COLLEGE OF DEVELOPMENT STUDIES

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IMPACTS OF ADOPTING IMPROVED WHEAT VARIETIES ON FOOD SECURITY IN GIRAR JARSO *WOREDA*, NORTH SHEWA ZONE, OROMIA REGION, ETHIOPIA

M.A. Thesis

By

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Advisor

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June 2018

Addis Ababa, Ethiopia

IMPACTS OF ADOPTING IMPROVED WHEAT VARIETIES ON FOOD SECURITY IN GIRAR JARSO WOREDA, NORTH SHEWA ZONE, OROMIA REGION, ETHIOPIA

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By

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DECLARATION

I**,** Hiwot Hailu Tirkaso, hereby declare that the thesis work entitled **"Impacts of adopting Improved Wheat Varieties on Food Security in Girar Jarso *Woreda,* North Shewa Zone, Oromia Region, Ethiopia"** is Submitted by me in partial fulfillment of the requirements for the award of the degree of Master of Art in Rural Development to the college of development studies center for Rural Development is the original work carried out by myself. The matter embodied in this thesis work has not been submitted earlier for award of any degree or diploma to the best of my knowledge and belief.

Name of the student: Hiwot Hailu
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This thesis has been submitted for examination with my approval as a University advisor

Advisor's Name: **Signature**

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APPROVAL

The undersigned certify that they have read and hereby recommend to college of development studies center for Rural Development and Addis Ababa University to accept the Thesis submitted by Hiwot Hailu Tirkaso entitled "**Impacts of adopting Improved Wheat Varieties on Food Security in Girar Jarso *Woreda*, North Shewa Zone, Oromia Region, Ethiopia**, in partial fulfillment of the requirements for the award of a master's Degree in Rural Development.

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Acronyms

AAU:	Addis Ababa University
AGP:	Agricultural Growth Program
ATE:	Average Treatment Effect
ATT:	Average Treatment of the Treated
CASCAPE:	Capacity Building for Scaling up of Evidenced-Based Best Practices in Agricultural Production in Ethiopia
CSA:	Central Statistical Agency.
EHNRI:	Ethiopian Health and Nutrition Research Institute
FAO:	Food and Agricultural Organization
FGDs:	Focus Group Discussion
FTC:	Farmer Training Center
GPS:	Generalized Propensity Score
HDDS:	Household Diet Diversity Score
HFBM:	Household Food Balance Model
KARC:	Kulumsa Agricultural Research Center
KIIs:	Key Informant Interviews
LATE:	Local Average Treatment
m.a.s.l:	Meters Above Sea Level
MLE:	Maximum Likelihood Estimation
MRA:	Minimum Recommended Allowance
NERICA:	New Variety Rice for Africa
NGO's:	Non-Governmental Organization
PPS:	Probability Proportional to Size of the Sample
PSM:	Propensity Score Matching
RUM:	Random Utility Model
SPSS:	Statistical Package for Social Scientist
TLU:	Tropical Livestock Unit
WARDO:	*Woreda* Agricultural and Rural Development Office
WB:	World Bank

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Abstract

The aim of this study is to assess impacts of adopting improved wheat varieties on food security in Girar JarsoWoreda, Oromia Region, Ethiopia. From Girar Jarso Woreda, three Kebeles are selected. A sample of 192 households comprised of 90 adopters and 102 non- adopters, were selected by using multistage sampling procedure. Both qualitative and quantitative data were collected from primary and secondary sources. Household survey, key informant interview of sample farmers and focus group discussion and review of reports were the means used to collect the data. The study used descriptive statics such as mean, standard deviation, frequency, percentage, t-test, and chi-square test methods for data analysis. A non-parametric estimation of Propensity Score Matching method and a parametric method of Logit model were employed. The researcher used a logit model to identify factors affecting adoption of improved wheat varieties and applied the Household Food Balance Model (HFBM) to quantify the net available food at household level. A Propensity Score Matching (PSM) method is also used to estimate the impact of improved wheat varieties on food security of the rural households. Hidase and Digelu ,Danda'a and Kubsa were types of improved Wheat varieties cultivated by adopters in the production year of 2017/2018. The results revealed that Education status , participation in demonstration and field day and activities , distance to the market, access to market information and member of farmer cooperative were significantly affect adoption decision of improved wheat varieties. The result of impact of improved wheat varieties on food security shows that, households that use improved wheat varieties tend to get higher kilocalorie available food and have higher consumption expenditure at household level than those who do not adopt. The study has also indicated that adopting of improved wheat varieties had a potential of increasing availability of food at household's level. Governmental and non-governmental organizations in the study area should give due attention for adoption of improved varieties to minimize the problem of food insecurity in the study area.

Keywords: Impact of improved Wheat Varieties, Household Food Security, Households in Girar Jarso Woreda

CHAPTER ONE: INTRODUCTION

1.1 Background

Among the priorities of each country's development goals, access to food security is one of the most important components (Lashgarara *et al*, 2010). According to World Bank, food security is one of the basic indicators of development. Access and utilization of adequate food is an indispensable part of each country's development goals. Growth in agricultural production can minimize food insecurity by increasing the amount food available for consumption (Tsegaye and Bekele, 2012). Increment in production and productivity enables farmers to get more yields and be able to economically better life.

Wheat is one of a staple food crop, which is produced in both developed and developing countries by serving as a source of food and cash. Recently, wheat has become one of the most important cereal crops (strategic crop) in terms of production and food security in Ethiopia (Tolossa,2014).

There are two wheat species, which are dominantly grown in the country. These two economically important wheat species are bread wheat (Triticumaestivum L.) and durum wheat (T. tirgidum var. durum) (Amare *et al*,2016). Wheat (bread and durum) covers over 1.5 million hectares of land annually, primarily as mid-altitude and highland rain fed crops, ranks 4th in area and 2nd in productivity among the cereal(CSA, 2013). In 2014/15 cropping season, the country produced 4.23 million tons of wheat grain on about 1.7 million hectares of land accounting 17.9 per cent of the cereal production and recording to 16.4 percent of the cereal area (Zewdie *et al*, 2016).

Ethiopia's wheat production covers only 75% of the national demand and the remaining 25% of the wheat is obtained through imports (Eyob *et al*, 2014). This indicates that still the country is under food imports, which requires high investment in agriculture sector to close the demand gaps. According to Misgana (2016), to minimize, wheat yield imports and cut down wheat national demand deficiency, conducting considerable scientific research works that can contribute to positive impact on wheat production and productivity is a critical issue.

There are a lot of wheat varieties used by farmers on different regions of the country. Studies to develop improved wheat technologies have been conducted since the 1950s with the assistance of international research centers and foreign donors resulting in several improved wheat varieties and management practices (Tsegaye and Bekele, 2012). Crop variety improvement, demonstration practices and scaling up of the best practices are continuing over years through various government bodies, NGOs, research institutes and universities (Tsegaye and Mulugeta, 2012; Misgana, 2016). Facilitating growers to make decisions in choosing the right varieties, which is compatible to the agro-ecological condition of the environment is an action still requiring a lot of commitment to work on it. Evidence shows that no country achieves food security depending only on food aid, rather majority of them reduced the problem of food deficit through making high investment on agricultural activities. That is why considerable amount of attention is given to agricultural sector enhancement and growth in Ethiopia. There is a need to develop farmers on appropriate technologies to achieve agricultural growth. According to Tolossa (2014), increasing yield and meeting the high demand has become the focus of the Ethiopian government's agricultural policy and extension activities.

CASCAPE is a project designed to assist the activities deployed under the Agricultural Growth Program (AGP) by further strengthening the capacity of AGP stakeholders in identifying, documenting, and disseminating best practices in agricultural production (Tewodros *et al*,2014). Broadly, the CASCAPE project is designed to support the Ethiopian government by verifying and testing best practices and innovation in agricultural production. Specifically, further scaling up of integrated improved wheat production technologies and through participatory evaluation of different improved wheat technologies (Degefa *et al, 2014)*. The current study is expected to come up with new insight that CASCAPE AAU will scale up some experiences of farmers who have adopted improved varieties of wheat.

1.2 Statement of the Problem

In Ethiopia cropping of local seed that has low disease resistance capacity as well as poor harvest per unit area is common in rural areas. As a result of this the productivity of wheat is very low and wheat disease has become increasingly limiting to the production of rain-fed and irrigating crops in the country specially those who have potential wheat production area in Oromia region. Low production is the main problem, which exacerbates food insecurity in rural areas. Insufficient production leads to an individual, household, community as well as a country to economical, psychological and health related stresses which be termed as cycle of food insecurity.

There is an effort on agricultural policies that promote adoption of a technologies as ways of improving productivity in the agricultural sector and the research system along with other stakeholders has to play a major role in improving technologies required to enhance wheat production and productivity and to improve food security in Ethiopia. The country has been working on developing high yielding, disease resistant and stable varieties that can meet increasing food demand of the growing population. The research system has been making continuous and potential endeavor on varietal development and seed replacement activities. Currently, more than 74 different wheat varieties have been released in Ethiopia to satisfy the growing production demands of the farmers in the country (Moti *et al*, 2014).

Accordingly, considerable efforts have been made to develop and disseminate several improved wheat varieties .Studies indicate that low-adoption of improved varieties over time, due to various factors leads to low productivity, and eventually make the farm households food insecure. According to data obtained from Agricultural and Rural Development Office of Girar Jarso *Woreda i*n the production year 2017/2018, the total area cultivated by wheat was 2737.5 hectare from this 2679 .25ha (98%) was covered by local seed whereas only 58 ha (2%) cultivated by improved wheat varieties which indicated that the level of adoption of improved wheat varieties was minimum. . Evidence shows Girar Jarso *Woreda i*s known by food insecurity. Study made by Meskerem, 2011, 85 percent of sample households were food non-self-sufficient.

There are a lot of studies in developing countries being undertaken on the adoption and impact of crop technologies on food security (Catherine *et al,*2014; Menale *et al,*2014;

Victor,2016; Zewde *et al*,2014). These studies focus on crops other than wheat. Additionally, some studies have looked at the impact of improved wheat varieties on food security (Tsegaye and Bekele, 2012; Shiferaw *et al*,2014) which were undertaken on other study areas. Studies by Meskerem, 2011; Degefa, 2015 looked at the situation of food security and determinants of food security at household level. However they did not go further on the exploring the impact of technologies on food security. Hence, this study focuses on impact of improved wheat varieties on food security and factors affecting adoption of improved wheat varieties of rural households, it is believed that the result of the study will come up with insight that add upon our understanding of food security and can also inform policy and action for addressing food security problem.

1.3 Objective of the Study

1.3.1 General Objective

The study attempted to assess the impacts of adopting improved wheat varieties on food security of rural households in Girar Jarso *Woreda.*

1.3.2 Specific Objectives

Specifically, the study pursued the following objectives: -

- To identify factors influencing adoption of improved wheat varieties.
- To compare the production of improved wheat varieties with traditional seeds.
- To explore the impact of adoption of improved wheat varieties on food security status at household level.

1.4 Significance of the Study

The study has a contribution for the gap existed in the literature on the impacts of improved wheat varieties adoption on household food security. The findings of the study are helpful to encourage local people to improve current agricultural production status by providing up to date and accurate information for scale up best practices obtained in the study area. Moreover, the results of the study can also be used in guiding policy makers and development planners on agricultural technologies introducing and dissemination on

the study area. Likewise, the findings may also provide future research directions for those who may be interested in conducting further research in related area.

1.5 Scope of the Study

The study focused on the impact of adoption of improved wheat varieties on food security. Socio-economic factors, institutional and market related factors influencing adoption of improved wheat varieties were considered. The study focused only on farmers, (farmers growing wheat in the production year (2017/2018 G.C) and only three wheat growing *Kebeles* namely Gino, Ilamu and Torbanashe of the Girar Jarso*Woreda.*

1.6 Limitation of the Study

Since it was not possible to study the factors that influence adoption of all improved wheat technologies, improved wheat varieties are the only technologies that were considered in this study. The study was made in a small geographical area of the country, so it cannot represent the whole region. The period of study under consideration was limited to 2017/2018 production year. The variables included focused on socio economic, institutional and market related factors.

1.7 Ethical Considerations

Study respondent's willingness to participate in the study area was respected and verbal consent was taken. Name of personalities, perception and culture of the study area was not mentioned in the report without consent in any case. In order to control data biased, the enumerators were assigned to the *Kebeles* where they do not work and daily monitoring and supervision was done by the researcher and the supervisor during the data collection.

1.8 Organization of the study

This thesis is organized into five chapters. The first chapter introduces the background of the study, statement of the problem; objectives, significance and limitation of the study were discussed. The second chapter review of relevant literature on the topic. The third chapter deals with the research methodology. The findings of the study were presented and discussed in the fourth chapter. The fifth chapter concludes and draws recommendation on the basis of the main findings of the study.

CHAPTER TWO: LITERATURE REVIEW

2.1 Conceptual Literature Review

2.1.1 Definition of Concepts

2.1.1.1 Food security

Different scholars define the term food security in different times. Food Security is defined as "access by all people at all times to enough food for an active and healthy life" (World Bank ,1986).It encompasses both food availability (adequate supply of food) and food access through home production, purchase in the market, or transfer (Degefa, 2002). Adequate food production contributes to the distribution and exchange of food elsewhere. The definition does not only focus on availability of food but also it is the combination of production, distribution, and exchange of food to other parts of the country (Degefa,2002).

According to World Food Summit in 1996, 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 a healthy and active life. A household is food secure when it has access to the food needed for a healthy life for all its members (adequate in terms of quality, quantity, and safety and culturally acceptable) and when it is not at undue risk of losing such access. Moreover, Getachew (1995) defines food security in the context of subsistence farmers as "ability to establish access to production resources such as land, livestock, agricultural inputs and family labor combined to produce food or cash".

Food security analyzed at the household level is determined by a household's own production and members' ability to purchase food of the right quality (Meskerem, 2011). According to Degefa (2005), Food self-sufficiency means a household's capability to adequately feed all members from its own farming activities all year round and Food Security is wider in scope that it refers to the capability to sufficiently meet food needs from both own production and partly by purchasing on market.

According to Reutlinger cited in Degefa (2002), Food insecurity is a situation in which individuals have neither physical nor economic access to the nourishment they need.

A household is said to be food insecure when its consumption falls to less than 80% of the daily Minimum Recommended Allowance (MRA) of caloric intake for an individual to be active and healthy (Degefa,2002). There are many challenges that affect food security of households. To overcome the problem, identifying appropriate strategies and implementing are activities undertaken by different countries like Ethiopia. To make available and accessible food at household level using improved varieties in agricultural production and productivity is the major strategy in Ethiopia in general and specifically in Oromia region.

2.1.1.2 Improved seed

Improved seeds can be defined as seeds that aim at increasing quality and production of crops by having characteristics of early maturity, high yielding, and drought tolerance (FAO, 2009). Cho (2013), define improved seeds by dividing it into pieces as: Open pollinated seeds which are those produced from natural, random pollination. Hybrid seeds result from crossbreeding two parent plants that have desirable traits. The improved wheat varieties are said to be drought resistant, early matured, high quality and high yielding. The improved wheat varieties (together with improved agronomic practices) have been introduced and disseminated to wheat farming communities in different parts of Ethiopia through the extension system operated by the government (Tsegaye and Bekele, 2012). Improved seed is one of the most basic and essential inputs to increase production and productivity of cereals (USAID, 2013). As output is theresultofinsertingappropriate input leads to good result. Increasing the quality of seeds can increase the yield potential of the crop by significant folds and it is the most economi cal inputs to agricultural development (FAO, 2006).

2.1.1.3 Adoption

Different scholars define the term adoption in different times. Rogers 1983, defined adoption as use or non use of a new technology by a farmer at a given period of time. It is about utilizing technology within specified time. According to Feeder *et al* cited in Hailu (2008), the adoption decision also involves the choice of how much resource (i.e. land) to be allocated to the new and the old technologies if the technology is not divisible (e.g. mechanization, irrigation) but if the technology is divisible (like improved seed, fertilizer, and herbicide), the decision process involves area allocations as well as level of use or rate of application. In this case adoption of a technology can be measured by area

allocation and level of use depending on the technology type. Thirtle and Ruttan(1987), defined aggregate adoption as the spread of a new technique within a population. Adoption is also considering coverage of a population on a specified area and in specified time. In adoption process, farmers make preferences for technology that depends on several criteria. According to Hasan (1996), before adoption choices are made a farmer makes a set of several inter dependent decisions. Generally, Adoption is a decision made by farmers depending on several factors to use or not to use a technology within a specified time and measured by area allocation or level of use based on technology type.

2.1.2 Importance of Wheat Crop at Global and National Level

Wheat has been a food for 8,000 years, it has been the most cultivated cereal crop in the world, and the quantity produced is more than other cereals, feeding about 40% of the world population (Adhiena, 2015). According to ECRDIS (2016), globally it is the leading source of vegetal protein in human food, having protein content of 13%, which is relatively high compared to other major cereals and an important source of carbohydrates. These are essential nutrients needed by human being to have better health and to be active.

It is a significant food for human nutrition, particularly in the developing countries where wheat products are primary foods (Shewery PR, 2015). Wheat residue and other by-products commonly used to overcome the shortage of livestock feed which is the biggest constraint to the livestock sector in the country (Degefa *et al, 2014).* Wheat consumption has been rapidly increasing during the past 20 years because of population growth, change in food preference and urbanization led to raise food gap in all regions of African countries (Harold,2015). Large proportions of Africa's populations are engaged in agriculture, but the produce from this sector cannot feed its citizens. So, African countries are obliged to import large quantities of grains and oil seeds every year by expending huge amounts of hard currency. In Africa in 2013, wheat (40.3million tons) was one of the top three imported items (Zerihun,2017). Increase in population makes more demands placed on global agriculture production. According to Vernon (ND), a significant increase and technical effort will be required, particularly in poorest counties, to keep pace of food production with growth in demand. Improvement in production requires to pave the way to the problems that arise, and food demands needed because of increase in population. Thus, the current level of crop productivity might be difficult to feed the

population in the developing world, especially in Africa, where the population is growing at an alarming rate (Zerihun and Kebebew,2012). So, in the coming years feeding the whole population will be difficult in areas specially in Africa.

Ethiopia is an agrarian country where more than 80% of the total population livelihood depends directly or indirectly on agriculture (Tsegaye and Bekele,2012). Agriculture contributes for about 38.8% of the GDP and more than 85% of the population derive their livelihood from agriculture according to the National Bank of Ethiopia report (NBE,2016). Even if its contribution is 38.8%, the sector is not well developed to fit the demand of food by the population of the country. Therefore, sustainably enhancing wheat production and productivity is requiring significant attention to maintain food security and to feed the rapidly growing population (Karta K. *et al*, 2015).

2.1.3 Adoption of Improved Varieties and Approaches

Adoption can be considered as a variable representing behavioral changes that farmers undergo in accepting new ideas and innovations in agriculture hoping for some positive impacts of those ideas and innovations (Tsegaye and Bekele, 2012). It is the relationship of the most important terms: knowledge (knowing and awareness of the technology), decision and action or practices. According to Hailu (2008), adoption and diffusion of technology are two interrelated concepts describing the decision to use or not to use and the dispersion of a given technology among economic units over a period of time.

According to Hailu (2008),there are two approaches that are common in the agricultural technology adoption in the literatures. The first approach emphasizes the adoption of the whole package and the second one is step-wise or sequential adoption of components of a package. There is a great tendency in agricultural extension programs of developing countries to promote technologies as a package and farmers are expected to adopt the whole package. According to Bingxin *et al* cited in Degefu *et al* (2017), the Ethiopian government has been promoting a package-driven extension that combines credit, fertilizers, improved seeds, and better management practices. Adoption studies focused on a single component of the technology package is difficult to have a clear understanding of the adoption of technology packages (Degefu *et al*, 2017). According to Mann, 1978 cited in Hailu (2008), opponents of the whole package approach strongly argue that farmers do not adopt technologies as a package, but rather adopt a single

component or a few suitable technologies. According to Ryan and subrahaman cited in Hailu (2008), Sequential adoption of components of technological package is a rational choice for the farmers who had limited cash. Since the focus of this study was on impact assessment , it was difficult to identify the effect of package technologies intervention in cross sectional survey research.

2.2 Empirical Literature Review

According to Hailu (2008), Food Security is a high priority in a country like Ethiopia. However, domestic food production and supply have consistently been below the requirements mainly due to low productivity of the agricultural system resulted from insufficient use of improved technologies such as improved seeds and fertilizers. According to USAID Ethiopia' s analysis of seed proclamation, many developing countries were able to transform their agricultural sectors and ensure food security through the adoption of high –yielding varieties of seed in addition to other modern inputs. The close relationship between food insecurity, farming, and environmental degradation on the impact of cultivation practices has received due attention in the last two decades (Tsegaye and Mulugeta, 2012). The generation and transfer of improved agricultural technologies in general and that of disease resistant, widely adaptable, and high yielding wheat varieties is one of the pillars in the national food security strategy adopted by the Government of Ethiopia (Zewdie *et al*, 2016).

There are many factors that affect the decision to use a new technology or practice by economic units on a regular basis. A study to identify the socio-economic factors that influence farmers' decision to adopt improved varieties indicates that the mean predicted probability of technology adoption to be age, income, education, and extension visits (Ebojei *et al*, 2009).

According to Victor. (2016), through using endogenous switching probit model adoption of improved varieties largely influenced by extension contact and educational level of farm households. In relation to the adoption of improved bread-wheat varieties in Ethiopia, Jalleta (2004), found that farmers refrained from the adoption of some improved varieties of bread wheat that were promoted by the extension services because the varieties performed poorly under farmers' particular conditions. Mussei (2001),

illustrated the importance of extension visits and the frequency of these visits in the adoption of improved wheat.

In relation to other drivers of adoption, a statistically significant relationship between credit and adoption has been shown, indicating that those farmers with good access to credit have a higher probability of adopting improved wheat varieties. A study in Ethiopia concluded that the availability of credit increased the probability of adoption by non-adopters by 84.3% (Kotu *et al*, 2000). The institutional factors such as government policy, prices, credit, input supply, land tenure, market, research, development and extension activity have a role on farmers' attitude towards new technology; knowledge and skills of decision maker.

Many literatures exist on determinants of adoption of wheat production technology by smallholder farmers (Abebe *et al*, 2010; Tolossa, 2014; Degefa *et al*, 2017). According to Abebe *et al*, 2010, household demographic characteristics, age, education level of household head, family size and wealth have different impacts on the decision behavior of smallholder farmers. Adoption of improved variety is influenced by household characteristics. According to Misganaw *et al* (2015), stability analysis in bread wheat in northwestern Ethiopia, the study differentiated 12 varieties released across different year influenced by the environment. The result indicates that farmer's preference is high for the varieties that are not highly influenced across the environment. According to Tesfaye *et al* (2001),Socio-economic ,institutional and technical factors are accountable for determining technology adoption.

There are also studies on assessing adoption and impact of improved wheat technologies on productivity and food security of households (Tsegaye and Mulugeta, 2012; Abebe *et al*, 2016). According to Setotaw *et al* cited in Tsegaye and Mulugeta (2012), that adoption of improved agricultural technologies (improved wheat varieties and agronomic practices) have positively and so importantly affected household's food security in Ethiopia. According to Abebe *et al* (2016), identified rust-resistance wheat varieties on productivity and household food security in Ethiopia through using Propensity Score Matching (PSM) the results suggested that adoption of rust resistant wheat varieties significantly increased the likelihood of food security and has a positive impact on cash earning of adopting households. According to Leake. G and Adam .B (2015),the use of

improved variety is considered as the most important input for the achievement agricultural productivity and food security status of farm households in Ethiopia. According to Gashaw (2016), using one-year randomized evaluation of impact package approach 80% of the farmers stated their willingness to plant improved wheat varieties.

Scholars have undertaken several studies on adoption of improved varieties in improving food security (Catherine *et al,*2014; Menale *et al*,2014; Victor,2016). However, these studies did not undertake to examine improved wheat varieties impact on food security of farm households. The current research was undertaken in view of contributing to the endeavor of filling the knowledge gap on this topic of area.

Girar Jarso *Woreda* is one of wheat producing district, which has benefited from researches on wheat and subsequent transfers of improved wheat varieties. While success stories can be anticipated regarding the extension of wheat technologies in Girar Jarso *Woreda*, no published study discussing the impact of adopting improved wheat varieties on households food security has been found (to the best of the authors knowledge). There are studies conducted so far related to situation of food security (e.g. Meskerem ,2011; Hana and Dereje,2016; Haymanot and Dereje, 2017). These studies indicated that the status of poverty, income and food security in Girar Jarso *Woreda*, but they did not go further to assess the impacts of technologies on food security. Therefore, this study has been designed to fill this research gap. Specifically, the study deals with the analysis of the impact of adopting improved wheat varieties on food security on the study area.

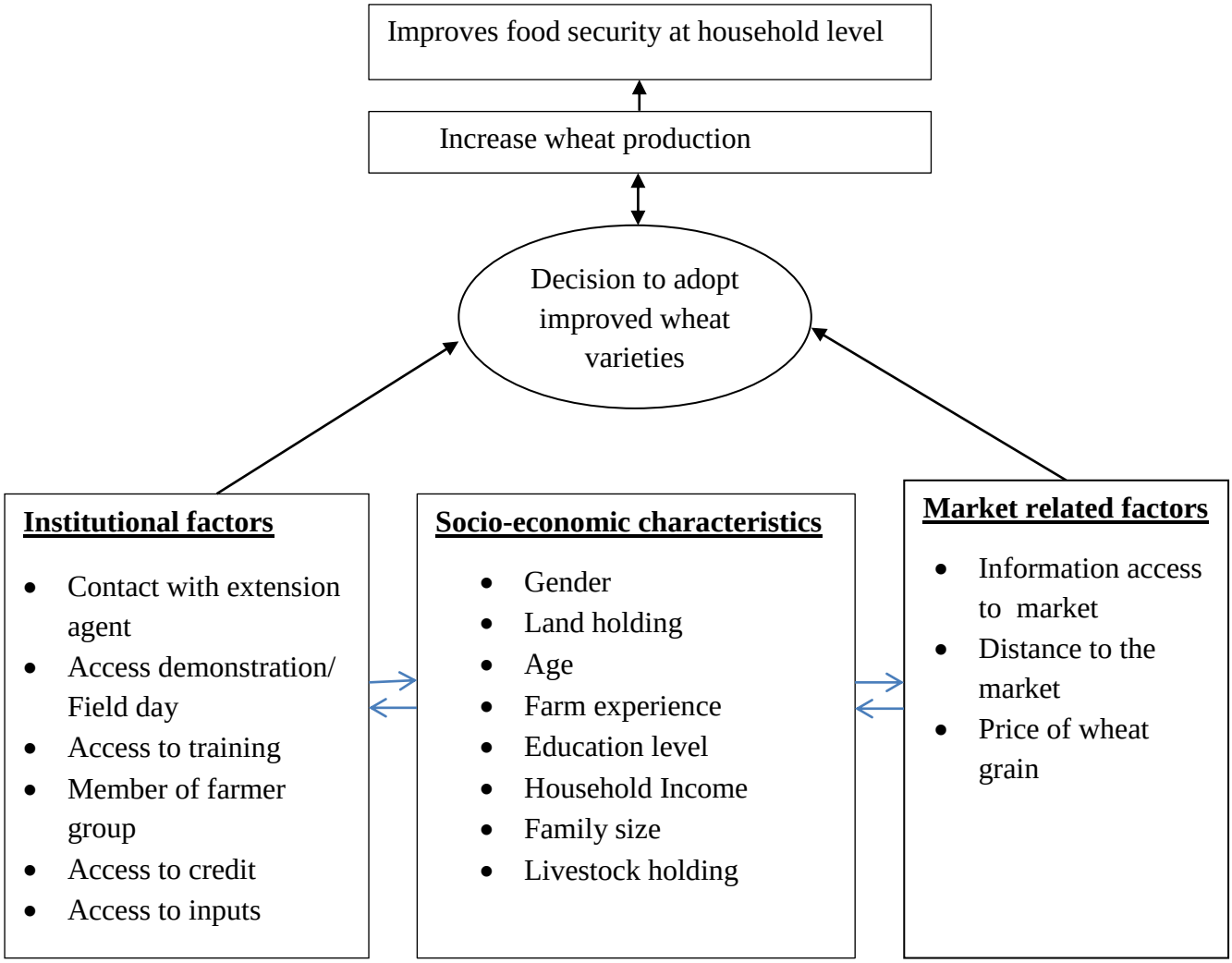
2.3 Analytical Framework

Based on previous literature, a wide range of factors can influence the decision to adopt improved varieties. Increasing crop production is crucial to improve income and for attaining food security (FAO, 2014). The variables that influence adoption decision of farmers included socio- economic characteristics, institutional and market related factors (Tsegaye and Bekele, 2012; Shifera *et al*, 2014; Ejigayehu ,2016:Abebe *et al*, 2016).

Figure 1 below shows analytical framework that indicate the relationship of variables. The questionnaire in this study was developed through using outcome variable (Food

Security) dependent variables (adoption of improved wheat varieties) and independent variables based on the following framework. It consists of different socioeconomic, institutional and market related factors affecting the adoption decision of improved wheat varieties, which in turn determines the situation of the households' food security. As depicted in the diagram the decision to adopt improved wheat varieties which affect production could lead to improvement of food security at a household level.

Figure 1: Analytical framework of the interrelationship between various variables



Source: Authors

CHAPTER THREE: METHODOLOGIES

3.1 The study Area

The study was conducted at Girar Jarso *Woreda* of North Shewa Zone *Oromia* National Regional State of Ethiopia. The *Woreda* has a total of 17*Kebeles*/peasant associations.

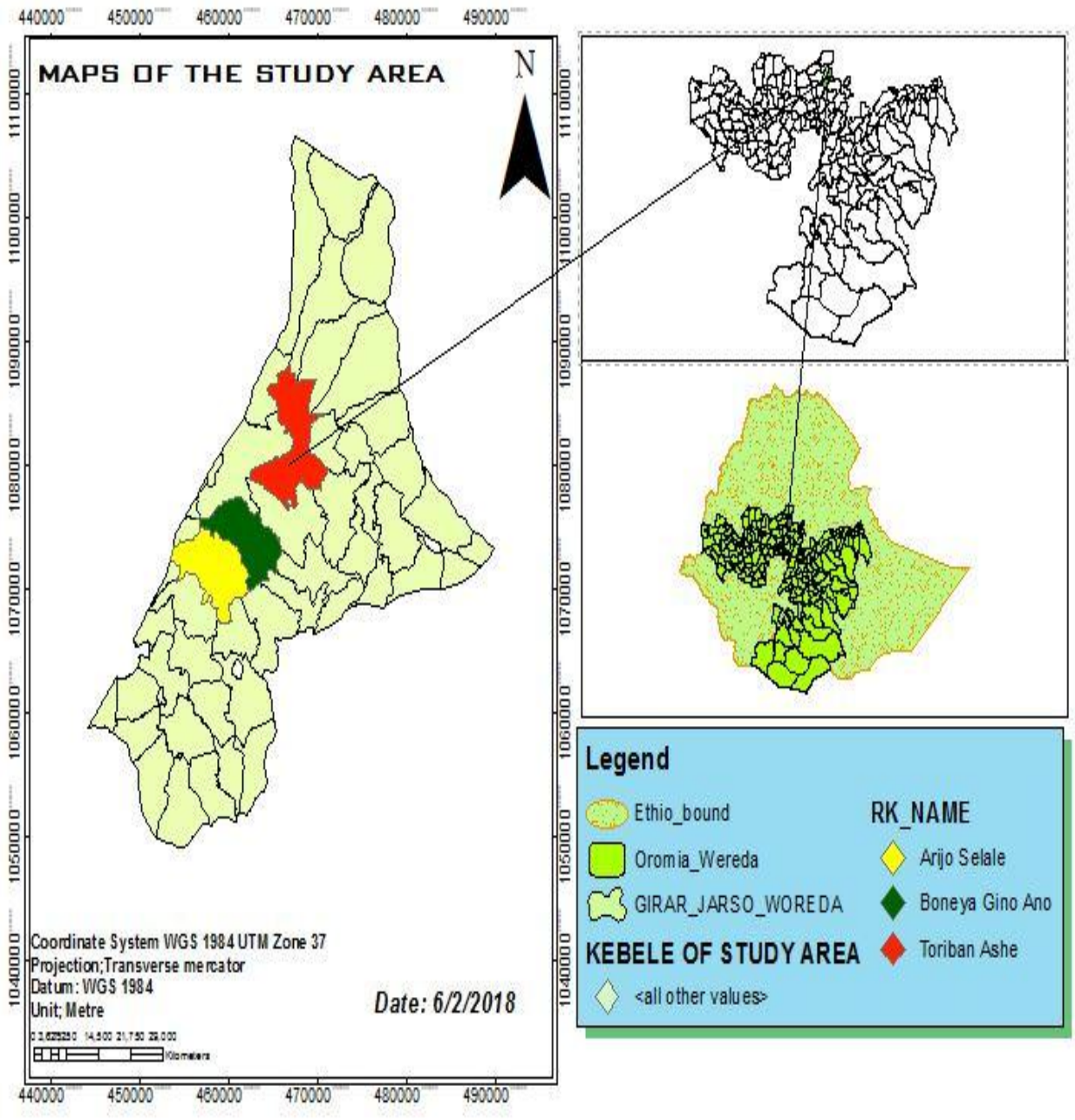


Figure 2: Map of Study area

(Source: Ethio GIS,2007)

Location and Land Use

Girar Jarso *Woreda is* located at 112 km distance from Addis Ababa, the capital city of Ethiopia along the highway to Amhara National Regional State in the Northwestern direction. It shares border with Amhara Region in the North, Yaya Gullalle *Woreda* in the East, Debre Libanos *Woreda* in the South and Degem *Woreda* in the West. Astronomically the *Woreda* occupies $9^0$35'-$10^0$00'N latitude and $38^0$39'-$38^0$39'E longitude.

The highest altitude of the *Woreda* is 3419 and the lowest 1300 meters above sea level. The total area coverage of the *Woreda* is 49,435 hectares and its land use and land cover distribution is that: cultivated land covers the largest share of land (37,006 hectares which is 75 percent), grazing land is the second largest land use pattern that covers 16 percent which is 7,909 hectares. About 6 percent of the *Woredas* land area is unusable land, which is neither cultivated nor grazed, this includes, rugged topography, mountainous and exhausted degraded land areas which is 2,847 in hectares. The remaining proportions include forestland 941 hectares and settlement areas 732 hectares that cover 2 and 1 percent, respectively (WOLA, 2018).

Climate, Soil and Vegetation

The agro-ecological zone of Girar Jarso *Woreda* is 52 % high land and 41% mid land and 7% is low land (WOLA,2018). According to Fiche Station metrological data, the average annual temperature ranges from 15 to 18°C, while the average annual rainfall varies between 1200 and 1400 mm.

The soil types of the *Woreda* are Nitosoil, cambi soil, Vertisoil and small percent of other type of soil according to the order of coverage (nitosoil 65%, Cambisoil 20%, vertisoil 14.6%, and other type of soil 0.4%. The types of soil in terms of color are 28% red, 25% black and 47% mixed color (WARDO, 2018). The vegetation coverage of the study *Woreda* is mainly natural forest, shrubs, bush, and woodland (WOLA, 2018).

Population

The *Woreda* has a total population of 67,312 (male 34,467 and female 32,845 (CSA,2007).Regarding religion, majority of the population are followers of orthodox Christianity. The result of the study indicated that 89 %, 3% and 8% of the respondents were Orthodox, Protestant and *Wakefeta* respectively.

Economic Activities

Mixed farming is the main activity of the household economy. Major crops grown include cereals (wheat, teff, barely, maize and sorghum), pulses (bean, peas, field pea, lentils and chickpea), fruits and vegetables (apple, cabbage, potato, onion) and oilseeds such as linseeds and nug. Wheat, barley and teff are important crops grown in *dega* and *woina dega* areas while sorghum , and maize are grown in *Kolla* areas. Pulses such as bean, pas, field pea, chickpea, and lentil are dominantly grown in *dega* and *woina dega* areas. Since the selected *Kebeles* agro ecology are dega and weindega cereals (wheat, barley and teff) and pulses were the only crops cultivated by the sample households.

Depending on Post-Harvest Assessment of WARDO (2018) report, the total land cultivated in 2009E.C crop year, was 21,401 hectares and expected output was 599,454.6 quintals but because of rusts, pests, climate change and weed related factors the *Woreda* faced 14% of losses and ultimately 515,521.9 quintals of different crop were harvested. Of this, cereals make up 70.5 percent of total production followed by pulses that covers 27.3 percent of the total production. Oil seeds constituted the remaining 2.1 percent. On individual crop production basis, teff constituted the largest proportion of cereals (27.3 percent) followed by sorghum (22.7 percent) and Wheat 18.1 percent.

Apart from crop production, livestock rearing is also another livelihood activity in which households engaged as a source of food, cash income and draft power in the study area. The total livestock population is estimated as 108,972 cattle, 67,465 sheep, 23,929 goats, 3,611 horses, 589 mules, 26,331donkeys, 115447 chicken, and 3,067 traditional and modern bee hives (WARDO,2018).

3.2 Research Design

The research design was relied on a mixing of quantitative with qualitative approach in order to capture the data required for the assessment the impact of adopting improved wheat varieties on food security in rural households. To bring results together and validate the quantitative findings with qualitative concurrent triangulation research design was employed.

3.3 Sampling Design

The sampling design employed in this study was simple random sampling and probability proportional to sample size in order to have a reasonable sample size. The sampling design for the household survey followed multistage sampling technique.

3.3.1 Sample Size Determination

The probability sampling technique was employed to generate the desired sample size on the study sites. The required sample size was determined by using Yamane (1967) sample size determination formula where the exact number of households in each *Kebele* or the sampling frame is known. It was used to provide more accurate and estimate samples selected on the study area. A simplified formula provided by (Yamane, 1967) to determine the required sample size at 93% confidence level, degree of variability=0.5 and level of precision= 7% (0.07).

$$n = \frac{N}{1+N(e^2)}$$

Where: n = the required sample size

N= population size

e= is the level of precision

n= 3334/1+3334 $(0.07)^2$=**192 households**

The total sample size of the respondents was 192 households. From this, 90 respondents were adopters and 102 were non-adopter farmers were selected with probability proportion to sample size from the three *Kebeles*.

3.3.2 Sampling Procedure

The study was based on cross-sectional data of the production year 2017/2018 G.C. The sampling unit in the study was a household who cultivates wheat crop at *Kebele* level. The procedures followed were three stages. At stage one, purposive selection of wheat crop growing *Kebeles* of the *Woreda* was undertaken by using secondary data obtained from the *Woreda* agricultural and rural development office At the meantime, potential wheat production area was considered. At stage, two, out of identified wheat growing *Kebeles o*f the *Woreda, households* who cultivate wheat with improved and traditional/ local seed were identified in collaboration with *Kebele* leaders and development agents of the respective *Kebeles.* Finally, sample of households were selected randomly at *Kebele* level based on probability proportional to size of the sample. The actual sample of 192farm households were selected from the sampling frame for the three *Kebeles* by Probability Proportional to the Size of the sample (PPS).

Table 1: Distribution of Sample Household

S. N	Sample *Kebeles*	Total number of household sample per *Kebele*			Sample of households		
		Male	Female	Total	Male	Female	Total
1	Ilamu	1066	223	1,292*	61	13	74***
2	Ginoo	972	138	1,104*	56	8	64***
3	Torbanashe	820	118	938*	47	7	54***
	Total	2,858	479	3,334*	164	28	192**

Note that: * obtained from basic data of (*Woreda* Office of Agriculture, 2018)

** obtained by the above technique of sample size determination.

*** obtained by probability proportional to the sample size

3.4 Source and Type of Data

The study utilized both qualitative and quantitative data type from primary and secondary sources. The primary data is obtained through household survey, Key Informant Interview and FGDs from sample respondents. Secondary data is collected from review of reports, published and unpublished materials, articles, related literature and organizational report.

3.5 Method of Data Collection

Primary method of data collection used through incorporating quantitative and qualitative data. From this household survey technique is applied to collect the quantitative data whereas, Focus Group Discussion, Key Informant Interview and observation techniques were used for the qualitative one. Likewise, secondary data including review of reports, published and unpublished materials, articles, related literature and organizational report were used. The questionnaire was refined and finalized after incorporating the inputs of the survey. One supervisor and six enumerators were trained to collect relevant data from sample households, on how to record the responses, and on detailed contents of the questionnaire before the start of the main survey.

Household Survey

In this study, household survey was undertaken to obtain the primary data by using structured questionnaire at household level. Before starting the data collection, the researcher accomplished three stages in order to make the data collection convenient and to obtain accurate data. At stage one, the structured questionnaires were translated into the local language known as "Afan Oromo". At stage two, supervisor at *Woreda* level and two data enumerators at each *Kebeles* totally six data enumerators were selected from the three *Kebeles.* In order to control data biased, the selected enumerators were from the *Kebele*s where they do not work.At the final stage, training to supervisor and data enumerators was provided before starting the data collection process. Moreover, monitoring and controlling was done by the researcher and the supervisor during the data collection.

1.**Key Informant Interview (KIIs)**: - was held with Development Agent (DA), model farmers, female headed household, *Woreda* agricultural officials and *Kebele* officials. The main purpose of the interview was to collect factors affecting adoption of improved wheat varieties, production effect of improved varieties, availability of inputs, attitude and perception of farmers towards improved wheat varieties and its effect on income and food security of farm households. With regard to the size of the participants for the Key Informants Interviews (KIIs), saturation points were considered. As the participants for these qualitative data collection techniques are selected based on a mix of pre-defined

criteria that mainly reflect knowledge about the adoption of improved wheat varieties and food security i.e. expert opinions of the point at which no additional data is required due to redundancy in information is taken as a saturation point. Moreover, the researcher made all efforts to ensure diversity in opinions and provide opportunity for a broader and inclusive participation.

2. Focus Group Discussion: - Three focus group discussions which consisted (8-12) participants was undertaken to collect data about smallholders' reaction to the improved wheat varieties production effect on food security, perception of farmers toward improved wheat varieties, institutional and market related factors in the adoption of technologies were discussed in detail. The first group consisted of household heads those adopt improved wheat varieties in order to identify effect of improved wheat varieties on food security. The second group comprised household head those use local wheat seed to identify factors constrain them. Figure 3 below indicates the interactions of different group of interests provide valuable information about the major constraint of the adoption of innovation in Ilamu Kebele at Girar Jarso *Woreda*. Moreover, on the third group a type of informal group discussion was held with smallholders coming from different parts on traditional drink house over the same issue. This also strengthened the reliability of the finding. The researcher allows group interaction such that participants were able to build on each other's ideas and comments to provide in-depth views, which would not be attainable from individual settings.

Figure 3: Focus Group Discussion at Ilamu *Kebele* in Girar Jarso *Woreda*

Source: Field Survey, 2018

3. Observation: was used to gather information about the nature of cropping patterns in the field, local production practices, agricultural implements, and interaction of farmers with DA.

3.6 Data Quality Controlling Procedure

To maintain data quality: data collectors were well trained, questionnaires were pretested ,logistic regression measurement instruments used and regularly calibrated, filled questionnaires reviewed daily and computer data cleanup is done appropriately. In order to control data biased, the enumerators were assigned to the *Kebeles* where they do not work and daily monitoring and supervision was done by the researcher.

3.7 Method of Data Analysis

Data analysis was employed quantitatively by using software like SPSS version 21& STATA version 13.To analyze factors affecting on the adoption of improved varieties Logit model is utilized. Household Food Balance Model (HFBM) was used to quantify available food at household level during the study year. Moreover, the effect of improved wheat varieties on food security was estimated by using a Propensity Score Matching method.

3.7.1 Measurement of Food Security

To measure food available in the household during the study year, a modified form of a simple equation termed as Household Food Balance Model, originally adapted by Degefa (1996) from FAO Regional Food Balance Model was used. The HFBM was used to quantify the net available grain food by each of the sample rural households in Girar Jarso *Woreda.* All variables required for the HFBM model were converted from the local grain measurement units into the corresponding kilogram grain equivalent. To compare the available (supply) and required (i.e., demand) grain food, FDRE FSS (1996), 2,100 kilo calories per person per day was used as a measure of calories required (i.e., demand) to enable an adult to live a healthy and moderately active life. A comparison between calories available and calories demanded by a household was used to determine the food security status of a household.

Expression of HFBM is:

$$\boldsymbol{NGA_{ij} = \left(GP_{ij} + GB_{ij} + FA_{ij} + GG_{ij}\right) - \left(HL_{ij} + GU_{ij} + GS_{ij} + GV_{ij}\right)}$$

Where;

NGA_{ij} = Net grain available by i^{th}household in year j

GP_{ij} = Total grain produced by i^{th} household in year j

GB_{ij}= Total grain bought by i^{th} household in year j

FA_{ij} = Quantity of food aid obtained by i^{th} household in year j

GG_{ij} = Total grain obtained through gift or remittance by i^{th} household in year j

HL_{ij} = Post harvest losses by i^{th} household in year j

GU_{ij} =Quantity of grain reserved for seed by i^{th} household in year j

GS_{ij} =Amount of grain sold by i^{th} household in year j

GV_{ij} =Grain given to others by i^{th} household in year j.

3.7.2 Factors Influencing Adoption Improved Wheat Varieties

In this study, a farmer was defined as an adopter if he or she cultivates any improved wheat variety either freshly purchased and /or recycled not more than five years (The five year cut off point was adopted from Shifera *et al*,2014). According to Shifera *et al* (2014), as number of years of recycling of improved wheat variety increases, productivity will decline, so this has an implication to the food security status of the household. The adoption variable was therefore defined as 1 if a farmer is an adopter of improved wheat variety and 0 otherwise. The logistic regression model was selected for this study to assess factors that determine farmer's adoption status. The response variable was binary, taking values of one if the farmer adopts improved wheat variety and zero otherwise. The logistic regression can help us to predict a response variable on the basis of continuous, discrete, dichotomous, or a mix of these predictor variables to determine the percent of variance in the response variable explained by the predictor variables, to rank the relative importance of predictor variables and to assess interaction effects.

Hosmer and Lemeshew (1989), pointed out that the logistic distribution (logit) has got advantage over the others in the analysis of dichotomous outcome variable in that it is extremely flexible and easily used model from mathematical point of view and results in a meaningful interpretation. The parameter estimates of the model were asymptotically consistent and efficient. The binary logistic model does not make the assumption of linearity between dependent and independent variables and does not assume homoscedasticity (CIMMYT,1993). Therefore, in this study to identify factors affecting the decision to use or not to use of improved wheat varieties: socio economic characteristics of households, agricultural extension service (training and extension contact), availability and accessibility of input and market related factors analyses was done by logistic regression analysis. If the response of the i^{th}farmer to the question of adoption was denoted by a random variable Yi and a corresponding probability (i.e., probability of adopt improved variety or not by p_i such that the probability of adoption (Yi = 1) = pi and the probability of non-adoption Yi = 0) = 1 – pi.

The logistic model is specified by:

$Y_i = \beta_0 + \beta_i X_i + U_i$…… (1)

*Where ;*Yi: be a dichotomous outcome random variable with categories 1(adoption) and 0 (non –adoption)

Xi: denotes the collection of p- predictor variables

Ui: Denotes to the error term, which has an independently distributed random variable with a mean of zero.

In the regression model ,because the dependent variable in this case adoption is taking the value 1 or 0, the use of LPM has a major problem that the predicted value can fall outside the relevant range of 0 to probability value. Therefore, the model was estimated through using Maximum Likelihood Estimation (MLE). So, the logistic cumulative probability function for adopters is represented by:

$\boldsymbol{P_i = \frac{1}{1+e^{-zi}} = \frac{e^{zi}}{1+e^{zi}}}$…… (2)

Where;

Pi is the probability that the i^{th}farmer adopted the improved wheat varieties and that Pi is Non-linearly related to *Zi* (*i.e. Xi* and *βs*).

$Z_i = \beta_0 + \beta_1 X_1 + \cdots + \beta_n X_n$and

e*:*represents the base of natural logarithms.

Then, (1-P), the probability of non-adopter of improved wheat varieties is presented as: $\boldsymbol{1 - P_i \frac{1}{1+e^{z}}}$……(3)

And then, by dividing equation 2 by equation 3, the odds ratio in favor of adopting the improved variety was obtained as follows:

$\frac{pi}{1-pi} = \frac{1+e^{zi}}{1+e^{-zi}} = e^{zi}$…… (4)

Then the dependent variable was transformed by taking the natural log of Equation 4 specified by:

$Li = Ln(\frac{pi}{1-pi}) = Zi = \beta o + \beta 1X1 + \cdots + \beta nXn + Ui$…….(5)

Where: Li is the log of the odds ratio, L is the logit

Zi: is which the stimulus index, where Pi ranges between 0 and 1.

Outcome Variable: The outcome variable for this study was food security, which was measured by available kilocalorie of food per day at household level.

Dependent variable: The dependent variable is adoption decision of improved wheat varieties. The variable takes value of 1 for the household that cultivated improved wheat varieties during 2017/2018 production year and 0 for household that did not cultivate improved wheat varieties.

Independent variable: The researcher based on literatures and past research findings on adoption of agricultural technology, major variables expected to have an influence on adoption of improved wheat varieties were selected .It is categorized under Household socio- economic characteristics, institutional and market related factors.

Gender (G): It is a dummy variable which takes a value of 1 if the Household head is male and0, otherwise. Sex was hypothesized to positively influence adoption of improved varieties.

Age of household (AGEHH): It is continuous variables measured by numbers of years of the household head. It has an important role in the production process (Zhera ,2014). As the age of the household head increases, the probability of adopting a technology likely to decrease. Fear of risk for technologies is more observed on older farmers than younger farmers. Therefore, age was hypothesized to negatively influence decision to adopt improved wheat varieties.

Level of education (EDUCLEVL). Level of education is assumed to increase a farmer's ability to obtain, process, and use information relevant to the adoption of improved bread wheat varieties and fertilizer (Tesfaye.2001).Education level is assumed that it has a positive relationship for decision to use improved varieties and also to increase income of the households.

Family size (FAMS): The size of the household has been identified to positively influence the rate of fertilizer adoption in Eastern Oromia, Ethiopia (Bezabih, 2000). Since adopting of improved varieties require labor for preparation of land, management practices and proper harvesting so as large number of family size will have a positive relationship for the decision to use improved varieties. And at the same time this large family requires more food, so it is assumed that large number of family size will negatively influence food security of the household.

Farm size (FAMS): it is a continuous variable. It refers to the area cultivated land possessed by the respondents or their families. It was assumed that larger the farm size the farmer has, better seek to information and contact extension agent and situated to be food secure and economically strong(Zhera ,2014). It was assumed that the larger farm size the more to use improved varieties and positively influence food security.

Farming experience (FARMEXP). The previous experience of farmers can be expected to either enhance or diminish their level of confidence. It is anticipated that with more experience, farmers could become risk-aversive regarding the adoption of specific wheat varieties (Tesfaye.2001). It was assumed that having more farming experience would positively influence to decision to use improved varieties.

Annual income (AINCOM): It was assumed that annual income was positively associated with the use of improved variety. Farmers with a high annual income are hypothesized to be more likely to adopt improved agricultural technologies than farmers experiencing low level of income (Zhera ,2014).

Livestock holding (TLU): It is the total number of livestock holding of the farmer and it is measured in Tropical Livestock Unit (TLU). Livestock holding was taken as an asset so as farmers those holds high number of livestock, they can easily generate an income that enables them to cover the required cost of improved seed. It was assumed livestock number positively influence adoption of improved wheat variety and also food security of rural household.

Access to extension service (ACES) : Efficiency of extension service depend on the frequency that extension agent visits of a given household in a specific crop year. According to Kidane and Degnet (2001) high frequency of extension contact accelerates effective dissemination of information that enhances adoption of new agricultural technologies. The more access to extension service positively influence the d**e**cision to use improved varieties.

Attend field day (ATTFDAY), participate in demonstration plot (PARTDEMO), Farmers who have attended field days, visited demonstration plots, and participated in formal agricultural training are expected to have a positive attitude to the adoption of improved wheat varieties and fertilizer (Tesfaye.2001).

Access to credit (CREDSTS). Access to credit was measured as a dummy variable take value of 1 if the farmer will have access to credit and 0 otherwise. Access to credit can relax farmers' financial constraints (Tesfaye.2001).Thus, access to credit would hypothesized to positively influence the farm household's adoption decision to improved varieties.

Attend Training (ATT TRA), Training builds framers' capacity and improves the knowhow of the technology. Thus, it was expected to have a positive attitude to the adoption of improved wheat varieties.

Farmer Associations (FASN): It is a dummy independent variable represented by 1 if the household head participates in a membership in the farmer 0, otherwise. It was assumed that being a participant in famer associations was expected positive in the adoption of improved varieties.

Access to market Information (ACC MKT IN), It is a dummy variable represented by 1if the households had the access to market and 0, otherwise. It was hypothesized that assess to market positively affect the adoption process.

Distance to markets (DIST): It is a continuous variable measured in kilometer that the household travel to reach the nearby market. Short distance to the nearest market was hypothesized to have a positive contribution to the adoption of improved varieties.

Price of Wheat Grain (PRIWG): It is a continuous variable measured in birr per quintal of wheat grain that the household sold at the market. High price of improved wheat grain was hypothesized to have a positive contribution to the adoption of improved wheat varieties.

Table 2: Description of independent variable

Variables	Type of variables	Description of the variable	Expected sign of the variables
Improved seed	Dummy	1 if a household used improved variety 0, otherwise	
Sex of Household head	Dummy	1if household head is male 0, otherwise	+ _
Age	Continuous	Age of household head in year	-
Education	Categorical	Illiterate, non –formal Formal education,	_ +
Family size	Continuous	Total number of family member in the household	+ -
Total land size	Continuous	Land holding (ha)	+
Farming experience	Continuous	Household head farming experience in years	-
Annual income (farm and non-farm	Continuous	Household annual income in Ethiopia (birr)	+
Livestock holding	Continuous	Livestock ownership in TLU	+
Extension contact	Categorical	More than twice,Twice a month,Once a month,Once in the season	+
Attend field day	Dummy	1if household participate in field day ,0 otherwise	+
Attend in Training	Dummy	1if household attend in training ,0 otherwise	+
Member of farmers' cooperative	Dummy	1if household is a member of farmer cooperative ,0 otherwise	+
Access to credit	Dummy	1if household have access to credit ,0 otherwise	+
Market Distance	Continuous	Distance of market in kilometer	-
Price of wheat grain	Continuous	Total price of wheat grain in birr	+

3.7.3 To determine the impact of improved wheat varieties on Food security of rural Households

A decision made by the household head to include new or improved varieties in usual farming practice depends on different factors. Farmers' decision to adopt improved varieties is assumed the product of a complex preference comparison made by a farm household (Abadi, 2014). On this study, there is an assumption that there is a potential for the households adopting the improved wheat varieties to increase productivity and improve food security. Farmers make choices of what to grow and which technologies to adopt with the goal to maximize their expected utility (Victor, 2016). The decision to adopt improved wheat varieties is predicted by perceived utility, which is expected to be higher. Profit maximization framework was used to examine the decision to adopt or not (Pryanishnikov and Katarina, 2003). Households are assumed to maximize their utility function subject to input constraints. The random utility framework shows the households adopt a technology if the utility level from the adoption increases. The difference between the utility from adoption (Ua) and the utility from non-adoption (Una) of a technology is given as (Um) such that the utility maximizing farm household i will choose to adopt an improved variety, if the utility gained from adopting is greater than the utility of not adopting. Therefore, this study is based on the Random Utility Model (RUM), which was offered by Thurstone (1927). In a Random Utility Model (RUM), a farmer (i) gains from adopting of a technology (j) is made up of observable deterministic component (V)and random component(e) .The random utility function is represented by(Greene,2003),

$$U_{ij}=V_{ij}+e_{ij} \quad \text{……..(1)}$$

According to Maddala(2001),the utilities derived from adoption of technology is assumed to depend on the features of the technology (Xj) and characteristics of a farmer (Zi).

Therefore, to explain such variation a random element (eij) is included as a component of adoption.

$$U_{ij}=V(X_j,Z_i)+e_{ij} \quad \text{……(2)}$$

These utilities are unobservable and variable that related to utility can be expressed using latent variable model. The difference between the net benefits derived from adoption of

improved wheat varieties by adopters and non-adopters denoted as (NB*) observable but the utility obtained from the net benefit after adopting of improved wheat varieties are not observable (latent variable).

3.7.3.1 Propensity Score Matching (PSM)

The commonly used techniques to analyze improved wheat varieties production effect on food security of rural households is the propensity score matching. Under the conditions, the standard econometric method of using a pooled sample of adopters and non-adopters might be inappropriate as it assumes that the set of regressors have the same impact on adopters and non-adopters (Shiferaw *et al*, 2010). In order to control for selection bias, Propensity Score Matching (PSM), which is a quasi-experimental research design was used. It constructs a statistical comparison group that was based on a model of the probability of adopting improved wheat varieties, using observed characteristics. Then adopters were matched to the non-adopter's groups based on the probability of adopting improved wheat varieties. Since matching adopters to non-adopters on each covariate will be practically difficult, we predict propensity score based on observed characteristics of adopters and non-adopters. The, the average treatment effect of improved wheat varieties was calculated as the mean difference in outcomes between these two groups.

Propensity Score Matching estimates the average impact of adoption of improved wheat varieties on adopters by constructing a statistical comparison group on the basis of the probability of adopting in the treatment T conditional on observed characteristics X, given by the propensity score (Rosenbaum and Rubin, 1983).

$$P(\chi i) = Pr\,(Ti = 1 \perp X) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where: Y1i = the outcome of unit i if i were exposed to the treatment Y0i =the outcome of unit i if i were not exposed to the treatment Ti ∈ {0, 1} = indicator of the treatment actually received by unit i Yi = Y0i + Ti (Y1i – Y0i) =the actually observed outcome of unit i and X-multidimensional vector of pre-determined characteristics or covariates (Rosenbaum and Rubin, 1985).

As a result, if the population of units denoted by *i* and the propensity score P (Xi) is identified, the average effect of Treatment on the Treated (ATT) can be estimated as follows:

$$T = E\{Yi^1 - Yi^0 \mid Ti = 1\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$= E\{E\{Yi^1 - Yi^0 \mid Ti = 1, p(Xi)\}$$

$$= E\{E\{Yi^1 | Ti = 1, p(Xi)\} - E\{Yi^0 | Ti = 0, p(Xi)\} | Ti = 1\}$$

Where the external expectation is over the distribution of (p (Xi) |Ti = 1), Y1i is potential outcome of the treated and Y0i is outcomes of the control.

Following Rosenbaum and Rubin (1983), the matching algorithms work with the following two strong assumptions:

The first one is conditional independence /un-confoundedness assumption: this presume that given a set of observable covariates X which are not affected by treatment, the potential outcomes are independent of treatment assignment: un-confoundedness, is that after controlling for covariates (X), mean outcomes of non-treated will be identical to outcomes of the treated if they had not received the program (Rosenbaum and Rubin, 1983).

$$\mathrm{Yi}^1, \mathrm{Yi}^0 \perp T\mathrm{i}, \mathrm{Xi} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

This implies that selection is only based on observable characteristics and that all variables that influence treatment assignment and potential outcomes simultaneously are observed by the researcher (Caliendo& Kopeinig, 2005). Caliendo & Kopeinig (2005) further noted suggested that if the balancing hypothesis of un-confoundedness is satisfied, observations with the same propensity score must have the same distribution of observable (and unobservable) characteristics independently of treatment status. In other words, for a given propensity score, exposure to treatment is random and therefore treated and control units should be, on average, observationally identical.

In this case, the treatment effects can be estimated by:

$$\begin{aligned}\beta &= \mathrm{E}(\mathrm{Y}i^1 \mid \mathrm{Xi}, \mathrm{Ti} = 1) - \mathrm{E}(\mathrm{Y}i^0 \mid \mathrm{Xi}, \mathrm{Ti} = 0) \\ &= \mathrm{E}(\mathrm{Y}i^1 - \mathrm{Y}i^0 \mid \mathrm{Xi}, \mathrm{Ti} = 1) + \mathrm{E}(\mathrm{Y}i^0 \mid \mathrm{Xi}, \mathrm{Ti} = 1) - \mathrm{E}(\mathrm{Y}i^0 \mid \mathrm{Xi}, \mathrm{Ti} = 0) \\ &= \mathrm{Y}i^1 - \mathrm{Y}i^0 \mid \mathrm{Xi}, \mathrm{Ti} = 1) \\ &= \mathrm{E}(\mathrm{Y}i^1 - \mathrm{Y}i^0 \mid \mathrm{Xi}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)\end{aligned}$$

Thus, because of conditional independence the selection effect=0, since

$$E(Yi^0 \mid Xi, Ti) = E(Yi^0 \mid Xi)$$

$$ATE = ATET \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

The second assumption is the common support assumption additional criterion besides independence is the satisfaction of overlap condition. It works with the trend of perfect predictability of D given X:

$$(\text{Over lap}) \quad 0 < P(T = 1 | X) < 1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

It makes sure that individuals with the same *X* values have a positive probability of being both participants and non-participants (Heckman, LaLonde, and Smith, 1999). Treatment units would therefore have to be similar to non-treatment units in terms of observed characteristics unaffected by the treatment; thus, persons that fall outside the region of common support area would be dropped.

Estimation Strategy: if conditional independence assumption is satisfied and there is sufficient overlap between the two groups which is called ‘strong ignorability assumption’ by Rosenbaum and Rubin (1983), the PSM estimator for ATT can be written in general as follows

$$ATT = E\, p(x)|T = 1\{E[Y(1)|T = 1, P(X)] - \{E[Y(0)|T = 0, P(X)]\} \ldots\ldots\ldots\ldots \quad (7)$$

Put simply, the Propensity Score Matching estimator is simply the mean difference in outcomes more than the common support, properly weighted by the propensity score distribution of adopters.

CHAPTER FOUR: RESULT AND DISCUSSION

4. Introduction

This chapter presents the results of analysis of the collected data. Based on the objective of the study, results of discussion were subdivided into socio-economic characteristics of households, Factors affecting adoption of improved wheat Varieties, Comparison of production with improved wheat varieties and local/traditional seed and impact improved wheat varieties on food security. The socio-economic characteristics of the sample households analyzed and presented using statistical tool such as Mean, standard deviation, frequency and percentage. Likewise, inferential statistics such as t-test for continuous variables and Chi-square test for dummy and categorical variables are utilized to compare adopters and non-adopter households. Moreover, the effect improved wheat varieties on food security is present by different Matching algorithm method.

4.1 Descriptive Results

4.1.1 Socio-Economic Characteristics of Adopter and Non-Adopter of households

The results of gender of household head, marital status, educational status and occupation of farmers are presented in Table 4. The result indicated that 85% of the respondents were male-headed households and 15 % were female-headed households. Among adopter farmers, 83% were male-headed households and 17% were female-headed households. Among non-adopter farmers, male-headed household were 86 % and female-headed household were 14%. However, the Chi^2- test reveals that these associations was not significant.

Marital status of the household head revealed that 87% were married. The disaggregate data among the married farmers revealed that 92% are adopters and 82%of them non-adopters. Among female headed households 7%were widowed of which, 6 % were adopters and 9% were non-adopters. Divorced farmers makeup 6% which of 2% were adopters and 6% were non-adopters. The Chi^2-test confirmed that the association between adopter and non-adopter of improved wheat varieties in terms of marital status was significant at 10% level.

Education gives an opportunity to benefit for agriculture related information and use of agricultural technologies in a better way. In terms of educational background of the household heads, 36% of the total respondents were illiterate. The proportion is significantly different between the adopters and non-adopters. Of which 24% and 46% of the adopters and non-adopters respectively are illiterate. From the total sample, 47% has received non- formal education, of which 50% were adopters and 44% non-adopters. From the total sample, 17% has primary education, of which 26% were adopters and 10% non -adopters. The Chi^2-test confirmed that the association between adopter and non-adopter of improved wheat varieties in terms of educational status was significant at 1% level. Results from FGD and the Key Informant Interviews indicated recently basic adult education to farmers at FTC level is given by Development Agents and extension worker, which help improving farmer's ability to read and write. Better education attainment of farmers can increase adoption of a technology.

In the study area farmers have been engaged in the agricultural activities of crop production and livestock rearing and non-farm activities. Crop production is the main source of livelihood in the study area. Majority of the respondents had farming as major occupation. The result indicated that the type of income generating activities revealed 82% of adopters and 81% of non-adopters. Totally, 82% of wheat farmers derived their livelihoods from farming activities. About 18% of adopters and 18% of non-adopters and aggregately 18% sample of households engaged in both farm and non-farm activities. However, the Chi^2- test reveals that these associations was not significant.

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Table 3: Household Characteristics of adopter and non -adopters of improved wheat varieties (Dummy Variables)

		Adopters		Non-adopters		Full sample		
Variables		Frequency	%	Frequency	%	Frequency	%	Chi^2-test
Sex	Male	75	83.3	88	86.3	163	84.9	0.570
	Female	15	16.7	14	13.7	29	15.1	
Marital status	Married	83	92.2	84	82.4	167	87	
	Divorced	2	2.2	9	8.8	11	5.7	0.087**
	Widowed	5	5.6	9	8.8	14	7.3	
Educational status	Illiterate	22	24.4	47	46.1	69	35.9	
	non-formal education	45	50.0	45	44.1	90	46.9	0.001*
	formal education	23	25.6	10	9.8	33	17.2	
Occupation	only own farming	74	82.2	83	81.4	157	81.8	0.642
	farm and non-farm activities	16	17.8	18	17.6	34	17.7	

Source: Field survey,2018

Note * and ** =significant at 1%and 10% respectively

Age is one of the important demographic characteristics of the household head in making decision to use improved wheat varieties. The mean age of the adopters were 45 years while, the mean age of non-adopters was 46 years. The t-test result shows that there is no significant difference of household age between adopters and non- adopters.

Land is one of the most important resources for any economic and social activities mainly in rural areas for agricultural production since the livelihood of people highly dependent on it. It was assumed that a farmer having access to land could lead to the higher possibility to use improved wheat varieties to increase production. Farm size influences households decision on choice of crops and improved agricultural technologies. The result indicated that the adopters had relatively bigger size of land with an average mean of 2.03 hectares compared to non-adopters who had a mean of 1.78 hectares. The land size computed is total land from rented in and rented out and land from share cropping. Bigger land size of adopters is due to rented in land. The data from FGD indicated that farmers who rented in land work more aggressively by using agricultural inputs than

those never rent. The t-test result indicated that there is a 5% significant difference of total landholding between adopters and non -adopters.

The mean household size of adopters and non-adopters is 6. In rural household's higher number of household (working group) can contribute to the decision to adopt improved wheat varieties since adoption requires high labor input than growing local seed.

In terms of livestock holding including cattle, sheep, goats, pack animals, and poultry in the area non-adopters and adopters were found to own 7.88 and 8.26 of Tropical Livestock Unit (TLU) respectively. These figures show that the difference in livestock ownership among non-adopters and adopters was not statistically significant. This implies that having large number of livestock is not correlated with adopting of improved wheat varieties (Table 4). This study is not in line with the study by Abdi (2014), which found significant correlation between livestock ownership and decision to adopt improved maize varieties in Oromia region, Ethiopia.

Income from farm indicated that non- adopters had a lower mean farm income of birr 17,479 compared to birr 37,321 per season obtained by the adopter farm households. The t-test result indicated there is a difference between adopters and non -adopters in terms of income from farm activities at 1% significance level. At the same time adopters had slightly more non- farm income at birr 2,569 per season than the non- adopters who had a mean of birr 1,607 per season. Non-farm income comprised of income from petty trading, home drinks and other incomes apart from the farm income. The t-test result indicated there is a difference between adopters and non -adopters in terms of income from non-farm activities at 1% significance level.

The mean wheat farming experience of both adopters and Non-adopter farmers was 17 years. The t-test result also shows there is no difference between adopters and non -adopters in terms of wheat farming experience.

Table 4: Household characteristics of adopter and non-adopter (Continuous Variables)

Variables	Non –adopters		Adopters		
	Mean	Standard Deviation	Mean	Standard Deviation	t-test
Age (in years)	46	9	45	9	0.253
Total Land	1.779	.860	2.031	0.687	0.026**
Number of households	6	2	6	2	0.510
Farming experience	17	7	17	7	0.930
Livestock holding(TLU)	7.88	4.22	8.26	3.25	0.490
Income from farm per year	17479.53	13935.06	37321.88	24934.28	0.000*
Income from non –farm per year	1607.45	1281.49	2569.24	1716.46	0.000*

Source: Field Survey,2018

Note * and ** =significant at 1%and 5% respectively

4.1.1.1Types of improved Wheat varieties Used by adopters

Types of improved wheat varieties used by adopters of sample households at Girar Jarso *Woreda* on the production year 2017/2018 were Hidase,Digelu,Danda'a and Kubsa. Table 6 below shows out of the total adopters 49(54%) used *Hidase,*24(27%) used *Digelu,*15(17%) used *Danda'a* and the remaining 2% used the variety type of *Kubsa.*

Table 5: Types of improved wheat varieties used

Type of improved variety	Frequency	Percent
Hidase	49	54.4
Digelu	24	26.7
Danda'a	15	16.7
Kubsa	2	2.2
Total	90	100.0

Source Field Survey, 2018

4.1.2 Institutional Characteristics of Rural Households

This study also tried to assess the awareness of respondents about agricultural extension services in relation to a need for the service and possessed the required information. Farmers who had contact with extension agent indicated that 87 %adopters and 53% of non-adopters had contacts with extension agent. The Chi^2-test confirmed that the association between adopter and non-adopter in terms of contact with extension agent was significant at 1% level. Nowadays, because of awareness creation made by the responsible governmental and non-governmental organizations, the majority of farmers had access to technological information.

Farmer's participation in field day and demonstration activity indicated that 78% of adopters and 22 % of non-adopters have participated in field day and demonstration activities. This implies that farmers were interested to learn from field day activities than regular meeting. The Chi^2-test indicated that there is a significant association between adopters and non- adopters at 1% significant level.

In terms of training the result of descriptive analysis indicated that 82% adopters and 48% of non -adopters have attended training. Training can improve the knowhow of farmers on technology. The more farmers involve in training the more they make a decision to use a technology. The Chi^2-test confirmed that the association between adopter and non-adopters in terms of attend in training was significant at 1% level. Farmers are more benefited by being a member of farmer cooperative, 64% of adopters and 17 % of non-adopters were a member of farmers' cooperative. The result from FGD indicated that farmers who are a member of farmer cooperative can easily access to input technology than non-member, and hence this can maximize the opportunities to use a technology. The Chi^2-test showed that the association between adopters and non-adopters in terms of member of farmer cooperative was significant at 1% level.

With regard to access to credit, both adopters and non-adopters had limited access to credit service. The result indicated that 7% of adopters and 10 % non-adopters had access to credit. Even if access to credit enables the households to fill the gap of budget constraints, but in this study both adopters and non-adopters had limited credit service. The FGD indicated that farmers did not use credit because of fear of repayment. The

Chi^2-test is also indicated there is no significant association between adopters and non-adopters in terms of access to credit.

Creating conducive environment for farmers in terms of infrastructure has played an important role in adopting of technology. The more farmers have access to road the more they can easily get inputs. The can also take their produce to the market easily. The result of the analysis indicated that 57% of adopters and 47 % of non-adopters had access to vehicle road. However, the Chi^2- test reveals that these associations was not significant.

Table 6: Institutional Characteristics of adopters and non- adopters

		Adopters		Non-adopters		
Attribute		Count	%	Count	%	Chi^2–test
Contact with extension agent	Yes	78	86.6	54	52.9	0.000*
	No	11	12.2	48	47	
Participated in demonstration	Yes	70	77.7	22	21.5	0.000*
	No	20	22.2	80	78.4	
Attend in training	Yes	74	82.2	49	48	0.000*
	No	16	21.1	53	51.9	
Member of farmers cooperatives	Yes	58	64.4	17	16.6	0.000*
	No	32	35.5	85	12.1	
Access to credit	Yes	6	6.6	10	9.8	0.433
	No	84	93.3	92	90.1	
Vehicle road access	Yes	51	56.6	47	46	0.143
	No	39	43.3	55	53.9	

Source Field Survey, 2018

Note * significant at 1%.

4.1.3 Market Related factors

The distance to the market shows that the adopters covered on average 12 kilometers, while the non-adopters are expected to cover 11kilometers. Distance to the market can affect the decision to use improved wheat varieties, as distance to the market is directly related to cost of transport. Result from Key Informant Interview at Ilamu *Kebele* indicated that farmers paid 20 birr /quintal for transport cost. This result is in line with studies such Shifera *et ,al* (2014) and Victor,(2016) in the adoption of improved varieties who found proxy distance to the output markets positively correlated with improved varieties adoption.

The result of price of wheat shows that adopters sell their product at higher price of 1,231 Ethiopian Birr per quintal, while the non-adopters sell at 1,154 Ethiopian Birr per quintal. This result confirmed that there is a difference between adopters and non-adopters selling price of wheat grain at 1 % significance level. As stated in sub section three of this paper farmer's decision to adopt improved varieties is based on utilizing maximum utility. Therefore, we can deduce that high price of wheat grain from improved seed initiates farmers decision to use improved wheat varieties.

Table 7: Market related factors among adopters and non- adopters

	Non- adopters		Adopters	
Variables	Mean	Standard Deviation	Mean	t-test
Distance to the market	11	4	12	0.11
Price of wheat grain	1154	86	1231	0.00*

Source: Field Survey, 2018
Note * and **=significant at 1%

Access to market information plays an important role in adoption of agricultural technologies. The result indicates 57% of adopters and 52% of non -adopters had access to market information. The Chi^2-test result showed that there is no significant association between adopters and non- adopters in terms of access to market information.

Table 8: Access to market Information by adopters and non -adopters

		Non adopters		Adopters		
Variable		Count	Percent	Count	Percent	Chi^2-test
Access to market	Yes	53	52	52	57	0.419
Information	No	49	48	38	43	

Source: Field survey, 2018

4.1.4 Reasons for not adopting of improved wheat varieties

The main reasons for not adopting of improved wheat varieties indicated in table below is due to price of seed ,risk aversion and compatibility of the seed with existing farming system in 44% ,26 and 25 respectively respondents. Apart from this high labor demand and other related issues by smallholder, farmers caused mistrusts on the technology and leads to not adopting it.

Table 9: Reason for not adopting of improved wheat varieties

Description	Frequency	Percent
Risk aversion	50	26.0
Price of seed	85	44.3
Compatibility with the existing farming system	48	25.0
Other	9	4.7
Total	192	100.0

Source: Field survey, 2018

4.2 Factors Affecting Adoption of Improved Wheat Varieties

To determine factors influencing adoption of the improved wheat varieties, a logit model is estimated. Based on the results of multivariate analysis, a model containing 12 selected predictor interaction terms were included in the multivariate analysis. Using the stepwise (likelihood ratio) method, five of the twelve predictor variables(Education status , participation in demonstration and field day and activities , distance to the market, access to market information and member of farmer cooperative) have a significant joint impact in determining household adoption of improved wheat varieties.

The overall model is proven, as it is statically significant at a p-value of 0.000. The pseudo R-squared is found about 0.3934, meaning all the explanatory important variables included in the model explain 39% of the probability of household's adoption of improved wheat varieties. The $LRCh^2$ (12) 104.42 with a P- value (Prob>ch2) 0.000 also tells the logit model as a whole is statically significant. The signs of the regression coefficients of the model (Table:10) fulfill the underlying assumption and the corresponding p-values imply that the predictor variables included in the multivariate model have a significant joint influence on the outcome variable. The estimation variance inflation factor was done to test whether multi-collinearity problem exist or not. There was no explanatory variable dropped from the estimation model since no series problem of multi-collinearity was detected from the VIF results which is very far less than 10 and again those of the tolerance level (1/VIF) were greater than 0.2 which further revealed no problem of multicollinearity (see Appendix II).

Table 10: Summary of adoption decision of improved wheat varieties: Result from logit model

Variables	Coef.	Std. Err.	P>z	dy/dx
Age of HH head	-.0060102	.026951	0.824	-.0014839
Educational Status	.8047635	.3298994	0.015**	.1986906
Land size	.3412936	.2830249	0.228	.084263
Household size	-.173828	.1398515	0.214	-.0429169
Contact with extension agent	-.0041598	.1623322	0.980	-.001027
Participation in field day	2.645724	.6380729	0.000*	.6532111
Participation in training	-.5356475	.6740601	0.427	-.1322477
Member of farmer cooperative	-1.344926	.5258338	0.011**	-.332053
Distance to the market	.205694	.0578027	0.000*	.0507844
Vehicle road access	.6280912	.51844	0.226	.1550714
Market information access	.9154776	.5101397	0.073***	.2260251
Livestock holding(TLU)	-.0761059	.0546372	0.164	-.01879
_cons	1.950911	1.922506	0.310	

Source: Field Survey, 2018

Number of obs = 192 LR chi2(12) = 104.42 Prob > chi2 = 0.0000

Log likelihood = -80.499304 Pseudo R2 = 0.3934

Note that *, **and *** are statically Significant at1,5,and 10% respectively.

The marginal effect results provided in table: 10 above show that keeping other factors constant, an increase the level of education of a household by one-year increases probability of adopting improved wheat varieties by 0.19(19%). Again, it is statically significant at 5 % significance level. Education status of a farmer had a positive and significant influence on the adoption of improved wheat varieties. The result of key informant interview indicated better education attainment of farmers could increase adoption of improved wheat varieties. This finding has a conformity with Shifera *et al* (2014) and Leake.G and Adam.B (2015) that educational level of household head can have a significant and positive effect on the adoption decision. Leake.G and Adam.B

(2015), Found that by using marginal effect increase the level of education by one year increases the level of adoption by 0.049 among the adopters.

Households who participated in demonstration and field day practices are 65% higher to adopt improved wheat varieties relative to those who did not participated. It is statically significant at 1% significance level. Farmers are more interested to learn from other farmer's life experience than they do from regular training. The result of focus group discussion with adopters of wheat farmers indicated that farmers learn more on field days is because the farmers share the life path of their farming experience at each step so attend in field day positively and significantly related to adoption of improved wheat varieties. The result is consistent with other studies that suggest Participation on field day is one of the means of teaching and learning process of improved technologies) (Tesfaye *et al*,2001;Desalegn *et al*, 2016; Tsegaye and Bekelle,2012; Bola *et al*,2012). Tesfaye *et al.* (2001), found that in field days, neighboring farmers will get an opportunity to observe how the new technology is practiced in the field. Desalegn *et al* (2016), found out the same result by using Logit model, in that attributes other being kept constant, the odds-ratio in favor of adopting improved varieties increases by a factor of 1.719 as a farmer ''engagement in field days'' increases by one unit. The study indicated that demonstration and dissemination of information through field day and demonstration activities might facilitate adoption of improved wheat varieties.

Distance to the market on the adoption decision of improved wheat varieties result shows, as distance to the market become proximate adoption of improved wheat varieties increases by 0.05.Again, it is statically significant at 1% probability level of significance. This implies farmers near the main road can get transportation facilities easily and at low cost than those farmers who are far from the main road to put wheat grain on the market.

From the analysis of marginal effect a unit increases of access to market information increases the probability of adopting improved wheat varieties by a factor of 0.22. It is statically significant at 10% probability level of significance. This implies that access to market information about the demand and supply of wheat grain and its products highly motivates farmers to cultivate improved wheat varieties**.**

Unexpectedly, being member of farmer cooperative of the household head was found to have a negative significant influence on adoption of the improved wheat varieties The result shows a one-unit increases of household participation in member of farmers' cooperative, the probability of adopting of improved wheat varieties decreases by a factor of 0.33. It is statically significant at 5 % probability level of significance. This might be farmers engagement in farmer cooperative would be to engage on other activities.

4.3 Comparison of production of improved wheat varieties with local seed

The major factors that determine crop production is land size, seed, fertilizer and labor utilized. The result reveals that there is a difference in terms of the variables mentioned above except for land at 1% significant level. The average farm size of adopters and non-adopters for the production of wheat was 0.68 and 0.53 hectare, respectively. This indicated that adopters predominantly use large plots of land for wheat production than their counterpart non-adopters. The t-test result confirmed that there was significance difference between adopter and non-adopters land used for wheat production at 1% level of significant.

The adopters reported higher average mean seeding rates (72kg) compared with the non-adopters (58kg). The t- test result shows there is a difference between adopters and non-adopters in terms of seed usage at 1% significance level. According to Edward *et al* (2017), the high demands for seed to the production of the local seed could be because of the use of poor quality seeds, which have low germination rates.

The average quantities of fertilizer used by adopters was (74kg) while, non -adopters used (35kg). This indicated that production of improved wheat variety was responsive to fertilizer. The average labor available for adopters and non-adopters was 4. The t-test result indicated that there is no significant difference among adopters and non- adopters in terms of labor available. The average mean output of wheat was also higher for the adopters 21quintal compared to the non-adopters 8 quintal; indicating that the improved wheat varieties had higher yield advantages compared with the local seed. The t-test result indicates that there was a difference between adopters and non- adopters in terms wheat yield at 1% significance level. This study is in line with the range of yield reported by Kijima *et al.* (2006), JICA (2006), Wilfred and Ogada (2014) and Edward *et al*

(2017). Yield variability is also higher among adopters than the non-adopters, indicating that improved technologies are suitable for enhancing yields, but also increase production risks (Wilfred and Ogada, 2014).

Table 11: Comparison of wheat production with improved varieties and local seed

Variable		N	Mean	Std. Deviation	t-test
Land size(ha)	Yes	90	0.68889	0.309746	0.001*
	No	102	0.53064	0.339461	
Seed used(Kg)	Yes	90	0.71722	0.345205	0.006*
	No	102	0.57931	0.337285	
Fertilizer used(Kg)	Yes	90	0.74444	0.357460	0.000*
	No	102	0.35294	0.245032	
Labor (number)	Yes	90	3.9800	1.24316	
	No	102	4.0559	1.24181	0.673
Yield obtained (quintal)	Yes	90	21.13	11.065	0.000*
	No	102	7.75	4.944	

Source: Field survey, 2018
Note * =Significant at 1%

4.4 Effect of Improved Wheat Varieties on Food Security of Rural Households

4.4.1 Availability of Food Grains of sample households

Availability of food at household level plays a significant role (Meskrem, 2011).As we stated in chapter three of this study, in order to quantify the net available food of sample households for household food security Household Food Balance Model (HFBM) is utilized. The model is modified form of the Regional Food Balance Model (Degefa, 1996, 2002). The data computed is obtained from field survey except for the estimates given for the total seed reserve and post-harvest loss due to poor storage facilities. Mesay (2001:73) citing Tegenye, *et al.* (1999) revealed that, farmers reserve 5 percent of their total food produced for seed while post-harvest loss are estimated at 10 percent(Degefa ,2002) of the total yield of a household produced. HFBM assess the available component of food security but still a good indicator, it did not include livestock and other horticultural crops. Therefore, the researcher has, converted the households annual available food grain supply into daily dietary energy equivalent using Ethiopian Health

and Nutrition Research Institute (EHNRI)'s Food Composition Table (Degefa, 1996, Mesay, 2001, Meskrem, 2011).

Table 12: Available of Food among adopters and non -adopters

	Non-adopters		Adopters		
	Mean	Standard Deviation	Mean	Standard Deviation	t-test
Available dietary energy (Kcal)	889.073	363.492	1728.62	922.25	0.000*

Source field survey, 2018

Note * =Significant at 1%

The result of mean available dietary energy indicated that adopters had 1728.62 while non-adopters had 889.073 Kcal at household level. This indicated that adopters had much better than non-adopters in terms of dietary energy available. The t-test result indicates that there was a difference between adopters and non- adopters in available kilocalorie per person per day at 1% significance level. The finding of this study shows increment of food available by adopter households when it compared with the result found by Meskerm,2011 at Girar Jarso *Woreda* which revealed average dietry energy available to a household was 951.9 kcal.

The researcher has made comparison of dietary energy available among adopters and non-adopters the amount of calories a person needs depends on the person's age, sex, body strength, physical exercise was under consideration. As shown in chapter three of this paper, comparison is undertaken Based on Minimum Recommended Allowance (MRA) for an adult, 2100 kcal per person per day. Table 13 indicated that 26% of adopters and 1% of non-adopter were food secured while 74% of adopters and 99% non-adopters were food insecure. This indicated that almost all of non- adopters were food insecure. The Chi^2-test indicated that there is a significant association between adopters and non- adopters in terms of food security status at 1% significant level.

Table 13: Food security status of adopter and non- adopter households

		Food insecure		food secured		
		Frequency	%	Frequency	%	Chi^2 -test
Adoption of improved wheat varieties	Non-adopters	101	90.0	1	1.0	0.000*
	Adopters	67	74.4	23	25.6	

Source: Field survey, 2018

4.4.2 Household Expenditure Among Adopters and Non- adopters

Technology adoption enables farm households to increase productivity and consumption expenditure. According to Asfaw *et al*. (2012), the household income indicates the ability of the household to purchase its basic needs of life while per AEU reflects the effective consumption of households and therefore provides information on food security status of households. In the datasets, the consumption variable included Food & stimulant items (cereals, pulses, oil, fruits, vegetables, coffee, tea, chat, sugar, salt) Non-food items (farm inputs of fertilizer, seed, pesticide, veterinary drugs and Clothing, foot wear, gas, candle, firewood, charcoal,) and medical expenditure, education and school fees for children.

The results indicated that the average consumption expenditure is higher among the adopters than non-adopters. The mean annual expenditure of food 4,195 birr for adopters and 3,022 birr for non-adopters. This study is consistent with Kassie *et al.*(2011), Amare *et al.* (2012) and Asfaw *et al*. (2012) which had similar results. It is also found that the mean annual expenditure for Non-food items 3,092 birr for adopters and 1,502 birr for non-adopters. The mean annual expenditure of school fee and medical expenses 4,857birr for adopters and 2,831 birr for non-adopters. The t-test results indicated there is significance difference among adopters and non-adopters in terms of household expenditure at 1% significant level.

Table 14: Household expenditure among adopters and non-adopters

Variables		N	Mean	Std. Deviation	Std. Er Mean	t-test
Estimated expenditure for food items (Birr)	Yes	90	4195.92	1590.673	167.672	0.573
	No	102	3022.45	1347.362	133.409	
Estimated expenditure for inputs (Birr)	Yes	90	3092.86	1644.926	173.390	0.000*
	No	102	1502.24	1088.210	107.749	
Estimated expenditure for non-food items (Birr)	Yes	90	4857.88	1918.313	202.208	0.000*
	No	102	2831.97	1080.864	107.021	

Source: Field Survey, 2018

Note * =Significant at 1%

4.4.3 Estimation of the Impact of Adoption of Improved Wheat Varieties on Food Security

This section describes the whole process to arrive at the impact of the adoption of improved wheat varieties on food security. The researcher estimated improved wheat varieties production effect on food security based on cross sectional data available.

To obtain the impact of improved wheat varieties on food security Propensity Score Matching method was performed by using STATA Version 13.The main purpose in using Propensity Score Matching was to identify the Average Treatment effect on the Treated (ATT).In the estimation data from the two groups; namely, adopters of improved wheat varieties and non-adopter of improved wheat varieties households were grouped on the dependent variable that takes a value 1if the household cultivated improved wheat seed, otherwise 0.

4.4.3.1 Matching Adopter and Non-adopter Households

Four main tasks should be done before presenting the matching task. First, predicted values of adoption decision (Propensity Scores) should be estimated for all households of adopters and non-adopters. It is to predict the propensity score of characteristics that are not affected by the treatment variable. Secondly, a common support condition should be imposed on the propensity score distributions of adopters and non- adopters households. The common support region is the area, which maximum and minimum propensity scores of adopters and non-adopters included. Thirdly, discarding observations whose predicted propensity scores fall outside the range of the common support region. Subsequent to this identification of an appropriate matching estimator was done. Finally, checking of balancing test is done whether the matching quality was satisfied or not.

The pseudo-R^2 value is 0.008. A low R^2value means that program households do not have many distinct characteristics than overall and as such finding a good match between adopters and non-adopters households becomes easier. The pseudo-R^2indicates how well the regressors 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 fairly low (Caliendo and Kopeinig, 2005).

Defining the common support region

As shown on table 15 the total treated observation 6 households (6.6 %) are off support, while 84 households (93.3%) are on support and all the control households are included on the common support region

Table 15: Psmatch2 Common Support

Psmatch2 Treatment assignment	Off support	On support	Total
Untreated	0	102	102
Treated	6	84	90
Total	6	186	192

Source: Field Survey, 2018

Each treated unit is matched only with the control units whose propensity scores falls into a predefined common support region of the propensity score matching.

Table 16 shows the "Pstest" results to check the balancing and to know reduction of mean bias of the data after matching .From the result the p-pseudo R^2 is minimized to 0.008 after matching and the mean bias also minimized to 7.7, which indicates the matching, was good.

Table 16: Pstest, graph both

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.332	88.07	0.000	65.0	37.0	159.5*	1.00	60
Matched	0.008	1.96	0.854	7.7	6.9	21.6	0.66	20

* if B>25%, R outside [0.5; 2]

Source field survey, 2018

Figure 4 below presents comparison of density estimation both treated and control group before matching and after matching

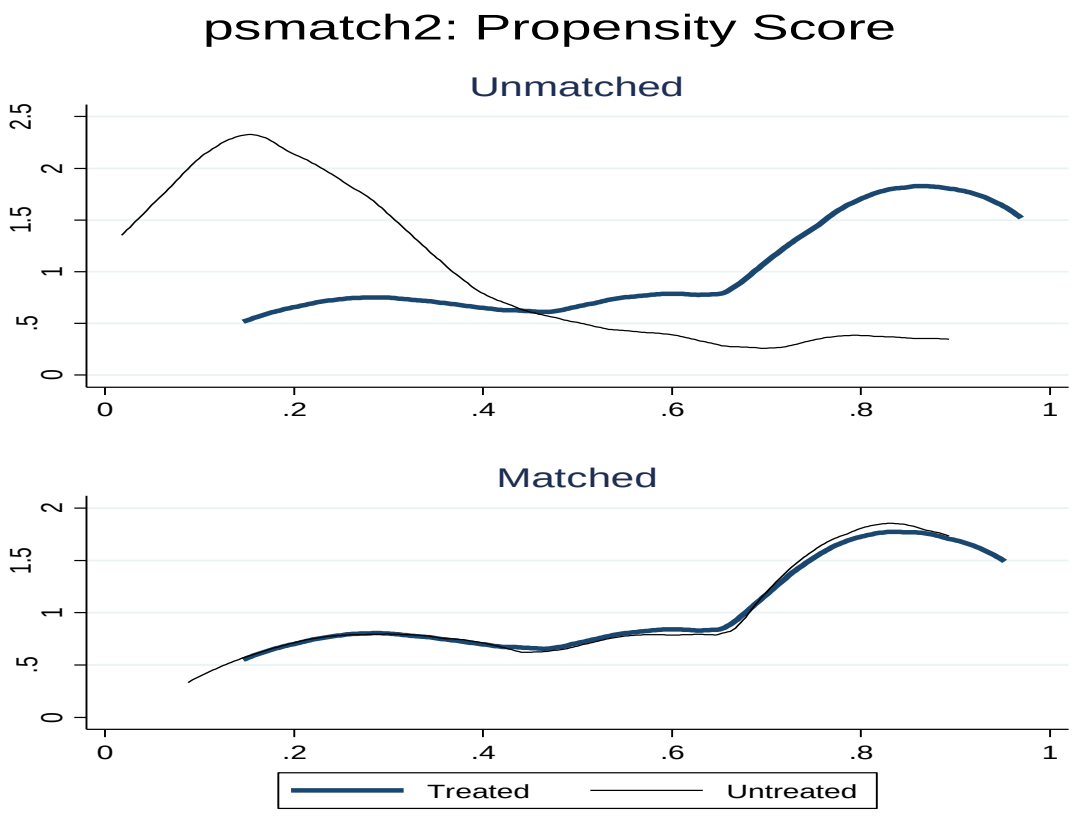

Figure 4: Propensity score of before and after matching of treated and non -treated

Figure 5 below indicates the histogram of Propensity Scores to check up if there is enough overlap between treated and control groups

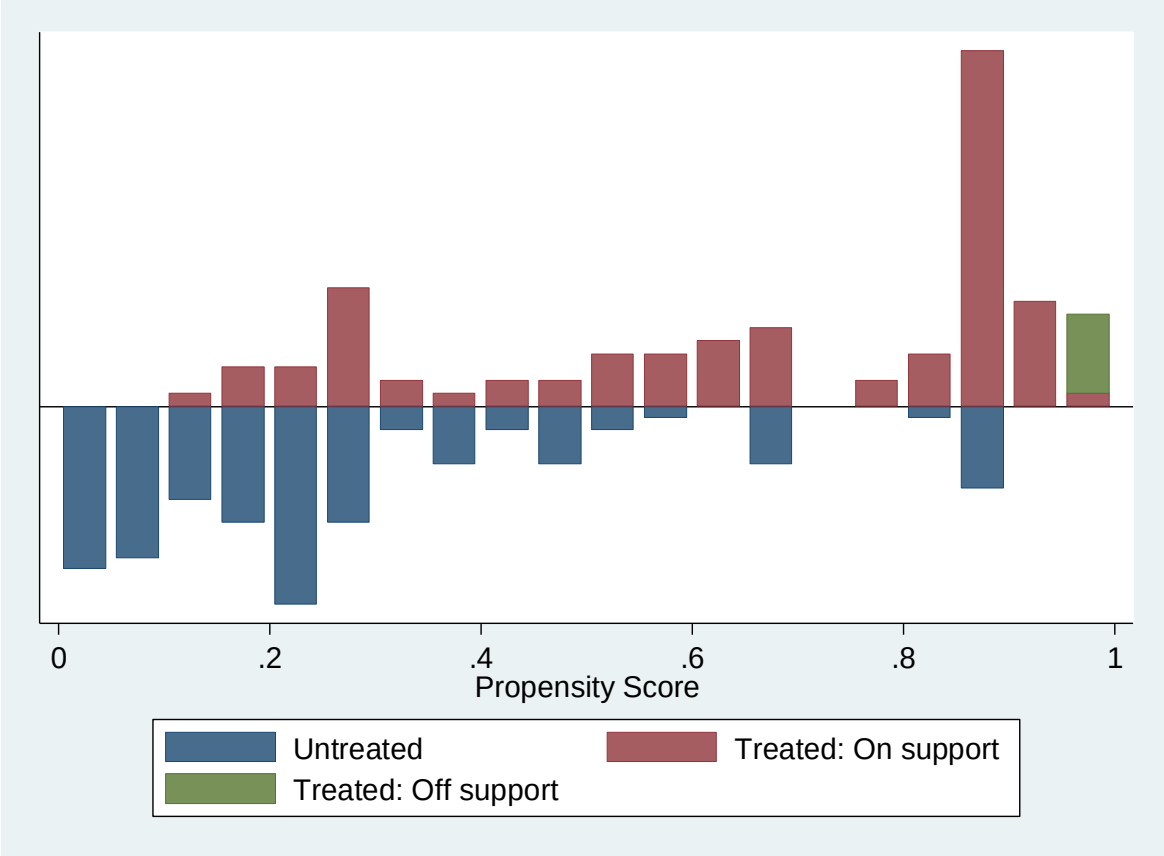

Figure: 5. Psgraph

Note: As shown in the above figure, treated on support indicated the farmers in the adoption group who find a suitable match, whereas untreated indicate non-adopters and treated off support indicate the individuals in the adoption group who did not find a suitable match.

The balancing procedure tests of adopters and non- adopters whether or not have the same distribution of propensity scores need a checkup. When balancing test failed, the researcher tried alternative specifications of the logit model as suggested by Khandker et al 2010.Therefore, in this study a complete and robust specification that satisfied the balancing tests was carried out.

The ATT result on table 17 below shows adopter of improved wheat varieties had average availability of food 880.467kcal, which is 51.1% higher than the non-adopters of improved wheat varieties households, which is significant at 1%.

Table 17: Propensity Score Matching of ATT effect

Variable sample	Treated	Controls	Difference	S.E	T-stat
Cal-per day unmatched	1728.62117	889.07349	839.54767	99.003805	8.48
ATT	1721.45957	850.992389	880.467183	128.879431	6.83

Source: Field Survey, 2018

The Average Treatment effect on the Treated (ATT) revealed increment come on the adopters of improved wheat varieties thus improving household's food security .This indicates that, adoption of improved wheat varieties has brought a significant impact on adopter's household food security status. This finding is consistent with (Kasie *et al*, 2010; Tsegaye and Bekele, 2012; Shifera *et al*, 2014).Tsegaye and Bekele (2012), found that adoption of improved wheat varieties positively and significantly affect food consumption level of households in South Eastern Ethiopia. Shifera *et al* (2014), also found the same result by using both Endogenous Switching Regression Model and Propensity Score Matching method the actual effect of adopters experienced through adopting improved wheat varieties ETB 976 of food consumption expenditure and 2.7% binary food security outcome in Ethiopia .Likewise, the study is in line with other studies undertaken on other crops impact on food security. Menale *et al* (2014), found that a one acre increase in the level of maize adoption on average increased the probability of food security and per capita consumption in Tanzania. Victor (2016),also found that adoption of improved sweet potato varieties led to higher probability or more likelihood of being food secure when compared to non -adopters in Kenya.

CHAPTER FIVE

5. Conclusion and Recommendation

5.1 Conclusion

This study assessed impact of adopting of improved wheat varieties on food security among wheat farming households in Girar Jarso *Woreda,* Oromia region. From the study, it is possible to understand that adoption of improved wheat varieties is affected by different factors. Participating in field day or demonstration activities, education status of household head ,access to market information and distance to the market have positively contributed for the decision to adopt improved wheat varieties. In contrast, member of farmer cooperative negatively affects adoption of improved wheat varieties. This finding implies that creating conducive production environment for the farmers plays a vital role for adoption of agricultural technologies.

The overall results are remarkably robust and the analysis supports the robustness of the matching estimator. From the findings, adopters of improved wheat varieties are significantly better than the non- adopters in terms of food availability at household level, which is a good indicator of food security. Adoption of improved wheat varieties has a crucial role in improving food security in general. The study also reveals that households who did not adopt had by far lower food availability at household level than the adopters. From the findings of the study, it is possible to conclude that households who participate in field day, who have more access to market information, who have better educational status and who have shorter distance to the market tend to adopt improved wheat varieties .Similarly, it was found out that households who could use the technology would improve the status of food availability and consumption. Overall, adoption of improved wheat varieties significantly has a positive effect on food security of rural households. The findings of the study is consistent with other study findings on the impact technology adoption on food security (Kasie *et a*l, 2010; Tsegaye and Bekele, 2012; Shifera *et al*, 2014).

5.2 Recommendation

Based on the above conclusion, the study provides the following recommendations:

- The results of the study give an important evidence on the impact of agricultural technology adoption (in our case improved wheat varieties) on improving food security in Girar Jarso *Woreda,* so governmental and non-governmental organizations in the study area should give due attention for adoption of improved varieties to minimize the problem of food insecurity in the study area.
- Policies aimed at enhancing wheat productivity and the adoption of improved wheat varieties should give much attention in providing appropriate information to the farmers.
- Field day demonstration techniques, creating conducive environment on farmer's access to market information and facilitating access to education to farmers are the major findings for adoption of improved wheat varieties. Such investments will have a positive influence for adoption of improved wheat varieties and improving household food security.
- It is important to scale up the best practices obtained by adopter households to other farmers in the area as an option to enhance food security in the study area.

5.3 For Further Research

- Further studies are recommended to provide empirical evidence about the intensity of adoption of improved wheat varieties in the study area.
- Future analysis using panel data may be needed to examine the relationship between the adoption of improved wheat varieties and food security, in order to control for unobserved specific heterogeneity, to provide more robust evidence on the implication of the adoption of improved wheat varieties for food security, and to see whether the result persists over time.

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Appendix

Annex – I: Household survey Question

Improved Wheat Varieties' Production Effect on Food Security in Girar Jarso Woreda, North Shewa Zone of Oromia Region, Ethiopia

Note: The respondent, to this questionnaire, should be the HH head or his/her partner

Part I: Socio-Economic Characteristics

S/N	Question	Category	Skip Rule
	Date of interview (Date,Month,Year)		
	Name of interviewer		
	Region		
	Woreda		
	Kebele		
	Agro ecology	Dega ☐ Weyina Dega ☐ Kolla ☐	
1	Name of the household /respondent		
2	Sex	Male ☐ Female ☐	
3	Age in years :	_____ years	
4	Religion	1.orthodox ☐ 2.Muslim ☐ 3.Protestant ☐ 4.Catholic ☐ 5.Other (specify) _____	
5	Marital status	1.single ☐ 2.Married ☐ 3.Divorced ☐ 4.Widowed ☐	
6	What is your educational level?	1.unable to read and write (Illiterate) ☐ 2.Non formal education ☐ 3. Primary School ☐ 4. Secondary School ☐ 5. Higher Level ☐	
7	Relationship of the respondent to the head of the household	Head ☐ Wife ☐ Child ☐ Relative ☐ Other specify	

8. Number of household members (including you): _____

S/N	Question	Category	Skip Rule
9	Do you have your own land for cropping and pasture	Yes ☐ ⟶ No ☐	Go to Q. 10
10	If yes Indicate the land tenure system on the land use	1.Owned land _____(ha) 2.Rented inland_____(ha) 3.Rented outland _____(ha) 4.Land for share cropping _____(ha) 5.Total Land _____(ha)	
11	What employment and Income earning opportunities do you engaged ?	1.only own farming (self-employment) ☐ 2.own non-farm employment (trading crafts) ☐ 3. farm laborer (work on other farms) ☐ 4.migration to work in other areas ☐ 5.non-farm laborer (work in cities) ☐ 6.Other, specify_____	

12.No of livestock holding

S/N	Livestock holding	(Number)	Equivalence in cash (in birr)
1	Oxen		
2	Cow		
3	Calves		
4	Bulls		
5	Heifers		
6	Goat		
7	Sheep		
8	Mule		
9	Donkey		
10	Horses		
11	Chicken		
12	Beehives		

13. Does your household own any of the following assets?

S/N	Asset name	Number	Current unit Value (in birr)	Total Value (in birr)
1	Ox ploughs			
2	Ox cart			
3	House			
4	Mobile Phone			
5	TV			
6	Radio			

14. How much of the following cereals did you harvest in 2016/17 (2009 /2010 E.C) cropping season

S/N	Type of crop	Land size	Seed used	Fertilizer used	Amount Obtained	Unit (Code*)	Equivalence in cash (in Birr)
1	Wheat						
2	Maize						
3	Teff						
4	Sorghum						
5	Barely						
6	Chickpea						
7	Beans						
8	Peas						
9	Lentil						
10	Faba bean						
11	Potato						
12	Onion						
13	Garlic						
14	Others specify						
						(Code*) 1.Quintal 2.Kilogram	

15.Annual income from farm and non-farm activities

16.1 From Farm Activities

S/N	Types of crop	Amount produced	Amount consumed	Amount Soled	Unit (Code*)	Income(in Birr)
1	Cereals					
2	Pulses					
3	Oils					
4	Vegetables					
5	Coffe sale					
6	Fruits					
7	Enset					
8	Chat					
9	Livestock products					
10	Other, specify					
					(Code*) 1.Quintal 2.Kilogram 3 Number	

16.2 From non- farm activities

S/N	Operations involved	Season of work	Total number of working days	Total income received in Birr/month
1	Daily laborer			
2	Petty trading			
3	Handicraft			
4	Firewood /charcoal selling			
5	Homemade drinks			
6	Selling grass and straw			
7	Selling stone & sand for construction			
8	Others (specify)			

Income earned as wage labor, if any family member engaged in any off-farm activities.

16.3 Other income sources in 2016/17 (2009 /2010 E.C)?

S/N	Income sources	Amount (Code*) 1.in cash 2.in kind	Per month	Per year
1	Remittances			
2	Land rent			
3	Other ,specify			

Part II: Information and Agricultural Extension service

S/N	Questions	Category	Skip Rule
1	Do you have contact with extension agent ?	Yes ☐ No ☐	
2	If yes How many times you meet local extension agents during cropping season ?	1. More than twice a month ☐ 2. Twice a month ☐ 3.Once a month ☐ 4.Once in the season ☐ 5. Other specify_____	
3	Have you participated in wheat demonstration /field day practices ?	Yes ☐ No ☐	
4	If yes what type of seed varieties were demonstrated ?	1.Hidase ☐ 2.Danda'a ☐ 3.kubsa ☐ 4.senate ☐ 5.Other (specify)_____	
5	Have you ever attended any training or seminar on improved wheat variety last year?	Yes ☐ No ☐	
6	If yes which topics were discussed ?	1. Wheat variety selection ☐ 2. Production of wheat ☐ 3. Wheat management practices ☐ 4. Marketing of Wheat ☐ 5. Other specify_____	
7	Are you a member of farmers cooperatives?	Yes ☐ No ☐	
8	What type of service you obtained last year related to wheat production ?	1. input supply ☐ 2. extension service ☐ 3. marketing services ☐ 4. Other specify_____	
9	Have you ever acquired any credit in the last one year?	Yes ☐ No ☐	Go to Q.14
10	If yes what was your reason for borrowing?	1. to buy production input ☐ 2. to buy food ☐ 3. medical bills ☐ 4.school fees ☐ 5. Other specify_____	
11	Do you have regular access to whether information?	Yes ☐ No ☐	
12	How far the nearest market from your residence	_____(kilometers)	
13	Do you have vehicle road access?	Yes ☐ No ☐	

Part III: Wheat Production

S/N	Question	Category	Skip Rule
1	Have you planted improved wheat varieties in 2016/17(2009/2010 E.C production year?	Yes ☐ → No ☐ →	Go to Q. 8 Go toQ.12
2	If yes what was the size of land under improved wheat varieties (ha)?	_____ha	
3	How much did you get wheat production from wheat variety ?	_____ Quintal	
4	After the Wheat was harvested what do you do on the land last year?	1.legumes was cropped ☐ 2.used as a pasture for livestock ☐ 3.abandoned the land ☐ 4.Other,specify_____	
5	Are there any culture or belief that hinder you from adopting the improved varieties?	1.Risk aversion ☐ 2.Price of seed ☐ 3.Wheather it fit with the existing wheat farming system ☐ 4.seed color (white/red) ☐ 5.Germination capacity ☐ 6.Other (specify_____	
6	If no, For no 7 what type of seed you used last year ?	_____	
7	what was the size of land under local wheat seed ?	_____(ha)	
8	How much did you get wheat production from local seed ?	_____Quintal	
9	How long have been doing wheat farming	_____(years)	
10	Is any insect or pest a problem for you in wheat production?	Yes ☐ No ☐	
11	If yes, what prevention /control measure do you apply ?	1.Cultural method 2.Insecticedes and pesticides 3.Integrated pest management practices 4.other, specify_____	

Part IV: Food security situations at household level

1. The staples foods that your household consumes are:

S/N	Crop type	A. 1. Yes 2. No	B. The three most important crops (in rank order)
1	Wheat		
2	Maize		
3	Teff		
4	Barley		1st _____
5	Sorghum		2nd _____
6	Pulses (horse beans, peas….)		
7	Oilseeds (Linseed, Sesame..…)		3rd _____
8	Fruits (Papaya, Banana, Mango…..)		
9	Potato		

2. What were the different sources of food for your family in 2016/17 (2009 /2010 E.C)?

No	Food items	Total amount using the local unit of measurement				
		Own Production	Received from food for work	Purchased from the market	Received from hiring our of labor	Received from food aid or relief food
1	Bread Wheat					
2	Maize					
3	Teff					
4	Sorghum					
5	Barely					
6	Pulses					
7	Chickpea					
8	Vegetables					
9	Vegetable oil					
10	Meat					
11	Fruits					
12	Eggs					
13	Milk dairy					
	Others specify					

3.Which foodstuff(s) are consumed at your home?

NO	Foodstuff	How many times was it consumed at your home during the last seven days? (in number)	Is there a time of a year when you encounter shortage of specific foods? 1. Yes 2. No	Which months of the year are shortage periods? (Code*)
1	*Injera* (sorghum, maize, teff….)			
2	Bread (*dabbo*)			
3	*Wat* (pulses)			
4	Cooking oil (oil seeds)			
5	Meat (beef, lamb, goat)			
6	Chicken and/or eggs			
7	Milk and/or cheese			
8	Butter			
9	Potatoes			
10	Vegetables (cabbage, carrot, tomato, etc.)			
11	Fruits (papaya, banana, mango…..)			
		(Code*) 1. Whole year 2. Nine months (March - November) 3. Six months (May - November) 4. Six months (December - May) 5. Six months (March -August) 6. Three months (June – August) 7. Three months (March – May) 8. Three months (December – February) 9. Other (specify)_____		

4. Would you tell me the amount of grains and other foodstuff that cover the annual consumption food requirements of your household member?

S/N	Grain type	Amount (Per Year)	Unit (Code*)	Estimated Valuein cash (*birr*)
1	Cereals			
2	Pulses			
3	Oilseeds (Linseed, Sesame..…)			
4	Vegetables (Cabbage, Carrot, Tomato, etc.)			
5	Fruit (Papaya, Banana, Mango…...)			
			(Code*) 1.Quintal 2.Kilogrtam	

5.Household food consumption in 2016/17 (2009 /2010 E.C) cropping season.

No	Food Items	Total amount of food consumed using the local unit of measurement						
		Consumed at home	Used for seed	Given out for hiring in labor	Given out for sharing in oxen	Repayment of crop loan	Marketed	Shared with relatives
1	Maize							
2	Wheat							
3	Barely							
4	Teff							
5	Sorghum							
6	Others							

6. Do you meet the all-year round food requirements of your household members from own production?

1. Yes => Q.8 2. No

7. What is your attitude towards food aid? 1=food aid is good 2=food aid is not good

8. If you are self-sufficient, for how many months do you produce cover the food requirement at home? (State the number of months) _____

9. According to your own self-assessment, is your household:

1. Food secure
2. Food insecure
3. Varies from one year to another
4. Varies from season to season
5. Do not know

10. In 2016/17 (2009 /2010 E.C) cropping season, on average, how much did you spend per month for the purchase of food and non-food items?

S/N	Expenditure Items	Estimated expenditure per month (Birr)	Estimated total expenditure per year (Birr)
1	Food & stimulant items • Purchase of cereals, pulses, oil, fruits, vegetables, coffee, tea, chat, sugar, salt		
2	Non-food items • Purchase of farm inputs (fertilizer, seed, pesticide, veterinary drugs)		
	• Clothing, foot wear, gas, candle, firewood, charcoal, medical expenditure, education and school fees for children		
	• Purchase of farm tools and implements		

A Checklist of Items for Focus Group Discussion (FGD)

Improved Wheat Varieties' Production Effect on Food Security in Girar Jarso Woreda Oromia Region, Ethiopia

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GENERAL INFORMATION

1. Region
2. Woreda
3. Kebele
4. Position

A. **Items for Focus Group Discussion (FGD)**

1. Types of improved wheat variety and local seeds which are available and accessible to smallholder farmers in your area?
2. Whether the smallholder's farmers use improved wheat Varieties or not
3. Percentages of wheat farmers who have adopted Improved Wheat Varieties?
4. Factors which affect adoption of improved Wheat Varieties in the area?
5. Strategies used by Agricultural and Rural development office of the woreda's to ensure the income and food security of the smallholder farmers.
6. Whether there is any capacity building initiatives in the area to ensure income and food security of smallholder farmers.
7. Whether there is any type of training provided to smallholder farmers on improved wheat Varieties?
8. Is food supply for most households adequate/are households self-sufficient? If not, why? And if yes and how?
9. Weather adopting of improved varieties of wheat has an effect on the income and' food security of the rural households?

B. Checklist for Field Observation

1. **Agro -ecology of the Environment:**

- Topography of the land (high land or lowland or medium),
- Land-use and land cover,
- Soil type (red soil, black soil),
- access to water bodies,
- condition of the temperature.

2. Socio Cultural status:

- Settlement patterns,
- Culture, value, traditions,
- Social relations neighborhood, network,

3. **Economic activity and income sources**:

- Main source of income: mixed farming, non-farm activities,
- Crop types: dominant in terms of area cultivated and size of harvest during meher and belg seasons,
- Source of staple food,
- Livestock: type, size, raising practices,
- Situations of social and economic infrastructure: transport, water, health, marketing, extension services, sources of water supply, schools, health posts.

4. Main agricultural extension services available:

- For Crop production,
- Livestock rearing,
- Resource management,
- Indigenous knowledge available,
- The approach of extension service provision

5. Improved wheat Variety production:

- Availability of improved wheat seeds,
- the perception of farmers towards improved seed,
- the production patterns and how practice their farming system.

6. Food security Status:

- Available food on the household who cultivate improved wheat varieties and who cultivate local wheat seed:
- source of staple food and
- Differentiation of households according to well-being status (rank): strata/category, criteria for differentiation, proportion of each category to the total number of community member

Annex II Econometric result of using propensity score matching (PSM)

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. pstest,graph both
```

Variable		Unmatched / Matched	Mean: Treated	Mean: Control	%bias	%reduct |bias|	t-test: t	t-test: p>|t|
HAVE_YOU_PARTICIPATED_IN_WHEAT_D	U		1.2222	1.7843	-135.2		-9.35	0.000
	M		1.2381	1.2553	-4.1	96.9	-0.26	0.797
ARE_YOU_A_MEMBER_OF_FARMERS_COOP	U		1.3556	1.8333	-110.8		-7.72	0.000
	M		1.369	1.4035	-8.0	92.8	-0.46	0.648
TOTAL_LAND	U		2.0308	1.7794	32.3		2.22	0.028
	M		2.0182	1.9001	15.2	53.1	1.00	0.318
TLU	U		8.2554	7.8818	9.9		0.68	0.497
	M		8.1386	7.9815	4.2	58.0	0.28	0.780
HOW_FAR_THE_NEAREST_MARKET_FROM	U		12.333	10.608	37.0		2.56	0.011
	M		11.702	12.024	-6.9	81.4	-0.54	0.591

```
* if variance ratio outside [0.66; 1.52] for U and [0.65; 1.54] for M
```

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.332	88.07	0.000	65.0	37.0	159.5*	1.00	60
Matched	0.008	1.96	0.854	7.7	6.9	21.6	0.66	20

* if B>25%, R outside [0.5; 2]

Multicolliniarity test using (VIF)

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. vif
```

Variable	VIF	1/VIF
HAVE_YOU_P~D	2.67	0.374660
HAVE_YOU_E~N	2.36	0.424078
ARE_YOU_A_~P	1.95	0.511971
HAVE_YOU_P~T	1.79	0.559354
DO_YOU_HAV~S	1.54	0.649390
HOW_FAR_TH~M	1.49	0.668951
DO_YOU_HAV~A	1.41	0.707267
TOTAL_LAND	1.34	0.744760
IF_YES_HOW~L	1.32	0.756363
WHAT_IS_YO~L	1.29	0.774574
AGE_IN_YEARS	1.28	0.779411
NUMBER_OF_~C	1.20	0.831633
TLU	1.15	0.872678
Mean VIF	1.60	

Annex III Conversion Factors

Conversion Factor to Estimate TLU

Livestock Category	**TLU**
Ox	1.00
Cow	1.00
Heifer	0.75
Bull	1.00
Horse	1.10
Calf	0.25
Donkey	0.70
Camel	1.25
Sheep	0.6
Goat	0.6
Chicken	0.013

Source : Storck et al.,(1991**)**