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IMPACTS OF PARTICIPATORY FOREST MANAGEMENT ON RURAL HOUSEHOLDS' LIVELIHOODS: THE CASE OF BONGA PARTICIPATORY FOREST MANAGEMENT PROJECT, SOUTH WEST, ETHIOPIA

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ABSTRACT

Participatory Forest Management (PFM) is a typical forest management approach that critically requires the active participation of the local community for the wise exploitation of forest products while protecting the forest from any unplanned intervention. PFM started in Ethiopia in the mid-1990s and proved to be successful practice in benefiting the local people and improving forest conditions. PFM has been practiced in Bonga forest, South West Ethiopia. There are no adequate site-specific empirical studies on the effectiveness of PFM approaches through the use of rigorous and scientifically valid impact assessment methods in this study area. This paper assessed the impacts of the PFM on the livelihoods of rural households' of PFM member of Bonga PFM sites. A total of 269 households, 141 from PFM member and 128 from Non-PFM members were randomly selected for household survey to collect socio-economic data. Key informant interview and focus group discussion was also employed. The collected cross-sectional data were analyzed using the propensity score matching (PSM) model. The result revealed that PFM increased the forest income of PFM members by 3466.60 ETB and the number of consumption assets by 1.25. PFM had also decreased livestock holding in TLU by 1.44 and household income from the crop by 4827.68 ETB. We conclude that PFM has a positive impact on rural households' livelihoods and recommend that other livelihood strengthening interventions should be integrated with PFM to enhance the performance of PFM.

KeyWords
PFM participant, impact assessment, livelihood assets, propensity score matching, rural household income

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1. Introduction

Participatory forest management (PFM) approaches started in the 1980's in the world as an institutional solution to combat the multiple challenges of sustainable forest resource management (Moss et al., 2005). The basic idea of PFM is that forests can be conserved and sustainably managed when local communities manage local forests and are able to derive direct benefits from their participation (Agrawal and Ostrom, 2001). PFM attempts to ensure the sustainable management of forest resources that are fallen under open-access situations; ultimately combating the tragedy of commons occurring on common-pool resources through well-defined and secure common property rights. Whereas these common property rights through PFM arrangements offer well-built institutions of property rights that prevent the resource from exhaustive depletion.

PFM has been started in the mid-1990s in Ethiopia as one of the ways applied to reverse deforestation and depletion of natural resources due to open access to forest and thereby improves the livelihood of participant households. The Government of Ethiopia (GoE) and other development partners have extended their support to local communities to design and implement community management of natural resources including forests in the country. In this regard, the participatory forest management (PFM) model has been initiated and practiced in Ethiopia with two projects (Temesgen et al., 2007).

PFM has been implemented in several places in Ethiopia and has been supported by several nongovernmental organizations (NGOs) including FARM-Africa, SOS Sahel Ethiopia, and other NGOs German Society for Technical Cooperation (GTZ), and Japan International Cooperation Agency (JICA) (Jirane et al., 2008). Some of the PFM locations are FARM-Africa's PFM projects in Bonga and Chilimo; SOS Sahel's PFM projects in Borana; GTZ's PFM project in Adaba Dodolla, and JICA's PFM project in Belete Gera (Tolessa, 2002; Feyissa, 2008). These PFM projects were established having as the major objective of contributing to sustainable forest management through the development of partnership between a government organization and forest-dependent local communities' (Lemenih and Bekele, 2008). Whereas the government retains the ownership right to the forests the local communities who organize themselves into Forest User Groups (FUG) have the user right to the local forests (Ameha et al., 2014a).

Studies have suggested that PFM in Ethiopia is bringing positive enhancement on condition of forests, creating a good partnership of stakeholders (government and community), improving participation of the local community in forest management, and improving their livelihoods (Tolessa, 2002; Temesgen et al. 2007; Lemenih and Bekele, 2008; Jirane et al., 2008; Gobeze et al., 2009; Yemiru et al., 2010; Ameha, 2011; Tesfaye, 2011; Lemenih et al., 2015; Ameha et al., 2016; Ayana et al., 2017; Tadesse et al., 2017a; Kedir et al., 2018; Siraj et al., 2018; Wood et al., 2019). But these studies were unable to properly separate changes due to PFM from changes due to other factors that are not related to PFM.

Previous studies followed a simple comparison of income differences within forest user groups (FUG) without using rigorous and scientifically valid impact assessment methods. Gobeze et al. (2009) had studied similar studies five years before this study conducted. Gobeze et al. (2009) have used a mixed qualitative and quantitative approach to assess the impacts of PFM and its impacts on livelihoods and forest status taking the case of the Bonga forest. However, quantitative measurements of the before and after cases, particularly in terms of income which is paired analysis of the income within-participant, were not made and compared between participant and non-participants households to undertake a more rigorous assessment of impacts.

Ameha et al. (2014b) and Takahashi and Todo (2012) have noted that the PFM impacts are variable across locations in their studies. However, only a few PFM programs have actually been systematically evaluated to documents their impacts and learn for future planning. In this regard, there are no sufficient empirical studies to reach a consensus on the effectiveness of PFM in Ethiopia through impact assessments that are conducted in more rigorous and scientifically valid methods except the few studies that cannot represent the overall environmental settings of pilot projects in the country.

Therefore, the present study is aimed at evaluating the impacts of the PFM program implemented on rural households' livelihoods which is to assess the level of achievement of PFM objectives in terms of livelihoods of participant households taking the case of Bonga PFM projects in South West Ethiopia. To inform the design and planning of future PFM scaling up efforts taking actual experiences that are empirically tested for their effectiveness:- (1) to assess the impact of PFM on the livelihoods of rural households involved in PFM (2) to describe the change in access to forest products due to PFM implementation for participants of PFM. The study uses propensity score matching to assess the impact of PFM on livelihoods by measuring the change in household income and asset accumulation.

2. Methodology and Ideological Options

2.1. Study Area

The study was conducted in two districts, Gimbo and Decha, within the Bonga forest area which is found within the Kaffa Zone of Southern Nations, Nationalities and other people Regional State (SNNPRS), South West Ethiopia (Fig. 1). Bonga forest is designated as a National Forest Priority Area (NFPA) and much of its parts are protected as closed forest. The first PFM project was started by FARM Africa in 2004 (Fekadu, 2007) and covered three districts namely, Gimbo, Decha, and Gewata. Out of more than 17 old pilot PFM sites found in the two districts (Gimbo and Decha), this study drew six PFM sites from the two districts namely Wacha, Matapa, and Kichib (from Gimbo district) and Decha, Meda, and Ermo (from Decha district) which were established.

2.1.1. Bonga PFM project

The forest area coverage under PFM in Bonga and the Keffa biosphere reserve includes 34169ha and 760144ha respectively (Temesgen and Lemenih, 2011). Six PFM sites that were selected from the two districts Gimbo (located at 7° 20' 0" N, 36° 10' 0" E with a total of population 128,887 (CSA, 2012)) and Decha (located at 6° 50' 0" N, 36° 10' 0" E with a total of population 89,892 (CSA, 2012)) districts. However, to increase the pool of non-PFM members for the subsequent analysis, the study also drew one adjacent non-PFM site (Meligawa kebele place name Sheka) in the study area. Whereas Wacha, Matapa, and Decha PFM projects have been supported by FARM Africa, Kichib, Meda, and Ermo were established through the partnership with FAO. In the projects, both husband and wife are expected to participate in PFM as independent individual PFM members. The PFM project implementation in the area might be considered that appeared to liberate, not only from poverty but also from social segregation adequately (Temesgen and Lemenih, 2011). In this study PFM members are the participants of PFM which they had an agreement with the state by pledging themselves to take responsibility, to manage, protect and use forest products except for timber from defined areas of the forest. Whereas Non-PFM member is not the participant of PFM in these areas they had also forest to be used in common (open access) but they had no agreement with the state as a participant of PFM.

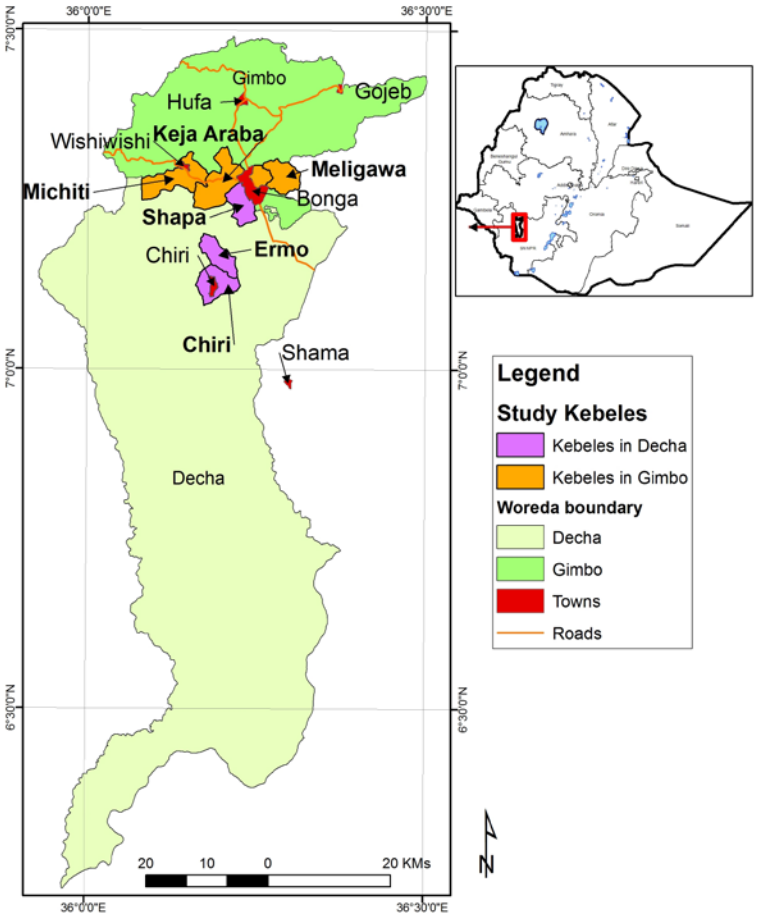

Figure 1: Map of the Study Area

Source: Demeke Nigussie (2014).

2.2. EMPIRICAL DATA

PFM members were selected based on considering in getting reliable estimates of program impact and in the household survey data variables also selected that are associated with the outcome (Calinedo and Kopeing, 2008). The survey was designed both conditions by sampling PFM and non-PFM member households from the same village and by providing a technique for collecting recall data from the establishment of PFM (before PFM)for matching.

In this study the base years were selected for data collection, the official year of PFM establishment before PFM which lies between 2004 - 2009 and 2014 for after PFM data collection years were considered respectively (Khandker et al., 2010). To improve recall, we selected a base year that could easily be remembered by the majority of community members. In this case; the day of the signing of an official agreement on the management plan and bylaws of the PFM with kebele, district, and zone agricultural offices, and administrative. Hence, in the income calculation, the currency was based on the data collection year 2014 for both before PFM and after PFM to eliminate time variation in impact evaluation. The total values of crops, livestock products, and forest products were calculated by multiplying the amount produced by the average price and/or substitute price in the local market of each item in the specific study year 2014.

Households from the village located adjacent to the forest, PFM members served as a treated group and the non-PFM member also served as a control group against which the impact of the PFM program on household livelihoods were estimated. Both the control (non-PFM members) and treated (PFM members) groups share the same common economic, social, and institutional variables and also use forest but the control group forest is not included in the PFM. This study used a combination of purposive and probability sampling methods to draw the sample household observations. A list of PFM and non-PFM members was prepared separately in consultation with community leaders. A random sample of 23 PFM members and 23 non-PFM members from each selected six PFM site was drawn. From the adjacent non-PFM member site, 46 non-PFM members' households were selected randomly. Eventually, total samples of 322 households were included in the study. From the whole 322 households 53 households' had to be dropped from the analysis due to extreme values and 269 households (141 from PFM member and 128 from Non-PFM members) were used for the analysis.

A total of 27 Key informants' interviews and 12 focus group discussions (6 to 10 people) were also conducted to generate more data. Key informants and participants of focus group discussions were identified by consulting local experts, village leaders, field workers, and project staff.

2.3. HOUSEHOLD SURVEY

The survey followed a total household accounts approach in a modified form of the Poverty Environment Network (PEN, 2007) questionnaire. The survey was used to evoke household socio-demographic characteristics and total annual income (both subsistence and cash income) which is household annual income from all different sources and related expenditure (expenses and costs), household collection, marketing, and annual revenue from forest products were considered.

The questionnaire used to produce all household-level data from various types of rural livelihood activities (agriculture, livestock production, forest income, off-farm activities income (like petty trading) and other income (remittance, gift …)) and the household assets for both the base year (recall data from the time of PFM establishment year) and the data collection year 2014. Numbers are stated in net income i.e. the gross value minus the expenditure cost including labor cost. Furthermore, the livestock holding was converted to Tropical Livestock Unit (TLU) (Storck et al., 1991).

The questionnaires were pre-tested and corrected accordingly. The field survey was administered by thirteen trained enumerators. The data collection was undertaken from June 28 to July 28, 2014, with close onsite supervision of the author.

3. Empirical Framework

3.1. EVALUATING PFM IMPACTS

In the absence of an experiment, the key tricky in estimating the household livelihoods impact of PFM is that what would have happened to those who, in fact, did participate, if they had not participated. Therefore, building this unobserved counterfactual remains the main difficulty of impact evaluation. Propensity Score Matching (PSM) Model is one of the correction strategies that correct for the selection biases in making estimates. PSM is used to compare treatment effects across participant and matched nonparticipant units, with the matching conducted on a range of observed characteristics (Khandker et al., 2010). The average impact of the program on its participants or the average effect of the treatment on the treated (ATT) is then calculated as the mean difference in outcomes across these two groups (ibid). From the character of this observational data in this study, PSM was used to find out the outcome of PFM intervention between PFM and non-PFM members.

PSM constructs a statistical comparison group that's supported a model of the probability of participating within the treatment T conditional on observed characteristics X, or the propensity score: $P(X) = Pr(T = 1|X)$ (Khandker et al., 2010).

Let Yi represents the outcomes to household i (Khandker et al., 2010). For participants, Ti = 1, and therefore the value of Yi under treatment is represented as Yi (1). For nonparticipants, Ti = 0, and the value of Yi can be represented as Yi (0).

If Yi (1) is employed across participating households as a comparison outcome for nonparticipant outcome Yi (0), the typical effect of the program could be represented as follows:

D = E (Yi (1) | Ti = 1) – E (Yi (0) | Ti = 0)……..Equation (1)

D = E (Yi (1) | Ti = 1) – E (Yi (0) | Y = 0) + [E (Yi (0) | Ti (0) | Ti = 1) – E (Yi (0) | Ti = 1)] ……Equation (2)

D = ATE + [E (Yi (0) | Ti = 1) – E (Yi (0) | T i = 0)]……Equation (3)

D = ATE + B…… Equation (4)

In the equation where D is the expected difference between two groups, ATE is the average treatment effect [E (Yi (1) | T i (0) | T i = 1)], namely, the typical gain in outcomes of participants relative to nonparticipants, as if nonparticipating households were also treated. The participating and nonparticipating households have an equal probability of receiving the treatment T, the ATE corresponds to a situation during which a randomly chosen household from the population is assigned to participate within the program. The extent of selection bias that crops up in using D as an estimate of the ATE is the term B, [E (Yi (0) | Ti = 1) – E (Yi (0) | T = 0)].

To find ways to urge obviate selection bias (B = 0) or to find ways to account for it is the basic objective of a sound impact assessment is then to find ways to urge obviate selection bias. To overcome the selection bias and to work with PSM two key necessary assumptions for the identification of the PFM effect were made. Conditional independence assumption is for a given set of observed covariates, participation assignment is independent of potential outcomes (Caliendo and Kopeing, 2008). Common support assumption: the common support or overlap condition: 0 < P (T) < 1. Treatment units have to be similar to non-treatment units in terms of observed characteristics unaltered by participation; thus, some non-treatment units may have to be dropped to ensure comparability (Khandker et al., 2010).

3.2. MATCHING ALGORITHM

The data were entered in Census and Survey Processing System (CSPro) version 5.0. Statistical Package for Social Sciences (SPSS) version 20 and Statistics and Data Statistical Software Package (Stata) version 13 with PSMATCH2 version 4.0.11, 22 Oct 2014 were used for the analysis. Propensity score matching model with logit model were the main ways of conducting the econometric analysis of the data.

This study applied several matching algorithms and selected epanechnikov kernel matching with a bandwidth of 0.25 as a benchmark estimator. The final choice of a matching estimator was guided by different criteria such as equal means test referred to as the balancing test; pseudo-R2 and matched sample size. This matching estimator is chosen because it has met the criteria, that after-matching the two groups has equal means of covariates, lowest standardized bias, lowest pseudo-R2, and large matched sample size.

3.3. MATCHING QUALITY

Literature sources suggest three criteria to assess matching quality – i)equal means test (insignificant means difference among all explanatory variables after matching between treated and control groups), ii) low pseudo-R2, and iii) large matched sample size (Khandker et al. (2010), Rosenbaum and Rubin (1985), Sianesi (2004) and Calinedo and Kopeing (2008)). Therefore, these three criteria were used based on trial and error method to assess the best matching methods suitable for the available data has been chosen from different matching estimators as per the matching quality strength, namely, the decrease of pseudo-R2, balancing test (Rosenbaum and Rubin (1985) standardized bias reduction difference ≥ 20) (highest balancing test) and by the largest number of matched observations. This has been done by running a logit model using the sample before matching and sample after matching.

3.4. VARIABLE SELECTION

In the variable selection, variables that affect both participation decision and outcome have to be included (Calinedo and Kopeing, 2008). Variables that are likely to influence not only participation in PFM but also its impacts on outcomes variables of interest have been selected and used in this study. Below there are the description and definition of variables and their measurement of how the latter variables were operationalized in this study.

Assumption: - household assets, the assets are in the same quality before PFM and after PFM (e.g. If we take the wood bed quality before and after PFM is the same).

Participation in PFM: - is a treatment dummy variable =1 if PFM member (FUG (Forest User Group)); = 0 if not PFM member.

Outcome variables listed below.

Number of Hives (NoofHives):- number of hives (traditional and modern beehive) that the household had in the forest and outside forest (around homestead) (Discrete).

Number of Livestock in TLU[2] (NOLIVTLU):- the total number of livestock measured in Tropical Livestock Unit (TLU) (Continuous).

Number of productive assets (NoProdAssets):- the number of productive assets (plough, sickle, pickaxe, hoe, spade, tom-a-hawk, pick ax, water pump (hand/foot), water pump (diesel) (Discrete).

Number of consumption assets (NoHHGoods):- number of consumption assets or household goods (wood bed, modern chair, modern table, sofa, cupboard (cloth/equipment), box) (Discrete).

[2] TLU (Tropical Livestock Unit) is the conversion factors for livestock units are: Oxen/caw=1, Heifer= 0.75, calf = 0.20, horse= 1.1, donkey= 0.7, Sheep/goat = 0.13 and hen= 0.013 (Storck *et al.*, 1991).

Number of Consumer Durables (NoCD):- number of Consumer Durable (Mobile telephone, radio, cassette/cd/vcd/dvd/player, television, bicycle, motorbike, cart for objects, improved stoves (gas or electric), grain mill) (Discrete).
Physical assets (Physicalasset):- household's number of physical assets (the sum of the number of productive assets, household goods and consumer durable (Discrete).
Roof Made Corrugated Iron sheet: - =1 if home roof made corrugated iron sheet after PFM; = 0 Otherwise (Dummy)
Crop Income (CropIncome):- Net income from both subsistence and cash income from farm products (Garden coffee, maize, wheat, sorghum, vegetables, teff, barley, enset, beans, pepper, chat, farm honey, godere, and others) by decreasing the cost of production in birr[3](Continuous).
Livestock Income (LivestockIncome):- Net income from both subsistence and cash income from livestock products (skin and hides, eggs, milk, butter, and cheese) by decreasing the cost of production in birr (Continuous).
Forest Income (ForestIncome):- Net income from both subsistence and cash income from forest products (forest honey, forest coffee, forest fodder, firewood, charcoal, bamboo, climber, medicinal plant use, wild animal meat, wild foods, tobacco, khat, palm, korerima, wild pepper, timber, construction pole, construction material bamboo, hives from wood, hives from bamboo and farm implements) by decreasing the cost of processing in birr (Continuous).
Off-farm Income (Off-farmIncome):- Income from off-farm activities like pottery and petty trading in birr (Continuous).
Other Income (OtherIncome):- Income from other incomes like remittance, gifts, support from NGO, government, friends and relatives in birr (Continuous).
Total Income (Total Income):- The sum of net income from both subsistence and cash income of crop, livestock, forest, off-farm and other income (Continuous).
Saving Money (Saving Money):- The households' sum money of saved in bank, credit association and saving club now after PFM (SavingMoneyAPFM) in birr (Continuous).
Credit Amount (Credit amount APFM):- The amount of money that the household can get for credit from anyone (can be relatives, friends, and micro-financial saving organizations) in birr (Continuous).
Training:- the number of training (Forest conservation and management, participatory forest management, beekeeping, poultry management, livestock rearing, value addition training, resource-saving, and management, business plan management/bookkeeping, financial management training, cooperative management, soil, and water conservation practice) that had given to the household head in the two-time interval (discrete).
Variables used as the independent variables (covariates) are listed below.
Household head Sex (HhSEX):- =1 if the sex of the household head is male (dummy)
Household head Age (HhAge6):- =1 if age 40 and more (dummy)
Family size (HHSIZ):- number of persons living in the household (discrete)
Number of economically active persons (LABAGE):- number of working-age in Family (labor force age - labor age (18-64)) (Discrete)
Household head Education (HhEdu6):- =1 if literate = 0 otherwise (dummy)
Household head marital status (HhMTS):- =1 if married (dummy)
Ethnic group (EthGrp2):- =1 if Menja (dummy)
Leadership role (LR5APFM):- =1 member in any social positions (dummy)
Residence in the Study Area (YRESIDENCE):- number of years the household has lived in the study area (Discrete)
Total Land Size (TLANDSIZ):- the amount of farm size the household-owned in hectare (continuous)
Distance to the forest (DISTFOR):- distance from their home to the forest (to PFM site) in walking hours (continuous)
Distance to market (DISTMART):- distance from their home to the market in walking hours (continuous)
Distance to town (DISTTOW):- distance from their home to the town in walking hours (continuous)
Contact with extension agents (EXTSERV):- Extension contact (number in annual repetitions their coming) (discrete)
Being Member of Saving Club (SC):- =1 if a member of any saving club (dummy)
Availability of non-farm (off-farm) Income (OffIncAvailBPFM):- =1 if having non-farm income or not for before PFM (dummy).
Credit Access (CA):- =1 if the access of the household to credit (dummy)

4. Results and Discussion

4.1. Household characteristics and economic indicators for respondents

The majority of sample households were male headed (93%) (Table 1). Households who participate in the PFM are closer to forests, have lower contact with extension agents, and higher in family size from non-participants of PFM (Table 2). Generally the mean comparison in outcome variable show that, households who participate in the program group are significantly have higher number of hives, higher number of consumption assets, and higher number of physical assets after PFM compared to non-participants of PFM (Table 3). Moreover, they are more likely to higher forest income and other income. They are also characterized by lower livestock holdings and lower crop income.

[3] Birr (ETB) stands for Ethiopian Birr the local currency, at the time of the field survey 1 Birr (ETB)= 0.05USD.

Table 1. Demographic characteristics of the sampled households for the categorical variables.
Remark: - ** and ***indicates 5% and 1% level of significance respectively.

Variables	PFM (N=141)	Non-PFM (N=128)	Mean Difference	T-value
	Mean	Mean	(SED)	
Household size (family size) in No.	6.19	5.61	0.58(0.24)	2.375**
Number of economically active persons (18 - 64) in No.	2.71	2.63	0.08(0.15)	0.580
Duration of household residence in the area in year	37.60	38.72	-1.12(1.57)	-0.709
Distance to Forest in walking hour	0.41	0.67	-0.26(0.05)	-4.861***
Physical assets Before PFM in No.	6.53	4.95	1.58(0.46)	3.418***
Total land size in ha	1.72	1.63	0.08(0.17)	0.485
Contact with extension agents in No. in year	14.04	18.51	-4.46(1.95)	-2.292**

Table 2. Demographic characteristics of the sampled households for the continuous variables.

Variables	Category	Participation in PFM		Total (Frequency and %)	Chi^2 square (Sig)
		PFM	Non-PFM		
Sex	1= Male	133	118	251(93.3)	0.000 ***
	0= Female	8	10	18(6.7)	
Age	1= Age 40 & more	68	68	136(50.55)	0.855
	0= Otherwise	73	60	133 (49.44)	
Household head education	1 = literate	77	48	125(46.47)	0.247
	0 = Illiterate	64	80	144(53.53)	
Household head marital status	1= Married	138	122	260(96.65)	0.000 ***
	0 = Otherwise	3	6	9 (3.35)	
Ethnic group	1= Menja	58	22	80(29.74)	0.000 ***
	0= Otherwise	83	106	189 (70.26)	
Leadership role	1= have social position	69	15	84(31.22)	0.000 ***
	0= none	72	113	185 (68.77)	
Being member of saving club before PFM	0= no	123	130	253(94.05)	0.000 ***
	1= yes	5	11	16(5.95)	
Credit Access before PFM	0= no	101	117	218(81.04)	0.000 ***
	1= yes	27	24	51(18.96)	
Availability of off-farm income	0= no	102	104	206(76.57)	0.000 ***
	1= yes	26	37	63(23.42)	

Remark: - Percentile in parenthesis, *** indicates 1% level of significance.

Table 3. Summary statistics of outcome (economic indicator) variables.

Variables	PFM (N=141)	Non-PFM (N=128)	Mean Difference		T -value
	Mean	Mean	Mean	SED	
Number of hives after PFM	14.00	5.70	8.31	2.00	4.148***
Number of livestock in TLU after PFM	3.62	4.58	-0.95	0.38	-2.466**
Number productive assets after PFM	4.46	4.87	-0.12	0.27	-0.435
Number of consumption assets after PFM	5.10	3.46	1.65	0.49	3.333**
Number of consumer durables after PFM	1.09	0.82	0.26	0.15	1.716
Number of Physical asset After PFM	10.98	9.16	1.81	0.71	2.547**
Saving Money After PFM	257.36	129.92	127.44	118.47	1.076
Credit amount After PFM	1217.58	1636.40	-418.81	300.50	-1.394
Training After PFM in number of repetition	10.44	10.24	0.20	1.27	0.161
Crop income after PFM	6421.55	10515.72	-4094.17	973.52	-4.205***
Livestock income after PFM	4540.59	3724.26	816.33	592.81	1.377
Forest income after PFM	10084.39	5386.72	4697.66	768.16	6.115***
Off-farm income after PFM	171.28	129.45	41.82	47.30	0.884
Other income after PFM	129.57	8.36	121.22	58.38	2.076**
Total income after PFM	21347.39	19764.53	1582.85	1674.54	0.945

Remark: - ** and ***indicates 5% and 1% level of significance respectively.

4.2. Estimation of propensity scores

The logit model estimates the propensity score as a function of pre-PFM observed characteristics of households' (Table 4). The likelihood of households to participate in PFM increases has family size of households' increases while the likelihood of households to participate in PFM increases has education level of households' increases (Table 3). If the household ethnic group is Menja, the household is more likely to participate in PFM. The likelihood of households to participate in PFM increases as the duration of household residence in the area increases. When the households has leadership role in the area the household is more likely to participate in PFM. The likelihood of households to participate in PFM increases as Physical assets before PFM increases. On the other hand the likelihood of the households to participate in PFM decreases as distance to forest increases. The likelihood of the households to participate in PFM decreases as contact with extension agents increases i.e. when the households contact with extension agents decreases, the households are more likely to participate in PFM. The study result is in line with for the factors that affect household's participation in PFM study from Gebradima forest, southwest Ethiopia by family size, education level and distance to forest (Tadesse *et al.*, 2017b).

Table 4: Logit Estimates of Participation in PFM.

Variable	Coefficient	Z-value	P-value
Family size (HHSIZ)	0.15 (0.09)	1.73	0.083*
Number of economically active persons (LABAGE)	-0.12 (0.16)	-0.70	0.485
Household head Sex (HhSEX)	0.93 (0.74)	1.25	0.210
Household head Age (HhAge6)	-0.47 (0.43)	-1.11	0.265
Household head Education (HhEdu6)	0.93 (0.34)	2.78	0.005***
Marital status (HhMTS)	0.76 (0.89)	0.85	0.394
Ethnic group (EthGrp2)	1.25 (0.39)	3.18	0.001***
Residence in area(YRESIDENCE)	0.04 (0.02)	2.54	0.011**
Distance to forest (DISTFOR)	-1.17 (0.39)	-2.98	0.003***
Leadership role (LR5) After PFM	1.84 (0.38)	4.79	0.000***
Physical asset Before PFM (PhysicalassetBPFM)	0.10 (0.04)	2.24	0.025**
Total land size Before PFM (TLANDSIZBPFM)	-0.20 (0.12)	-1.54	0.125
Contact with extension agents (EXTSERV)	-0.02(0.01)	-2.11	0.035**
Saving club before PFM (SCBPFM)	1.04(0.71)	1.45	0.146
Credit access before PFM (CABPFM)	-0.27(0.43)	-0.63	0.526
Off-farm income availability before PFM (OffIncAvailBPFM)	-0.23(0.38)	-0.59	0.553
Constant	-4.20(1.71)	-2.44	0.015**
Pseudo R^2	0.2614		
Prob > chi^2	0.0000		
LR $chi^2(16)$	97.35		
Log likelihood	-137.48122		
Observations	269		

Notes: Dependent variable (participation) equals one if a household participated in PFM programme and zero if not. Standard errors in parenthesis. *, ** and *** indicate statistical significance level at 10%, 5 and 1%, respectively.

4.3. Matching Quality

The change in the likelihood ratio (LR chi2) (Caliendo and Kopeinig (2008)), pseudo-R2 with other indicators like variance has been revealed before matching to after matching in the selected matching estimator (kernel matching with bandwidth 0.25) (Table 5).

Table 5: Matching Quality Indicators change for the before and after matching cases.

Sample	Pseudo-R^2	LR chi^2	p>chi^2	MeanBias	MedBias	Variance (%)
Before matching (Unmatched)	0.264	98.12	0.000	33.2	16.6	33
After matching (Matched)	0.012	3.09	1.000	4.9	3.0	11

4.4. Average Effect of Participation in PFM

Impact of PFM on Rural Household Income

When PFM member's households are matched with non-PFM households using the kernel matching bandwidth 0.25 methods, the estimated program impact is not only different in direction, but also statistically significant. The result showed that there is a significant difference in increased forest income and decreased crop income between the participants and non-participant households (Table 6).

The difference (ATT) indicates participant in PFM income has been increased average forest income by 3466.60ETB which is equal to 52.39% of average household forest income. This might be because participant of PFM have secured hives and number of coffee trees in forest than non-participants (non-PFM). The forest income share of PFM members is different from other studies 27% and 24% in Chilimo and Dodola, respectively Ameha *et al.* (2014b) and the range of 20–40% reported from other developing countries Vedeld *et al.* (2004). The household's income relies on the three primary livelihood portfolios: agriculture, livestock and forest utilization like other studies in Ethiopia (Babulo *et al.,* 2008; Mamo *et al.,* 2007; Yemiru *et al.,* 2010; Mohammed and Inoue, 2013). While the PFM program decreased average crop income by 4827.68 ETB which is equal to 43.2% of average household crop income as compared to Non-participants which entails the non-participant household's crop income greater than the participant households. This might be due to their focus of livelihood strategies differ between participants and non-participants. Non- members focused their livelihood strategy on agriculture. For the non-PFM members, the income share from agricultural crop production is greater

than PFM members; which is in line with other studies twice as large as the share from the other income components Ameha *et al.* (2014b).

There is no significant difference between participants and non-participants of PFM for livestock income, off-farm income, other income, and total income. In this regard, the results of this study are in line with Ameha *et al.* (2014b) that indicates positive impacts of PFM on forest income in both PFM sites for the Dodola case (PFM members experienced increased annual forest income of (475 - 482 ETB) (170-177%)) while for the case of Chilimo area (increased annual forest income of (246 - 250 ETB) (70-72%)). This study result also in line with the study conducted in one of this study area districts in selected villages of Gimbo District in south-western Ethiopia of Gelo and Alemu (2015) which revealed the PFM program increased average consumption by 336.73 ETB (US$30.12), which is 17.8 percent of average household consumption. The study result also in line with the study conducted in Bonga Gobeze et al., (2009) on PFM increasing household income.

Impact of PFM on Saving and Credit Access

Most of PFM sites as PFM members have a capital of more than 10,000 ETB and as Forest User Cooperatives (FUC) they had more, even if most of PFM sites established by FAO do not start 70% for PFM members and 30% for PFM due to inconvenience between FAO and government agents during establishment of PFM sites. Most of them have saving club formed by PFM members like on only women but there are discontinued saving after some time. The result in line with study from Gebradima forest, southwest Ethiopia Tadesse *et al.*(2017a) where there is no significant difference between participant and non-participant of PFM in access to credit services.

Impacts of PFM on Rural Household Asset Accumulation

The asset accumulation impacts of PFM also showing different results (see Table 6). The households of program participant livestock holding decreased by 1.44TLU which is 29.45% of average livestock holding compared to non-participants. The non-participant's livestock holding is higher than the program participant households. This might be due to the more susceptible to be members of the PFM Menja ethnic group's higher dependency on forest livelihood strategies. This result differs from another study result of Ameha *et al.* (2014b) PFM members have larger livestock holdings than non-members in the Dodola case. The result is different from the study in the Gebradima forest there is no significant difference in livestock assets between PFM participants and non-participant (Tadesse *et al.,* 2017a). On the other hand, regarding the number of consumption assets after the PFM program participant households increased by 1.25 which is 32.13% of the average number of consumption assets after PFM compared to non-participants. This might be because the annual income from forest coffee and forest honey and dividend as per their contribution from Forest User Cooperatives (FUCs) is high. On the other asset accumulation variables; the number of hives, number of consumer durables, physical assets (sum of the number of productive assets, consumer durables, and consumption assets) even if there is a positive change there is no significance between the two groups in the above asset accumulations (Table 6).

The change in home roof made from corrugated iron sheet after PFM the result indicates that from 141 participant of PFM 78 participant of PFM their home made from corrugated iron sheet after PFM which means 29% from the total number of Participant of PFM. Also there are a lot of members on the way of changing their home from straw to corrugated iron sheet even if there is no significance difference between the groups (Table 6).

Table 6: Matching estimates on the average impact of PFM (ATT) in Bonga PFM sites.

Outcome variables	Treated	Control	Difference (ATT)	S.E[B]	T value
Crop income after PFM	6348.17	11175.85	- 4827.68	2352.93	-3.93***
Livestock income after PFM	4064.62	3936.09	128.53	1193.18	0.18
Forest income after PFM	10083.49	6616.89	3466.60	1435.81	3.50***
Off-farm income after PFM	123.91	163.54	- 39.62	85.29	-0.82
Other income after PFM	122.93	22.37	100.57	79.39	1.31
Total income after PFM	20743.13	21914.74	- 1171.61	4050.30	-0.55
Home roof made corrugated iron sheet after PFM	0.29	0.26	0.03	0.10	0.43
Number of hives after PFM	11.31	8.21	3.11	3.33	1.27
Number of livestock in TLU after PFM	3.46	4.89	-1.44	0.94	-2.89**
Number of productive assets after PFM	4.71	4.99	-0.27	0.55	-0.82
Number of consumption assets after PFM	5.14	3.89	1.25	0.88	1.96 **
Number of consumer durables after PFM	1.06	0.95	0.109	0.24	0.77
Physical assets after PFM	10.92	9.83	1.08	1.56	1.20
Saving club after PFM	0.26	0.31	- 0.05	0.10	-0.79
Saving money after PFM	166.17	270.83	-104.66	273.89	-0.81
Credit access after PFM	0.45	0.49	-0.04	0.10	-0.51
Credit amount after PFM	1400.54	1414.11	-13.57	422.55	-0.03
Training after PFM	10.49	10.39	0.10	2.04	0.06

Remark: - *, ** and *** implies significant at 10%, 5% and 1% significance levels, respectively. [B] Stands for bootstrapped standard error which is obtained after 100 replications. Difference indicates the relative mean difference between participant and non-participant households.

5. Conclusions

As this study endeavored to solve the dilemma of whether the impact of participatory forest management on rural households' livelihoods is positive or negative taking the case of Bonga PFM Project, SNNPR, Ethiopia; the result confirms that there is a positive impact of PFM on forest income and number of consumption assets. On the other hand, there is also a negative impact on crop income and livestock holding on participants of PFM. Participatory forest management (PFM) recorded some impacts of livelihoods aspects on the rural household's like income of forest is high for the participant of PFM, the participant asset accumulation is higher on the number of consumption assets(the number of household goods (wood bed, modern chair, modern table, sofa, cupboard (cloth/equipment), box)) as compared to non-participant of PFM.

The income sources dependency from participant to non-participants differs in proportion. There is no negative impact of PFM in relation to gender role; all sex and age have their own role in collecting and processing forest products.

Undeniably PFM has an impact on the core livelihoods of rural households by increasing the welfare of the households even its impact not huge; it rescued the participant of PFM from uncertainty and gives responsibility to the PFM sites with the conservation of the forest. So PFM to be more successful it has to be merged and applied with another program continued until the households are economically self-reliant.

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