.*, 2010). There are steps to undertake propensity score matching analysis.

The first step under this methodology is estimation of propensity scores. Binary logistic regression is appropriate for estimating propensity scores, when the observed outcome for a dependent variable can have only two possible values (Gujarati, 2004; Luellen *et al.,* 2005).

The imposition of the common support is the second assignment in this methodology. There are two formal guidelines which are used to determine the region of common support (Caliendo and Kopeinig, 2005). Comparing the minima and maxima of the propensity score in both groups is the first method. This method is based on the notion that deleting observations whose propensity score is smaller than the minimum and greater than the maximum value in the opposite group. After the overlap region has been identified, observations whose propensity score fall outside this region will be rejected and for these individuals the treatment effect cannot be estimated. The second way is based on estimating the density distribution in both groups.

In evaluation literatures, there are mainly three different criteria's used for checking out the matching quality and choosing the best matching algorism which is suited for the available data for analysis (Caliendo and Kopeinig, 2005; Stuart, 2010). These are equal means test; low pseudo-R^2 value and large matched sample size are the commonly used criteria's. Matching algorism which provides insignificant means difference among all explanatory variables after matching between treated and control groups, low pseudo-R^2 value, and large matched sample is chosen as the best matching estimator.

Once the best matching algorism is selected, checking whether the propensity score adequately balances characteristics between the treatment and comparison group units is the following task. There are three alternative tests which can be used to prove the matching quality. These are standardized bias test, t test, Joint significance and Pseudo-R^2 tests (Heinrich *et al.*, 2010). The basic idea of all approaches is to compare the situation before and after matching and check if there remain any differences after conditioning on the propensity score (Caliendo and Kopeinig, 2005). If there are differences, matching on the score was not successful and remedial measures have to be done.

Subsequent to undertaking the above tests to check the validity of PSM, estimating the treatment impact of plantation program is the succeeding assignment. For a binary treatment, let D_i is program participation and let Di = 1 for those who receive treatment (participate in to plantation) and Di = 0 for those who do not receive treatment (not participate in to plantation). Then, the impact of a treatment on individual i, is the difference between the potential outcomes with and without treatment:

$$\tau_i = Y_1 - Y_0$$

Where, τ_i is treatment effect (effects due to participation in plantation), Y_1 is outcomes of participant household and Y_0 is outcomes of non participant household.

To evaluate the impact of a program over the population, it is possible to compute the average treatment effect (ATE) as:

$$ATE = E[\tau_i] = E(Y_1 - Y_0)$$

The parameter that received the most attention in evaluation literature is the average treatment effect on the treated (ATT) (Caliendo and Kopeinig, 2005; Diaz and Handa, 2004; Baum, 2013), which is defined as:

$$ATT = E(\tau_i / D = 1) = E[(Y_1 - Y_0)/D = 1]$$
$$= E(Y_1 / D=1) - E(Y_0/D=1)$$

Where $E\ (Y_1/\ D=1)$ is the average outcome of those households who participated in plantation and $E\ (Y_0/D=1)$ is the average outcome of those households if they were not participated in plantation program.

However, $E\ (Y_0/D=1)$ is unobserved and is the counterfactual of interest: what the outcome for treated units would have been had they not received treatment; however, this counterfactual is not observable in the data. What we can observe instead is the average outcome in the untreated state $E\ (Y_0\ /\ D=0)$[6], which could serve as an estimate for the counterfactual and ATT can be computed as,

$$ATT = E\ (Y_1/D = 1) - E\ (Y_0/D = 0)$$

The difference between the counterfactual for treated units and observed outcomes for untreated units is called selection bias term (Baum, 2013). That is,

$$E\ [Y_0/D = 1] - E\ [Y_0/D = 0] = \text{selection bias (SB)}.$$

The true parameter *ATT is* only identified, if selection bias is zero (SB=0); that is;

$$SB = E\ [Y_0/D = 1] - E\ [Y_0/D = 0] = 0$$

Conducting of sensitivity analysis is the final procedure in PSM. The matching only control for the differences on the observed variables and there may be some bias resulting from unobserved covariates that could affect whether subjects receive treatment or not (Luellen *et al.,* 2005). If there are unobserved variables which affect assignment into treatment and the outcome variable simultaneously, a hidden bias might arise to which matching estimators are not robust (Becker and Caliendo, 2007). The concern here is, whether or not inference about treatment effects may be altered by unobserved factors.

[6] In our case, $E\ (Y_0\ /\ D=0)$ is the average outcome of those households who didn't participated in plantation (households who don't have planted tees).

3. Methodology

3.1 The Study Area

Lay Gayint district is found in South Gondar zone of Amhara National Regional State. It is found 75 km away from the zonal capital Debre Tabor, and about 175 km from Bahir Dar, along with the main road from Bahir Dar to Woldia. Geographically, the district is located between 11^0 32′-12^0 16′ north latitude and $38^0$12′-38^0 19′ east longitude. Altitude of Lay Gayint ranges from 1 500 to 4 231 meters above sea level. The mean annual temperature in the district is between 8 ^{0}C and 20 ^{0}C, while average annual rainfall ranges from 660 mms to 1 200 mms (Lay Gayint District Agricultural Office, 2013). Crop production, livestock and forest products mainly from plantation are the principal sources of livelihood for farmers. The district has a great potential for forest plantation. Especially, *Eucalyptus globules* and *Cupresses lustanica* tree species are widely planted in this district.

Fagta Locuma district has a total land cover of 67 733.32 hectares and it is one of the eighth district's of Awi zone; Amhara region. It has about 25 rural and 2 urban kebeles. Agriculture and tree plantation are the basis of the livelihood of the district. Recently, the district has become known in its *Acacia diccurence* plantation. The latitude of the district ranges from 1,800 to 2,950 metres above sea level while the average rain fall and temperature of the area is 2 371 mm and 20 °C respectively (Fagta Locuma District OoFED, 2014).

3.2 Sampling Techniques

A multistage sampling technique was used to select sample households. In the first stage, two districts namely; Lay Gayint and Fagta Locuma were purposely selected because of their best smallholder plantation experience and plantation species differences. *Eucalyptus globules* and *Acacia decurrence* plantation experience are widely found in Lay Gayint and Fagta Locuma districts respectively. In the second stage, in consultation with district level experts from each district, two sampled kebeles (a total of four kebeles) were purposively selected for their considerable plantation forestry practices. In the third stage, households in the selected kebeles were stratified into planters (program participants) and non-planters (program non participants). In the final stage, a total sample of 300 households (a sample of 150 households from each district) from which 153 participants (planters) and 147 non-participants (non participants) were randomly selected for the analysis.

3.3 Data

Both primary and secondary data were used. Primary data on the socio economic characteristics, farm characteristics, and demographic characteristics, resource ownerships of the households, tree plantation practices, hypothesized impact indicators and other variables which are relevant for the study were collected using a pre-tested structured questionnaire through household survey. Secondary data on the price of each crop in the respective districts were collected from different institutions; the Trade and Transport Bureau of Amhara National Regional State; Trade and Transport Office, Finance and Economic Development Office and Agricultural Office of district's.

3.4 The Analytical Model

To estimate the multidimensional impacts of plantation, one must first calculate the propensity score $P(X)$ on the basis of all observed covariates X that jointly affect participation in plantation and the outcome of interest (Khandker *et al.*, 2010). Propensity score typically computed using logistic regression (Caliendo and Kopeinig, 2005; Luellen *et al.*, 2005; Domingue and Briggs, 2009). The study assumed that participation in plantation is program intervention and households who have planted trees were considered to be a treated group and households who don't have planted trees were the controlled group. Therefore, PSM was used to compare the level of economic and social impacts of planters to that of non-planters.

Accordingly, the logit model for participation in plantation program is specified as follows.

$$Pr(participation) = f(X_i)$$

Where $Pr(participation)$ is the probability of participation in plantation (both in *Eucalyptus* and *Acacia decurrence)*; $f(X_i)$ is dependent variable of the model; household's participation in plantation forest. It takes value 1 if the household is participated in plantation and takes 0 otherwise. Households' having planted trees with area cover of 0.125 hectare and above were considered as planters whereas households who never planted trees or have planted trees with area cover below 0.125 hectare of land were considered as non planters. $X_i s$ are multidimensional vector of covariates affecting the probability of participation in plantation.

$$X = (sex, age, fmly\_size, educ, land\ size, land\_prod, livestock, ex\_service, mkt\_distc, nursery)$$

Where;

$-sex$ = sex of the household head (1= male and 0= otherwise)

$-age$ = age of the household head in years.

$-fmly\_size$ = the number of individual members in a given household.

$-educ$ = a dummy variable used to measure the educational status of the household head (1= literate and 0= illiterate)

$-land\_size$ = the amount of land holding in hectares.

$-land\_prod$ = a proxy variable used to measure the productivity of agricultural land (main crop produced in the study area) of the household measured in monetary value per hectare per year.

$-livestock$ = the total number of livestock holding measured in tropical livestock unit.

$-ex\_service$ = the number of days per year in which agricultural extension workers visit a given household farming practice for the provision of extension service.

$-mkt\_distc$ = the distance measured in kilometre from household's village to the nearest market centre at which farmers sell plantation product (sell at the farm get price).

$-nursery$ = a dummy variable for ownership of nursery by a household and takes value 1 if a household has a nursery site and 0 otherwise.

The impact indicator variables used to assess the impact of tree plantation on participant households in this study includes:

Household income (cash income): It is the amount of annual household cash income which is generated from different income generating activities (from crop sale, livestock and the sale of their product, sale of forest and plantation tress, and income from other off farm activities etc).

Improved agricultural input use: It is the adoption of improved agricultural inputs by households in farm practice. It is the amount of annual household's spending in birr for the purchase of improved agricultural input (for fertilizers, improved seeds, pesticides, insecticides, adoption of improved animal species etc). Participation in plantation is expected to increases the incomes of households.

Education spending: This is the annual amount of birr spent for educating household members who are currently enrolled in education.
Expenditure on health care service: This is the annual health care spending of household for their family members measured in terms of birr.

4. Results and Discussion

4.1 Descriptive Statistics Results

Table 4.1 shows that statistically there is a significant difference between planters and non-planters in terms of family size, land holding in hectare, livestock holdings, extension service provision and distance to the nearest market centre. Family size and extension services are significant at 5% and 10% probability levels respectively while land holding in hectare, market distance and livestock holdings are significant at 1% probability level. In contrast to the non-planter households, planter households have large family size, larger land holding, livestock holding, being visited more frequently by development agents and short distance to the nearest market centre.

Table 4.1: Summary Statistics and Mean Difference Test on Continuous Covariate Variables

Variables	Unit	Planters (N=153)		Non-planters (N=147)		Total (N=300)		Mean Difference		T value
		Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	
age	Year	50.85	13.75	49.67	14.59	50.27	14.16	1.18	1.64	0.719
family size	No	5.74	1.99	5.27	2.09	5.51	2.05	0.45	0.24	1.976**
land size	ha	1.53	0.76	1.004	0.69	1.27	0.77	0.53	0.84	6.245*
livestock	TLU	5.17	3.37	3 .93	2.61	4.56	3.08	1.23	0.35	3.53*
extension service	Day	28.07	23.87	23.46	23.65	25.81	23.83	4.62	2.74	1.68***
market distance	Km	3.94	2.60	4.90	3.39	4.41	3.05	-0.97	0.35	-2.783*
land productivity	Birr	8013.2	10869.4	6590.3	6597.5	7316	9045.5	1423	1043.9	1.364

Remark: *, ** and *** significant at 1%, 5% and 10% significance levels respectively.
Source: Survey result

The output tabulated in Table 4.2 also revealed that, there is a statistically significant difference between planters and non-planters in total cash income, spending on the access to modern agricultural inputs, education and health care services. Planters on average obtain total cash income of birr 27.45 thousands which is 206.7 percent higher than the total cash income of non-planter households and this result is significant at 1% probability level. Similarly, on average planter households spend 86.2 percent and 53 percent more money for education and the purchase of modern agricultural inputs as compared to non-planter households and significant at 1% and 10% probability levels respectively. Hence it is possible to signify that, non-planter households spend birr 0.61 thousands on average more than that of the planter households for healthcare and this result is significant at 5 % probability level.

In cognizant, on average, at 1% probability level planter households approximately educate one more (0.001 thousand) family member (kid) than non-planter households. Moreover, planter households spend birr 0.32 thousands more per head (kid) per annum for education compared to non-planter households.

Table 4.2: Summary Statistics and Mean Difference Test of Outcome Variables (in thousands)

Variables	Planters (N=153)		Non-planters (N=147)		Total (N=300)		Mean difference		T value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Total income	27.45	49.25	8.95	19.02	18.38	38.67	18.5	4.35	4.25*
Crop income	1.39	2.3	0.69	1.27	1.05	1.90	0.7	0.22	3.18*
Livestock income	3.46	7.93	4.07	16.86	3.76	17.07	-0.61	1.51	-0.41
Plantation income	18.02	47.39	1.45	5.83	9.9	35.03	16.57	3.94	4.21*
Off_ income	4.59	10.72	2.75	6.43	3.68	8.91	1.84	1.02	1.8***
Input spending	2.05	3.75	1.34	2.5	1.7	3.22	0.71	0.37	1.92***
Education enrolment	0.003	0.002	0.002	0.0013	0.0023	0.0014	0.001	0.0002	5.0*
Education spending	2.42	3.46	1.3	1.99	1.87	2.89	1.12	0.33	3.4*
Spending per kid	0.97	1.45	0.65	0.79	0.82	1.2	0.32	0.15	2.13**
Health spending	0.81	1.39	1.42	3.38	1.11	2.58	-0.61	0.3	-2.1**

Remark: *, ** and *** implies significant at 1%, 5% and 10% significance levels respectively.
Source: Survey result

4.2 The Logit Outcome

Prior to econometric estimation, different econometric assumptions were tested using appropriate techniques to check the reliability and consistency of the collected data. The presences of strong collinearity among explanatory variables were tested using variance inflation factor and contingency coefficients for continuous and discrete explanatory variables respectively.

Thus, the test results confirmed that, there are no serious multicollinearity problems among explanatory variables. Similarly, presence of hetroscedasticity problem was tested by Breusch-Pagan test and the result proved that there is no problem of hetroscedasticity.

4.2.1 Propensity Scores

Binary logistic regression model was used to estimate propensity scores for matching treated households with control households. For estimating propensity scores only those variables which affect both the likelihood of plantation and the outcomes of interest were included. The estimated regression results (see Table 4.3) shows that the probability of participation in plantation is significantly and positively affected by nursery ownership, land holding size, land productivity, and household head education and these results are significant at 1%, 1% 5 % and 5% probability level respectively. On the other hand, the probability of participation in plantation is negatively affected by distance to the nearest market centre which is significant at 1% probability level. A strong and positive relation between nursery ownership and participation in plantation might be due to the fact that, having nursery reduces the investment funds, which is potentially limited for smallholders, incurred to purchase seedling, and hence increases the likelihood of planting trees. Households who have large land holding have the likelihood of planting trees. The reason as to why this might be the case is that in plantation, investments and returns occur in different time horizons, so that net return maximization is an inter-temporal problem. Smallholders continuously discount the expected costs and returns. Therefore, having large land holding may help households to allocate parts of it for crop production, animal grazing and the remaining for planting trees. This result is consistent with the finding obtained in Sodo Zuria district, southern Ethiopian (Bliss and Zeleke, 2010) and in New Zealand (Dhakal *et al*, 2008).

Likewise, land productivity strongly affects plantation participation. This implies that households who own productive land have higher probability of planting trees (mainly due to high market demand for plantation products) than households whose land is less productive. This finding is also in line with the study made by Bliss and Zeleke (2010) in Sodo Zuria district, southern

Ethiopia. In terms of the educational status of head of the household, households having literate head are more likely to plant trees than their illiterate counterparts. The possible explanation for this might be because literate households better know the environmental and economic benefits of planting trees and plantation management techniques than the illiterate ones. Education level is also found to have positive correlation with tree plantation in Sri Lanka (Karunarathna and Gunatilake, 2002).

Table 4.3: Logistic Regression Results for Plantation Participation

Variables	Coefficients	dy/dx (Marginal effects)[a]	Z_value
_cons	-1.55	-	-2.00
Sex	-0.67	-0.162	-1.17
Extension service	0 .003	0.0004	0.22
Livestock	.03	0.006	0.38
age	-0.0024	-0.0008	-0.28
Family size	0.009	0.0032	0.12
Nursery ownership	1.38	0.332	4.96*
Land size	1.17	0.292	4.26*
Market distance	-0.16	-0.038	-2.99*
Land productivity	0.00005	0.00002	2.34**
Education	0.59	0.1455	1.98**
Number of obs =	300		
LR $chi^2(10)$ =	91.02		
Prob > chi^2 =	0.0000		
Log likelihood =	-162.37663		
Pseudo R^2 =	0.2189		
% correctly predicted =	80%		

Remark: *, and ** indicates significant at 1% and 5% significance levels, respectively.

a dy/dx is for discrete change of dummy variable from 0 to 1

Source: Estimation result

Since market inaccessibility restricts opportunities for income-generation (IFAD, 2003), there is also an inverse relationship between the planting decision and the distance to the nearest market centre. As a result, those households who are living near to the market centre are more likely to plant trees than households who are far apart from the market centre. This might be because nearest to the market households are likely to incur lower transaction and transport costs, have better access to information and extension services than the distant households.

4.2.2 Common Support Region

After estimation of propensity score, determination of the common support region is the next assignment. The common support is determined by using the comparison of the minima and maxima of the propensity scores. The common support region (Table 4.4) lies between 0.0800483 and 0.9891113. This implies that, out of the total 300 observations, ten observations were deleted from the analysis and not used to estimate the treatment impact.

Table 4.4: Distribution of Estimated Propensity Scores

Groups	Obs.	Mean	Sta. dev.	Min	Max	Omitted obs.
All sampled households	300	.51	.2610326	.0249842	.9899327	10
Planter households	153	.6459373	.2218888	.0800483	.9899327	1
Non-planter households	147	.3685143	.2208271	.0249842	.9891113	9

Source: Estimation result

4.2.3 Matching Algorism

Three different criteria; equal means test; low pseudo-R^2 value and large matched sample size were used to prove the matching quality and choosing the best matching algorism. In line with this, kernel matching with band width 0.1 fits all the three criteria and hence the best matching estimators for this study. Thus, results are given based on kernel matching algorism with 0.1 band width.

4.2.4 Testing the Balance of Propensity Score and Covariates

Standardized bias, t-test, Joint significance and Pseudo-R^2 are used to check the matching quality. With regards to these tests, the result shows that after matching, the distributions of covariates have no significant differences for both planter and non-planter households and it is trustworthy to estimate treatment effect based on the available data set.

4.2.5 The Impacts of Smallholder Plantation

The main goal of propensity score analysis is to balance two non-equivalent groups; treated and control groups, on observed covariates to get more accurate estimates of the effects of a treatment (average treatment effect on the treated) on which the two groups differ (Luellen *et al.*, 2005). In line with this, the result from the propensity score matching estimation (Table 4.5) shows that there is significant difference in total cash income between planter and non-planter households and this result is significant at 1% probability level. It has been found that, on average, planter households have an income of birr 27.6 thousands, which is by 141.68 percent higher than the total cash incomes of non-planter households. This leads to a viable proposition that households participated in plantation set a prior aim of generating cash income.

Also, there is a statistically significant difference between planters and non-planters on education spending for household members who are currently enrolled in education (Table 4.5). Planter households spend 69.45 percent more birr for educating their household member than their counter parts. This might be because, first, as compared to the other agricultural activities plantation demands less labour force and hence school aged household members may attend education and educational spending rises in line with the number of enrolment. Second, plantation product is more liquid and divisible asset than another asset and hence enables households to easily access finances required for education and other related costs. Third, having high income is positively associated with education (Blanden, Gregg and Machin, 2002).

With regard to healthcare spending, there is a significant difference between planter and non-planter households and this difference is significant at 10% probability level. Looking into the health care spending, on average non-planter households spend about birr 0.92 thousands more than the planter households. The reason might be due to the fact that planter households have generated more income especially from plantation and this opportunity enables them to consume a balanced and diversified diet, to buy more sanitary materials and cloth than to that of the their counter parts and hence reduces health care spending. Poor diets and poor nutrition can lead to a number of different and very serious health problems (FAO, n.d). Balanced diets and good eating habits are fundamental for proper growth and development and for the prevention of disease. It helps to prevent from debilitating health problems caused by poor nutrition.

Table 4.5: Impacts of Plantation Forest on Households (per annum)

Outcome Variables in thousands	Treated	Controls	Difference	S.E[B]	T value
Total cash income	27.6	11.42	16.18	4.31	3.75*
Educational spending	2.44	1.44	1.00	0.38	2.63**
Health care spending	0.82	1.74	-0.92	0.50	-1.84***
Agricultural input spending	2.051	1.664	0.39	0.40	0.975

Remark: *, ** and *** implies significant at 1%, 5% and 10% significance levels, respectively.

[B] Stands for bootstrapped standard error which is obtained after100 replication.

Source: Estimation result

Modern agricultural input use which is measured in terms of monetary spending on the purchase of such inputs (for example fertilizer, improved seeds, insecticides, insecticides and so forth) is the last outcome indicator variables of plantation participation. As it is shown in Table 4.5, there is insignificant difference between planters and non-planters in terms of modern agricultural input use. The possible reasons might be; first planters are shifting some proportions of their land for planting trees; which does not require the use of modern agricultural inputs and hence spending on such inputs was low. Second, planter households may spend more of their plantation income for consumption purpose especially on manufactured consumer goods, which are highly income elastic and the purchase of other asset bearing activities like livestock, house construction and the like.

4.2.6 Sensitivity Analysis

Sensitivity analysis helps to check the estimated results based on matching are robust to the possible presence of unobserved confounders (Keele, 2010). The Rosenbaum bounding approach of sensitivity analysis was used to assess how robust the findings are to hidden bias due to an unobserved confounder in this study. The sensitivity analysis result shows even though two groups (planters and non-planters) with the same observed covariates (after matching) may differ in their odds of receiving the treatment by a sensitivity parameter up to Γ=6, the inferences on the impacts of smallholder plantation on the households total cash income, educational and health care spending results are insensitive to unmeasured covariates.

5. Conclusion and Policy Implication

5.1 Conclusion

This study examined the impacts of smallholder plantation on the households' total cash income, modern agricultural input use, educational and health care spending in Fagta Locuma and Lay Gayint districts of the Amhara National Regional State, in Ethiopia. Cross sectional data sets using structured questionnaires were drawn from a sample of 153 planter and 147 non-planter households.

Findings have shown that there is a statistically significant difference between planters and non-planters in terms of total cash income, education and health spending and modern agricultural input uses. Planter households have higher total cash income, educational spending and modern agricultural input use than non-planter households. In contrast, non-planters have higher health care spending than the planters.

The propensity score matching estimation result shows that, there is a significant difference between planters and non-planters in terms of the outcome variables; total cash income, education spending and health care spending. The effect of plantation on households total cash income revealed that, on average planter households generated a cash income of birr 27.57 thousands, which is by 141.68 percent higher than the total cash incomes of non planter households. Moreover, for education purpose, on average planter households spend 69.85 percent more birr than the non-planter households. In addition, non-planter households spend 918 more birr over the planter households for health care service. In contrast, smallholder plantation has not brought significant effect on the planters in terms of modern agricultural input use in the study area under consideration.

5.2 Policy Implication

Evaluating the impacts of smallholder plantation has a paramount importance to scale up plantation practices by prioritizing certain areas of intervention in the sector through designing policies, programs and projects. Thus, the following recommendations are drown for better development of smallholder plantation.

- The likelihood of plantation participation is significantly and positively affected by land productivity. Applying certain sustainable land management practices such as soil bounds, stone bounds, check dams and so forth; fertility improvement practices such as application of chemical and natural fertilizer (ex. manure) and agronomic practices such as crop rotation and fallowing has a great role for improving the productivity of land. Thus, attention has to be given to intensify such practices.
- The educational status of the household head is also another significant factor which affects plantation participation. Therefore, better attentions have to be given to educate farmers (to increase the awareness of farm households). Especially, more focuses have to be given for farmers training, functional adult literacy and vocational education and trainings.
- Nursery ownership has also positive impact on plantation participation. Poor seedlings are likely to have slower growth, to be less able to compete with weeds, and to be more liable to damage by insects and pests. Further, in a poor nursery, fewer seedlings will be raised from a given quantity of seed, and there will be considerable waste of money and time. Thus,

owning nursery (nurseries) helps in matching demand with production of planting materials and controlling its quality, to reduce the financial money spend for purchasing seedlings. Therefore, emphasis have to be given on the establishments of own nursery sites by households coupled with the provision of quality seeds and other required inputs.

- Better attentions have to be given to establish and expand market centres, infrastructure like road, telecommunication, and market information system near to smallholder farm households.
- Due attention is required to expand plantation practices as it is considered to be a key instrument to reduce rural poverty.
- Concerns also have to be given to organize farmers into cooperatives so as to increase the bargaining power of farmers in the market place to obtain good prices for their plantation products, developing new market channels for the products, enable cost-effective delivery of extension services and to access timely information for the member households.

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