

**IMPACT OF PRODUCTIVE SAFETY NET PROGRAM ON
HOUSEHOLD FOOD SECURITY AND ASSET BUILDING: THE CASE
OF GORO GUTU DISTRICT, EAST HARARGHE ZONE OF OROMIA
NATIONAL REGIONAL STATE, ETHIOPIA**

MSc THESIS

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**Impact of Productive Safety Net Program on Household Food Security and
Asset Building: The Case of Goro Gutu District, East Hararghe Zone of
Oromia National Regional State, Ethiopia**

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DEDICATION

I dedicate this Thesis manuscript to my beloved grandmother, Momina Umar and my late grandfather, AdemYusuf for their partnership in the success of my life.

STATEMENT OF AUTHOR

By my signature below, I declare and affirm that this Thesis is my own work. I have followed all ethical and technical principle of scholarship in the preparation, data collection, data analysis and compilation of this Thesis. Any scholarly matter that is included in the Thesis has been given recognition through citations.

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BIOGRAPHICAL SKETCH

The author was born on May 13, 1992 from his father Mohammed Adem and his mother Fatuma Uso at Goro Gutu District, East Hararghe Zone of Oromia National Regional State. He attended his primary education at Kora Bilu Elementary School and Kara Mille Elementary Schools, respectively. He attended his high school and preparatory education at Kara Mille Senior Secondary and Preparatory School from 2008 to 2012. After successfully passing the Ethiopian Higher Education Entrance Qualification Certificate Examination, he joined Addis Ababa University in October 2012 and graduate with Bachelor of Science Degree in Agricultural Economics in July 2015. Soon after graduation, the author was employed by Ministry of Education to Dembi Dolo University as a graduate assistant and directly joined Haramaya University for his postgraduate study in October 2015.

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ACRONYMS

ADB	Asian Development Bank
AE	Adult Equivalent
ATE	Average Treatment Effect
ATT	Average Treatment Effect on the Treated
CIA	Conditional Independence Assumption
CSA	Central Statistics Agency
DA	Development Agent
DFSO	District Food Security Office
DOARD	District Office of Agriculture and Rural Development
DPPA	Disaster Prevention and Preparedness Agency
FSCB	Food Security Coordination Bureau
FSP	Food Security Program
GAPVU	Gabinete de Apoio à População Vulnerável [Mozambique]
HH	Household
MoARD	Ministry of Agriculture and Rural Development
NNM	Nearest Neighbor Matching
PSNP	Productive Safety Net Program
PSM	Propensity Score Matching
SSA	Sub-Saharan Africa
USAID	United States Agency for International Development
VIF	Variance Inflation Factor

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Impact of Productive Safety Net Program on Household Food Security and Asset Building: The Case of Goro Gutu District, East Hararghe Zone of Oromia National Regional State, Ethiopia

ABSTRACT

In Ethiopia, the problem of food security is an enduring critical challenge, which their responses were dominated by annual emergency food aid for a long time. In 2005, to combat the problem of food security and to 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 was evaluated the impact of PSNP on household food security and asset building in Goro Gutu District which composed of three agro-ecological zones since no study was conducted in the area. In this study, a multi-stage sampling technique was used to select 190 sample households which 90 program beneficiaries and 100 non-program beneficiaries. The primary data was collected using an interview schedule. Various documents were reviewed to collect secondary data. To analyze the data, propensity score matching model was employed. The logit regression result indicated that household program participation were influenced by age of the household head, dependency ratio and use of improved seed positively at 5% significance level, by marital status of the household head and educational level of the household head negatively at 5% significance level and by extension contacts and shock experience positively at 10% significance level. The propensity score matching estimation result found that as compared to non-program beneficiary households the program intervention increased the program beneficiary households' kilocalorie consumption and household asset by 11.67% and 69.90% respectively. Finally, provision of formal education as one component of the PSNP with integrated family planning programs, timely provision of improved seeds with modern agricultural inputs, provision of climate resilience services that helps the households to cope up with shocks, advising and following the program beneficiary households to invest cash transfer on productive asset were recommended for policy maker and practitioners.

Key words: *Productive safety net, impact, food security, household asset, propensity score matching, Goro Gutu*

1. INTRODUCTION

1.1. Background of the Study

The United Nation Food and Agriculture Organization estimate that about 805 million people in the world or one in nine were suffering from chronic undernourishment in 2012-2014. Out of total estimates, 791 million hungry people live in developing countries, representing 13.5% or one in eight of the population of developing countries (FAO, 2014).

Developing countries as a whole have registered significant progress towards the MDG hunger target. Despite overall progress, differences across regions persist. Sub-Saharan Africa (SSA) remains the region with the highest prevalence of undernourishment, with modest progress in 2012. Western Asia shows no progress, while Southern Asia and Northern Africa showed slow progress. Significant reductions in both the estimated number and prevalence of undernourishment have occurred in most countries of Eastern and South Eastern Asia, as well as in Latin America (FAO, 2013).

In Africa, food insecurity is not a new challenge. For more than twenty years, the continent has struggled with hunger. There are several challenges that have prevented African countries from achieving food security. Having an underdeveloped agricultural sector, poverty, barriers to market access, effects of globalization, rapid population growth and climate change are the most important challenges to food security in Africa (Astou, 2015).

Food insecurity resulting from poverty and recurrent droughts continues to be a major challenge in Sub Saharan African countries (Fekadu and Mbrenghwa, 2009). This has led to a shift in policy approaches where initiatives to sustainably resolve food insecurity are combined with social protection measures that aim to alleviate the impact of food insecurity (Devereux and Sabates–wheeler, 2004).

The Productive Safety Net Program (PSNP) is the largest operating social protection program in SSA, outside of South Africa. It differs from previous food for work programs, in that it focuses continuously on selected households over several years and in that the explicit objective was that it will eventually be phased out (Anderson *et al.*, 2009). Productive safety net program operates as a safety net, intended to enable households to smooth consumption so

that they will not need to sell productive assets in order to overcome food shortages. It targeted transfers to poor households in two ways, through public works and direct support. Public work is the one through which food insecure people were employed in public works for five days a month during the agricultural slack season. Direct support is the other way through which direct unconditional transfers of cash or food to vulnerable households with no able-bodied members who can participate in public works (MoARD, 2006).

For over two decades, Ethiopia has been known as a country that is heavily reliant on emergency relief as a typical response to its widespread and persistent food insecurity. Although this humanitarian assistance was, substantial (estimated at about US\$265 million per annum between 1997 and 2002) and saved many lives but it was unpredictable for both planners and households and often arrived too little. The delays and uncertainties meant that the emergency aid could not be used effectively and did little to protect livelihoods, prevent environmental degradation, generate community assets and preserve household assets (MoARD, 2010). These consequences suggest that programs to reduce chronic food insecurity should address both the immediate lack of food and the need to build resilience among smallholder incomes and assets (USAID, 2012).

Since 2004, the government of Ethiopia, World Food Program (WFP) and development partners started working together to increase families' long-term resilience to food shortages. In 2005, PSNP was established and aimed at enabling the rural poor facing chronic food insecurity to resist shocks, create assets and become food self-sufficient. Productive safety net program provides multi-annual predictable transfers as food, cash or a combination of both, to help chronically food insecure people survive food deficit periods and avoid depleting their productive assets while attempting to meet their basic food requirements. The combination of cash and food transfer is based on season and need with food given primarily in the lean season between June and August. Vulnerable households receive six months of assistance annually to protect them from acute food insecurity (WFP, 2012).

According to MoARD (2005), PSNP operates in 262 chronically food insecure districts in eight regions (Tigray, Amhara, Oromia, SNNPR, Harari, Dire Dawa, Afar, and Somali) that had been significant recipients of food aid between 2002 and 2004. The program initially assisted

about 5 million chronically food insecure people in rural Ethiopia in 2005 which was scaled up to reach 8 million in 2006.

Goro Gutu district is one of the PSNP beneficiary districts in the East Hararghe zone of Oromia National Regional State. According to Goro Gutu district food security office, in the district the program started in 2005 by targeting 3166 chronically food insecure households in ten *kebeles*. In the district, there is low level of graduation from program, were only 1266 households graduated in the first five year and 1842 households from 3070 households were graduated in the second five years. Following low graduation rate, currently the program operates in fourteen *kebeles* with caseload of 4594 chronically food insecure households. Hence, this study intended to assess the impact of PSNP on food security and asset building of program beneficiary household.

1.2. Statement of the Problem

The problem of food security is not a new phenomenon in Ethiopia, rather than a long history that has affected millions of people for decades. Food security problem in Ethiopia is highly linked to recurring food shortage and famine in the country (Abdusalam, 2017). Recurrent drought, environmental degradation, population pressure, limited access to services, shortage of farm land, lack of productive assets, low input and subsistence agricultural practices are the most prominent causes of food insecurity in Ethiopia (MoARD, 2007).

The Ethiopian government has been undertaking different actions in response to the problem of food security. However, the typical response to food insecurity in Ethiopia, prior to the start of PSNP was emergency food relief sourced through unpredictable annual appeals process. While there was no doubt that this relief saved many lives, it did not halt the increasing numbers of food insecure people (MoARD, 2009).

Therefore, differently from the previous approach, PSNP started in 2005 under the umbrella of Food Security Programs (FSP). It provides cash and/or food transfers to chronically food insecure households in ways designed to smooth food consumption, prevent asset depletion at the household level and promote asset creation at the community level. It addresses chronic food insecurity while simultaneously requiring households to engage in sustainable productive

activities and promoting market development by increasing households' purchasing power (FSCB, 2009).

Households in the study area have been affected by chronic food insecurity resulted from recurrent drought, rainfall variability, land degradation in the form of soil erosion, loss of soil fertility, moisture stress, high fertility rate and limited off/non-farm employment opportunities. Hence, the livelihood of farm households in the study area has remained dependent on emergency appeals food aid on annual basis for long time. According to Goro Gutu District Food Security Office (DFSO), in the past decade, during the season of severe drought households in the study area were forced to sell off their assets for consumption and migrate to the other places of Oromia region (DFSO, 2016).

In the study area, to solve the problem food insecurity and shortcomings of the previous practice of assistance PSNP was started implementing in 2005 with high beneficiary households. This program was also initiated with the objective of improving the food security of chronically food insecure households and building their household assets in away the households' sustainable resolve food insecurity resulting from seasonal shocks. To achieve the program objective over time the number of program beneficiary households decrease, reflecting the success of the program in assisting households to graduate. However, in the study area, the number of program beneficiary households became increasing and increasing. Moreover, there is a case where those households that graduated from program unable to withstand even small shocks to achieve their household food security without food assistance and currently eligible for program participation again (DFSO, 2016). The central questions are thus; do PSNP have an impact in improving the household food security and asset building of program beneficiary households? If yes, to what extent are the household daily kilocalorie intakes per AE and the household assets increase?

Even though several attempts have been made to evaluate the impact of PSNP countrywide, there is no empirical study on the impact of PSNP on household food security and asset building for program beneficiary households using standard econometric techniques in the study area. Hence, this study attempted to assess the impact of PSNP on improving household food security and asset building in Goro Gutu district.

1.3. Research Questions

Based on the above statement of problem, this research was intended to answer the following research questions:

1. What are those factors influencing participation of households in productive safety net program in the study area?
2. Does productive safety net program participation improve the household kilocalorie food consumption in the study area?
3. Does participation in productive safety net program help the program beneficiary households in accumulation of more household asset in the study area?

1.4. Objectives of the Study

The general objective of this study was to evaluate the impact of productive safety net program on household food security and asset building of participating households in Goro Gutu district, East Hararghe Zone of Oromia National Regional State.

The specific objectives of the study were:

1. To identify factors influencing participation of households in productive safety net program; and
2. To evaluate the impact of productive safety net program on household food security and asset building in the study area

1.5. Scope and Limitations of the Study

The Ethiopian Government is undertaking different FSPs in different chronically food insecure districts in the country. Productive safety net program is one of the largest FSPs implemented in many chronically food insecure districts of the country including this particular study area. This study was analyzed the impact of PSNP on household kilocalorie consumption and asset building of the program beneficiary households. The study was limited to only Goro Gutu District, which may somehow represent others with similar agro-ecological conditions in the region and the nation. Limited area coverage in terms of locations selected for the study hinder drawing conclusions about the program impact at macro level. Use of cross-sectional data to

assess the program impact because of no record of time series data among program beneficiary households was another limitation. This study does not consider the program impact on non-program beneficiary households and the impact of other FSPs in relation to PSNP because of limited resource availability and time to undertake the study on a wider scale.

During the time of data collection, there were challenging to convince few of the sample respondents to obtain exact information on food consumption and assets holding of the households. This is because some of the respondents were exactly not able to recall all their assets and food consumption. Another problem was some of the respondents were suspecting the aim of the study and some of them expecting some sort of incentives and some of them in fear of exclusion from the program to give exact information. These might have created some bias in the results of the study.

1.6. Significance of the Study

This study was intended to evaluate the impact of PSNP on household food security and asset building and its success in achieving the program goals. It provides information to the local government, communities, policy makers, and other development actors, which are implementing the program whether this program was achieving household food security and asset building for program beneficiary households in the study area. This study may contribute to the understanding of the impact of PSNP for different stakeholders as well as for anyone who want to use the study result. It may also provide baseline data on factors affecting the participation of households in the program and the role of the program on enhancing household food security and asset building. Furthermore, the study serve as a reference for other studies in the future on same and other related issues.

1.7. Organization of the Thesis

This thesis is organized in five chapters. The first chapter introduces the background of the study. The second chapter deals with review of literature that includes concepts of food security and household asset, social protection, impact assessment approaches, empirical studies on the impacts of PSNP on household food security and asset building and conceptual framework of the study. The third chapter presents a brief description of the study area and

research methodology employed. The fourth chapter deals with the results and discussions. Finally, the fifth chapter presents summary, conclusion and recommendations based on the major findings of the study.

2. REVIEW OF LITERATURE

In this chapter, concepts and definitions of food security and household assets, social protection, safety net in Africa, PSNP in Ethiopia, review of impact evaluation methods and related literature are presented.

2.1. Concepts of Food Security and Household Asset

2.1.1. Food Security

Food security is a concept that defined in different ways over time and there are many literatures on the potential to household food security dimensions. According to Hoddinott (1999), approximately there are 200 definitions of food security and 450 indicators of food security.

Today the most widely used definition of food security is the one adopted from 1996 World Food Summit (WFS). According to this definition “Food security exists when all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life“. This definition has been identified with the four dimensions of food security: availability, access, stability, and utilization (FAO, 2012).

Additionally, in 2009 Declaration of the World Summit on food security officially reaffirmed the 1996 WFS definition of food security by adding the word “social” to the phrase “physical, social and economic access”. Accordingly, define food security as “a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life“. This definition also identifies four dimensions of food security as the former one. These four dimensions of food security are availability, access, utilization, and stability (FAO, 2012).

Food availability: This is a concept that explains the quantity of food the households/ regions/nations have at a point in time. It addresses the “supply side” of food security and is determined by the level of local food production, food importation and food aid.

Food accessibility: It is the ability of the nation, region, household or individual to gain access to the available food. The factors that determine this access could be economic in nature or not. In the economic aspect is the purchasing power of the household to acquire the food needed for its nutritional need. It is clear that the sources of food for a household are different, households typically whether: (a) grow and consume from their own stocks; (b) purchase from the markets; (c) receive as a transfer from relatives, members of the community, government, or from foreign donors (Bassie, 2014).

Food utilization: Food utilization is the concept that determines the quality of food that meets the nutritional requirement for the household. It is commonly understood as the way the body makes the most of various nutrients in the food.

Stability of access: Stability of access has to do with the ability of the household to have continuous access to the food source over time, with minimal risks. Different risks such as shocks arise in form of drought, loss of jobs, illnesses, death, loss of productive resource and conflicts determine the stability of access to the food needed.

2.1.2. Household Asset

Household asset accumulation means increasing the real value of all types of assets of the household over a specified reference period. The specified period is usually the period of time for which a program or an intervention that is expected to bring asset accumulation is implemented (Tadele, 2011; Mulugeta, 2014). In this study, the household asset is measured in the initial value of the household asset minus depreciation to get current value of the household assets.

In accounting, the term asset is resource owned including liability. In the farming household context, asset includes all livestock owned, productive assets and consumer durable assets that belong to the household. Although there is a variation in owning of these assets in Ethiopia, they can be listed as follows:

Livestock assets: Include cattle, sheep and goats, poultry, donkey, camels and equines.

Productive assets: Include all asset used to produce crop and livestock like plough-equipments, water pump, sickle, spade, beehives, cart, pick axes and axes.

Consumer durable assets: Include telephone, radio, television, bed, home, bicycle, etc.

2.2. Social Protection

Social protection as an agenda in social policy became popular in the years 1980 and 1990's, following the global reaction to various forms of economic and financial crisis. Social protection is term take different forms in different countries and defined differently by different organizations. For example, UN define social protection as “a set of public and private policies and programs under taken by societies in response to various contingencies to offset the absence of substantial reduction of income from work to provide assistance to families with children as well as provide people with basic health care and housing” (Barrientos and Hulme, 2008).

But Asian Development Bank defines social protection as the set of policies and programs designed to reduce poverty and vulnerability by promoting efficient labor markets, diminishing people's exposure to risks, and enhancing their capacity to protect themselves against or cope with hazards and interruption or loss of income (ADB, 2010).

Social protection involves policies and programs that protect people against risk and vulnerability, mitigate the impacts of shocks, and support people who suffer from chronic incapacities to secure basic livelihoods. It can also build assets, reducing both short-term and intergenerational transmission of poverty. In general, there exists a broad range of social protection programs. It includes social insurance (such as health, life, and asset insurance, which may involve contributions from employers and/or beneficiaries); social assistance (mainly cash, food, vouchers, or subsidies); and services (such as maternal and child health and nutrition programs). Interventions that provide training and credit for income-generating activities also have a social protection component (Adato and Hoddinott, 2008).

One form of social protection is social assistance, which involves non-contributory transfers to those deemed eligible by society based on their vulnerability or poverty (Farrington and Slater 2006). It includes food transfers (food stamps, food rations, food price subsidies), cash transfers (grants, non-contributory pensions, family allowance programs), service subsidies (social housing programs, utility subsidies and childcare centers), and conditional cash

transfers (conditional on child and maternal health care practices, school attendance, and nutritional standards, or on the use of welfare programs) (Tasew, 2009).

Social protection strategies are integrated system of institutionalized national measures, which included contributory pensions, insurance schemes and safety nets (Holzmann, 2003). Social protections take different forms in different countries but their ultimate aim was the same helping the vulnerable section of the society.

2.2.1. Safety Net in Africa

South Africa's experience with social safety net program provides important lessons for other African countries concerning the practical implementation of social security schemes with regard to poverty reduction, reduction of gender inequalities, incentive effects, and improvements in education and health and in terms of financing and fiscal sustainability (Devereux, 2002).

A study that examined two social safety net interventions in Southern Africa namely cash transfers in Namibia (social pensions), Mozambique (cash payments to urban destitute (GAPVU)). Both programs comprise social safety nets in that they protect poor citizens against income shocks associated with old age, destitution caused by war, and drought, respectively (Devereux, 2002).

Accordingly, in Mozambique, survey found that the number of beneficiary households living in absolute poverty had fallen from 71% to 65% because of GAPVU. GAPVU also made a greater contribution to total household income rise in the small, poor town of Chimoio (41%) than in the large wealthier city of Maputo (Deverux, 2002).

2.2.2. Productive Safety Net Program in Ethiopia

Ethiopia's productive safety net program is the largest social protection program in SSA outside South Africa and initially took up an annual budget of US\$500 million (Legovini, 2006; Gilligan *et al.*, 2008). It is a development oriented social protection program aimed at solving the chronic food needs of rural households in the country. In 2005, the program commenced by covering more than 1.6 million households (5 million people) in 263 districts identified as chronically food insecure areas (Legovini, 2006; Gilligan *et al.*, 2009; Aschale,

2012). After the pastoralist, areas of the country are included in the program and the size of the beneficiaries has increased to 8.3 million people in 319 districts (Aschale, 2012; Desalegn *et al.*, 2013). The PSNP provided food or cash transfers through public work projects to more than 7 million poor and chronically food-insecure Ethiopians. A smaller number of individuals eligible for the PSNP (roughly 15%) who were unable to supply labor to the public work projects due to disability, infirmity or a very high household dependency ratio received income transfers through direct support. Initially, participants in public work under the PSNP received transfers of 6 birr per day or 3 kg of cereals. The cash transfers increased to 8 birr per day in 2008 and 10 birr per day in 2010 to compensate for the steep rise in cereal prices over that period (Hoddinott *et al.*, 2012).

2.2.2.1. Objectives of productive safety net program

The objective of the PSNP is to assure food consumption and prevent asset depletion for food insecure households in chronically food insecure districts, while stimulating markets, improving access to services and natural resources, and rehabilitating and enhancing the natural environment (MOARD, 2010).

2.2.2.2. Components of productive safety net program

The PSNP consists of two components. These components are labour intensive public works for those households who able to contribute labor and direct support for labor-poor households (elder, disabled, chronically ill) (FSCB, 2004).

A. Public works

The public works element was basically meant for community asset building including the rehabilitation of natural resources e.g. land, water and vegetation. Public works were labour intensive community-based activities which were designed to provide employment for chronically food insecure people who have able-bodied labor, for which the PSNP transfers are payment. According to MoARD (2009), there are principles of PSNP public works which were necessary for achieving its objectives. These fundamental principles of public works are:

Labor-based: Works must be labor-intensive and use simple tools as possible;

Participation: The community participates in the selection, planning, monitoring and evaluation of projects;

Predictability: Program participants were expected to be aware of the timing of public works;

Proximity: Public works were provided as much as possible in the immediate localities of the people in need;

Watershed approach: Public Works will be planned according to the community based watershed management approach;

Integration: Public works were expected to be integrated into district development plans and planned on an inter-sectorial basis;

Gender sensitivity: Public works were designed to enable women to participate, and priority was given to works which reduce women's regular work burden; and

Work on private land: The creation of community assets was the primary objective of the PSNP. However, the watershed approach allows public works labor to work on private land if this work was necessary for the treatment of the watershed.

According to MoARD (2006), PSNP revised implementation manual the eligible beneficiary households will be selected to participate to public works activities on the basis of the following criteria:

- 1) Public work is intended for able-bodied adult men and women from households which are within the category of chronic food insecure rural households;
- 2) Facing severe food shortages and unable to meet their basic food needs while preserving essential productive assets;
- 3) An individual is eligible to work in public works if he/she is an able-bodied adult;
- 4) Accepted by the community as meeting the established selection criteria;
- 5) A member of the community;

- 6) It includes pregnant women up to four months, lactating women after ten months, and female heads of households; and
- 7) It excludes sick, physically or mentally challenged people unable to undertake even light work, pregnant women after the sixth month, and lactating women in the first ten months after childbirth.

B. Direct support

Direct support component deliver assistances to those households, who were eligible for PSNP and have no labor and no other source of support, including some disabled persons. According to MoARD (2006), PSNP revised implementation manual only two groups of individuals are targeted as eligible for direct supports. Those groups are:

- 1) The first group includes those individuals
 - i. who do not have labor to participate in public works,
 - ii. who do not have sufficient and reliable support from sons/daughters, or remittances from relatives away from the village; and
 - iii. who cannot participate or contribute to other community based activities/initiatives. Such individuals include some physically challenged persons.
- 2) The second group are those individuals can assist direct support component includes
 - iv. those individuals who are able to participate or contribute in other community activities (example. managing day-care facilities)
 - v. those individuals include all pregnant women should be engaged in lighter works mainly related to nursery works, light repairs, weaved materials for specific public works should be as near to their homes as much as possible within one kilometer distance from residence, lactating mothers in the first ten months after birth, pregnant women after the sixth month, and orphaned teenagers.

2.2.2.3. Graduation from productive safety net program

In the PSNP program implementation manual, the term graduation was first introduced as a key goal of safety net program in 2004 (MOARD, 2004). Afterward in 2006 graduation was an overall goal of the government food security program (FSP) of which PSNP is the major component (MOARD, 2006).

In 2007, a definition of graduation was introduced into the food security program to guide its implementation. Graduation is introduced as a two stage process. The first stage is graduation from PSNP and the second is graduation from FSP. Graduation from FSP is a much more complex and longer term issue that cannot be addressed on the basis of current context where only a small proportion have graduated even from PSNP. This occurs when a household has improved its food security status to a level that shifts it from being classified as chronically food insecure to food self-sufficient, it is no longer eligible for PSNP. Graduation from safety net is therefore defined as “a household has graduated when in the absence of receiving PSNP transfer; it can meet its food needs for all twelve months and is able to withstand modest shocks”. This state is described as being food self-sufficient (MOARD, 2007).

Graduation arises from the combined effect of FSP components and other development processes, not from the activities of the PSNP alone. Improvements in all of these contributors are required for graduation. Therefore, the success of the PSNP cannot be judged by graduation rates. In this phase the PSNP and wider FSP have been designed in such a way that there are greater prospects to achieve graduation at scale, through close complementarity between the different services that households have access to under the different components of the FSP (MOARD, 2010).

A household is considered ready to graduate from the PSNP when it has achieved food sufficiency which was defined in the Graduation Guidance Note for the PSNP as follows: A household has graduated when, in the absence of receiving PSNP transfers, it can meet its food needs for all twelve months and is able to withstand modest shocks. Conceptually it is clear; this definition raises several questions at an operational level, including how to assess whether a household is food sufficient over a twelve months period and how to assess whether the household is resilient against modest shocks. These questions are important because Food

Security Task Forces constituted at the local *Kebele* level are responsible for assessing the readiness of households to graduate, so clear guidelines are needed to implement graduation in practice (MOARD, 2010).

The challenges of operationalizing the definition of graduation in the Graduation Guidance Note led to the introduction of asset-based thresholds or benchmarks, which serve as proxies for food sufficiency and resilience. Each region (e.g. Oromia, Tigray) is required to set a benchmark in Birr, which represents the local market value of a bundle of assets (such as livestock and farm tools) that are deemed to be adequate for a household to cover its food needs for at least 12 months and to buffer the household against modest shocks. The benchmark value could vary across and even between regions. For instance it could be adjusted by livelihood zone given that different livelihoods (e.g. food crop farming, cash crop farming, and pastorals) require different sets of assets to be viable and sustainable (MOARD, 2010).

2.3. Impact Assessment Approaches

Impact assessment of a designed program intervention is to show the effect of the program on participating group and comparator group that did not participate in the program as a control group, but having similar pre-intervention socio-economic characteristics. Thus, estimating the impact of a program requires separating its effect from intervening factors which may be correlated with the outcomes, but not caused by the program (Ravallion, 2005).

In general, there are two main approaches in impact assessment. These are randomized (experimental) method and quasi-experimental (non-randomized) method (Baker, 2000).

2.3.1. Experimental (Randomized) Method

Experimental method is an approach in which both participants and non-participants of a program randomly drawn from the same population before the implementation of the program. That is, by randomly allocating the intervention among eligible beneficiaries, the assignment process itself creates comparable treatment and control groups that are statistically equivalent to one another, given appropriate sample sizes (Baker, 2000). According to Ezemenari *et al.* (1999), a random assignment of individuals to treatment and non-treatment groups ensures that

on average any difference in outcomes of the two groups after the intervention can be attributed to the intervention.

The main advantage of experimental method is its ability to avoid problem of selection bias, which arises when participation in the program by individuals is related to their unobservable or unmeasured characteristics, which in turn determine the program outcome. However, this method has also several problems .i, it may be unethical to randomly assign eligible members as a control group and exclude them from benefits or services for the purposes of the study. ii, it can be politically difficult to provide benefits to one group and exclude another. iii, it is difficult to obtain control groups for programs implemented in large scale that involve all groups. iv, individuals in control groups may change certain identifying characteristics during the experiment that could invalidate or contaminate the results. v, it may be difficult to ensure that assignment is truly random. vi, experimental designs are not time and cost effective, especially in the collection of new data (Baker, 2000).

2.3.2. Quasi-experimental (Non-randomized) Method

Quasi-experimental design involves matching treatment groups with a comparable control group of individuals who did not participate in the program. This approach simulates randomization but need not take place prior to the intervention (Kerr *et al.*, 2000). It can be used when constructing treatment and control groups though experimental design is not possible. This method is the only alternative in two cases. First, when there is no baseline data and the second one is when randomizations are not feasible options (Jalan and Ravallion, 2003).

Since the treatment and comparison groups are usually selected after the intervention by using non-random methods, it is necessary to apply statistical controls to address differences between the treatment and comparison groups. Additionally, sophisticated matching techniques should be used to construct a comparison group that is more or less similar to the treatment group (Gilligan *et al.*, 2008).

Quasi-experimental design has its own advantages and disadvantages. The main advantages of this method are it can draw on existing data sources, it is quicker and cheaper to implement and

it can be performed after a program has been implemented. In contrast, their some disadvantages are as the methodology is less robust statistically the reliability of the results is often reduced, selection bias problem that yields inaccurate results and statistical complexities (Baker, 2000). These disadvantages impose methodological challenge in non-experimental evaluation methods and hence affect the reliability of results when generating a comparison groups (Foster, 2003). To avoid or reduce these problems, different econometric approaches have been developed of which some are discussed as follows:

2.3.2.1. Difference in difference (Double difference)

This method compares changes in outcome before and after the project intervention for a sample of participants and non-participants. Typically, one collects outcome data of both participants and non-participants using a baseline survey before the program and repeats this survey at some later point after the program is implemented (Becker and Ichino, 2002). The mean program impact is estimated by comparing the mean difference in outcomes “after” and “before” the intervention between the participant and non-participant groups (Baker, 2000). Consequently, this approach incurs higher costs and spends more time as compared to propensity score matching approach.

2.3.2.2. A reflexive comparison

In a reflexive comparison the counterfactual is constructed on the basis of the situation of program participants before the program. Thus, program participants are compared to themselves before and after the intervention and function as both treatment and comparison group. This design is particularly useful in evaluations of full-coverage interventions such as nationwide policies and programs in which the entire population participates and there is no scope for a control group (White *et al.*, 2006). However, a major drawback with reflexive comparison method is the situation of program participants before and after the intervention may change owing to myriad reasons independent of the program.

2.3.2.3. Instrument variables

It is a method which one uses one or more variables that matter to participation but not to outcomes given participation. This identifies the exogenous variation in outcomes attributable

to the program, recognizing that its placement is not random but purposive. In other words, this approach relies on exclusion restriction assumption to control for unobserved heterogeneity: i.e. the determinants of participation include at least one variable that does not affect outcomes and the instrument is a source of exogenous variation that restore some sort of conditional independence (Essama-Nssah, 2006).

This evaluation design is relatively cheap and easy to implement since it can draw on existing data sources. However, it has a number of difficulties. First, the reliability of result is often reduced as the methodology is less robust statistically. Second, the methodology has some statistical complexities that may require some expertise in the design of the evaluation and in the analysis and interpretation of results. Third, it is possible to partially correct for selection bias, full correction remains as a challenge (White *et al.*, 2006).

2.3.2.4. Propensity score matching

The basic idea of the propensity score matching method is to match program participants with non-participants typically using individual observable characteristics. This method builds a control group by selecting a large group of non-participants those individuals who are similar to the participants in all relevant pre-treatment characteristics. When the comparison includes a large set of observed characteristics, the matching between participants and non-participants can be performed using propensity scores. Propensity scores measure an individual's predicted probability of being a program participant given their observed characteristics (Ravallion, 2005). This probability (propensity score) is estimated as a function of individual characteristics typically using a statistical model such as logit or probit model. The matching method pairs participants and control groups from a similar socioeconomic environment with the closest propensity scores. A measure of this closeness is the absolute difference in scores. The mean program impact is estimated by the difference between the observed mean outcome of the program participants and the mean outcome of the matched non-participants (Foster, 2003).

Propensity score matching estimate is more reliable if: (i) participants and controls have the same distribution of unobserved characteristics; (ii) they have the same distribution of observed characteristics; (iii) the same questionnaire is administered to both participant and non-

participant groups; and (iv) treated and control households are from the same economic environment. In the absence of these features, the difference between the mean impact of the participants and the matched non-participants is biased estimate of the mean impact of the program (Jalan and Ravallion, 1999).

Propensity score matching has its own potential problematic assumptions and implementation challenges. Propensity score matching requires large amounts of data both on the universe of variables that could potentially confound the relationship between outcome and intervention (Bernard *et al.*, 2010). We can never be entirely sure that all relevant covariates included in the model and effectively satisfied the conditional independence assumption (CIA). Furthermore, PSM is non-parametric: we do not make any functional form assumptions regarding the average differences in the outcome. Although it involves specification choices example, functional form like logit and probit, empirical analyses tend to find impact estimates that are reasonably robust to different functional forms. Moreover, if unobservable characteristics also affect the outcomes, PSM approach is unable to address this bias (Ravallion, 2005).

Irrespective of its shortcomings, PSM is extensively used in the recent literature on program impact evaluation (Jalan and Ravallion, 2003). It is very appealing to evaluators with time constraints and working without the benefit of baseline data given that it can be used with a single cross-sectional data, where this study envisaged to employ.

2.4. Empirical Studies on the Impacts of Productive Safety Net Program

A number of researchers have applied PSM model to evaluate impact of PSNP. Some of the studies that have applied PSM in program evaluations are briefly discussed below.

A study conducted by Devereux *et al.* (2006), used qualitative survey data to assess the PSNP impact. According to this study, there was a significant impact on food consumption after the program implementation that the program beneficiary households have shown an improvement in quality as well as the quantity of food consumption. The other impacts of PSNP are asset protection and household assets building, because of PSNP bought important household items such as cloth and medication and avoiding selling of physical productive assets like goat and cattle. Most of the beneficiary households have been bought productive assets like oxen dairy

cows and goats by what they received and avoid harvesting of the pre matured crops in order to meet their immediate food shortage.

Gilligan *et al.* (2008), in 68 beneficiary districts in Tigray, Amhara, Oromia, and SNNP using a quantitative household and community survey, conducted the impact evaluation study. The study used PSM model to estimate the impacts. Accordingly, the treatment household group that received payment at least 90 birr per person for participating in the PSNP-supported public works in the period June 2005 to May 2006 showed an improvement in daily calorie intake as compared to control group. In addition, there was an increase in per capita calorie acquisition. In addition to this, households were considered beneficiaries if they received any payment in participating in PSNP-supported public works and they received access at least one intervention or service provided under the other FSP. Under the above definition of beneficiary households in relation to the control group, they are more likely to be food secure, use credit service for productive purpose using improved agricultural technologies, and operate non-farm own business activities.

Andersson *et al.* (2009) has conducted study on impacts of PSNP in Ethiopia on livestock and tree holdings of rural households using PSM technique. They found no indication that participation in PSNP induces households to disinvest in livestock or trees. In fact, households that participated in the program increased the number of trees planted, but there was no increase in their livestock holdings. They found no strong evidence that the PSNP protects livestock in times of shock. Shocks appear to lead households to disinvest in livestock, but not in trees. It suggests that there is increased forestry activity as a result of PSNP and improved credit access encourages households to increase their livestock holdings.

According to Temesgen (2014) who analyzed the impact of PSNP on farm households' food security and asset building in Alaba special district of Southern Nations Nationalities and Peoples region using PSM technique, the program intervention has significant influence on livelihood and food security of the poor rural households. The study result showed that as compared to non-participant households the program intervention increases the participant households' calorie intake by 18%, food expenditure by 40% and total annual income by 47% and the non-food expenditure by 28% but there was no impact on household livestock asset. In addition, the study result showed that those factors influencing the household participation in

the program were dependency ratio, land holding, credit utilization and shock experience, participation in other food security program, education, non-farm income and extension visit.

Kidanu (2014) evaluated the impact of PSNP on food security and household asset building in Midaga district of Eastern Oromia by using PSM method. Accordingly, the program intervention has resulted in a positive and statistically significant mean difference between participants and non-participants of the program in terms of daily calorie intake and livestock holding of the households. They found that the program intervention has increased daily calorie intake and livestock holding of the program participant households by 25% and 20% respectively. In addition the program has increased farm and household equipment holding of participant households by 186.39 Birr but this difference is statistically not significant.

Mulugeta (2014) assessed the impact of PSNP on rural households' food security and asset holding in Gurgura district of Dire Dawa Administration. PSM method was employed to analyze the impact of program. They found that the program has increased physical food consumption in calorie intake of the participant households nearly 7% more than what they would have consumed in the absence of the program. In addition the study evaluates whether or not the program protect the asset holding, specially livestock and other productive assets of program beneficiary households. The result showed that change in value of livestock for the participant household was 34% better than non-participant households. Therefore, the PSNP showed that a significant impact on livestock assets holding.

Another study conducted by Nesreddin (2014) on the impact of PSNP on the livelihood and food security of rural households in Sofi District of Harari region by using PSM model. The study evaluates the effect of PSNP on farmers' livelihood in food self-sufficiency in kcal intake, asset formation, annual income generation and expenditure. Accordingly, the study result showed that program participant households gain 15.31% more mean annual income, consume 2.99% more kilocalorie food intake per AE per day, incur 11.38% more annual food and non-food expenditure and hold 31.8% more livestock assets than non-program participant households.

2.5. Conceptual Framework of the Study

It is clear that the aim of PSNP is to ensure the food security of poor chronically food insecure households by increasing food consumption and prevent asset depletion through improving the household productive assets. In addition the program stimulate markets, improve access to services and natural resources, and rehabilitating and enhancing the natural environment.

The productive safety net program has the following elements to achieve their objectives by focusing primarily on chronically food insecure households:

It aims to assure food consumption, so that chronically food insecure households to have enough food to eat throughout the year by supplementing foods. Prevent asset depletion, so that food insecure households do not have to lose their assets like livestock, productive assets and household goods in order to provide food for them. To address the underlying causes of food insecurity by rehabilitating the natural resources base; contribute to the creation of an enabling environment for community development by improving access to services, such as health, education, roads and market infrastructure.

With this objective element the PSNP provides a safety net to protect people falling further into trouble of food insecurity and help the program beneficiaries by improving their household income, protecting household asset, improving food consumption, creating community asset and improving the household food security.

However, there are several factors influencing participation of households in PSNP. These factors are demographic factors like age, sex, household size, dependency ratio and marital status; socio-economic factors like education level, landholding, use of improved seeds, use of chemical fertilizer, off/non-farm income and institutional factors like extension contacts, access to irrigation, credit received, distance from market center and received remittance; environmental factors like drought, rainfall variability and pest and disease. The conceptual framework described below incorporates these factors influencing household food security and participation of households in PSNP that have direct influences on household food security and the impacts of PSNP in improving household food security and asset building.

Source: Own construction (2016)

3. RESEARCH METHODOLOGY

This chapter describes the general features of the study area and the methodology to be employed. It briefly explains and discusses about the physical setting, demographic characteristics, and socio-economic conditions of the study area. Data sources and data collection methods, sampling techniques and methods of data analysis are also briefly discussed in this chapter.

3.1. Description of the Study Area

3.1.1. Physical Setting

Goro Gutu district is located in East Hararghe zone of the Oromia National Regional State. It lies between $9^{\circ} 18'$ and $9^{\circ} 33'$ N latitude and $41^{\circ} 33'$ and $41^{\circ} 30'$ E longitude. The district is bordered by Meta district in the east, Deder district in the south, West Hararghe administrative zone in the west and Somali National Regional State in the north respectively. The district has a total area of 531.23 km square, which accounts about 2.35% of the total area of the East Hararghe zone. The district has 28 rural and 2 urban *Kebeles*. The town of the district Kara Mile is located at a distance of 108 km from Harar city and 410 km from Addis Ababa on the main road from Harar to Addis Ababa. The altitude of the district ranges from 1200 to 2657 meters above sea level. Topography of the area is characterized by mountain, plateau, dissected gullies and degraded hills (DOARD, 2011).

Goro Gutu district has bimodal rainfall patterns. The shortest season (*belg*) is from mid-February to April and the longest season (*Meher*) is from June to the end of September. Annual average rainfall ranges from 330 mm in the lowland to nearly 2100 mm in the upper highland. According to climatic classification, the agro-ecological classification of the district is categorized into three zonation; these are high land, mid-land and lowland constitutes 23%, 28% and 49% of the total area of the district respectively. The district average precipitation is inadequate even for rain fed agriculture. Besides, the uneven nature of rainfall distribution and weather variability especially in the lowland and midland of the district has resulted in frequent crop failure and loss of livestock (DOARD, 2015).

The land use pattern within the district shows that 43% of the total area is arable land, 2.3% pastureland and 19.95 is forest and bush land, 34.8% degraded and settlement areas. Mixed farming is practiced in the district and 95% of the farmers produce mainly cereals (sorghum, maize, wheat) and legumes and keeps limited livestock per household (DOARD, 2011). Agriculture is total rain fed and crop production is undertaken once a year, the total cultivated land of the district is 26,703.9 hectares and total households that use such land are 22,597.

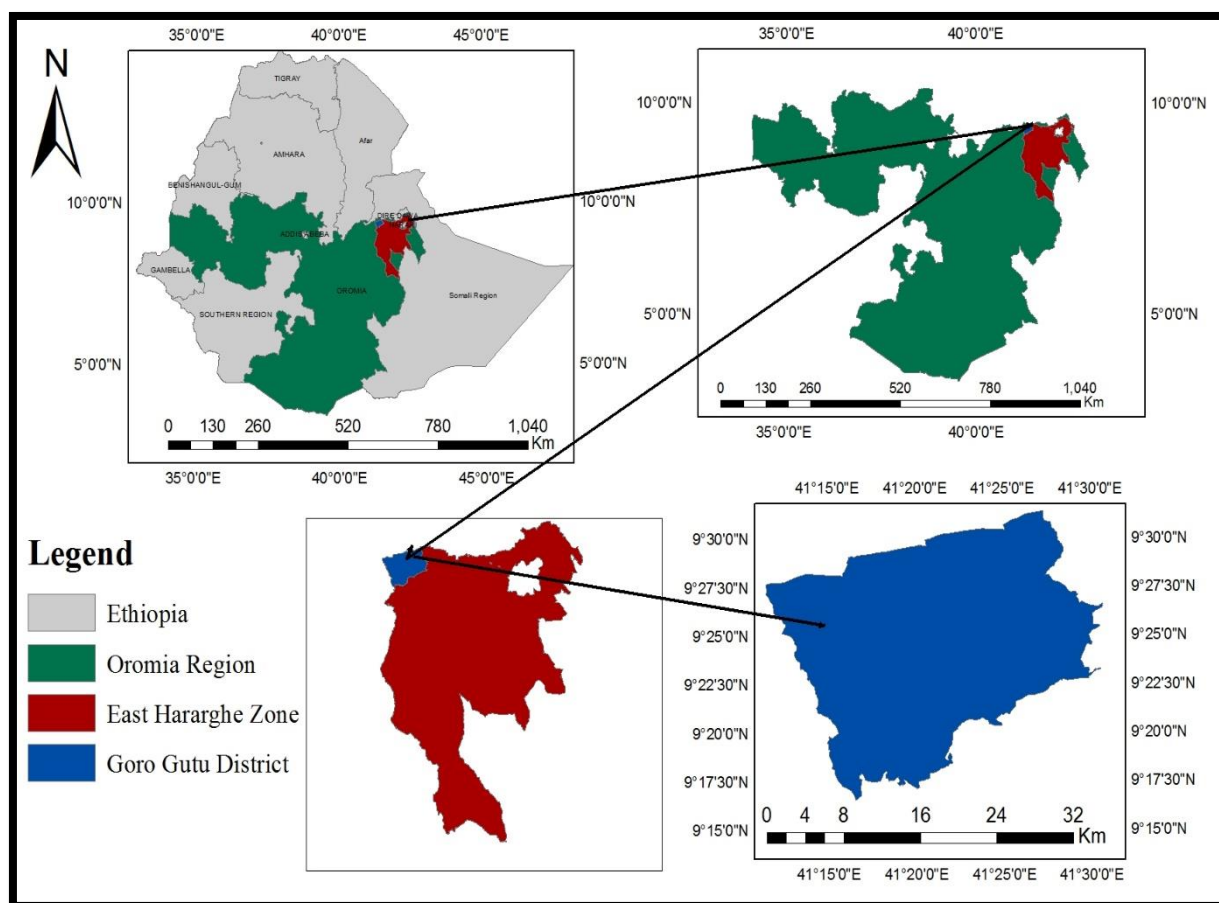


Figure 2. Map of the study area

Source: Own sketch from Ethiopian map (Ethio-GIS)

3.1.2. Demographic Characteristics

Goro Gutu district has a total population of 186,486 of which 94,990 (50.94%) are male and the remaining 91,496 (49.06%) are female. About 91.3% of the population living in rural areas and other 8.7% live in the pre-urban areas. The mean population density is estimated to be 351 people per square km (CSA, 2013).

3.1.3. Socio-economic Conditions

Agriculture is the major occupation of the people living in the study district. The livelihood of the population is directly or indirectly dependent on agriculture. Agricultural production (both crop and livestock) is the main source of income and employment to the society. The average land holding per household in the district is 0.37 hectares, with the minimum and the maximum size of holdings of 0.18 and 1.57 hectares, respectively. The principal agricultural activity is crop cultivation, which is about 94.8% rain fed with livestock rearing as a secondary activity. The farming system of the district is governed by the agro-ecology of the area, which consists of all the main types. Dominantly mixed farming is practiced in the district, most of the crops produced in the district are cereals (sorghum, maize, wheat, barley) and legumes especially haricot bean are intercrop with cereals. About 90% of the households practice mixed farming (with crop production as the major activity and livestock production as the secondary activity) and only 0.5% of the households that depended solely on livestock production for the purpose of earning a living (DOARD, 2015). *Chat* and coffee are the two cash crops grown in the district. *Chat* grows almost in all agro-climatic zones of the district while coffee grown in the midland and lowland.

Livestock play important roles in the social and economic life of the people of Goro Gutu district. Livestock serve as a source of food, as draft power in the process of crop production, as a source of organic fertilizer and as a source of cash income. The types of livestock that are commonly raised in the district are cattle, goats, sheep, camels, equines and poultry. Some households of the district also keep beehives for acquiring additional income. According to East Hararghe Agriculture Development Department (2004), the district has the livestock population of 217,949 which is about 6.82% of the zone's livestock population.

3.2. Data Types, Sources and Methods of Data Collection

This study used both qualitative and quantitative data types and relevant data were collected from both primary and secondary sources. The primary data on household and farm characteristics were collected from the sample households using semi-structured questionnaire, which were filled by trained enumerators who speak the local language, by interview schedule. To get information regarding food intake of households, sample households were asked the

kind and amount of food items consumed by their families in seven days preceding the survey. These kind and amount of food items were collected, computed and transformed in to kilocalorie intake of sample households.

Relevant secondary data were also collected from secondary sources in order to supplement the primary data. These include East Hararghe Agriculture Development Department, DOARD, Goro Gutu District Food Security Office, Central Statistical Agency (CSA) and NGOs.

3.3. Sampling Techniques and Sample Size

Goro Gutu district has 30 *Kebeles* of which 28 are rural and 2 are urban *Kebeles* having different agro-climatic characteristics. The sampling frame of this study was rural households that were found in three agro-ecological zones of Goro Gutu district. From the 28 rural *Kebeles* in Goro Gutu district, PSNP has been operating in 14 rural *Kebeles*.

In this study, a multi-stage sampling technique was used to select representative sample households. Firstly, out of 28 rural *Kebeles* of the district, 14 rural *Kebeles* were selected purposively since PSNP was implemented in those *Kebeles*. Secondly, the 14 PSNP beneficiary rural *Kebeles* of the districts were stratified by their relative agro-ecological zone (2 highland, 4 midland and 8 lowland). Thirdly, based on the proportion of program beneficiary *Kebeles* in each agro-ecology six rural *Kebeles* (1 highland, 2 midland and 3 lowland) were randomly selected. In the fourth stage, households from each selected *kebeles* were categorized into two strata, which are PSNP beneficiary households and non-PSNP beneficiary households. Finally, from total number of households in the sampled *Kebeles*, 190 households were randomly selected based on probability proportional to their size.

The total sample was determined by using the formula given by Cochran (1963) sample for proportions.

$$n = \frac{Z^2 pq}{e^2}$$

Where n is the sample size, Z is the selected critical value of desired confidence level (1.96), p is the estimated proportion of an attribute that is present in the population (23%), q = 1-p and e is the desired level of precision which is 0.06.

Table1. Distribution of sample households by *Kebeles*

Agro-ecological zones	Sample <i>Kebeles</i>	Total households		Sample households	
		Non-PSNP	PSNP	Non-PSNP	PSNP
Highland	Biftu Diramu	551	332	15	14
Midland	Qobo Walteha	400	319	11	14
	Lafto M/Telila	676	395	18	17
Lowland	Erer	591	350	16	15
	Ifa Jalala	719	361	19	15
	Yeka Aman	776	358	21	15
Total		3713	2115	100	90

Source: Own estimation from *kebeles*' administration data (2016)

3.4. Methods of Data Analysis

In this study, descriptive statistics and econometric model were used to analyze primary data collected from both program beneficiary and non-program beneficiary households.

3.4.1. Descriptive Statistics

Descriptive statistics such as mean, standard deviation, frequency, percentages and graphs were used in analyzing the data and also to compare and contrast different categories of sample units with respect to the desired characteristics. Moreover, inferential statistics such as t-test (for continuous variables) and chi-square test (for dummy and categorical variables) were used to compare and contrast means and proportions of the different categories of sample units based on their desirable characteristics.

3.4.2. Propensity Score Matching (PSM) Method

Propensity score matching is the current popular method used to evaluate the impact of the programs compared to other non-experimental methods. The method is the most widely used type of matching in which the control group is matched with the treatment group based on a set of observable characteristics by using the propensity score. Therefore, selection of PSNP participation was also based on pre-program observable household characteristics but not on random manners.

The purpose of this study was also to estimate the average treatment effect on household food security and asset building of the PSNP beneficiary households that depends on number of pre-

program observable characteristics or variables. These variables are selected in such a way that they are not affected by the treatment. The basic idea is to find in a group of non-participants, those individuals who are similar to the participants in all relevant pre-treatment characteristics. Propensity score is used to compare the treatment units in the observational studies in order to determine the causal effects when the treatment assignment is not random. In doing this, a problem of selection bias can happen when evaluating the difference between program participants' outcome with and without treatment, so that there is no possibility to observe both outcomes for the same individual at the same time. In observational studies this type of unobserved outcome is called counterfactual outcome. According to Caliendo and Kopeinig (2005), took the mean outcome of non-participants, as an approximation is not advisable, since participants and non-participants usually differ even in the absence of treatment.

Therefore, PSM is an appropriate technique to analyze the casual effects of program intervention for data that is generated by non-randomized experiment. However, it has to rely on unverifiable assumption to solve the problem of selection bias.

Our main parameter of interest in this regard is average treatment effect on treated (ATT) which is defined as:

$$ATT = E[Y_1|D = 1] - E[Y_0|D = 1] \quad (1)$$

where $D=1$ indicates the treatment (PSNP beneficiary households). The potential outcomes are indicated by Y_1 and Y_0 with Y_1 the value of the outcome that would be observed from the unit of PSNP beneficiary household and the same unit of outcome value observed from non-PSNP beneficiary household. $E[Y_0|D = 1]$, above is unobservable outcome which is called counterfactual outcome. The estimation of a treatment effect hinges on a counterfactual that is inferences must be made about outcomes that would have been observed for the treated had they not received the treatment. In order to estimate ATT using the mean outcome of untreated individuals $E[Y_0|D = 1]$ leading to a self-selection bias because of the reason already stated above, the outcome of individuals from treatment and comparison group would differ even in the absence of treatment. It can be possible to note ATT as:

$$E[Y_1|D = 1] - E[Y_0|D = 0] = ATT + E[Y_0|D = 1] - E[Y_0|D = 0] \quad (2)$$

Selection bias is defined as the difference between left hand side of equation (2) above and ATT. Our main parameter of interest, ATT is only defined if:

$$E[Y_0|D = 1] - E[Y_0|D = 0] = 0 \quad (3)$$

In non-experimental studies one has to introduce some identifying assumptions to solve the selection bias problem. The following are two strong assumptions to solve the problem of selection bias.

Conditional Independence Assumption (CIA): Given a set of observable characteristics, which are not affected by treatment, potential outcomes, are independent of treatment assignment. It implies that the selection is solely based on observable characteristics and variables that influence treatment assignment and potential outcomes are simultaneously observed.

$$(Y_1, Y_0) \perp D | X \quad (4)$$

Where; Y_1 - Outcomes of program beneficiary households

Y_0 - Outcomes of non-program beneficiary households

$\perp$ - Independence and

D - Treatment assignment

X - Set of observable characteristics

Common Support Assumption: This assumption also ensures that persons with the same values have a positive probability of being both participants and non-participants. It rules out the phenomenon of perfect predictability of D given X :

$$(\text{Overlap}) \quad 0 < P(D = 1|X) < 1 \quad (5)$$

Given these two assumptions and assuming additionally there is overlap between both groups, the PSM estimator of ATT can be written as:

$$ATT = E_{P(X)|D=1} \{E[Y_1|D = 1, P(X)] - E[Y_0|D = 0, P(X)]\} \quad (6)$$

Where $P(X)$ is the propensity score computed on the covariates X . Equation (6) is explained as the PSM estimator is the mean difference in outcomes over the common support, appropriately weighted by the propensity score distribution of participants (Caliendo and Kopeinig, 2005).

3.4.2.1. Estimation of the propensity scores

The first step in PSM method is to estimate the propensity scores. When estimating the propensity score, two choices have to be made. The first one concerns the model to be used for the estimation and the second one the variables to be included in the model.

Propensity score was obtained using either logit or probit models to predict the probability of participation of households. According to Caliendo and Kopeinig (2008), for the binary treatment case, where we estimate the probability of participation versus non-participation, both logit and probit models usually yield similar results. Hence, model choice is not too critical. In this study logit model was used to estimate propensity scores using a composite of pre-intervention characteristics of the sample households.

Regarding the choice of variables should be included in the model; the matching strategy should be built on the CIA that requires the outcome variables must be independent of treatment conditional on the propensity score. Hence, implementing matching method is based on choosing a set of variables X that credibly satisfy this condition. Only variables that influence simultaneously the participation decision and the outcome variable should be included in the model (Caliendo and Kopeinig, 2005). In this respect, the study was including many important variables as much as possible to minimize the omission of important covariates which result in biased estimates.

In estimating the logit model, the dependent variable is participation in PSNP, which takes the value of 1 if the household is PSNP beneficiary and 0 otherwise. The mathematical formulation of logit model is as follows:

$$P_i = \frac{e^{Z_i}}{1 + e^{-Z_i}} \quad (7)$$

where: $e = 2.71828$

P_i = is a probability of being program participant or not

Z_i = is a function of explanatory variables (X_i) which is also expressed as:

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n \quad (8)$$

The probability that a household participates in the program is expressed by:

$$P_i = \frac{1}{1+e^{-Z_i}} \quad (9)$$

While, the probability of not participant in program is expressed by

$$1 - P_i = \frac{1}{1+e^{Z_i}} \quad (10)$$

Therefore, we can write:

$$\frac{P_i}{1+P_i} = \frac{1+e^{Z_i}}{1+e^{-Z_i}} \quad (11)$$

Now equation above $(\frac{P_i}{1+P_i})$ is simply the odds ratio in favor of participating in the program.

The ratio of the probability that the household participated in the program to the probability of the household not participated in the program.

Finally, taking the natural log of the equation above, we obtain:

$$L_i = \ln \left(\frac{P_i}{1+P_i} \right) = Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n \quad (12)$$

β_0 = is an intercept,

$\beta_1, \beta_2, \beta_3, \beta_n$ = are slopes of the equation in the model,

L_i = is log of the odds ratio, which is not only linear in X_i but also linear in the parameters,

X_i = is vector of relevant pre-intervention household characteristics

If the disturbance term (u_i) is introduced to the logit model becomes:

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + u_i \quad (13)$$

3.4.2.2. Choice of matching algorithm

After estimation of the propensity scores, the major task of a program evaluator is seeking an appropriate matching estimator. There are different matching estimators in theory. However, the most commonly applied matching estimators are described below.

Nearest neighbor matching: In NNM, an individual from the comparison is chosen as a matching partner for a treated individual that is closest in terms of propensity score. NNM can be with replacement and without replacement. Matching with replacement indicates that untreated individual can be used more than once as a match, which would result in increased quality of matches and decreased precision of estimates. On the other hand, matching without replacement a comparison individual can be used only once which would result increases in bias but it could improve the precision of the estimates (Abadie and Imbens, 2004). The nearest neighbor matching estimator set is:

$$C(P_i) = [j: \|P_i - P_j\| \min_x \|P_i - P_k\|] \quad (14)$$

In this case there is only one comparison unit matched to each treatment unit. Weights are given by $W(i, j) = 1[j = k]$ where $1[.]$ is an indicator function.

Caliper matching: In this case, the estimator chooses the nearest neighbor inside a caliper or tolerance width. This is an alternative way of imposing the common support condition. The caliper matching estimator is a variation of nearest neighbor that allows matches only under a tolerance δ on the distance $\|P_i - P_j\|$ in the attempt to avoid matches where the comparisons are “too far away” from the treatment unit. If the dimension of the neighborhood is set to be very small, it is possible that some treated units are not matched because the neighborhood does not contain a control unit. On the other hand, the smaller the size of the neighborhood the better is the quality of the matches (Becker and Ichino, 2002).

For caliper matching the neighborhood for treatment “ i ” is:

$$C(P_i) = \{j: \delta > \|P_i - P_j\| = \min \|P_i - P_k\|\} \quad (15)$$

and a single comparison unit is matched when its distance to the treatment unit is the lowest and below the tolerance δ . If none of the comparison units is within the tolerance criterion, then treatment unit “ i ” is left unmatched. Weights are given by $W(i, j) = 1[j = k]$.

Kernel and local linear matching: This is another matching method whereby all treated units are matched with a weighted average of all controls with weights which are inversely proportional to the distance between the propensity scores of treated and controls (Becker and

Ichino, 2002). The weighting function is a (Gaussian) kernel density. All the observations in the comparison group inside the common support region are used, the farther the comparison unit from the control unit the lower the weight. Consider for example that the kernel matching estimator given by:

$$\alpha KM = \frac{1}{n_1} \sum_{i \in I_1}^{n_1} \left[Y_{1i} - \frac{\sum_{j \in I_0} Y_{0j} G\left(\frac{P_j - P_i}{h_n}\right)}{\sum_{k \in I_0} G\left(\frac{P_k - P_i}{h_n}\right)} \right] \quad (16)$$

Where $G(\cdot)$ is a kernel function and h_n is a bandwidth parameter (bandwidth is the range of frequencies within a band; maximum rate at which data can be transferred over a communications network (Computers)). From the above equation, the weighting function equals:

$$W(i, j) = \frac{G\left(\frac{P_j - P_i}{h_n}\right)}{\sum_{k \in I_0} G\left(\frac{P_k - P_i}{h_n}\right)} \quad (17)$$

Stratification or interval matching: This matching is to partition the common support of the propensity score into a set of intervals or strata and to calculate the impact within each interval by taking the mean difference in outcomes between treated and control observations. The number of strata is determined by checking the balance of the propensity score or the covariates within each stratum (Caliendo and Kopeinig, 2005). Most of the algorithms can be described in the following way: First, check if within a stratum the propensity score is balanced. If not, strata are too large and need to be split. If conditional on the propensity score being balanced, the covariates are unbalanced; the specification of the propensity score is not adequate and has to be re-specified, for example, through the addition of higher-order terms or interactions (Dehejia and Wahba, 1999).

3.4.2.3. Common support condition

The common support region is the area, which contains the minimum and maximum propensity scores of treatment and control group households, respectively. Only the subset of the comparison group that is comparable to the treatment group should be used in the analysis *i.e.*, observations which lie outside this region are discarded from analysis (Caliendo and Kopeinig, 2008). Hence, an important step is to check the overlap and the region of common support

between treatment and comparison group. One means to determine the region of common support more precisely is by comparing the minima and maxima of the propensity score in both groups.

3.4.2.4. Testing the matching quality

The primary purpose of the PSM is that it serves as a balancing method for covariates between the two groups (treatment and control groups). Consequently, the idea behind balancing tests is to check whether the propensity score is adequately balanced. In other words, a balancing test seeks to examine if at each value of the propensity score, a given characteristic has the same distribution for the treatment and comparison groups. The propensity scores themselves serve only as devices to balance the observed distribution of covariates between the treated and comparison groups. The resultant balance therefore assesses the success of propensity score estimation rather than by the fit of the models used to create, the estimated propensity scores (Lee, 2006).

The most commonly applied approaches in balancing covariate between treated and non-treated individuals such as standardized bias, t-test, joint significance and pseudo-R² (Bryson *et al.*, 2002).

Standardized bias: It is the mean absolute standardized bias between treated and control groups suggested by Rosenbaum and Rubin (1985). For each covariate X it is defined as the difference of sample means in the treated and matched control groups as a percentage of the square root of the average of sample variances in both groups. The standardized bias before matching is given by:

$$SB_{\text{before}} = 100 \times \frac{(\bar{X}_1 - \bar{X}_0)}{\sqrt{0.5 \cdot (V_1(X) + V_0(X))}} \quad (18)$$

The standardized bias after matching is given by:

$$SB_{\text{after}} = 100 \times \frac{(\bar{X}_{1M} - \bar{X}_{0M})}{\sqrt{0.5 \cdot (V_{1M}(X) + V_{0M}(X))}} \quad (19)$$

where X_1 (V_1) is the mean (variance) in the treatment group before matching and X_0 (V_0) the analogue for the control group. X_{1M} (V_{1M}) and X_{0M} (V_{0M}) are the corresponding values for the matched samples. One possible problem with the standardized bias approach is that there is no clear indication for the success of the matching procedure, even though in most empirical studies a bias reduction below 3% or 5% after matching is acceptable (Caliendo and Kopeinig, 2005). Rosenbaum and Rubin (1985) argue that after matching, total bias in excess of 20% should be considered as large.

The bias reduction (BR) can be computed as:

$$BR = 100 \times \left(1 - \frac{B(X)_{\text{after}}}{B(X)_{\text{before}}} \right) \quad (20)$$

where $B(X)_{\text{before}}$ and $B(X)_{\text{after}}$ are the total bias of before and after matching, respectively.

t-test: A similar approach uses a two sample t-test to check if there are significant differences in covariate means for both groups (Rosenbaum and Rubin, 1985). Before matching differences are expected, but after matching the covariates should be balanced in both groups and hence no significant differences should be found. The t-test might be preferred if the evaluator is concerned with the statistical significance of the results. The shortcoming here is that the bias reduction before and after matching, is not clearly visible.

Joint significance and Pseudo- R^2 : Additionally, Sianesi (2004) suggests to re-estimate the propensity score on the matched sample, that is only on participants and matched non-participants and compare the pseudo- R^2 's before and after matching. The pseudo- R^2 indicates how well the regressors X explain the participation probability. After matching there should be no systematic differences in the distribution of covariates between both groups and therefore, the pseudo- R^2 should be low. The test should not be rejected before and should be rejected after matching.

In this particular study, in order to test the matching quality of matching estimators the combinations of the above procedures were applied.

3.4.2.5. Estimation of standard errors

Testing the statistical significance of treatment effects and computing their standard errors is not a straightforward thing to do. The problem is that the estimated variance of the treatment effect should also include the variance due to the estimation of the propensity score, the imputation of the common support and possibly also the order in which treated individuals are matched. These estimation steps add variation beyond the normal sampling variation (Heckman *et al.*, 1998). For example, in the case of NNM with one nearest neighbor, treating the matched observations as given will understate the standard errors (Smith, 2000).

Bootstrapping: Standard errors in `psmatch2` are invalid, since they do not take into account the estimation uncertainty involved in the probit/logit regressions. One way to deal with this problem is to use bootstrapping as suggested by Lechner (2002). This method is a popular way to estimate standard errors in case analytical estimates are biased or unavailable. Even though Imbens (2004) notes that there is little formal evidence to justify bootstrapping, it is widely applied (Sianesi, 2004). Each bootstrap draw includes the re-estimation of the results, including the first steps of the estimation (propensity score, common support, etc.). One practical problem arises because bootstrapping is very time consuming and might therefore not be feasible in some cases (Caliendo and Kopeinig, 2005).

3.4.2.6. Sensitivity analysis

The estimation of treatment effects with matching estimators is based on the CIA that selection on observable characteristics. However, if there are unobserved variables that affect assignment into treatment and the outcome variable simultaneously a 'hidden bias' might arise (Caliendo and Kopeinig, 2005). This results in biased estimates of ATTs (Rosenbaum, 2002). Since matching estimators are not robust against hidden biases, it is important to test the robustness of results to departures from the identifying assumption. However, it is impossible to estimate the magnitude of selection bias with non-experimental data. Therefore, this problem can be addressed by sensitivity analysis (Caliendo and Kopeinig, 2005). Rosenbaum (2002) suggested that use of Rosenbaum bounding is the best approach to check the sensitivity of the estimated ATT on statistically significant outcome variables with respect to deviation from the CIA.

3.5. Definition of Variables and Hypotheses

It is important to specify and hypothesize the dependent, outcome and explanatory variables that were used in the model. Hence, this sub-section specifies and explains the dependent and outcome variables. In addition, it specifies, explains and hypothesizes the household and farm household characteristics that affect the households' program participation and outcome variables.

3.5.1. Dependent Variable

Participation in PSNP is a dummy variable that takes a value of 1 if the household was PSNP beneficiary and 0 otherwise.

3.5.2. Outcome Variables

Daily calorie intake: It is a continuous variable measured in kilocalorie intake of the food consumption by the household per adult equivalent per day. In order to measure the household food security, the household information concerning type and amount of food items consumed by their families in the last seven days preceding the survey were collected from both program beneficiary and non-program beneficiary households. Different units of local measurement were converted into a common measure for each food item. Acquisition of each food item was converted to kilocalories and food kilocalories were added up for each household and then converted to daily amounts. Finally, the aggregate daily food kilocalorie acquisition for each household was divided to household AE, which resulted in household kilocalorie intake per AE per day.

Household assets: It is a continuous variable shows that the household asset holding in birr. Household assets such as farm tools, household durables and house constructed for rent serve as source of saving except livestock assets. Household assets are also an important impact indicator to compare the amount of farm and other household equipment owned by the program beneficiary and non-program beneficiary household groups.

3.5.3. Independent Variables

The independent variables are the pre-intervention household characteristics influencing participation of the household in the program. Based on empirical evidences from available literature the following sets of variables were selected as combination of factors affecting households' participation in PSNP as well as the outcomes variables.

Age of the household head (AGEHHH): It refers to the age of the household head which is a continuous variable measured in years since from birth. Age of the household head plays an important role in increasing household income. Household head with young age have strong labor force, which can produce more and high capacity to participate in different income generating works by exerting his/her labor and build more household assets. Indris (2012) indicated in his study that age of the household head affected food insecurity positively. The study by Girma (2012) showed that age of the household head affected the household participation in food security program positively. In contrast, as age of the household head increases the probability of household participation in food security program expected to decrease because old age household head have more experience in farming to produce more, which resulted in accumulation of more household asset and food secure. Abebaw (2003) indicated that an increase in age of the household head increases the household probability to become food secure. This is because older household heads get more and more experience in their farming operation, climatic knowledge of their area, accumulates wealth and use better planning than the younger household heads. In other words, it means that as the probability to be food secure increases the probability to participate in PSNP decreases. Therefore, this study hypothesized that household head with old age has a higher probability to participate in PSNP.

Sex of the household head (SEXHHH): It refers to the sex of the household head. It is a dummy variable that takes value of 1 if the household was male-headed and 0 otherwise. Labor supply plays great role in agricultural production but due to lack of labor, female-headed households were not able to produce enough food and forced to rent their land. Male-headed households are in a better position to pull more labor force than the female-headed households. Women farmers may need a long adjustment period to diversify their income sources (Glawin *et al.*, 2001). In this study, female-headed households are expected to have a higher probability of participation in the PSNP than male-headed households in the study area.

Marital status of the household head (MASHHH): It is the status of household head regarding marriage. Whether the household head is married or not can affect food security status and asset holding of the households. Married households put aside some resources for unforeseen circumstances to smoothen their life (Aschalew, 2006). Therefore, this study hypothesized that households who were married are more likely to be food secure and less likely to be participant of PSNP than those without marriage (i.e. not married, divorced and widowed).

Educational Level of the household head (EDLHHH): It refers to the educational level of the household head, which is a continuous variable measured in term of year or grade of formal schooling. According to the study conducted by Girma (2012) the level of education negatively and significantly affected food insecurity situation of the household. Education is essential to understand and implement new technologies. As a result, an educated household head is assumed to be better adopter of new technologies (use of fertilizer, improved seeds and the like) which in turn increase the production of households and the level of food security status. In fact, in this study it is hypothesized that having better educational level of the household head and the probability of the household to be PSNP participant are inversely related because those households who headed by educated household head are more likely to get additional income and hence food secured and built more assets.

Dependency Ratio (DEPRAT): It is a continuous variable measured in AE of the dependency ratio calculated as $(\text{age under 15} + \text{age over 65})/(\text{working age between 15-65})$. When a large household size corresponds with the availability of adequate adult labor, it can have a positive effect. But a household with more inactive productive labor force compared to the active age shows a high dependency ratio and it is more likely to be food insecure (Bigsten *et al.*, 2002). Another study by Fekadu (2008) also showed that the presence of high dependent family members in the household were increased a burden on the active labour and negatively affected the household food security. Therefore, existence of large number of economically dependent individuals in a given household deteriorates household food security and asset holding. Therefore, this study also hypothesized that a household with larger number of dependent family members (high dependency ratio) have a higher tendency to participate in PSNP.

Household size (HHSIZE): It refers to the total number of household members who live and consume from the same household. Household size is one of the important demographic factors that affect household food security status in rural households. According to the study result of Girma (2012), larger household size tends to be food insecure compared to smaller family size. Another study result also indicated that smaller household size tends to be food secure as compared to larger family size (Amsalu *et al.*, 2012). Likewise, the study by Tsegay (2009) found out that large family size has high influence in worsening the food insecurity status of households. It is obvious that family size increases the number of mouths to feed from the available food. This study also hypothesized that the households with relatively large number of family members are likely to be food insecure and more likely to be participant in PSNP.

Off/non-farm income (ONFAIN): It is a continuous variable measured in birr. It represents the amount of income earned by any of the household member from off/non-farm activities in the year. Off-farm income represents the amount of income the household earns in a year out of own farm activities in the farm. In contrast non-farm income is the amount of income generated from activities other than crop and livestock production like labour in non-agricultural activities. When crop production output and income earned from sales of livestock and livestock products are inadequate, households often look for other income sources other than agriculture to push themselves to the threshold of securing access to food (Abebaw, 2003). Accordingly, income earned from such activities enables households to reduce the probability of being food insecure. So, it is expected that the participation in off/non-farm income generating activities is positively associated with household food security and asset building. Therefore, it is hypothesized that participation in off/non-farm income generating activities increases the probability of the household to be non-PSNP participant.

Credit Received (CREREC): It is a continuous variable measured in Birr if the household received credit either for purchase of production inputs or for purchase of food for their households. According to the study by Abebaw (2003), amount of credit received is negatively influenced household food insecurity. The negative relationship implies that those households who receive credit have more capacity to produce more through purchase and use of agricultural inputs. Additionally, this credit received helps the households to spend on some other income generating activities, which increases the household probability to accumulate

more household assets and become food secure. Another study by Ganta (2011) also indicated that a household that had participated in credit for fertilizer and other farm tools purchase is more likely to be food secured and better food security status compared to non-participant. Hence, this particular study hypothesized that credit received and being PSNP participant are negatively related.

Extension Contact (NUEXCT): It is a continuous variable measured in the number of contacts with the development agents (DAs) during survey year. Tadele (2011) reported an increase in the DAs contact frequency increased the probability of participating in PSNP positively. Another study conducted by Nesreddin (2014) showed that access to extension service is positively related to PSNP participation. This indicates that, the continuous observation of their food insecurity status by the extension workers has made the participant group to be known as food insecure households since these development agents were constant members and main actors in the targeting and screening of PSNP participant. Therefore, this study hypothesized that number of extension advice to have positive influence on participation in PSNP.

Access to irrigation (ACCIRR): It is a dummy variable that takes a value of 1 if the household has access to irrigation use and 0 otherwise. In Ethiopia most of the agricultural production is practice in rain-fed. This type of production practice is highly susceptible to climate change and variability, full of risk and uncertainties and one time production period in a year. Utilization of irrigation reduces the above problem of rain-fed agricultural production practice. Irrigation has a great contribution to increase production, productivity and enhances the income of the households as well which in turn reduces the probability of household to be food insecure. Based on the above evidence this study hypothesized that access to irrigation use expected to have a negative effect on participation in the PSNP.

Use of chemical fertilizer (UCHFER): It is a dummy variable that takes a value of 1, if the household use chemical fertilizer and 0, otherwise. The use of chemical fertilizer is taken as important yield improving per unit area. Soil fertility reduction is believed to be among the major factors for low food production that hinders food security (Tesfaye, 2005). The households that use chemical fertilizer may have better yield than non-users. Based on the

above information this study hypothesized that use of chemical fertilizer is negatively related to participation in PSNP.

Use of improved seeds (USIMSE): It is a dummy variable that take value of 1, if the household use improved seeds and 0 otherwise. Seed is an essential agricultural input, which affects production. Improved seeds may withstand drought and erratic rainfall distribution when they are resistant to moisture stress. They can increase agricultural productivity by boosting overall production, which in turn contributes to attaining food security at the household level (Lipton, 2005; Dorward *et al.*, 2003). Hence, using improved seeds was expected to be positively association with household food security and negatively affects participation in PSNP.

Distance from market center (DISTMC): It refers to the distance between the household home and the nearest market center, which is usually measured in kilometers. Household nearer to market center may have more opportunities to off/non-farm employment, easy access to input, easy access for their products and easy access to transport facilities, which in turn increases household income and food security. Closeness to market center creates access to additional income via off-farm/non-farm employment opportunities, easy access to information on inputs and transportation (Dorward *et al.*, 2003). Therefore, this study also hypothesized that there is negative association between access to the nearest market center and participation in PSNP.

Received remittance (RECREM): It is a continuous variable measured in Birr. It refers to relative economic support in the form of money or food to the household from abroad and within the country, mainly from urban dwellers (Adugna, 2008). Therefore, those households who have an economic support from abroad and/or within the country have more probability to be food secure and build more household assets and negatively related to participation in PSNP.

Shock experience (SHOEXP): It is a dummy variable that takes value 1 if household entertained any shock and 0, otherwise. In this case shock means any problems that affect households' income like crop failure and livestock losses due to drought, crop or/and livestock disease manifestation. Shock experience depletes the assets and the capabilities of the

household towards food security and asset holding. Temesgen (2014) indicated that having shock experience increases the probability of household participation in PSNP by a factor of 0.465 positively. So, that this study hypothesized that shock experience is positively related with participation in the PSNP.

Table 2. Summary of variable types, measurement and hypothesis

Variables	Variable code	Types of variable	Measurement	Hypothesis
Dependent variable				
Participation in PSNP		Binary	1, If the HH is PSNP beneficiary 0, otherwise	
Outcome variables				
Daily calorie intake per AE		Continuous	Kilocalorie per AE per day	
Household assets		Continuous	Birr	
Independent variables				
Age of the household head	AGEHHH	Continuous	Number of years	+
Sex of the household head	SEXHHH	Dummy	1, if male-headed 0, otherwise	-
Marital status of the household head	MASHHH	Categorical	1, married 2, widowed 3, divorced 4, unmarried	-
Educational level of the household head	EDLHHH	Continuous	Number of class years	-
Dependency ratio	DEPRAT	Continuous	AE	+
Household size	HHSIZE	Continuous	Number	+
Off/non-farm income	ONFAIN	Continuous	Birr	-
Credit received	CREREC	Continuous	Birr	-
Extension contacts	NUEXCT	Continuous	Number	+
Access to irrigation	ACCIRR	Dummy	1, if HH is access to irrigation and 0, otherwise	-
Use of chemical fertilizer	UCHFER	Dummy	1, if HH use chemical fertilizer and 0, otherwise	-
Use of improved seeds	USIMSE	Dummy	1, if HH use improved seeds and 0, otherwise	-
Distance from market center	DISTMC	Continuous	Kilometers	-
Received remittance	RECREM	Continuous	Birr	-
Shock experience	SHOEXP	Dummy	1 if HH entertained any shock and 0, otherwise	+

Source: Own definitions (2016)

4. RESULTS AND DISCUSSION

In this chapter, descriptive statistics and econometric model results are presented. In the first section, descriptive statistics of an important household and farm characteristics, which are expected to determine the household's participation in PSNP and outcome variables, are presented. In the second section, the results of propensity score matching methods are presented.

4.1. Descriptive Statistics Results

The descriptive analysis made use of tools such as mean, standard deviation, frequency distribution and percentage. t-test and chi-square test were also employed to compare PSNP beneficiary and non-PSNP beneficiary households with respect to different continuous, dummy and categorical explanatory variables.

4.1.1. Descriptive Statistics of Continuous Variables

Age of the household head: The mean age of the sample household heads was 42.61 years with standard deviation of 11.51. As indicated in Table 3, the mean age of PSNP beneficiary households was 44.36 years with standard deviation of 12.07, whereas, the mean age of non-PSNP beneficiary households was 41.04 years with standard deviation of 10.80. The statistical analysis ($t = -1.998$) showed significant mean difference between PSNP beneficiary and non-PSNP beneficiary households in terms of age.

Household size: The mean household size of the sampled households was 6.50 with standard deviation of 1.99. Accordingly, the mean household size of PSNP beneficiary and non-PSNP beneficiary households was 7 and 6.06 with their standard deviation of 1.75 and 2.09 respectively. Therefore, there was a significant difference in the mean household size between PSNP beneficiary and non-PSNP beneficiary household groups at 1% probability level ($t = -3.335$).

Dependency ratio: The dependency ratio in AE of the sample households was found to be 0.97. Accordingly, dependency ratio in AE of the PSNP beneficiary households was 1.08 while that of the non-PSNP beneficiary households was 0.86. The result of the t-test for the differences in dependency ratio in AE between the two groups was significant at 10%

probability level ($t = -1.951$). This implies that every economically active person in the PSNP beneficiary households had to support more than one economically inactive person and every economically active person in non-PSNP beneficiary households had to support less than one economically inactive person.

Education level of the household head: The mean education level of the total sample household heads was found to be 2.68 class years with standard deviation of 3.03. The mean educational level of the PSNP beneficiary households was 2.02 years with standard deviation of 2.50 while the mean for non-PSNP beneficiary households was 3.27 years with standard deviation of 3.34. The result of t-test for the difference in educational level between the two groups confirmed that there is a statistically significant mean difference in educational level between the two groups at 1% probability level ($t = 2.885$).

Off/non-farm income: The mean off/non-farm income of sampled households was 2849.55 with a standard deviation of 3636.78. However, the mean off/non-farm income of PSNP beneficiary and non-PSNP beneficiary households was 2827.89 birr and 2869.05 birr with standard deviation of 3360.10 and 3885.78 respectively. The survey result of the t-test showed that there was no mean off/non-farm income difference between the PSNP beneficiary and non-PSNP beneficiary households in the study area.

Received remittance: As indicated in Table 3, the mean received remittance of sampled households was 548.42 birr with standard deviation of 4402.64. The mean received remittance of the PSNP beneficiary households was 138.89 birr with standard deviation of 580.33 while the mean of non-PSNP beneficiary households was 917 birr with standard deviation of 6034.23. The result of t-test for the difference in received remittance between the two groups confirmed that there is no statistically significant mean difference in received remittance between the two groups.

Credit received: The mean credit received by the total sample household was 668.66 birr with standard deviation of 1844.02. The mean credit received by the PSNP beneficiary households was 937.44 birr with standard deviation of 2434.76 while the mean credit received by non-PSNP beneficiary households was 426.75 birr with standard deviation of 1018.64. The result of t-test for the difference in credit received between the two groups confirmed that there is a

statistically significant mean difference in credit received between the two groups at 10% probability level ($t = -1.919$).

Extension contacts: The number of extension visits by DA's of total sample households was found to be 1.58 times in a year on average with standard deviation of 2.18. For the PSNP beneficiary households the number of extension visit was 2.08 times in a year having standard deviation of 2.38. However, the number of extension visits for non-PSNP beneficiary households was 1.14 time in a year with standard deviation of 1.89. The result of the t-test for the difference in the number of extension visits by DA's between the PSNP beneficiary and non-PSNP beneficiary households group was found to be statistically significant at 1% probability level ($t = -3.012$).

Distance from market center: The study result showed that the sample households are living on mean distance of 5.17 km from the nearest market center having a standard deviation of 2.22. However, to compare the mean distance from the nearest market center between the PSNP beneficiary and non-PSNP beneficiary households was found to be 5.35 km and 5 km with standard deviation of 2.18 and 2.25 respectively. The result of the t-test for the mean difference in the distance from the nearest market place between the PSNP beneficiary and non-PSNP beneficiary households groups was found to be statistically insignificant ($t = -1.098$).

Table 3. Descriptive statistics of sample households (continuous variables)

Variables	Sample households N = (190)		PSNP beneficiary households N = (90)		Non-PSNP beneficiary households N = (100)		t-value
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	
Age	42.61	11.51	44.35	12.07	41.04	10.81	-1.998**
Educational level	2.68	3.03	2.02	2.50	3.27	3.34	2.885***
Dependency ratio	0.97	0.78	1.08	0.85	0.86	0.71	-1.951*
Household size	6.50	1.99	7	1.75	6.06	2.09	-3.335***
Off/non-farm income	2849.5	3636.78	2827.89	3360.10	2869.05	3885.78	0.078
Remittance	548.42	4402.64	138.89	580.33	917	6034.23	1.218
Credit received	668.66	1844.02	937.44	2434.76	426.75	1018.64	-1.919*
Extension contacts	1.58	2.18	2.08	2.38	1.14	1.89	-3.012***
Distance from market center	5.17	2.22	5.35	2.18	5	2.25	-1.098

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

Source: Own computation result (2017)

4.1.2. Descriptive Statistics of Dummy and Categorical Variables

Sex of the household head: The study result showed that, out of 190 total sampled households, 85.26% were male-headed and the rest 14.74% were female-headed (Table 4). Among the PSNP beneficiary households, 84.44% were male-headed and 15.56% were female-headed households while in non-PSNP beneficiary households 86% were male-headed and the remaining 14% were female-headed households. The result of the chi-square test for the difference in the sex of the sample households between the PSNP beneficiary households and non-PSNP beneficiary households group was found to be statistically insignificant.

Marital status of the household head: Marital status of sample household heads indicated that married, widowed and divorced household head accounted for about 90%, 8.42% and 1.58% respectively with no single household heads. The result shows that there was statistical significant difference between the program beneficiary and non-beneficiary households regarding marital status of the household heads (Table 4).

Access to irrigation: From the total sample households, 22.11% of them had access to irrigation for either cash crop or vegetable crop production while the rest 77.89% households had not access to irrigation. When comparing between the two groups, 23.33% of the PSNP beneficiary households and 21% of the non-PSNP beneficiary households had access to irrigation. In contrast, 76.67% PSNP beneficiary households and 79% of the respondents in the non-PSNP beneficiary households had not access to irrigation. The result of chi-square test for the difference in access to irrigation of the sample households between the two groups was found to be statistically insignificant.

Use of chemical fertilizer: The survey result showed that, out of total sample households, 65.79% use chemical fertilizer for their crop production whereas 34.21% were not. However, among the PSNP beneficiary households and non-PSNP beneficiary households those households use chemical fertilizer were 72.22% and 60% respectively. The result of chi-square test for the difference in use of chemical fertilizer between the program beneficiary and non-

program beneficiary households group was found to be statistically significant at 10% probability level (Table 4).

Use of improved seeds: The survey result showed that, out of total sample households, 49.47% use improved seeds in their crop production where as 50.53% were not. Among the PSNP beneficiary households and non-PSNP beneficiary households those households who use improved seeds were 62.22% and 38% respectively. The result of chi-square test for the difference in use of improved seeds between the program beneficiary and non-program beneficiary household group was found to be statistically significant at 1% probability level.

Shock experience: Out of total sampled households, almost all of them 85.79% households entertained shocks in the recent five years but the rest 14.21% did not entertained any shocks in the specified period. To compare the shock experience between the two groups 92.22% PSNP beneficiary households and 80% of non-PSNP beneficiary households was entertained shocks in the recent five years period. The study result showed statistically significant difference between two groups in relation to shock experience at 5% probability level.

Table 4. Descriptive statistics of sample households (dummy and categorical variables)

Variables	Category	Sample households N = (190)		PSNP beneficiary households N = (90)		Non-PSNP beneficiary households N = (100)		χ^2 - value
		Freq.	%	Freq.	%	Freq.	%	
Sex	Male	162	85.26	76	84.44	86	86	0.091
	Female	28	14.74	14	15.56	14	14	
Marital status	Married	171	90	84	93.33	87	87	3.870*
	Widowed	16	8.42	4	4.44	12	12	
	Divorced	3	1.58	2	2.22	1	1	
Chemical fertilizer use	Yes	125	65.79	65	72.22	60	60	3.144*
	No	65	34.21	25	27.78	40	40	
Improved seed use	Yes	94	49.47	56	62.22	38	38	11.118***
	No	96	50.53	34	37.78	62	62	
Access to irrigation	Yes	42	22.11	21	23.33	21	21	0.150
	No	148	77.89	69	76.67	79	79	
Shock experience	Entertained	163	85.79	83	92.22	80	80	5.804**
	Not entertained	27	14.21	7	7.78	20	20	

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

Source: Own computation result (2017)

4.1.3. Descriptive Statistics of Outcome Variables

Calorie intake per adult equivalent: The finding of the study show that the mean calorie intake of the total sampled households was 2525.09 Kcal/AE/day while the mean calorie intake of program beneficiary and non-program beneficiary households was found to be 2636.94 and 2424.44 Kcal/AE/day, respectively. This means that households in the program are better off in terms of calorie intake in Kcal/AE/day. The result of t-test for the mean difference in calorie intake between the two groups confirmed that there is statistically significant mean difference in calorie intake between the two groups at 1% probability level ($t = -2.60$).

Household assets: The mean household asset holding of the sample households was found to be 4934.61 Birr with standard deviation of 3620.80. The survey result of the study showed that the mean household asset holding of program beneficiary households was 6394.60 Birr with standard deviation of 3634.75 whereas the mean household asset holding of non-program beneficiary households was 3620.62 Birr with standard deviation of 3077.31. This means that PSNP beneficiary households are better off in terms of household asset holding. The statistical analysis revealed that the mean difference between the two groups in relation to household asset holding was statistically significant at 1% probability level (Table 5).

Table 5. Descriptive statistics results of outcome variables

Variables	Total sample Households		PSNP beneficiary households		Non-PSNP beneficiary households		t-value
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	
Daily calorie consumption	2525.09	570.37	2636.94	638.19	2424.44	483.03	2.60***
Household assets	4934.6	3620.8	6394.6	3634.8	3620.6	3077.3	5.69***

*** means significant at 1% probability level

Source: Own computation result (2017)

4.2. Econometric Model Results

This section presents the whole process of measuring impact of PSNP on household food security and asset building using propensity score matching method. It explains the estimation of propensity scores, matching methods, common support region, balancing test and sensitivity analysis. It also explains the treatment effect of the program across the program beneficiary households.

4.2.1. Propensity Scores Estimation

Binary logistic regression model was used to estimate propensity scores to match the program beneficiary and non-program beneficiary households based on the observable characteristics. The impact of PSNP intervention on the outcomes were estimated using STATA 13.0 software using the propensity score matching algorithm (psmatch2) developed by Leuven and Sianesi (2003). In estimating the propensity score, the dependent variable used in the model was a binary variable indicating 1 for PSNP beneficiary and 0 otherwise.

Before proceeding to impact estimation, Variance Inflation Factor (VIF) was applied to check for the presence of serious multicollinearity problem among the explanatory variables (Appendix Table 1). The model results for VIF test of the variables showed that there were no serious problems of multicollinearity among explanatory variables. Therefore, there is no explanatory variable dropped from the model since no serious problem of multicollinearity among explanatory variables.

The logistic regression model was used to estimate the propensity score of each program beneficiary and non-program beneficiary households as a function of observed household characteristics. The results from the logistic regression model of sample household participation in the PSNP were used to create propensity scores for the matching algorithms.

The logistic regression result revealed a low pseudo- R^2 of 0.211 (Table 6). The pseudo- R^2 indicates how well the regressors X explain the participation probability (Caliendo and Kopeinig, 2005). A low pseudo- R^2 value means sample households do not have as such distinct characteristics and it is easier to find a good match between the two groups.

The estimated logistic regression model indicated that seven of the fifteen explanatory variables used in the propensity score matching estimation model significantly influenced program participation. These includes age of the household head, marital status of the household head, educational level of the household head, dependency ratio, use of improved seed, extension contacts and shock experience. Among these seven variables, two variables have negatively and the remaining five variables have positively affected the household participation in PSNP. The explanations for significant variables are the following below.

Age of the household head: It was hypothesized that PSNP participation would be affected positively as the age of the household head increases. The result of logit regression justified that keeping all other variable constant, an increase in age of household head by one year increases the probability of household to be PSNP beneficiary by a factor of 0.011 at 5% significance level. This result is in line with the result of Nesreddin (2014) which confirmed that age of household head had a positive effect on household program participation.

Marital status of the household head: It was hypothesized that marital status of the household head affects the probability of participation in PSNP negatively. In line with the hypothesis, marital status of household head had a negative effect on household PSNP participation and was significant at 10% probability level. It means that as compared to married household heads those widowed and divorced household heads were more probability of participation in PSNP.

Educational level of the household head: It was hypothesized that educational level of the household head affects the probability of household participation in PSNP negatively. It was found that an increase in educational level of the household head by one year increases the probability of household participation in PSNP by a factor of 0.036 negatively at 5% significance level. Kidanu (2014) which raveled that educational level of the household head had a negative effect on household program participation supports this result.

Dependency ratio: As it was hypothesized, dependency ratio in AE had a positive effect on household program participation and significant at 5% probability level. This is because the existence of large number of in active labor force (children under age of 15 and old age of above 65) in the family could worsen the household's food insecurity status. Due to the fact

that the small active labor force (working age between 15-64 years) supports large number of inactive labor force (dependent persons) in the family in addition to themselves. This finding is supported by the result of Nesreddin (2014).

Use of improved seed: This study hypothesized that use of improved seeds negatively influences participation in the PSNP. In contrast with the hypothesis, use of improved seed increases the probability of household participation in PSNP by a factor of 0.201 positively and significantly at 5% probability level, *ceteris paribus*. This is because in the study area there is a problem of on time delivery of improved seed for farmers. In addition to this use of improved seeds for agricultural production needs fertilizer application but either of improved seeds or fertilizer is not rich farmer on required time, which adversely affects production and increases the probability of household participation in PSNP.

Extension contacts: It was hypothesized that extension contacts affect the probability of participation in PSNP positively. The study result shows that an increase in the number of extension contacts by 1 unit increases the probability of household participation in PSNP by a factor of 0.041 positively and significantly at 10% probability level. This is because a frequent visit of household by extension worker helps to understand the households' food security status and asset level.

Shock experience: It was hypothesized that shock experience affects the probability of household participation in PSNP positively. In line with the hypothesis, having shock experience increases the probability of household participation in the PSNP by a factor of 0.225 positively and significantly at 10% probability level. This is due to the fact that households who experienced shocks loss their assets which leave households with little capacity to cope, fall into food insecurity and as a result need food assistance and might stand illegible to participate in such a program as transitory food insecure (MoARD, 2010).

Table 6. Logistic regression results of household program participation

Variables	Coefficients	Standard Error	Marginal effect
Age of the household head	0.043**	0.019	0.011
Sex of the household head	-0.936	0.814	-0.229
Marital status of the household head	-1.002**	0.547	-0.245
Educational level of the household head	-0.147**	0.071	-0.036
Dependency ratio	0.597**	0.271	0.146
Household size	0.119	0.112	0.029
Use of chemical fertilizer	-0.141	0.432	-0.035
Use of improved seeds	0.829**	0.407	0.201
Off/non-farm income	-4.47e ⁻⁰⁵	5.25e ⁻⁰⁵	1.10e ⁻⁰⁵
Received remittance	-4.03e ⁻⁰⁴	2.67e ⁻⁰⁴	-9.89e ⁻⁰⁵
Credit received	1.75e ⁻⁰⁴	1.43e ⁻⁰⁴	4.28e ⁻⁰⁵
Extension contacts	0.168*	0.090	0.041
Access to irrigation	0.423	0.447	0.104
Distance from market center	0.084	0.087	0.021
Shock experience	1.012*	0.573	0.225
Constant	-2.098	2.274	
Sample size = 190			
LR chi2 (16) = 55.38			
Prob > chi2 = 0.000			
Pseudo R ² = 0.211			
Log likelihood = -103.747			

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

Source: Own computation result (2017)

4.2.2. Imposing Common Support Region

After propensity score estimation, the common support region should be imposed on the propensity scores distribution of the PSNP beneficiary households and non-PSNP beneficiary households. As shown in Table 7, the estimated propensity scores vary between 0.072 and 0.982 (mean = 0.606) for program beneficiary (treatment) households and between 3.48e-11 and 0.855 (mean = 0.355) for non-program beneficiary (control) households. The common support region would then lie between 0.072 and 0.855. In other words, households whose estimated propensity scores are less than 0.072 and larger than 0.855 are not considered for the matching exercise. As a result of this restriction, 10 program beneficiary and 12 non-program beneficiary households were discarded from the analysis.

Table 7. Distribution of estimated propensity scores

Group	Observation	Mean	Std. Dev	Minimum	Maximum
Total sample households	190	0.474	0.253	3.48e-11	0.982
Treatment households	90	0.606	0.208	0.072	0.982
Control households	100	0.355	0.230	3.48e-11	0.855

Source: Own computation result (2017)

Figure 3 shows the distribution of estimated propensity scores of sample households, program beneficiary households and non-program beneficiary households before imposition of the common support condition.

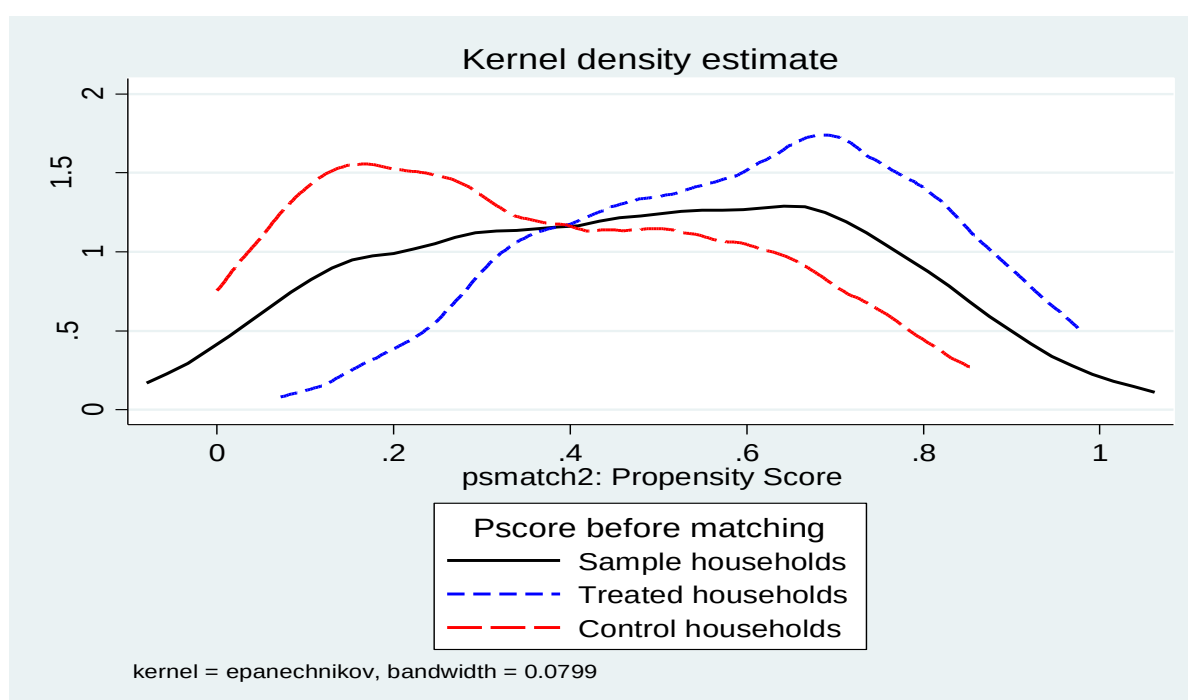


Figure 3. Kernel density propensity score of all households before matching

Source: Own computation result (2017)

Figure 4 and 5 shows the distribution of estimated propensity scores before and after the imposition of the common support condition for program beneficiary and non-program beneficiary households, respectively. It also shows that most of the program beneficiary households have propensity score around 0.7 while majority of the non-program beneficiary households have propensity score around 0.2.

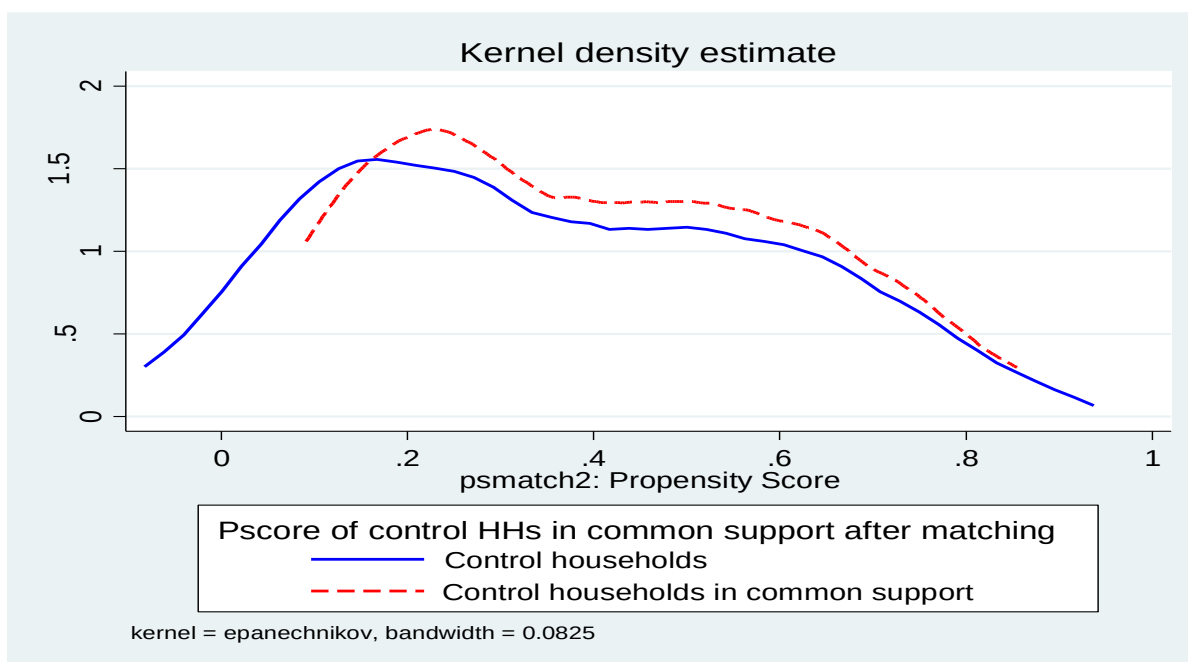


Figure 4. Kernel density propensity score of control HHs in common support after matching

Source: Own computation result (2017)

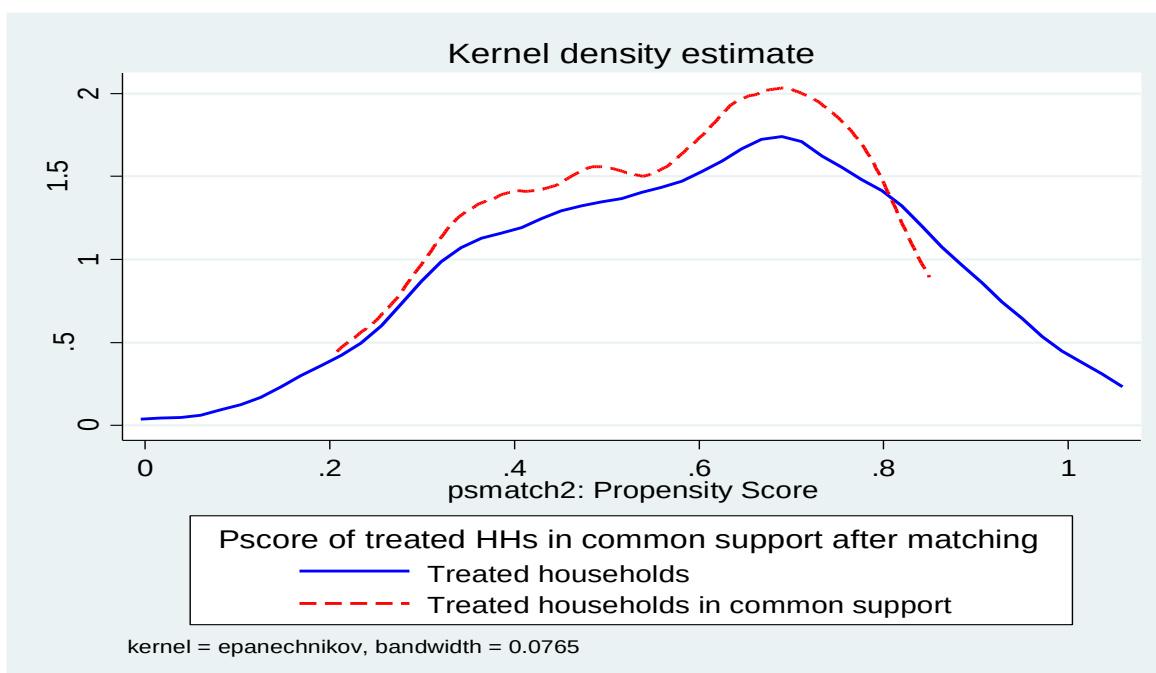


Figure 5. Kernel density propensity score of treated HHs in common support after matching

Source: Own computation result (2017)

4.2.3. Choosing a Matching Algorithm

Different alternatives of matching estimators were conducted to match the treatment households and control households fall in the common support region. The decision on the final choice of an appropriate matching estimator was based on three different criteria as suggested by Dehejia and Wahba (2002). First, equal means test referred to as the balancing test which suggests that a matching estimator which balances all explanatory variables (i.e., results in insignificant mean differences between the two groups) after matching is preferred. Second, looking into pseudo- R^2 value, the smallest value is preferable. Third, a matching estimator that results in the largest number of matched sample size is preferred. Therefore, a matching estimator that balances all explanatory variables, with lowest pseudo- R^2 value and produces a large matched sample size is preferable.

Table 8 presents the estimated results of tests of matching quality based on the above three mentioned performance criteria. Accordingly, kernel matching with bandwidth of 0.1 is the best matching estimator for the data in this study. Hence, the estimation results and discussion for this study are the direct outcomes of the kernel matching algorithm based on a bandwidth of 0.1.

Table 8. Comparison of the three matching estimators by performance criteria

Matching estimator	Performance criteria		
	Balancing test	Pseudo R^2	Matched sample size
Nearest Neighbor Matching			
Nearest Neighbor (1)	15	0.111	168
Nearest Neighbor (2)	15	0.049	168
Nearest Neighbor (3)	15	0.024	168
Nearest Neighbor (4)	15	0.014	168
Nearest Neighbor (5)	15	0.011	168
Radius and caliper			
0.01	15	0.069	134
0.1	15	0.008	168
0.25	15	0.018	168
0.5	13	0.076	168
Kernel Matching (KM)			
Bandwidth of 0.01	15	0.068	134
Bandwidth of 0.1	15	0.007	168
Bandwidth of 0.25	15	0.010	168
Bandwidth of 0.5	15	0.042	168

Source: Own computation result (2017)

4.2.4. Balancing Test

After choosing the best performing matching algorithm the next task is to check the balancing of propensity score and covariate using different procedures by applying the selected matching algorithm (in our case kernel matching). The main purpose of the propensity score estimation is not to obtain a precise prediction of selection in to treatment, but rather to balance the distributions of relevant variables in both groups. The balancing powers of the estimations are ensured by different testing methods such as reduction in the mean standardized bias between the matched and unmatched households, equality of means using t-test and chi-square test for joint significance of the variables used.

The fifth and sixth columns of Table 9 shows the mean standardized bias before and after matching and the total bias reduction obtained by the matching procedure, respectively. The standardized difference in covariates before matching is in the range of 1.13% and 49.67% in absolute value. After matching the remaining standardized difference of covariates for all covariates lies between 0% and 7.2% which is below the critical level of 20% suggested by Rosenbaum and Rubin (1985). In all cases, it is evident that sample differences in the unmatched data significantly exceed those in the samples of matched cases. Therefore, the process of matching thus creates a high degree of covariate balance between the treatment and control samples that are ready to use in the estimation procedure.

Similarly, t-test also revealed that all covariates became insignificant after matching while ten of them were significant before matching.

Table 9. Propensity score and covariate balance

Variables	Sample	Mean		Standardized bias %	Reduction in bias %	Test	
		Treated	Control			t	p > t
Age	Unmatched	44.36	41.04	28.98		-1.99	0.047
	Matched	44.19	43.77	3.6	87.58	0.23	0.822
Sex	Unmatched	0.84	0.86	-4.36		0.30	0.764
	Matched	0.90	0.92	-5.1	16.97	-0.40	0.690
Marital status	Unmatched	2.11	2.25	-24.9		1.69	0.091
	Matched	2.11	2.09	2.7	110.84	0.22	0.824
Educational level	Unmatched	2.02	3.27	-42.23		2.89	0.004
	Matched	2.23	2.43	-7.1	83.19	-0.50	0.615
Dependency ratio	Unmatched	1.08	0.86	28.25		-1.95	0.053
	Matched	1.01	1.01	0.0	100.00	0.00	0.998

Household size	Unmatched	7	6.06	48.68		-3.33	0.001
	Matched	6.89	6.81	4.0	91.78	0.28	0.781
Chemical fertilizer use	Unmatched	0.72	0.6	25.9		-1.78	0.077
	Matched	0.71	0.71	-0.3	101.16	-0.02	0.982
Improved seed use	Unmatched	0.62	0.38	49.67		-3.42	0.001
	Matched	0.60	0.59	1.6	96.78	0.10	0.920
Off/non-farm income	Unmatched	2827.9	2869.05	-1.13		0.08	0.938
	Matched	2927	2737	5.2	560.18	0.34	0.738
Received remittance	Unmatched	138.89	917.00	-18.15		1.22	0.223
	Matched	156.25	110.11	1.1	106.06	0.56	0.576
Credit received	Unmatched	937.44	426.75	27.36		-1.92	0.056
	Matched	565.88	564.30	0.1	63.46	0.01	0.994
Remittance Extension	Unmatched	2.08	1.14	43.57		-3.02	0.003
contacts	Matched	1.89	2.0	-6.4	114.69	-0.39	0.699
Access to irrigation	Unmatched	0.23	0.21	5.59		-0.39	0.701
	Matched	0.21	0.23	-5.4	196.60	-0.34	0.736
Distance from market center	Unmatched	5.35	5	15.97		-1.09	0.274
	Matched	5.33	5.12	7.2	54.92	0.47	0.642
Shock experience	Unmatched	0.92	0.8	35.72		-2.43	0.016
	Matched	0.91	0.92	-1.1	103.08	-0.08	0.935

Source: Own estimation result (2017)

The low pseudo- R^2 and insignificant likelihood ratio tests support the hypothesis that both groups have the same distribution in covariates X after matching (Table 10). These results clearly show that the matching procedure is able to balance the characteristics in the treated and the matched comparison groups of sample households. Hence, these results can be used to evaluate the impact of PSNP among groups of households having similar observed characteristics. This enables us to compare observed outcomes for treatments with those of a control groups sharing a common support.

Table 10. Chi-square test for the joint significance of variables

Sample	Pseudo- R^2	LR χ^2	Prob. > χ^2
Unmatched	0.211	55.38	0.000
Matched	0.007	1.54	1.000

Source: Own computation result (2017)

4.2.5. Treatment Effect on the Treated

The effect of PSNP on household food security and asset building in daily calorie consumption in kcal intake/AE/day and household asset holding in Birr were analyzed. The estimation result

showed in Table 11 provides a supportive evidence of statistically significant effects of the PSNP on the household daily calorie intake in kcal /AE/day and household asset holding in Birr.

After passing different steps of matching technique and controlling for differences in the household pre-intervention characteristics of the PSNP beneficiary and non-PSNP beneficiary households, it has been found that the program has increased the daily calorie intake of the program beneficiary households by 11.67% (273.97 kilocalories) and this difference was statistically significant at 1% level of significance.

Similarly, in case of household asset building, the program has increased household asset holding of program beneficiary households by 69.90% (2599.60 Birr) and this difference was statistically significant at 1% level of significance.

Table 11. The result of average treatment effect on the treated

Outcome variable	Treated	Controls	Difference	S.E ¹	t-test
Daily calorie consumption (Kcal)	2620.87	2346.89	273.97	133.71	2.86***
Household assets (Birr)	6318.48	3718.88	2599.60	1007.76	4.53***

*** means significant at 1% probability level

¹ The bootstrapped S.E. is obtained after 100 replications.

Source: Own computation result (2017)

4.2.6. Sensitivity Analysis

A sensitivity analysis is designed to provide a quantifiable increase in uncertainty when a key assumption is relaxed. The results of sensitivity analysis in PSNP intervention show that the effects on different outcome variables would be detected from any unobservable biases. The rbounds package provides analysts with convenient set of software tools for performing sensitivity tests. As noted by Rosenbaum (2002), sensitivity analysis for insignificant effects on outcome variable is not meaningfully considered to test. Thus, sensitivity analysis is checked for the significant and lower bound outcome variables. The other values that correspond to each row of the significant outcome variables are p-critical values (or the upper bound of Wilcoxon significance level -Sig+) at different critical value of α .

Results show that the inference for the effect of PSNP intervention is not changing, though program beneficiary and non-program beneficiary households have been allowed to differ in their odds of being treated up to 200% ($e^{\gamma} = 3$) in terms of unobserved covariates. That means for all outcome variables estimated, at various levels of critical values of e^{γ} , the p-critical values are significant which further indicates that we have considered important covariates that affected both participation and outcome variables. We could not get the critical value of e^{γ} where the estimated ATT is questioned even if we have set e^{γ} largely up to 3, which is larger value compared to the value set in different literature which is usually 2(100%). Thus, it can be concluded that impact estimates (ATT) of this study are insensitive to unobserved selection bias and are pure effects of PSNP intervention (Table 12).

Table 12. Results of sensitivity analysis on ATT of outcome variables

Outcome variables	$e^{\gamma} = 1$	$e^{\gamma} = 1.25$	$e^{\gamma} = 1.5$	$e^{\gamma} = 1.75$	$e^{\gamma} = 2$	$e^{\gamma} = 2.25$	$e^{\gamma} = 2.5$	$e^{\gamma} = 2.75$	$e^{\gamma} = 3$
Daily Kcal intake	0	0	0	0	8.9e-16	3.3e-14	5.8e-13	6.1e-12	4.3e-11
Household asset	0	0	0	0	8.9e-16	3.3e-14	5.8e-13	6.1e-12	4.3e-11

Source: Own computation result (2017)

Note: (Gamma) = log odds of differential due to unobserved factors where Wilcoxon significance level for each significant outcome variable is calculated.

5. SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1. Summary

In this study the impact of PSNP on household food security and asset building in Goro Gutu district, East Hararghe zone of Oromia National Regional State has been evaluated using cross sectional data collected from six rural *kebeles* of the district. In addition, the study has also identified those factors determining the household participation in the program. The primary data for this study were collected from 190 households (90 program beneficiary and 100 non-program beneficiary households) from six rural *kebeles* of the district using scheduled interview. The primary data collected from sampled households were thoroughly analyzed using descriptive and econometric analyses.

Descriptive statistics results indicated that mean difference between program beneficiary and non-program beneficiary are statistically significant mean difference in terms of age of the household head, educational level of the household head, dependency ratio, household size, extension contact, credit received, marital status of the household head, use of chemical fertilizer, use of improved seeds and shock experiences. In contrast, the two groups have shown a statistically insignificant mean difference in terms of off/non-farm income, received remittance, distance from market center, sex of the household head and access to irrigation.

The logit model result also showed that the household program participation was significantly influenced by a combination of factors such as age of household head, marital status of household head, educational level of the household head, dependency ratio, use of improved seeds, extension contacts and shock experiences.

Before proceeding to calculate the treatment effects on the treated, the resulting matches passed through different processes of matching quality tests such as t-tests, reduction in standardized bias, and chi-square tests. In addition, the computed parametric standard error was bootstrapped to capture all sources of error in the estimates. Obtaining a reliable estimate of a program needs to adequately control for such confounding factors. Propensity score matching has resulted 80 program beneficiary households to be matched with 88 non-program beneficiary households after discarding households whose propensity score is outside of the

common support region. Hence, matched comparison was conducted on these households who share common pre-intervention household characteristics except program participation.

The impact estimation result shows that the PSNP had brought statistically significant and positive effect on program beneficiary households in daily kilocalorie consumption and household asset holding in the study area.

Finally, sensitivity analysis was carried out on the estimated average treatment effect using alternative matching estimators. All the matching estimators resulted in statistically significant effects of the program on program beneficiary households. Therefore, the impact estimates (ATT) are insensitive to unobserved selection bias.

5.2. Conclusion and Recommendations

Based on the findings of this study the following conclusion and recommendations were forwarded:

The results of logit model showed that the household program participation was positively influenced by age of the household head and dependency ratio and negatively by educational level of the household head. This implies that those households headed by less educated household heads had higher dependent household members. To address this problem the program designers, implementers, and funding agents need to focus on formal education as one component of the PSNP with integrated family planning programs are required in the study area.

Marital status of the household head was negatively influenced the probability of household program participation. It means that as compared to married household heads those widowed and divorced household heads have less capacity to build more household assets, which help them to put aside some resources for unforeseen circumstances to smoothen their household food security. Therefore, the program designers and implementers should give attention for those household heads to produce more products and build more household assets.

Use of improved seeds and the probability of program participation were positively related. This can happen because of two main reasons. The first one is, there is gap in what types of

improved seed households got and what they want is different, so they use for consumption purpose rather than production. The second one is the problem of on time delivery of improved seeds for the households. Hence, it is recommended that the concerned body should do more on timely provision of improved seeds with modern agricultural inputs based on the types of input needed by users, which can help program beneficiary households to produce more food for their family.

The household shock experiences and the probability of program participation were also positively related. It means that those households entertained weather related shocks like recurrent drought and crop or/and livestock disease manifestation has more probability to be program beneficiary than those households not entertained those shocks because those households whose affected by shocks loss their income and household assets. Therefore, funding agents, program designers and implementers should work more on providing the climate resilience services that improve the ability of households to cope up with those shocks.

Based on the PSM model results PSNP has brought significant improvement on household food kilocalorie consumption and household asset holding for program beneficiary households, which improves food security and reduces the asset depletion of program beneficiary households. Accordingly, as compared to non-program beneficiary household the program intervention increased the program beneficiary household kilocalorie consumption and asset holding by 11.67% and 69.90% respectively. However, the program has more impact on asset building than kilocalorie consumption. This is because those program beneficiary households invest more of their cash transfer on household asset building as compared to food consumption. Even if those household assets that the household invest more of their cash transfer on it is not product asset rather unproductive one. This is what makes the program beneficiary households become eligible for program year after year in study area. Therefore, the program implementer should advise and follow the program beneficiary households to invest more of their cash transfer on productive assets in the study area.

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7. APPENDICES

Appendix Table 1. Multicollinearity test for explanatory variables included in PSM model

Variable	VIF	1/VIF
MASHHH	2.49	0.402
SEXHHH	2.29	0.436
AGEHHH	1.57	0.636
USIMSE	1.52	0.656
HHSIZE	1.52	0.658
EDLHHH	1.49	0.671
UCHFER	1.37	0.731
NUEXCT	1.32	0.757
DEPRAT	1.32	0.759
DISTMC	1.31	0.765
ONFAIN	1.19	0.839
CREREC	1.17	0.854
ACCIRR	1.16	0.860
SHOEXP	1.11	0.903
RECREM	1.09	0.921
Mean VIF	1.46	

Source: Own computation result (2017)

Appendix Table 2. Conversion factor used to compute Adult Equivalent (AE)

Age group	Male	Female
< 10	0.6	0.6
10 – 13	0.9	0.8
14 – 16	1	0.75
17 – 50	1	0.75
> 50	1	0.75

Source: Storck *et al.*, 1991

Appendix Table 3. Conversion factors used to compute kilocalorie intake

No.	Food items	Unit	Kilocalorie	No.	Food items	unit	Kilocalorie
1	Sorghum	Kg	3550	21	Honey	Kg	2860
2	Maize	Kg	3630	22	Vegetable oil	Litre	9000
3	Wheat	Kg	3440	23	Sugar	Kg	4000
4	<i>Teff</i>	Kg	3450	24	Salt	Kg	1780
5	Barley	Kg	3390	25	Coffee	kg	1103
6	Rice	Kg	3540	26	Irish Potato	kg	750
7	Pasta	Kg	3420	27	Sweet potato	kg	1140
8	Macaroni	Kg	3550	28	Onion/garlic	kg	480
9	Spaghetti	Kg	3550	29	Tomato	kg	200
10	Haricot bean	Kg	3461	30	Cabbage	kg	480
11	Bean	Kg	3390	31	Red pepper	kg	933
12	Pea	Kg	3400	32	Spice	kg	2970
13	Chickpea	Kg	3400	33	Pumpkin	kg	360
14	Lentil	Kg	3390	34	Tea	Kg	1190
15	Linseeds	Kg	5109	35	Vetch	kg	3400
16	Soybean	Kg	3820	36	Oats	kg	3880
17	Egg	Kg	1580	37	Banana	kg	1160
18	Beef	Kg	2020	38	Orange	kg	530
19	Milk	Litre	640	39	Mango	kg	630
20	Butter	Kg	7450				

Source: USAID and DPPA of Ethiopia, 2007

SURVEY QUESTIONNAIRE

A. General Information for Identification of Household Profile

Household ID: _____

Name of *Kebele*: _____

Name of interviewee: _____

Name of enumerator: _____

Date of interview: _____

Signature: _____

B. Demographic Characteristics of Respondents (For Both PSNP Beneficiaries and Non-beneficiaries)

No	Name of HH members	Age	Sex	Relation ship to HH head	Marital Status	Educational status	Highest grade attained
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							

Key:

- Sex: 1. Male 0. Female
- Relationship to HH head: 1. Head 2. Wife/husband 3. Son/daughter
4. Parent 5. Grandchild 6. Brother/sister 7. Other relatives 8. Not related
- Marital status: 1. Single 2. Married 3. Divorced 4. Widowed
- Educational status: 1. Literate 0. Illiterate

C. Land Resource

1. Do you have your own farm land? 1. Yes 0. No
2. If yes, specify the size in hectares or other locally known measures _____
3. What is the total area of land you cultivated last year in hectares (ha)? _____
1. Own 2. Share cropped 3. Rented in 4. Taken as gift
5. Others(specify) _____
4. Do you think that your piece of land is enough to support your household? 1. Yes 0. No
5. If no to Q4, what do you think is the reason? 1. Small size 2. Lack of agricultural inputs 3. Large household size 4. Less fertile land 5. Others (specify) _____
6. Does your land utilize all your family labor? 1. Yes 0. No
7. If no to Q6, where does a surplus labor go?
 1. Go for labor selling 2. Collects firewood & Charcoal 3. Stay at village for nothing
 4. Others (specify) _____
8. Did you use chemical fertilizer to improve your farm productivity? 1. Yes 0. No
9. Did you use improved seed to improve productivity? 1. Yes 0. No
10. From where you got the improved seed? _____
11. If yes to Q9, what types of improved seed you got?
 - a. Cereals (Maize, Sorghum, *Teff*, Wheat, Barley, Bean, Haricot bean)
 - b. Vegetables (Potato, Tomato, Cabbage, Carrot, Onion, Garlic)
 - c. Fruits (Mango, Apple, Papaya, Avocado, Banana)
 - d. Others (specify) _____
12. Did you get on time? 1. Yes 0. No
13. If no to Q12, at what time you got it? 1. Before sowing 2. At any time they need
3. After sowing time is passed

D. Household Food Consumption

1. What are your mostly used staple foods? _____
2. What are the main sources of your food consumption?
 - a. Own produced b. Purchased from market c. Gift from relatives/others
 - d. Borrowing from relative'se. PSNP f. Other (if any) _____
3. If the answer to Q2 is PSNP, how much percent of your food consumption? _____

4. Please tell us the type and quantity of each food items that your household has been consumed for the last weeks?

No.	Food items	Unit of measurement	Sources				Total
			Own produce	Purchase	PSNP	Other sources (if any)	
1	Sorghum						
2	Maize						
3	Wheat						
4	<i>Teff</i>						
5	Barley						
6	Rice						
7	Pasta						
8	Macaroni						
9	Spaghetti						
10	Bean						
11	Haricot bean						
12	Soybean						
13	Lentil						
14	Pea						
15	Chickpea						
16	Linseeds						
17	Flax seeds						
18	Egg						
19	Meat						
20	Milk						
21	Butter						
22	Edible oil						
23	Sugar						
24	Salt						
25	Coffee						
26	Potato						
27	Sweet potato						
28	Onion						
29	Tomato						
30	Cabbage						
31	Red pepper						
32	Spice						
33	Pumpkin						
34	Mango						
35	Banana						
36	Orange						

4. Any time when the household lacks enough food to eat 5. Others
4. What are the current livestock holding as compared to five years before?
1. Increasing 2. Constant 3. Decreasing
5. If the answer to Q4 is decreasing, what is the reason?
1. Forced to sell them to buy food for household
2. Forced to sell them to pay for education and health expense
3. Death due to drought (lack of feed and water)
4. Loss due to disease manifestation 5. Other (specify if any) _____
6. If the answer to Q4, is increasing what is the reason?
1. Reproduced 2. Bought additional livestock 3. Someone gave us for gift
4. Other reason if any _____
7. Do you have any types of improved livestock species? 1. Yes 2. No
8. How many of each of the following farm equipment's do you have?

No	Farm equipment	Current holding	Initial Price	Years of owner ship	Estimated service in years	Depretiation	Current value
1	Plough(Maresha)						
2	Spade (Akefa)						
3	Sickle (Machid)						
4	Chopper (Mench)						
5	Axes (Materabiya)						
6	Pick axe (doma)						
7	Hoe (mekotkocha)						
8	Traditional beehive						
9	Transition beehive						
10	Modern beehive						
11	Water pump (diesel)						
12	Fork Rake (Mensh)						
13	If other specify						

9. Household equipments holding (Consumer durables assets)

No	Fixed Asset holding	Unit	Quantity	Current market price	Total value
1	Mobile/ telephone				
2	Television				
3	Refrigerator				
4	Radio				
5	Bed				

6	Table and Chair Carpet				
7	Mattress(frash)				
8	Charcoal stove				
9	House in town for rent service				

F. Household Income

1. What is (are) the major source(s) of your income?

- | | |
|--|-----------------------------|
| 1. Crop production | 2. Animal husbandry |
| 3. Both crop production and animal husbandry | 4. Trade |
| 5. Selling of food aid | 6. Off/ non-farm employment |
| 7. Daily laborer | 8. Other (specify) _____ |

2. Do you have off/non-farm income sources? 1. Yes 0. No

3. If yes to Q2, Please specify the source and amount of income you obtained from off- farm activities in the last one year.

No	Description of income sources	Annual incomes	Remark
1	Sale crop		
2	Sale of vegetables		
3	Sale of fruits		
4	Sale of khat		
5	If any others specify		

4. Please specify the source and amount of income you obtained from non-farm activities in the last one year.

No	Description of income sources	Annual income	Remarks
1	Petty trade		
2	Casual work		
3	Sale of charcoal and firewood		
4	Sale of labour		
5	If any others specify		

5. Have you received remittance from somewhere in last year? 1. Yes 0. No

6. If yes how much was it and from whom you received?

Source _____ Amount in a year _____

G. Access to Credit Service

1. Did you have access to credit service? 1. Yes 0. No
2. If yes to the Q1, what were the sources of the credit? 1. Individuals 2. Cooperatives
3. Government 4. NGOs 5. Others (specify) _____
3. What was the type of the credit you obtained?
1. Cash/money 2. Seed 3. Farm tools 4. Fertilizer
5. Pesticides 6. Other (specify) _____
4. If the answer to Q3 is cash/money, for what purpose you obtained?
1. Seed purchase 2. Fertilizer purchase 3. Livestock purchase
4. To purchase household equipment's 5. Others (specify) _____
5. What was the amount of credit you obtained from this source in birr? _____
6. If no to the Q1, what is the reason?
1. There is no credit service in the area 2. Lack of collateral
3. There is not sufficient service in the area 4. I don't want the service
5. Others (specify) _____

H. Access to Extension, Irrigation and Market

1. Do you have access to extension advice? 1. Yes 0. No
2. If the answer to Q1 is yes, how many times did you contact DA's last year? _____
3. Did you access to any irrigation scheme? 1. Yes 0. No
4. If the answer to Q3 is yes, which type of irrigation scheme?
1. Modern 2. Traditional 3. Both
5. How many times of land you cultivated using irrigation? _____
6. What types of crops did you produce using irrigation?
1. Cash crop 2. Cereals crops 3. Vegetables 4. Fruits
7. Do you have access to market? 1. Yes 0. No
8. How much far is the nearest market center from your home in km? _____
9. What are the basic sources of market information?
1. Radio 2. Merchants/traders 3. Development agents
4. Friends /relatives/neighbors 5. Others _____
10. Where did you sell agricultural products?
1. On farm 2. Nearest local market 3. Any market where the price is better

I. Shock Experience

1. Have you encountered any shocks in the last five years? 1. Yes 0. No
2. If yes to Q1, which of the followings? 1. Crop failure shock 2. Livestock loss shock
3. Both 1 and 2 4. Specify if other_____
3. What are the main causes of the shock you face? 1. Drought 2. Irregular rainfall
3. Pest or/and disease 4. Flood 5. Other (specify) _____
4. How much assets you loss because of those shock in last year's?
1. Number of livestock lost_____
2. Estimated value of lost crops_____

Questions about the program (For the program beneficiaries only)

1. Has your household received any food or cash from PSNP since January 2011?
1. Yes 2. No
2. If yes to Q1, in what component of PSNP did you participate?
1. Public work 2. Direct support
3. Who selected you to participate in the program?
1. Kebele Food Security Task Force 2. Kebele Administration 3. Community
4. D.As 5. Other (specify if any) _____
4. What types of benefits your household received from PSNP?
1. Cash only 2. Food only 3. Both cash and food
5. Do you get what types of benefits your household need to receive? 1. Yes 2. No
6. If no to Q5, who decides what types of benefits you receive?
1. Kebele Food Security Task Force 2. Kebele Administration 3. Community
4. D.As 5. District Food Security Office 6. Other (specify if any) _____
7. How much food or cash did your household receive in the last 12 months?

Types of benefit	Unit	Per month	In a year
Food			
Wheat	Kg		
Pea	Kg		
Oil	Littre		
Cash	Birr		

8. What did you do with all the food or cash you received?

1. Consume all as food 2. Purchase additional livestock 3.
Purchase household equipment's 4. Other (specify if any)_____

9. What do you think the PSNP's performance regarding household food security when it is compare to the former household food security?

1. Best 2. Better 3. The same 4. Worse

10. On your opinion, in which of the following parameters did the PSNP has an impact at household level?

1. Increase households food consumption 2. Increase the household equipment
Increase the household livestock assets 3.
4. Improve all
5. If other specify _____

11. On your opinion, in which of the following parameters did the PSNP has an impact at community level?

1. Improve infrastructure in the community like roads to health center, market
2. Rehabilitate the natural resources base like forest and water
3. Both
4. Specify if others _____

Did your household get any additional services for participation in PSNP ? 1. Yes 0. No

13. If yes to Q12, which of the following?

1. Facilitation in access to credit service
2. Additional follow up from DAs than usual
3. Access to irrigation not yet before
4. Access to improved seed or/and livestock breed
5. Access to chemical fertilizer at lower cost or/and on time than before
6. Specify (if any others) _____

14. For how many years your household was received the benefit? _____

15. Do you know about graduation from PSNP? 1. Yes 2. No

16. If yes to Q16, what is your plan in the future?

1. To graduate from the program
2. Continuing to receive the program benefits

17. If the answer to Q16 is continue to receive the program benefit, for how many years? _____

18. Please rise if you have any comments, complaints or appreciations regarding the program and program benefits?

THANK YOU FOR YOUR COOPERATION !!!