

# Impacts of Productive Safety Net Program on Households 'calorie Intake per Adult Equivalent, Expenditure and Livestock Asset Holding; Empirical evidence from Eastern Ethiopia

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**Abstract:** *Chronic food insecurity is one of the main problems, which affected millions of Ethiopians for centuries. To solve the food insecurity problem and move away from the previous system of annual emergency appeals, the Ethiopian government in collaboration with development partners launched social protection program called productive safety net program. This study evaluated the impacts of productive safety net program on household poverty alleviation, by measuring the wellbeing of rural households using outcome indicators of the program i.e. calorie intake, consumption expenditure and livestock asset using cross-sectional survey data collected from 200 households in ECC-SDCOH facilitated kebeles of productive safety net program in eastern Ethiopia. Multistage stage sampling technique was used to randomly select representative household heads. Both primary and secondary data were analyzed using descriptive and econometric statistics. Applying a propensity score matching technique, the study found that the program has significantly increased participating households' calorie intake by 30% (i.e., 856 calories), the consumption expenditure by 2.84% and livestock asset by 40% compared to that of non-participating households. The results of the logit model also indicated that program participation is significantly influenced by family size, education, marital status, dependency ratio, size of land holding and credit use. Therefore, to reduce poverty level of the country, due attention has to be given by the program to reducing gender disparity in poverty and sustained effort is needed to government-administered productive safety net program districts to accelerate the rate of poverty reduction. And the program should consider roles of significant variables in the selection of participant households for the desired impact under related locations.*

**Keywords:** Productive safety net, calorie intake, impact, PSM, Ethiopia

## **INTRODUCTION**

Ethiopia is one of the poorest countries in the world ranking 174<sup>th</sup> out of the 188 countries with about 39.6% of the population living below the poverty line with USD 1523 per capita Gross National Income (GNI) and infant mortality rate is 41.4 per 1,000 live births. (UNDP, 2016). Ethiopia, with a population of 73.9 million, is the most populous country in the Horn of Africa with growth rate of 2.6%. The majority of the population (84 %) lives in the rural areas, mainly depending on agriculture for its livelihood (CSA, 2008).

Agriculture sector is the backbone for economic growth especially for most of the African countries where it generates about 25% of the Gross Domestic Product (GDP) in Sub Saharan Africa (Schaffnit-Chatterjee, 2014). In Ethiopia, agricultural sector accounts for the average 34.9% for GDP and a source of livelihood for 80% of the country's population (NBE, 2018). It failed to feed tremendously growing population of the country in, which more than 27 million people are under the problem of food insecure. Total population of 18.1 million people need food assistance in 2016, due to climate change, and 2015 El Nino drought derived problem in the country which was the strongest drought that have been recorded in the history of the nation (FAO, 2017).

According (FAO *et al.*, 2018), about 10.9% of the world, 20.4 percent of Africa, and 31.4% of the Eastern African people undernourished in 2017. Food insecurity becomes a major challenge in rural Ethiopia. Endalew *et al.*, 2015, for instance, stated that about 10% of Ethiopians were chronically food insecure and this figure increased to 15% during frequent droughts. In addition, in 2018 the Global Food Security Index (GFSI) of the economist Intelligence Unit (EIU) ranked Ethiopia as 100th among 113 countries with food affordability, availability, quality, and safety. According to the EIU, 2018 index, Ethiopia is a state with 28.8% prevalence of undernourishment, 201 kcal/person/day of intensity of food deprivation, and very low results (performance) in diet diversification, sufficiency of food supply, micronutrient availability, and food consumption as a share of household expenditure and proportion of population under the global poverty line.

Food insecurity emerged as a key problem since the early 1970's and became pervasive. As a result, every year for more than two decades the government of Ethiopia had to launch an international emergency appeal for food aid. This annual emergency assistance was designed to meet the consumption needs of both chronically and transitorily food-insecure households. Even though the total amount of humanitarian assistance provided was substantial (estimated to the average of 700,000 metric tons of food aid annually over the past 15 years (MoARD, 2006) and saved many lives, evaluations have shown that it was unpredictable for both planners and households, often arriving late relative to need. The

delays and uncertainties meant that the emergency aid could not be used effectively in the public works it was meant to support and thus did little to protect livelihoods, prevent environmental degradation, generate community assets, or preserve household assets (physical or human capital). Thus, despite the large food aid inflows, household-level food insecurity remains both widespread and chronic. Indeed, chronic food insecurity had been increasing in the aftermath of repeated droughts as vulnerable households failed to manage their effects and slide deeper into poverty. As part of the same phenomenon, rural growth had also stagnated. Given these shortcomings of the emergency aid regime, the Ethiopian government decided that an alternative instrument was needed to support chronically food-insecure households and to address some of the major underlying causes of food insecurity. In response to this problem, Government of Ethiopia has introduced different food security program (FSP). One of these programs is the productive safety net program (PSNP) initiated in 2005, to reduce household vulnerability, improve community resilience to shock and stress and break the cycle of dependence on food aid (MoARD, 2015). The program has two main components: public works (PW) and direct support. The direct support is a small portion of PSNP and delivers assistance to members of the community who cannot participate in PW but food insecure and require assistance. However, the public works is the largest portion of Program which aimed to mitigate the impacts of climate change and food insecurity risks in chronically food insecure households by creating employment opportunity to “able bodied” laborers in the community. It is the most important component of the Program Since it creates a labour market for unskilled labour, through the participation of able bodied individual in different community development activities, such as land and water resources rehabilitation, water supply projects, and small scale irrigation, reforestation and developing community infrastructures, including rural road, schools and clinics (Debela and Holden, 2014; Welteji *et al.*, 2017).

The Ethiopian Catholics Church Social Development coordinating office of Harar has been facilitating PSNP program in collaboration with the Government. This Relief Services was also initiated with the objective of improving the livelihoods of chronically food insecure households in the PSNP target Woredas by diversifying livelihood options. Therefore, ECC-SDCOH has been implementing to facilitate the program in three woredas of East Hararghe zone, namely *Gorogutu*, *Kersa* and *Meta*, and in Dire Dawa Administration. The number of targeted households to benefit from this program facilitation were 11051 households (2750-*Kersa*, 2750- *Gorogutu*, 3621- *Meta* and 1930 Dire Dawa) living in 59 *kebeles* (15 *Kersa*, 13 *Gorogutu*, 25 *Meta* and 6 Dire Dawa).

The interest in developing a safety net program in Ethiopia grew out of the fact that the emergency system in Ethiopia was failing to stabilize livelihoods. Lives were being saved but, over time, livelihoods continued to erode. As a consequence, more and more people were in need, resulting in an overwhelming humanitarian caseload. Each emergency

resulted in further asset loss and destitution. As the population lost productive assets and became less able to cope, minor events had the impact of major shocks (SC-UK, 2008). Both government and donors became convinced of the need for this program. For donors, increased interest in budget support mechanisms, as well as growing support for social protection, also played a part. For the government, a concern that the emergency response system was encouraging dependency syndrome and unease about Ethiopia's image as a 'basket case' were strong incentives (SC-UK, 2008). According to DDADPFSO (2005), more than 48,275 people in rural Dire Dawa are identified to be chronically food insecure and another 60,000 people are acutely affected in bad production years. A complex combination of factors has contributed to the alarming increase of rural food shortage vulnerability. The major ones are: low Agricultural Production and Productivity as well as limited income generating alternatives and opportunities.

Accordingly, the causes of limited income generating opportunities are due to lack of knowledge, attitude, and entrepreneurial skill/practice, lack of access to financial assets, poor rural-urban linkage and poor diversification of on and off-farm activities. The proposed study areas, Rural Dire Dawa administration, are among the 292 districts identified as chronically food insecure and eligible for the PSNP. Despite the fact that the PSNP has been implemented since 2005 in the country to address the above-mentioned problems and shortcomings of the previous practice of assistance that focuses only on saving lives, evaluation of the effects of such programs has not yet given attention especially in our country. Thus this study, attempts to fill this research gap by conducting an empirical study on the impact of the PSNP on household's poverty alleviation in ECC-SDCOH facilitated rural kebeles of Dire Dawa Administration. In this study, improvement in the livelihoods of rural households was assessed by examining the impact of household participation in the PSNP using daily caloric intake per adult equivalent measure of food security, monthly consumption expenditure reflection of differences in permanent income and household accumulation of livestock assets. Therefore the objective of the study is to evaluate the impact of productive safety net program on of household beneficiaries and to measure the impact of the Program on household calorie intake per adult equivalent, expenditure and livestock holding; Therefore, using matching methods, this study assesses whether, after five years of operation, the ECC-SDCOH facilitated kebeles of PSNP beneficiaries raised consumption levels, improved food security and whether it had led to sustained livestock asset accumulation.

## **MATERIALS AND METHODS**

### **Description of the Study Area**

The study was undertaken in rural areas of the Dire Dawa Administration. Dire Dawa is located between 9°27'N and 9°49'N latitude and 41°38'E and 42°19'E longitude in the eastern part of Ethiopia. It is located about 515 kilometers road distance to the east of Addis Ababa and 311 kilometers to the West of Djibouti port. The total area of the region is about 128,802 hectare: out of which urban accounts for 2684 hectare (2%) and the remaining 98%

is for rural. The total population of Dire Dawa was estimated to be 342,827 out of which 74% (253,692) live in urban while the rest 26% (89,135) live in rural areas. According to CSA (2007), Population and Housing of census Analytical report, the total projected households are 75,693 of which 47,998 households are male headed and the rest 27,695 female headed. Out of the total population 49.8 % (170,897) were female and the remaining 50.2% (171,930) male. Dire Dawa is classified as semi-arid. The mean annual rainfall is 657 mm and mean monthly values vary between 5.7 mm (December) and 119 mm (April), which indicate poor temporal distribution of rainfall. The average Maximum temperature of the Administration is 31.4<sup>0</sup>C, while its minimum temperature is 18.2<sup>0</sup>C. The mean annual average air temperature is 25.3<sup>0</sup>C and June is the warmest month of the year while December and January are coldest (DDAO, 2010) There are 9 urban and rural *kebeles*. The specific study area is located to the east of the city of Dire Dawa. Of the 38 rural *kebeles*, it covers 6 rural *kebeles* with in the ECC-SDCOH facilitated Productive Safety Net Program namely *Debele, Kulayu, Elhamer, Melkakeru, Ayalegumgum, and Legedini*.

#### **Data sources, Method of data collection and Sampling techniques**

The primary data needed for the study were obtained from rural households. More particularly, a three-stage sampling technique was adopted to generate the primary data. Firstly, the six rural *kebeles* of Dire Dawa Administration, where the program had been operating were purposively chosen. Secondly, households in each of the six *kebeles* were grouped into two strata. Stratum one, represents the treatment group, consists of 842 participating households. These households were identified from the record of beneficiaries list in the program implementing organization's Dire Dawa Office. Neither the remaining 1220 non-participating households who benefited from ECC-SDCOH facilitated PSNP nor any other similar interventions in their local area were categorized under stratum two, representing the control group. Similarly these households were identified in consultation with their respective *Kebele* representatives. Finally, proportionate random samples of 100 households from treatment group and 100 households from control group were chosen. As a result, a semi structured questionnaire was administered to 200 sample households from programs and non-program participants.

Table 1: Sample size by *kebeles*

S. N	Sample Kebeles	Beneficiaries of ECC-SDCOH PSNP Households (N)	Non-beneficiaries ECC-SDCOH PSNP Households (N)	Sample Households from Treatment group	Sample Households from Control group
1	Ayalegumgum	144	226	17	18
2	Debele	157	204	19	17
3	Elhamer	127	180	15	15
4	Kulayu	96	194	11	16
5	Lagedini	140	185	17	15
6	Melkakero	178	231	21	19
Total		842	1220	100	100

Source: Own design

Trained enumerators filled the questionnaire by interviewing the households. Concerning indicator data for consumption, sample households were asked to state their weekly cost of food purchased, drinks and tobacco; and one-month recall for non-food expenditure. These collected values of food and non-food items were computed and transformed to per capita consumption of sample households. Besides, for calculation of calorie intake, households were asked to report the kind and amount of food items consumed by their families preceding the survey.

Secondary data were collected from various sources like Dire Dawa Bureau of Agriculture rural development office and other relevant private and public institutions like Central Statistical Authority, Dire Dawa *Kebele* Administrations, ECC-SDCOH, Ministry of Finance and Economic Development, Journals, etc. to supplement primary data.

### Method of Data Analysis

Descriptive statistics such as mean, standard deviation, percentages, frequency, charts, and graphs, one can compare and contrast different categories of sample units with respect to the desired characteristics so as to draw some important conclusions. Moreover, inferential statistics such as chi-square test (for categorical variables) and t-test (for continuous variables) were used to compare and contrast different categories of sample units with respect to the desired characters so as to draw some important conclusions.

Rosenbaum and Rubin (1983) were the first to develop the Propensity score matching (PSM) statistical tool. The technique has attracted the attention of social program evaluators (Jalan and Ravallion, 2003; Dehejia and Wahba, 1999). PSM is a non-parametric estimation method that works by re-weighting the comparison sample to provide an estimate of the counterfactual of interest-what the outcome of a beneficiary household would have been

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had it not received program benefits. Since PSNP has targeted poor and vulnerable households in a non-random manner, comparison of mean outcomes between beneficiaries and non-beneficiaries would lead to biased estimates. In order to circumvent this problem the study uses the matching technique called propensity score matching method, which is capable of extracting a comparable pair of treatment-comparison households in a non-random program setup and absence of baseline data.

The approach assumes that after controlling for all pre-programme observable household and community characteristics that are correlated with programme participation and the outcome variable, non-beneficiaries have the same average outcome as beneficiaries would have had if they did not receive the programme. PSM provides biased estimates of programme impact if, for any chosen outcome, it is not feasible to control for enough observable characteristics. In other words, the outcomes in the untreated state are independent of program participation conditional on a particular set of observable characteristics. This is the conditional independence assumption, the ignorable treatment assignment (Rosenbaum and Rubin, 1983), and the assumption of selection on observables (Heckman and Robb, 1985). Denoting by  $X$  the set of observables, the identification assumption can be expressed as:  $Y_0 \perp D | P(X)$  (1)

Where the symbol  $\perp$  denotes independence and  $P(X)$  is the propensity score. Actually, we require an even weaker condition to identify our treatment parameter, that of conditional mean independence:

$$E(Y_0 | D = 1, P(X)) = E(Y_0 | D = 0, P(X)) \quad (2)$$

By conditioning on we can get an estimate of the unobserved component in the TT parameter. In particular, we can identify the parameter as follows

$$\begin{aligned} TT(X) &= E(Y_1 | D = 1, P(X)) - E(Y_0 | D = 1, P(X)) \\ &= E(Y_1 | D = 1, P(X)) - E(Y_0 | D = 0, P(X)). \end{aligned} \quad (3)$$

A valid measure of the impact of PSNP should compare outcomes in households that received PSNP benefit to what those outcomes would have been had the same households not received any PSNP benefits. The estimator constructs a plausible comparison group by matching PSNP participant to similar no participants using a rich set of control variables.

Following Smith and Todd (2005), let  $Y_1$  be a household's outcome if it is participating and receive a PSNP benefit and let  $Y_0$  be a household's outcome if it does not receive a PSNP benefit. The impact of PSNP is the difference in the outcome caused by receiving PSNP benefits. To construct an estimate of the average impact of PSNP on those that receive it the average impact of the treatment on the treated (ATT):

$$ATT=E\} | D=1 Y_1 \{=E \} | S=1 Y_0 - Y_1 \{=E\} | D=0 Y_0 \{ \quad (4)$$

Let D be an indicator variable equal to 1 if the households participating in the program and 0 otherwise. We can observe the first term of equation (4), but the second term is not observable, households participating in the program cannot be simultaneously observed in two states. A household can either be in the program or outside the program. Hence, this study applies a propensity score matching technique to estimate the impact of PSNP on poverty alleviation by estimating the counterfactual outcome for the participant (Rosenbaum and Rubin 1983). According to Caliendo and Kopeinig (2008), there are steps to implementing PSM. These are an estimation of the propensity scores, choosing a matching algorithm, checking on common support condition and testing the matching quality.

Once the analytical procedure of the study and its requirements are known, it is necessary to identify the potential explanatory and dependent variables that will be used in the models. A combination of socioeconomic and demographic factors was used to explain households' participation in the productive safety net program and the outcomes in terms of household wellbeing indicators in poverty alleviation. To calculate the average treatment effects in the propensity score matching method, the study uses a set of outcome variables, which the ECC-SDCOH PSNP use as indicators that objectives are being met. These include measures of food security: caloric acquisition and availability in the seven days preceding the survey, consumption expenditure: which can be thought of as a measure of the permanent income that flows from the household's stock of assets, and asset holdings: which is also an indicator of program's success in preventing households from reducing their already low asset base (HCS, 2007). The study considers measuring the following three indicators of livelihood in its attempt of quantifying the impacts of the program at households' level. The explanatory variables expected to have an association with participation in the program are below. Hence, the demographic and socio economic factors which are selected by the researcher, based on theoretical background and related empirical review of the literature, are defined in Table 2.

Table 2: Variable definition and measurement

Variable	Type and definition	Measurement
Dependent variables		
Treatment (Psm)	Dummy, participation in PSNP	1 for participated household and 0 for non- participated ones
Calori (Mlr M)	Continuous, calorie intake per Adult Equivalent (AE)	calorie
Outcome Variables		
Calorie	Continuous, calorie intake per AE	calorie



Expenditure	Continuous, mean monthly HH food and non-food consumption expenditure per adult equivalent	Birr
TLU	Continuous, number of livestock owned.	Tropical Livestock Unit
Explanatory variables		
Age	Continuous, age of household head	Number of years
Education	Dummy for illiterate household head	1 if a household head is illiterate and 0 otherwise
Sex	Dummy for female household head	1 if a household head is female and 0 if not
Marital Status	Dummy for married household head	1 if a household head is married and 0 if not
Dependency Ratio	Continuous, ratio of number of active labour to total family size	Number
Family Size	Continuous, family size	Number
Land Size	Continuous, size of land holding	Hectare
Credit	Dummy for credit use	1 if a household uses credit service and 0 if not
Off/Non-Farm	Dummy, employment in off /non-farm activities	1 if a household head is employed and 0 otherwise

Source: own design

## RESULTS AND DISCUSSION

Household participation in the PSNP is determined by various household attributes. Of these attributes, demographic and socio-economic characteristics are the major ones. Hence, this section presents household characteristics, which determine program participation, like sex, age, marital status, education, family size, land size, non-farm employment, dependency ratio and access to credit service.

**Dependency ratio and age of household heads:** The mean age of the sample household heads was found to be 40.65 years with standard deviation of 0.647. The mean age of program households was 40.09 years and that of non-program households was 41.22 years. The statistical analysis ( $t= 0.89$ ) revealed that there was not a significant difference in age between program participant and non-participant (Table 3).

Table 3: Distribution of sample household heads by age, dependency ratio and beneficiary

Status

Variable	Beneficiary (N=100)		Non beneficiary (N=100)		Total (N=200)		t- value
	Mean	Std.Err.	Mean	Std.Err.	Mean	Std.Err.	
	Age	40.09	0.824	41.22	0.95	40.655	
Dep.ratio	0.517	0.017	0.401	0.021	0.463	0.014	4.01***

\*\*\* indicates statistically significant at less than 1% probability level

Source: Survey result

The Results in table 3 showed that the mean dependency ratio was 0.51 for participants and 0.401 for the non- participants households. As evidenced by the value of t=-4.01 the statistical analysis showed that there is a significant difference in the mean dependency ratio between program and non-program households at 1 percent probability level.

**Sex of household head:** Out of the 200 respondents, 49 percent were male-headed and 41 percent were female-headed households. Among participants households 57 percent were male headed and 43 percent were female headed. Likewise, of the non-participants households 61 percent and 39 percent were male headed and female headed respectively. The Chi-square test indicated that there is no significant difference between participants and non-participants in terms of sex ( $\chi^2 = 0.882$ ) (Table 4).

Table 4: Distribution of sample households by sex of household heads and beneficiary status

Sex of the HH	Beneficiary		Non beneficiary		Total		$\chi^2$ value
	No	%	No	%	No	%	
Male	57	57	61	61	118	59	0.882
Female	43	43	39	39	82	41	
Overall	100	100	100	100	200	100	

Source: Survey result

**Family Size:** Family size was considered and hypothesized as one of the potential variables that would influence households' participation in the PSNP. The average family size of sampled program households was 5.84 with a standard error of 0.168 while that of the non-program households was 4.96 with a standard error 0.114. The survey result also revealed that there was a significant difference in the mean family size between program and non-program sample household groups. While the overall average family size of the sample

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household was 5.4, it is above the national average of 5 persons (CSA, 1994). This result is in complete agreement with the prior expectation (Table 5).

Table 5: Distribution of sample households by family size and beneficiary status

Variable	Beneficiary (N=100)		Non beneficiary (N=100)		Total (N=200)		t-value
	Mean	Std. Err.	Mean	Std. Err.	Mean	Std. Err.	
Family size	5.84	0.168	4.96	0.114	5.4	0.12	3.00***
Adult eqvlt.	4.78	0.144	4.22	0.154	4.5	0.54	2.6***

\*\*\* indicates statistically significant at less than 1% probability level

Source: Survey result

The average household size in adult equivalent has also exhibited significant difference between the program and non-program sample household groups ( $t=2.6$ ). In this, the average household size in AE of the program and non-program household was 4.78 and 4.22, respectively. The overall mean was found to be 4.50.

**Marital status:** With regard to the marital status of the respondents, 54% of the program participant households and 57% of the program non participant households were married. While only 5, 12 and 26% of the program household heads were found to be single, divorced and widowed respectively the corresponding figure for the non-participant households were 4%,8% and16% respectively. Similarly, above 3% of the program participant household heads and 15% of the non-participant household heads were polygamous. Though in this study it was hypothesized that marital status of household heads would have a noticeable effect on households' participation in the program, the survey result revealed that there was no significant difference between the participant and non-participant household with respect to marital status of household heads, and the Chi-square test indicates that the systematic relationship between program participation and marital status of household head is very weak ( $p>0.10$ ) (Table 6).

Table 6. Distribution of sample households by marital status and beneficiary status

Marital status	Beneficiary		Non beneficiary		Total		$\chi^2$ -value
	No	%	No	%	No	%	
	Single	5	5	4	4	9	
Divorced	12	12	8	8	20	10	
Widowed	26	26	16	16	42	21	0.987
Polygamous	3	3	15	15	18	9	
Married	54	54	57	57	111	55	
Total	100	100	100	100	200	100	

Source: Survey result

**Level of education:** The survey results indicated that 85.5% of the total sampled household heads were illiterate while 8.5% were able to read and write. Similarly, the remaining (6%) respondents attended primary education (1-4). It was hypothesized that as the level of education increases, the probability of participating in the program increases. The survey result is a complete agreement with the hypothesis. However, the mean difference between the two sample groups with regard to the level of education was found to be statistically insignificant.

Table 7: Distribution of households by level of education and beneficiary status

Educational level	Beneficiary		Non beneficiary		Total		$\chi^2$ -value
	No	%	No	%	No	%	
	Illiterate	80	80	91	91	171	
Read and write	11	11	6	6	17	8.5	0.876
Elementary	9	9	3	3	12	6	
Total	100	100	100	100	200	100	

Source: Survey result

**Off/non-farm employment:** Agricultural production is not the only source of income/livelihood for the rural households in the study area; rather they have multiple livelihood strategies. It was hypothesized that the participation in off/non-farm income generating activities would be negatively associated with program participation, in that

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participation in off/non-farm income generation increases the probability of being self-sufficient. However, the survey results, on contrary, revealed that 36% of the program participant households were engaged in off/non-farm employment. The corresponding figure being only 18% for the non-program participant households, the two groups of sample household had a statistically significant difference at 1% probability level with respect to off-farm employment. This shown by value of  $\chi^2= 4.836$  and prob = 0.0279 (Table 8).

Table 8: Distribution of sample households by engagement in off farm/non-farm employment

Non-farm employment	Beneficiary		Non beneficiary		Total		$\chi^2$ -value
	N <sub>0</sub>	%	N <sub>0</sub>	%	N <sub>0</sub>	%	
Yes	36	36	18	18	54	27	4.836***
No	64	64	82	82	146	73	
Total	100	100	100	100	200	100	

\*\*\* Significant at less than 1% probability level

Source: Survey result

**Land holding :** Land is the most important resource in agriculture. The fertility status, location and other attributes of land in association with its size make it a binding resource in agriculture. In the study area, the average land size owned by program and non-program households was found to be 0.97 ha and 1.23 ha, respectively. The overall average land holding was 1.102 ha. The result of the t-test shows that the mean difference between the two sample groups with regard to size of farm land was found to be statistically significant at 5 percent probability level (t=2.394 and prob= 0.0176).

**Credit access:** Credit service improves food security status of households through improving households' ability of purchasing agricultural inputs like improved seed and chemical fertilizers. In the study area, there is credit service for production purpose. In this regard, 72.5% of the total sample respondents reported that they had access to credit service. As anticipated, the result of the study indicated that 87% of program households and 58 percent of non-program households had received credit services, which indicates that rural credit services have a noticeable effect on program participation. The result also revealed that there was a statistically significant difference between the two groups of sample respondents with respect to access to credit services ( $\chi^2= 12.545$  and prob = 0.0004) (Table 9).

Table 9: Distribution of sample households by Access to rural credit services

Access to credit service	Beneficiary		Non beneficiary		Total		$\chi^2$ value
	Number	Percent	Number	Percent	Number	Percent	
Yes	87	87	58	58	145	72.5	12.552
No	13	13	42	42	55	27.5	
Total	100	100	100	100	200	100	

Source: Survey result

**Calorie intake and consumption expenditure:** Table 10 presents descriptive statistics result of sample households based on their calorie intake, food and non-food consumption expenditure as well as asset holdings in terms of Tropical Livestock Unit (TLU).

The survey results show that program and non-program households had an average calorie intake of 2792.033 and 2001.54 kilocalories, respectively while the average calorie intake of the total sampled households was 2396 kilo calories. This means that households in the program are better off in terms of calorie intake. The t-test indicates that the two groups are significantly different at 1% probability level in terms of mean calorie intake ( $t= 2.876$ ) (Table 10). However, this result cannot tell us whether the observed difference is exclusively because of the program or not. In fact, it is not possible to attribute the difference in calorie intake of the two groups exclusively to the program as comparisons are not yet restricted to households who have similar characteristics. As stated earlier, a further analysis must be performed using propensity score matching techniques to address this issue.

The sampled households on average spent ETB 232 per AE with a standard deviation of 5.648 while this figure was ETB 241 per AE with standard deviation of 8.07 for program households and ETB 229 per AE with standard deviation of 52.64 for non-program households. The statistical analysis revealed that the mean difference between two groups in relation to expenditure per AE was statistically insignificant.

**Livestock holding:** Livestock production plays an important role in the study area. Livestock provide milk, meat, traction power and transport. Livestock species owned by the sample households include cattle, sheep and goat, equine and poultry. The average livestock population owned by the sample respondents was 5.51 in TLU. Table 10 shows that the average livestock holding was 6.78TLU and 4.54 for program and non-program households respectively. The result of this study showed that the mean difference of the livestock holdings, in terms of TLU, between the PSNP beneficiary households and the non-PSNP beneficiary households was positive and significant. The t-test also showed that this difference was statistically significant ( $t= 2.45$ ). The PSNP beneficiary households, as a result of PSNP intervention, have increased their livestock holdings. Thus, the program enables them to protect (increase) their livestock holdings.

Table 10. Current expenditure, calorie intake and asset holding of sample households

Variables	Sample households (N=200)		Program households (N=100)		Non-Program(N=100)		Difference		t-value
	Mean	Std	Mean	Std	Mean	Std	Mean	Std	
Dailycalorie	2396	416.34	2792.03	245.61	2001.54	705.05	790.49	246.09	2.88***
Monthly exp	232.48	5.65	241.48	8.08	229.49	52.64	11.99	8.47	1.98**
TLU	5.51	0.97	6.78	1.25	4.54	1.30	2.24	1.60	2.45***

\*\*\* and \*\* indicates significant at the 1% and 5% probability levels, respectively

Source: Survey result

### Econometric Results

To examine the impact of PSNP on rural households' calorie intake, consumption expenditure and livestock asset, Propensity Score Matching (PSM) model was deployed. Therefore, this section describes the estimation of propensity scores, matching methods, common support, balancing test and calorie expenditure elasticities of the households.

#### 3.2.1. Propensity scores estimation

The logistic regression model was used to estimate propensity scores to match the PSNP beneficiary households and non-PSNP beneficiary household based on the observable characteristics. Table 11 presents the results from the logit model of participation in the program used to create propensity scores for the matching algorithm. The estimated model appears to perform well for our intended matching exercise. Even though  $R^2$  is not meaningful in binary regressand models, the pseudo  $R^2$  indicates how well the regressors explain the probability of participation. Hence, the pseudo-  $R^2$  value of 0.335, in the logit regression, shows that the explanatory power of the matching variables is fairly low even before matching.

The estimated logistic regression model indicated that program participation was significantly influenced by family size, education, marital status, dependency ratio, size of land holding and credit use. Education had a strong and negative effect on household program participation and was significant at 1% probability level, likewise, family size, credit use and dependency ratio had a strong positive effect on household program participation and was significant at 1% probability level. This shows that, a household with more family member has a high probability of program participation. On the other hand, the size of land holding and marital status had a negative effect on household program participation and was statistically significant at 5% probability level.

Table 11. Logit results of household program participation

Variables	Coefficients	Standard Error	Z-values
Sex	-0.258	0.680	-0.38
Age	0.013	0.021	0.62
Education	-1.964***	0.532	-3.69
Marital status	-0.667**	0.265	-2.51
Dependency ratio	5.410***	1.306	4.14
Family size	3.103***	1.033	3.00
Land size	-1.008**	0.350	-2.88
Credit	1.586***	0.484	3.28
Off/Non-farm	-0.067	0.699	-0.1
Constant	-12.637**	2.245	-5.63
Sample size (N)	200		
PseudoR <sup>2</sup>	0.335		
LR chi2(9)	111.88		
Prob>chi2	0.000		
Log-likelihood	-92.189		

\*\*\*, \*\* and \* means significant at the 1%, 5% and 10% probability levels, respectively

Source: Survey result

### Imposing common support region

After the step of propensity score estimation, the common support region should be imposed on the propensity scores distribution of the PSNP beneficiary households and non-beneficiary households. As shown in Table 12, the estimated propensity scores vary between 0.15 and 0.99 (mean = 0.76) for program or treatment households and between 0.01 and 0.95 (mean = 0.24) for non-program (control) households. The common support region would then lie between 0.15 and 0.95. In other words, households whose estimated propensity scores are less than 0.15 and larger than 0.95 are not considered for the matching exercise.

Table 12. Distribution of estimated propensity scores

Group	Obs	Mean	Std. Dev	Minimu	Maximum
Total households	200	0.5	0.363	0.03	0.97
Treatment households	100	0.76	0.22	0.15	0.99
Control households	100	0.24	0.278	0.01	0.95

Source: Own estimation results

### Choosing a matching algorithm

The vast majority of studies using PSM employ different criteria in choosing between different matching algorithms that are, among alternative ways of using the propensity score to match comparison units with treated units. Following Yibeltal (2008), the final choice of a



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matching estimator for this study was guided by three criteria such as equal means test referred to as the balancing test, pseudo- $R^2$  and matched sample size. Specifically, a matching estimator which balances all explanatory variables (i.e., results in insignificant mean differences between the two groups), bears a low pseudo- $R^2$  value and also results in large matched sample size was chosen as being the benchmark estimator of the data considered.

Table 13. Performance of matching estimators

Matching Estimator	Performance criteria		
	Balancing test*	Pseudo- $R^2$	Matched sample
<b>Nearest Neighbor</b>			
Without replacement	9	0.038	130
With replacement	9	0.026	181
<b>Radius caliper Matching</b>			
Caliper (0.01)	7	0.157	145
Caliper (0.25)	8	0.047	177
<b>Kernel Matching</b>			
Band width (0.05)	8	0.07	177
Band width (0.25)	9	0.035	177
Band width (0.1)	9	0.034	178
Band width (0.5)	9	0.07	177

Source: Own estimation result.

\* Number of explanatory variables with no mean differences.

Table 13 presents the estimated results of tests of matching based on the above-mentioned performance criteria. Accordingly, Nearest Neighbor Matching with replacement, in which case, an untreated individual can be used more than once as a match, was found out to be the benchmark estimator for the data. As indicated in Table 13, this estimator has resulted in the lowest pseudo  $R^2$  value, well balanced covariates and largest sample size by discarding only 19 households (7 program and 12 control households) from the sample.

### Balancing test

Table 14 shows the balancing test of covariates, which tests the significance of the mean difference between the matched and unmatched samples in terms of all the nine covariates used for the matching purpose. As shown in Table 14, the unmatched samples of the program and non-program households were significantly different in terms of certain characteristics. However, one looks to see that any differences in the covariate means between the two groups in the matched sample have been eliminated, which would increase the likelihood of unbiased treatment effects.

The calculated test result measures the balancing of the distribution of t-test, for each variable used in the regression; it calculates the t-test for equality of means in participant and non-participant group, both before and after matching. The t-test is based on a regression

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of the variable on participant indicator. Before matching this is an unweighted regression on the whole sample while after matching the regression is weighted using the matching weight and is based on the support sample. As the column of the table differences were removed after matching.

According to the t value of individual t-tests show similarities in the mean values between treatment and control groups in this matching estimator, relatively all of the variables have lower t-value (insignificant). This shows NN matching is preferred as the best estimator of the average treatment effect. Consequently, only the outcome from this estimator is used to meet the study objectives of estimating the impacts of PSNP on poverty alleviation in the households.

As proposed by Smith and Todd (2005), if matching is successful, the after-matching logit should have no explanatory power so that the pseudo-R<sup>2</sup> should be fairly low. Accordingly, the results in Table 14 showed that the pseudo-R<sup>2</sup> values using the sample after matching compared with that obtained from the logit estimation using the sample before matching are considerably close to zero in almost all of the estimators, showing that the conditional independence assumption is plausible in all cases.

Table 14. Balancing tests of covariates

<b>Matching Variables</b>	<b>Sample before Matching</b>	<b>Sample after Matching</b>
<b>Average age</b>		
Mean (treatment)	40.09	40.59
Mean (control)	41.22	40.72
t-test (p value)	0.89	0.77
<b>Sex of HH head</b>		
Mean (treatment)	0.43	0.41
Mean (control)	0.39	0.40
t-test	-0.24	-0.16
<b>Education</b>		
Mean (treatment)	0.80	0.83
Mean (control)	0.91	0.89
t test (p value)	2.22	1.17
<b>MRITAL STATUS</b>		
Mean (treatment)	0.54	0.55
Mean (control)	0.57	0.56
t test (p value)	0.42	0.18
<b>Average family size</b>		
Mean (treatment)	5.84	5.53
Mean (control)	4.96	5.48
t test(p-value)	-3.0	-1.42
<b>Dependency ratio</b>		
Mean (treatment)	0.52	0.50
Mean (control)	0.40	0.46
t test(p-value)	-4.01	-1.32

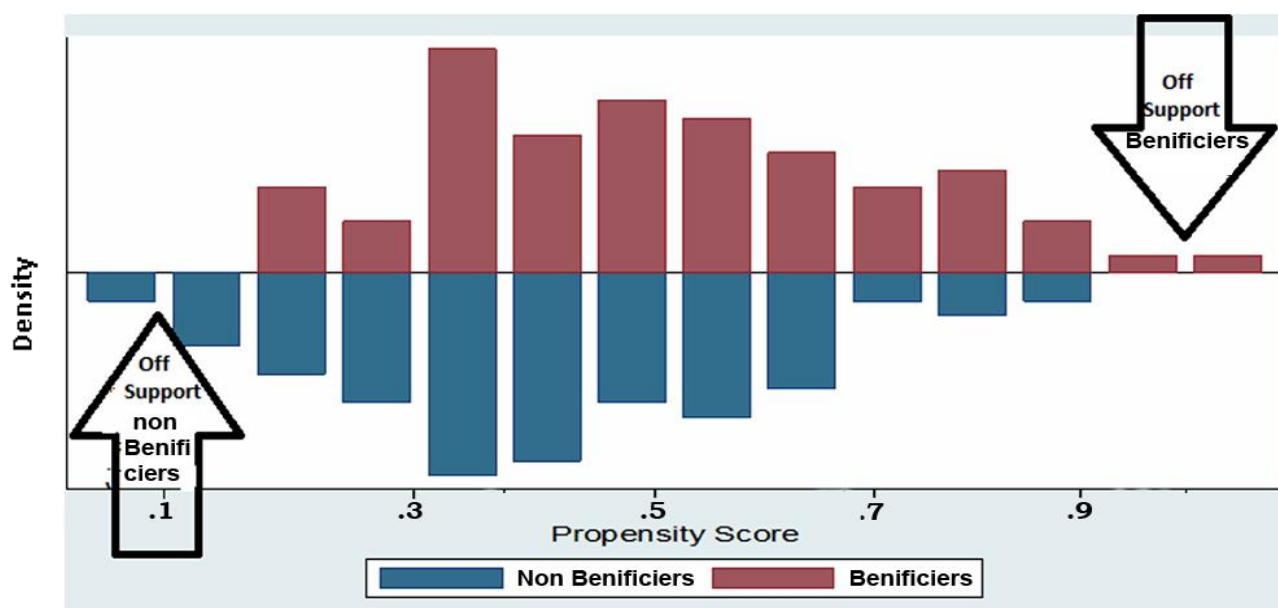
<b>Land owned size</b>		
Mean (treatment)	0.97	1.00
Mean (control)	1.23	0.82
t test (p value)	2.39	1.65
<b>Credit</b>		
Mean (treatment)	0.87	0.83
Mean (control)	0.58	0.89
t test (p value)	4.83	1.17
<b>Non/off farm</b>		
Mean (treatment)	0.36	0.46
Mean (control)	0.18	0.51
t test (p value)	-2.91	-0.48
pseudo R <sup>2</sup>	0.3302	0.082
N (treatment)	100	93
N (control)	100	88

Source: own estimation result

### Testing the overlap Assumptions

As can be seen from the tables 14 the value of pseudo R<sup>2</sup> is fairly low after matching denoting that the unconfoundedness assumption is plausible. Moreover, the study uses p score graph to test the plausibility of the overlap assumption.

Figure - 4 shows the distribution of propensity scores of both treatment and control observations before common support condition is imposed. The figure revealed that there appeared unmatched observations in both of the treated and untreated groups before common support is imposed.



Source: Survey result

However, as can be seen clearly in the Figure 5 below, after matching the data using the NN matching with replacement method, the common support condition has trimmed out a total of 19 observations from the model (7 from the beneficiary households and 12 from the non-beneficiary households which lie in the off-support regions) signifying that the overlap assumption is also plausible for this estimator.

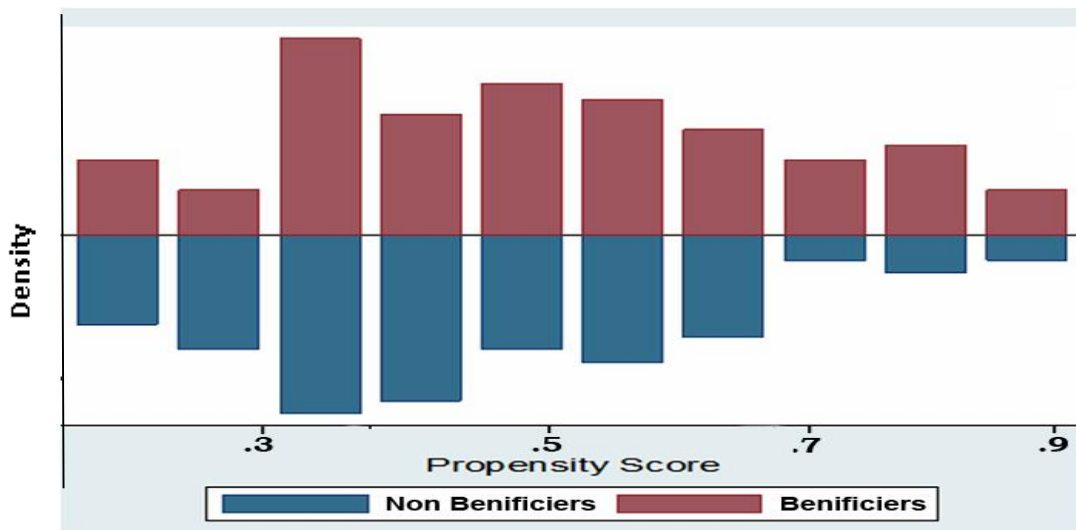


Figure 5: Distribution of propensity scores of treated and untreated households after common support  
Source: Survey result

**Treatment effect on the treated**

In this section, the thesis provides evidence as to whether or not the PSNP has brought significant impact on participating household in poverty alleviation. The estimation result presented in Table 15 provides a supportive evidence of statistically significant effect of the program on participating households. On average, the program has increased daily caloric intake per adult equivalent of the participating households by 30 % (i.e., 856), monthly consumption expenditure per adult equivalent by 2.84% and livestock holding by 40% compared to that of non-participating households.

Table 15 presents estimates of the average impact of participation in the PSNP. The outcomes considered include daily caloric intake per adult equivalent, monthly consumption expenditure per adult equivalent and size of livestock holding per household.

Table 15: Average Treatment Effect of outcome variables for matched groups of program participants and non-participants

Outcome Variables	Treated	Controls	ATT	T-Value
Calorie intake	2843.8	1988.11	855.69	3.21***
Expenditure	238	231.23	6.77	1.75*
TLU	8.48	5.03	3.44	2.77*

Source: Survey result

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A different trend was reflected in the second outcome, consumption expenditure. In the simple unmatched comparison, program participants have a monthly consumption expenditure that was on average 11.99 birr (i.e., 4.96 per cent) higher than non-participant (Table 10) and the difference was statistically significant at the 5 per cent level of significance. However, for the matched sample, the difference in monthly consumption expenditure between participants and non-participants was seen to decrease to 6.77 birrs (i.e. 2.84 per cent), although statistically significant at the 10 % probability level.

### **CONCLUSION AND RECOMMENDATIONS**

Using a cross-sectional data from six selected rural kebeles of Dire Dawa Administration, this research study analyzed the impact of PSNP on households' poverty alleviation. The primary data for this study was collected from 200 households from an equal number of the program beneficiaries and non-beneficiaries in the study areas.

Since the PSNP has targeted the poor and vulnerable households in a non-random manner, assessing the impacts of the program using a simple mean difference comparison of outcomes between beneficiaries and non-beneficiaries would lead to biased estimates. In order to circumvent this problem, the study used the matching techniques called propensity score matching method, which is capable of extracting a comparable pair of treatment-comparison households in a non-random program setup and absence of baseline data.

Prior to employing the PSM method, a simple with and without approach was used to measure the impacts of the program on the level of selected outcomes namely: daily calorie intake per AE, monthly consumption expenditure per household and livestock asset holdings of the households. Accordingly, the results indicate that households in the program are better off in all the three outcomes of interest showing a statistically significant mean difference between program and non program samples.

Moreover, descriptive and inferential results indicated that program participants and non participants showed a statistically significant mean difference in terms demographic characteristics like (sex, family size, level of education and marital status of household heads), dependency ratio, land holding size and credit use. However, the two groups have shown a statistically insignificant mean difference in terms of age and non-farm employment. The results of the logit model also indicated that program participation is significantly influenced by a combination of factors. For instance, households in the program were more likely to have large dependents, small land size and better access credit service. Besides, they are more likely to be female headed and have large family size. On the other hand, non-program households have shown a higher tendency of having married and literate.

Due to these differences, it was not possible to attribute the difference in the outcomes of the two groups exclusively to the program. Hence, finding a reliable estimate of the program

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impact thus requires controlling for all such factors adequately. In doing so, propensity score matching has trimmed out 19 households allowing for 93 program households to be matched with 88 non-program households. As a result, the after matching balancing test showed that all the differences in the covariate means between the two groups in the matched sample have been eliminated. Hence, a matched comparison of outcomes was performed on these households who shared similar characteristics except the program.

After matching participants in the PSNP with non-participants on the basis of some socio-economic, demographic and other variables, the study found out that the level of daily calorie intake, consumption expenditure and livestock asset holding of the PSNP participants are respectively 30%, 2.8% and 40% higher than that of non-participants. This difference would suggest that the program has effective at increasing key welfare outcomes for participant households. On the other hand, the results showed that the program has a strong and significant impact on improving food security, consumption expenditure and livestock asset holding in rural participating households and also effective in poverty alleviating in the participant.

Based on the findings of this study, the possible recommendations which have important implications for anti-poverty measures in the study are forwarded:

The descriptive results of the study showed that off/non-farm employment and program participation are strongly and negatively related. This shows that program participants are less encouraged to be employed in such activities than non-participating households. On the other hand, improving households' off/non-farm income will have a greater impact on improving the wellbeing of rural households especially in the study area, where expansion of agriculture has no more opportunity. Therefore, intervention measures such as creating diversified off-and non-farm activities should be incorporated as one potential activity in the study areas to enhance the present impacts of the PSNP. Furthermore, government and NGOs operating in the area should also closely relate their financial services to diversifying off-farm/non-farm activities.

From the results of the logit model, land holding size was found to have a negative relationship with households' probability of participating in the program. Hence, physical and biological conservation measures should be widely incorporated in the program to enable the households to to enhance their income rather than expanding the land size. On the other hand, household head's level of formal education has shown a negative relationship with program participation. To address this, ways should be explored for integrating formal and non-formal education as one component of the PSNP in the study area.

Even though the results of the study clearly showed the achievement of the program in improving its beneficiaries' food security levels and enhancing their consumption expenditures, it has been shown that the program has a strong and significant impact on

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improving the livestock holdings of its beneficiaries. Since the consumption expenditure not proportional with the calorie intake it is highly recommended that programme system implementers should be taken into consideration towards improving the purchasing ability of food items for beneficially. This incorporates more food transfer than cash transfer. So the programme implementer in PSNP is crucial for working more on modalities of transfer. Incorporating a family planning program is a must. Because of larger family size increase the impact of the programme on participating more of their family member. Larger family members getting more food transferred due to participating in the public work. This probably encourages the household to have more children in the long term.

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