COLLEGE OF AGRICULTURE AND NATURAL RESOURCE
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Factors Affecting Adoption of Improved Maize Varieties in Woliso District of Southwest Shewa Zone, Ethiopia

Submitted to department of agricultural economics in partial fulfillment of the requirements for BSc. Degree in agricultural economics.

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ABSTRACT

Adoption of improved maize varieties in agricultural production is considered as one of the most promising ways to ensure food security and alleviate poverty in Ethiopia. However, the adoption and dissemination of these varieties were constrained by various factors. Thus, this study was aimed at identifying the factors that influence adoption of improved maize varieties in Woliso woreda of south west shoa zone, Oromia regional state. A primary data collected from eighty-nine (89) maize producing household heads selected using two-stage random sampling technique was used. Both descriptive statistics and econometric model were used to analyze the data. The finding of the study indicated that family size, access to fertilizer, number of oxen owned, Land fertility and *Total livestock owned by the farm household were statistically significant in affecting households adoption status. Based on the findings, the following recommendations were forwarded. Policy and development intervention should give emphasis to the improvement of institutional support system by strengthening, providing the required fertilizes, strengthening protection of land fertility, expanding the education to rationalize family size for to achieve adoption of improved maize varieties for increasing the production and productivity of smallholder farmers in Woliso District .*

Key words: adoption**,** agriculture, maize varieties, Woliso, Probity model.

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LIST OF ACRONYMS AND ABBREVIATIONS

CSA	Central Statistical Agency
EARO	Ethiopia Agriculture Research Organization
EIAR	Ethiopian Institute of Agricultural Research
ESE	Ethiopian Seed Enterprise
FAO	Food and Agriculture Organization
IMV	Improved Maize Varieties
MoA	Ministry of Agriculture
MoFED	Ministry of Finance and Economic Development
MoARD	Ministry of Agriculture Research Development
NGOs	Non- Governmental Organizations
OPV	Open-Pollinated Variety
SNNPR	Southern Nations Nationalities and Peoples Region
SSA	Sub-Saharan Africa
USD	United States Dollar
WB	World Bank
WDR	World Development Report

1. INTRODUCTION

1.1. Background of the Study

In developing countries, agricultural innovations are perceived as significant pathways out of poverty (Simtowe et al., 2011; Mwangi and Kariuki, 2015) and therefore, improved new agricultural technology adoption has become an important way of boosting productivity (Mignouna et al. 2011). A new technology is assumed to offer a pathway to substantially increase production and income (Beshir and Wegary, 2014).Increasing agricultural productivity using improved agricultural technologies that enhances sustainable food and fiber production is critical for sustainable food security and economic development (Mwangi and Kariuki, 2015).

Addressing food security and poverty problems in agriculture-based economies demand for substantial efforts in improving agricultural production and productivity (WDR, 2008). Alene et al. (2009) and Kassie et al. (2011) also shows the contributions of agricultural technologies to the welfare of smallholder farmers and other poor households who benefited from the enhanced adoption of technologies and improved agricultural productivity and production over time.

Improvement of agricultural productivity provides an important solution in addressing the problems of food insecurity and poverty, and enhancing the development of agriculture in Ethiopia. Consequently, attempts are being channeled in ways by which increased agricultural productivity can be achieved through promoting the use of improved agricultural technologies and improving the efficiency of production of agriculture in Ethiopia (Sinafikeh et al., 2010; Yu and Nin-Pratt, 2014).

Increasing agricultural production at the household level is vital to achieve food security (Degnet and Belay, 2001). On the other hand, any marketable surplus could be sold to the non-farming and even to the farming communities (Hailu, 2008).Therefore, increasing the production and productivity in a sustainable manner could address the problem of food shortage (Habtemariam, 2004). As one of the approaches to ensure households food security, the Ethiopian rural development policy and strategy document has given weight to follow diversification and specializations in production systems along with improved access and use of agricultural technologies (Hailu, 2008).

In general, raising agricultural output and productivity on a sustainable basis necessitates large scale adoption and diffusion of new technologies (Mohumud et al., 2009). Maize is a major staple food crop grown in diverse agro-ecological zones and farming systems, and consumed by people with varying food preferences and socio-economic backgrounds in Sub-Saharan Africa (SSA). The central role of maize as a staple food in SSA is comparable to that of rice or wheat in Asia, with consumption rates being the highest in eastern and southern Africa. Of the 22 countries in the world where maize forms the highest percentage of calorie intake in the national diet, 16 are in Africa. Maize accounts for almost half of the calories and protein consumed in, and one-fifth of the calories and protein consumed in West Africa. An estimated 208 million people in SSA depend on maize as a source of food security and economic wellbeing. Maize occupies more than 33 million ha of SSA's estimated 200 million ha of cultivated land. Considering the low average maize grain yields that are still pervasive in farmers' fields, meeting the increase demand for maize grain in Africa presents a challenge (Harold, 2015).

The major cereal crops cultivated in Ethiopia are teff (3.02milion ha), maize (2.11milion ha), sorghum (1.83million ha), wheat (1.66million ha), and barley (0.99million ha) (CSA 2015). Although agriculture is the foundation of the country's economy, crop productivity has remained low. For instance, the average national yield of important food crops such as teff, maize, sorghum and wheat are 1.58, 3.43, 2.37 and 2.54 tons per hectare respectively (CSA, 2015) while the potential of those crops are two to three times higher (MoARD, 2008).

Among cereals, maize is the most important crop in terms of production and contributes significantly to the economic and social development of Ethiopia (CSA, 2015). Maize cultivation is largely a smallholder phenomenon. The smallholder farmers that comprise about 80% of Ethiopia's population are both the primary producers and consumers of maize in Ethiopia (Alemu et al., 2008).

In Ethiopia, maize is currently produced by more farmers than any other crop (Chamberlin and Schmidt, 2012) and its total cropping area is still expanding (Taffesse et al., 2012).Maize is a strategic crop grown in agro-ecological zones covering 90% of Ethiopia. Ethiopia is one of the largest maize producing countries in Africa (FAO, 2013). Within the country in any one year; small holder farmers produce over 95% of the total maize, maize is the largest cereal commodity in terms of total production and yield and the second in terms of acreage next to Teff. It is also

the most important crop where 8.7 million smallholder farmers are engaged in its cultivation (CSA, 2015).

There have been good attempts to improve the productivity of maize through the utilization of improved maize verities in Ethiopia. However, some studies such as Paarlberg et al. (2006), ECEA (2009) and Yu and Nin-Pratt (2014) attest that the utilization of better production technologies on the part of maize producing farmers were not to the required levels. The use of improved variety is considered as an important input for the achievement of increased agricultural productivity and food security status of farm households in Ethiopia. In this regard, there has been an increasing effort to improve crop productivity primarily through agricultural intensification, involving an increased use of inputs, including seeds of improved crop varieties (Byerlee et al., 2007).

1.2. Statement of the problems

In Ethiopia, adoption of improved agricultural technologies has been a long-term concern of agricultural experts, policy makers, and agricultural research and many others linked to the sector. However, several area-specific evidences indicate that adoption rate of modern agricultural technologies in the country is very low (Degnet et al., 2001). This low rate of adoption decisions of farmers may usually be determined by various factors which may be specific to socio-cultural, geographical and agro-ecological zones. This study is important to identify the factors affecting adoption of improved Maize varieties which is case by those factors.

Most developing economies are characterized by heavy dependence on rain fed agriculture, traditional type of farm practices, low adoption rate of technology and farm inputs, poor infrastructure facilities including roads, transport, marketing, higher labor to capital ratio and low farm productivity (Berhane, 2009; Alemitu, 2011; Susan, 2011). Ethiopia is one of the developing economies which is not realizing its full agricultural potential, as the sector is dominated by subsistence oriented, low input/low output and rain-fed farming systems. Ethiopia's agricultural produce is also limited in production diversity (WB, 2008). On the other hand, agriculture is the main source of livelihood for the majority of the population particularly for peoples residing in rural areas (Schmidt and Kedir, 2009).

Maize is one of the most important crops that contribute to household's food security in Woliso district. Increase in maize yield could be achieved by many approaches, one of the major factor is increase in use of the improved maize varieties (Lyimo *et al.*, 2014). Average maize yield of the improved maize varieties is greater than the traditional varieties. Due to its yield and its early maturity stage, maize has been grown by most of the farmers in the study area. The households rely on maize as the main staple food, and even though many households are not self-sufficient in maize, they still sell some maize at harvest time to meet immediate cash needs and later buy. Research efforts have been made to generate and release improved varieties of maize and a number of improved varieties of maize has been developed and disseminated among the farmers through different extension organizations such as MoARD and NGOs (CSA, 2015).

Improved maize varieties like BH 540, PHB 3250, BH 140, and BH 660 are introduced to the study area by MoARD that are tested by the Ethiopian National Seed Industry and Ethiopian Agricultural Research Organization (EARO). The decision to adopt or not hinges upon a care full evaluation of factors influencing adoption of maize varieties in the study area. Furthermore, the farmers are not adopting the intended maize varieties completely and efficiently as recommended by the agronomist. That is the adoption rate and level remained at low level and the output is not satisfactory (Degnet et al., 2001). However, the study on the adoption of improved maize varieties was conducted in the study area ,but the improved maize varieties was not availability on time so as to know the gap. In order to improve production and productivities of maize, identifying factors affecting adoption of improved maize varieties and to assess households improved maize varieties adoption status in the study area. Therefore, this study was initiated to identify factors affecting adoption of improved maize varieties in study area.

1.3. Scope and Limitation of the Study

This study was conducted in Woliso district of South West Shoa zone of Oromia Regional State. The study was restricted to cross-sectional household level data and identification of factors influencing probability of adoption and status of adoption of improved maize seed varieties in the study area. The study was covers only **2** kebeles from the **five** maize producing kebeles of the study area. Accordingly, improved seed varieties coverage is limited to only maize production and also limited to the district in terms of area coverage.

Due to shortage of time, budget and other resources primary data collection for the study was limited to two purposively selected rural kebeles in the district and 89 samples households was interviewed.

1.4. Significance of the Study

Development partners like extension educators, technical assistants, NGOs and other development agents involved in agricultural development must be aware and understand factors affecting the adoption of improved maize seed varieties and level of adoption of this technology in order to target and extend appropriate technologies to farmers. It is also important for policy makers to know the critical factors that could accelerate the adoption of improved maize seed varieties. This could facilitate allocation of major resources for research, extension and development programs. Hence, understanding these factors are important for the researchers in providing information to develop agricultural technologies, which is favorable to the current situation of smallholder farmers in the study area. The output of study provide information for planners and policy makers for further promotion of important improved maize varieties in the area by identifying the most important factors that influence the adoption of improved maize varieties.

1.5 Justification of the study

Increase in maize production could be achieved if farmers will adopt improved maize varieties. Increase in adoption of IMV could be achieved if factors which may affect adoption of that technology are identified and explained. The current study aims at determining factors influencing farmer's adoption decision and status of use of early maturing maize varieties. The study is useful in explaining reasons behind the low adoption of early maturing maize varieties. Findings will facilitate the designing of strategies for scaling up adoption of this technology. Technology adoption will increase production, ensure food security, and increase rural income and ultimately poverty reduction.

1.6. Research questions

1. What is the status of improved maize varieties adoption looks like in the study area?

2. What are the important factors influencing adoption of improved maize variety among smallholder farm households in Woliso District?

1.7. Objectives of the Study

The general objective of the study is to analyze factors affecting adoption of improved maize varieties by smallholder farmers in Woliso District**.**

The specific objectives were:-

1. To assess households improved maize varieties adoption status in the study area; and
2. To identify the important factors influencing adoption of improved maize varieties in the study area.

2. LITERATURE REVIEW

2.1 Theoretical Literature

2.1.1. Improved Maize Varieties

Seeds are basic agricultural inputs. More importantly, quality seeds of any preferred variety are a basis of improved agricultural productivity since they respond to farmers needs for both their increasing productivity and crop uses (Pelmer, 2005). Improved seed varieties can be defined as seeds that aim at increasing quality and production of crops by having characteristics such as drought tolerance, high yielding and early maturity (FAO, 2009). Nkonya (2001) defines an improved seed variety as any variety that has been bred using formal plant breeding methods.

Cho (2013) define improved seeds by dividing it into pieces as: Open pollinated seeds which are those produced from natural, random pollination. Traditionally, farmers saved the best of these seeds for use from year to year. Hybrid seeds result from cross-breeding two parent plants that have desirable traits. The resulting plants realize their potential in the first season, but lose effectiveness in subsequent generations so farmers must buy new seeds each year and genetically, modified seeds are created when one or two genes with the desired traits from any living organism are transferred directly into the plants genome.

2.1.2. Adoption of Agricultural Technology

Adoption can be defined as an act of accepting a new technology with approval (CSA 2015). It is also defined as the integration of an improved technology into current practice and is usually preceded by a period of ‘trying’ and certain degree of adaptation (Feder 2006). The production and diffusion of high maize yielding technology is the only possible means of achieving high agricultural productivity (Asfaw et al., 2007). Adoption of improved maize technology is very essential as masses of the population are poor and draw their household livelihood from agricultural production (Feder et al., 2005).

In agriculture the adoption process often involves a series of stages that the farmers passes through, from an awareness stage (first hearing about the technology), the evaluation stage (to collecting information on the expected benefit of the technology's in terms of its ease of operation and profitability) the trial stage and the final full-scale adoption stage of the new

technology (with available and adequate information and positive evaluation, the farmer will experiment with the new technology) (Feder et al., 2005).

The adoption of new agricultural technology such as improved seed varieties plays a fundamental role in the development process. In order to increase adoption of new agricultural technology different strategies needs to be undertaken. One of these strategies is promotion of the new agricultural technology. Promotion can be done through field trials and demonstration plots. Promotion can enable farmers to see the benefit from the introduced technology. After promotion evaluation must be done in order to see whether the technology has been adopted by the target group. Adoption of improved seed varieties is important because it helps farmers to have enough food and reduce poverty. For instance, a study in Mexico showed that adoption of improved maize varieties improves household welfare (Becerril and Abdulai, 2010). Similarly, in sub-Saharan Africa, adoption of improved maize varieties was indicated to have positive outcomes in poverty reduction (Alene et al., 2009).

The adoption of improved farming technologies influences the increasing rate of agricultural output. It also regulates how the increase in farming output impacts on the poverty levels and degradation of the environment (Meinzen-Dick et al., 2002).

Several scholars defined adoption of agricultural technologies in different times. According to Doss (2003), adoption can be defined as the continued use of recommended idea or practice by individuals over a reasonably long period of time and the adoption is not a permanent behavior. Adoption is a mental process through which an individual passes from hearing about an innovation to its adoption that follows awareness, interest, evaluation, trial, and adoption stages (Bahadur and Siegfried, 2004). Also Rogers (2003) defines adoption as the decision of full use of an innovation as the best course of action is available.

2.1.3. Improved maize varieties and Productivity

Productivity increases in agriculture can reduce poverty by increasing farmers' income, reducing food prices and thereby enhancing increments in consumption (Diagne et al., 2009). It is also of considerable significance that when agricultural production increases through the use of improved varieties of crops in a given area, farmers and their communities derive added socioeconomic benefit. Such activities can increase the value of locally produced crops, generate

local employment, stimulate local cash flow, and through processing, marketing, and related activities can bring about improvement in socio-economic status and the quality of life (Mwabu et al., 2006).

However, several research findings have pointed to the fact that the use of new agricultural technology, such as high yielding varieties of improved seed could lead to significant increase in agricultural productivity in Africa and stimulate the transition from low productivity subsistence agriculture to a high productivity agro-industrial economy (World Bank, 2008).

Solomon et al. (2011) stated that governments of developing countries have sought to promote the diversification of production and exports away from the traditional commodities in order to accelerate economic growth, expand employment opportunities, and reduce rural poverty. However, mere increase in production cannot guarantee for the overall improved welfare of the smallholder farmers. Domestic and international markets opportunities should be created so that farmers can supply their surplus production and support their lives with additional incomes. Increasing maize productivity will benefit smallholder farmers only if the marketing activity (aggregation and trading) is well-developed (IFPRI, 2008).

Low crop productivity in SSA including Ethiopia is mainly due to a limited use of improved seeds varieties by smallholder farmers. The supply of certified seeds of grain crops in Ethiopia is estimated to be about 10% of the annual seed planted (Spielman et al., 2010). However, deficiencies have been observed in improved seed supply due to inadequacies in seed varieties demanded and quantity required, prices, and untimely seed delivery (Sahlu et al., 2008).

2.1.4. Seed System and Smallholder Agriculture in Ethiopia

One of the most important inputs in agriculture is seed. Seeds form the foundation of all agriculture. Without seeds there is no next season's crop. The use of good quality seed of improved varieties is widely recognized as fundamental to ensure increased crop production and productivity. This is even more important in SSA in the view of increasingly available land, declining soil fertility and ever growing population; those facts increase the importance of promotion and use of good quality seed as a means to intensify crop production. The potential benefits from the distribution of good quality seed of improved varieties are enormous, and the

availability of quality seed of wide range of varieties and crops to the farmers is the key to achieve food security in SSA. Enhanced productivity, higher harvest index, reduced risks from pest and disease pressure, and higher incomes are some of the direct benefits potentially accrued to the farmers (FAO, 2004).

The supply of any seed material depends on the availability of seed from the formal and the informal sectors and their ability to develop and provide seeds of the cultivars needed by the local producers. The Ethiopian formal seed sector is composed of the Ethiopian Institute of Agricultural Research (EIAR) and Universities (as crop breeding bodies) and the Ethiopian Seed Enterprise (ESE) (as seed multiplier and supplier). Unlike the formal sector where there is clear distinction between cultivar development and seed production and supply, in the informal seed sector both, the production and the supply ends are linked, as farmers are the ones who manage both. It is largely recognized in Ethiopia that farmers can obtain seed from the formal (seed companies/enterprises, agricultural research centers and universities) as well as the informal (local or traditional including farmers' saved seed, local markets exchanges). (Yealembirhan, 2006).

The supply of basic seed such as improved maize varieties are the mandate of public research institutes while the Ethiopian Seed Enterprise (ESE) mainly handled certified seed provision until 2008. Seed and other inputs were delivered to farmers on credit through government offices. The private seed companies have a considerable market share (30-40%) (Tesfaye et al., 2012) in the hybrid maize seed provision whereas the OPVs are entirely provided by the public sector. Most of the private companies use publicly−bred seed and are sub-contractors to the ESE except for the Pioneer Hybrid. Both the public and the private seed enterprises deliver their seed through the public extension services to farmers' cooperative unions for distribution and marketing.

Like in many other Sub-Sahara African countries, maize plays a major role in the livelihood and food security of most smallholder farmers in Ethiopia. Maize is grown in most parts of the country with different productivity potentials. For many years, maize in Ethiopia has been the first in production and second (next to teff) in area of cropped land (Legese et al., 2011).

Maize is Ethiopia's leading cereal in terms of production, with 7.2 million tons produced by 8.68 million farmers across 2.11 million hectares of land (CSA, 2015). Over two-thirds of all Ethiopian farmers grow maize, mostly for subsistence, with 75 % of all maize produced being consumed by the farming household. Maize is the cheapest source of calorie intake in Ethiopia, providing 20.6 % of per capita calorie intake nationally (IFPRI, 2011).

Maize is thus an important crop for overall food security. As compared to other cereals, maize can attain the highest potential yield per unit area. World average yield for maize is about 5.0 t/ha and that of developed countries is 6.2 t/ha (MoA, 2014). The average yield in developing countries is 2.5 t/ha. In Ethiopia the national average yield is about 3.43 t/ha (CSA, 2015).

Maize is instrumental for the food security of Ethiopian households, and is the lowest cost caloric source among all major cereals, which is significant given that cereals dominate household diets in Ethiopia; the unit cost of calories per US dollar for maize is one-and-a-half and two times lower than wheat and teff respectively. Maize is also a low-cost source of protein in comparison to other cereals: maize provides 0.2 kg of protein per USD, compared to 0.1 kg of protein per USD from teff and 0.2 kg of protein from wheat and sorghum. An average Ethiopian consumes a total of 1,858 kilocalories daily of which four major cereals (maize, teff, wheat, and sorghum) account for more than 60 percent, with maize and wheat representing 20 percent each (Rashid et al., 2010).

The importance of maize in the country's agricultural economy and household level food security calls for increasing its production and productivity through use of improved maize varieties. However, smallholder farmers' knowledge and use of agricultural technologies in general and improved maize varieties in particular, are limited due to various factors that are either internal or external to the farmers' circumstances. Most commonly internal factors that affect adoption and use of agricultural technologies are farmers' attitude towards risk (Feder et al.,2005), household characteristics that affects the level of production and consumption, resource endowments, and the like. External factors could be access to technologies, in particular through a well-developed seed system (Byerlee and Heisey, 1996; Croppenstedt et al., 2003; Alemu et al., 2008; Shiferaw et al., 2008; Asfaw et al., 2011), infrastructure, institutions (Beke, 2011), markets, and enabling policy environments (Maredia et al., 2000; Smale et al., 2011;Tripp and Rohrbach, 2001).

2.1.5. Adoption of Improved Maize varieties

2.1.5.1. Farmers' decision-making behavior

The theories of decision-making have been largely rooted in disciplines economics and psychology. In psychology, observations are made to describe human judgment process and how people make alternative judgments based on their perception. According to Dunn (2004) decision-making is a ubiquitous activity inherent in the behavior of individuals or society. Decision can be categorized as intuitive, programmed, and analyzed. Those choices that individuals make without conscious thought as to the alternatives and the relative evaluation are known as intuitive decisions. Whereas programmed decision making are those in principle capable of being automated. There are certain decisions that one has to analyze possible outcomes and their consequences (Gebre-Mariam, 2012).

Most empirical studies on adoption of agricultural technologies such as Mureithi et al. (2000), Mulugeta (2001) and Ransom et al. (2003) concentrate on farmers‟ characteristics as the main factors that influence adoption or rejection of agricultural technology's package. They compare farmers who have adopted or rejected a certain technology at a point in time against their own socio-economic characteristics. They overlook the influence that technology characteristics can have on adoption. Technology specific attributes can influence the farmer's adoption decision in the same way as his/ her own socio-economic circumstances can influence his/her decision to adopt or reject a technology. These technology characteristics include initial cost, risk involved, relative profitability and complexity of technology.

A decision problem consists of: (i) alternatives available to the decision maker, (ii) state of nature (rainfall, price etc), (iii) probability attached to the state of nature influencing the decision problem (iv) consequence of action, (v) process of conducting experiments to obtain additional benefit, (vi) process of conducting additional information about the likelihood of outcome given the state of nature, and (vii) the strategy for action which are conditional on the experimental outcome observed (Dunn,2004). The distinction between farmers producing improved varieties or old or both is key for studying farmers behavior which is much complex when the environment is highly unpredictable.

Decision-making takes different aspects. According to the Rational Decision-making Model; a model in which decisions are made systematically and based consistently on the principle of economic rationality people strive to maximize their individual economic outcomes (Taher, 2006; Mendola, 2007).

Information about all possible alternatives, their outcomes and the preference of decision makers is assumed available. Various statements identified the factors influencing the decision-making process in farm management. Taher (2006) emphasized the community influence on the farmer. He argues that decisions in farming will be determined not only by the goal of maximizing the benefit or of reducing the risk, but also by willingness to accept criticism from the community (depending very much on a farmer's social position in different groups). Barriers to adoption of improved maize technologies include: unavailability of credit, inadequate capacity of seed companies impeding product delivery at large scale, lack of awareness, inadequate availability of improved maize seed, and unaffordable seed price (Tahirou et al., 2009; Fisher et al., 2015).Technology adoption is a pro-poor if it benefits the poor relatively more than non-poor (Kakwani, 2005).

According to Reijntjes et al. (2002), the decision-making process is influenced not only by the culture of the community to which the household belongs but also by other factors such as personality of the decision maker, biophysical characteristics of the farm, the availability and quality of external inputs and services, and socio-economic and cultural processes within the community. More details about the characteristics of households that influence the farm household decision-making are the number of men, women and children, their ages, state of health, abilities, desires, needs, farming experience, knowledge and skill, and the relations between household members. Those factors that influence the farmers' decision-making to achieve their outcomes can be systematized in physical environment, socio-economic environment (included political aspect), and farmers' household size and production factors.

Adoption is acceptance and use of new agricultural technologies by the farmers. It is a dynamic process that is determined by various factors such as farmers perception of benefits of the technology, efforts made by the extension services to disseminate these technologies to the

farmers, risks involved, costs involved, profitability and complexity like that the likelihood that farmers will be able to apply it correctly. Adoption of agricultural technologies by the farmers is an essential pre-requisite for economic prosperity in less developed countries (Nkonya et al.,2007).

Most empirical studies on adoption of agricultural technologies such as Ransom et al. (2003) concentrate on farmers' characteristics as the main factors that influence adoption or rejection of agricultural technology package. They compare farmers who have adopted or rejected a certain technology at a point in time against their own socio-economic characteristics. They overlook the influence that technology characteristics can have on adoption. Technology specific attributes can influence the farmers adoption decision in the same way as his/ her own socio-economic circumstances can influence his/her decision to adopt or reject a technology. These technology characteristics include initial cost, risk involved, relative profitability and complexity of technology. The present study will be used some selected socioeconomic, demographic and institutional characteristics to examine how they have influence adoption of improved maize varieties in Woliso district.

2.1.5.2. Farmers Seed Variety Adoption

Improving maize production is considered to be one of the most important strategies for food security in the developing countries. The diffusion of the improved maize varieties (IMV), like hybrids and open pollinated varieties (OPV) can greatly increase maize yield per unit of land. However, farmers‟ choice on improved varieties is one of the most crucial factors affecting the productivity of a crop. This is influenced by many factors that affect the farmers‟ variety adoption decisions (Rogers, 2003).

Decision of farmers to adopt a new agricultural technology in preference to other alternative technologies is based on intricate factors such as farmers' resource endowment, socio-economic status, demographic characteristics and access to institutional services (Negatu and Parikh, 2009). Farmers' decision-making may not be based on as rational decision-making model suggests, is based on the assumption that individual have perfect information and there are less constraint in choices thus individuals are expected to maximize their economic outcomes (Taher, 2006).

The adoption of agricultural innovation such as improved maize seed varieties has obtained substantial attention among researchers and policy makers because the majority of the populations of less developed countries derive their livelihood from agriculture mainly crop farming. Improved agricultural technologies (improved seed varieties) are believed to offer an opportunity to increase production substantially. The introduction of improved agricultural technologies, however, has met with only limited success, as measured by observed rates of adoption. Spielman et al. (2010) documented aggregate adoption of crop in Ethiopia between 4.7% to 19%. Langyintuo et al. (2010) reported that improved maize adoption in many Africa countries is low with few exceptions.

2.1.5.3 Farmers Access to Maize Seed and the Seed Quality in Ethiopia

Access to quality seed is crucial for food crop production. In order to realize sustained crop production and productivity, modern breeding has considerably increased the yield potential and improved varieties of crops seed over the last century. Both modern breeding and farmer seed selection have significantly contributed in generating suitable seed for sustainable food production. The provision of improved variety seeds has remained a point of discussion in developing countries such as Ethiopia (MoFED, 2010).

Different approaches of seed provision such as local seed projects and emergency seed projects have been tried in developing counties in order to increase farmers' access to suitable seed (Tripp, 2006). In Ethiopia, for example, farmer based seed multiplication and marketing schemes were executed across the country to boost certified seed provision (Sahlu et al., 2008).

2.2 Empirical Literature

2.2.1 Maize production in Ethiopia

Maize is one of the important cereal crops in Ethiopia, and grows in practically all parts of the country. In terms of area, it is the second most important commodity covering 1.33 million ha of land and accounting for 20.86% of the total arable land allotted for cereal crop production in Ethiopia. It also ranks first in production and productivity (CSA, 2000).

Maize is an important crop widely grown and consumed in most parts of Ethiopia. It is used as a raw material for local drink, boiled grain, green cobs, and bread making. The minimal use of improved maize production practices could probably be attributed to poor dissemination of improved technology, high cost in terms of time, money, and labor or compatibility of the technology or some other reasons. However, research on maize (moisture conservation, sowing date, plant density, cultivation and crop mixtures) has been conducted for several years at various locations of the country and results were achieved (Hussein et al., 2000; Tenaw et al., 2003; Tenaw, , 2000).

Agricultural productivity is becoming increasingly important as the world population continues to grow a productive farm is one that provides most of the resources necessary for the farmer's family to live, such as food, etc. It is a farm which ensures food security as well as a way to sustain the well-being of a community (Tenaw, 2015).

2.2.2 Empirical Studies on Improved Seed Varieties Adoption

The study conducted on adoption of improved maize varieties in developing countries, particularly Africa and South Asia, pointed out a number of socio-economic characteristics, agro-ecological variables, and farmers' perception as an important determinant of maize varieties adoption (Bindod, 2010).Among these variables, extension contact, education, farm size, credit availability, use of fertilizer, low land area, yield and profitability are found to be major determinants which have strong positive influences. The adoption studies are found more focused to socio-economic variables in comparison to agro-ecological variables and farmers' perception. Researchers suggested considering these variables as important as the socioeconomic variables in any adoption studies of agricultural innovations (Bindod, 2010).

Several studies in Ethiopia with regard to factors influencing the adoption of improved seed showed that extension service, access to credit and market are the main factors influencing the adoption of improved maize seed and also emphasized that access to credit is a powerful policy option in raising the probability of adoption of improved maize seeds like Negasa et al. (1997); Degu et al. (2000); Feleke et al.(2006).

The study conducted by Alene et al. (2000) to examine factors that influence the adoption and status of utilization of improved maize varieties in the West Shoa Zone in the central Highlands of Ethiopia indicate that age, level of education, household labor, farm size, extension services, farm income, off farm income, and timely availability of improved maize seeds significantly influence the adoption and intensity of use of improved maize.

Mubarak (2009) also identified that farmers' educational level, farm size, number of oxen, total active labor force, total livestock holding, crop income, off-farm income, contact with extension agents and perception of the technology were found to have a positive influence on the probability of adoption and area allocated to the improved maize varieties, whereas age and market distance were found to have a significant and positive influence on the adoption decisions of the improved maize technology.

Bezabih (2001) shows in his study that land quality, disposable household income, extension services, and the qualities of the new varieties play significant roles in the adoption decision. The result revealed that with increased land fertility, the probability of adoption of package of the technologies was low. This could be due to the decision behavior of the farmers in the study area. Household income is key to financing the new technologies. Dissemination of agricultural information through radio programs positively and significantly influenced the adoption behavior. Quality index of a variety is also important determinant of adoption of the package.

2.3. Conceptual Framework of the Study

Agricultural technology adoption and diffusion patterns often vary from location to location. The variations in adoption patterns are created due to the presence of disparity in agro ecology, Institutional and social factors. Moreover farmers' adoption behavior, especially Low-income countries, is influenced by a complex set of socioeconomic, demographic, technical, institutional and bio-physical factors (Feder et al., 2005). From different literature review depending on the adoption decision of the technology the important key variables that were expected to influence the adoption of improved maize varieties in the study area were summarized in conceptual framework as follows.

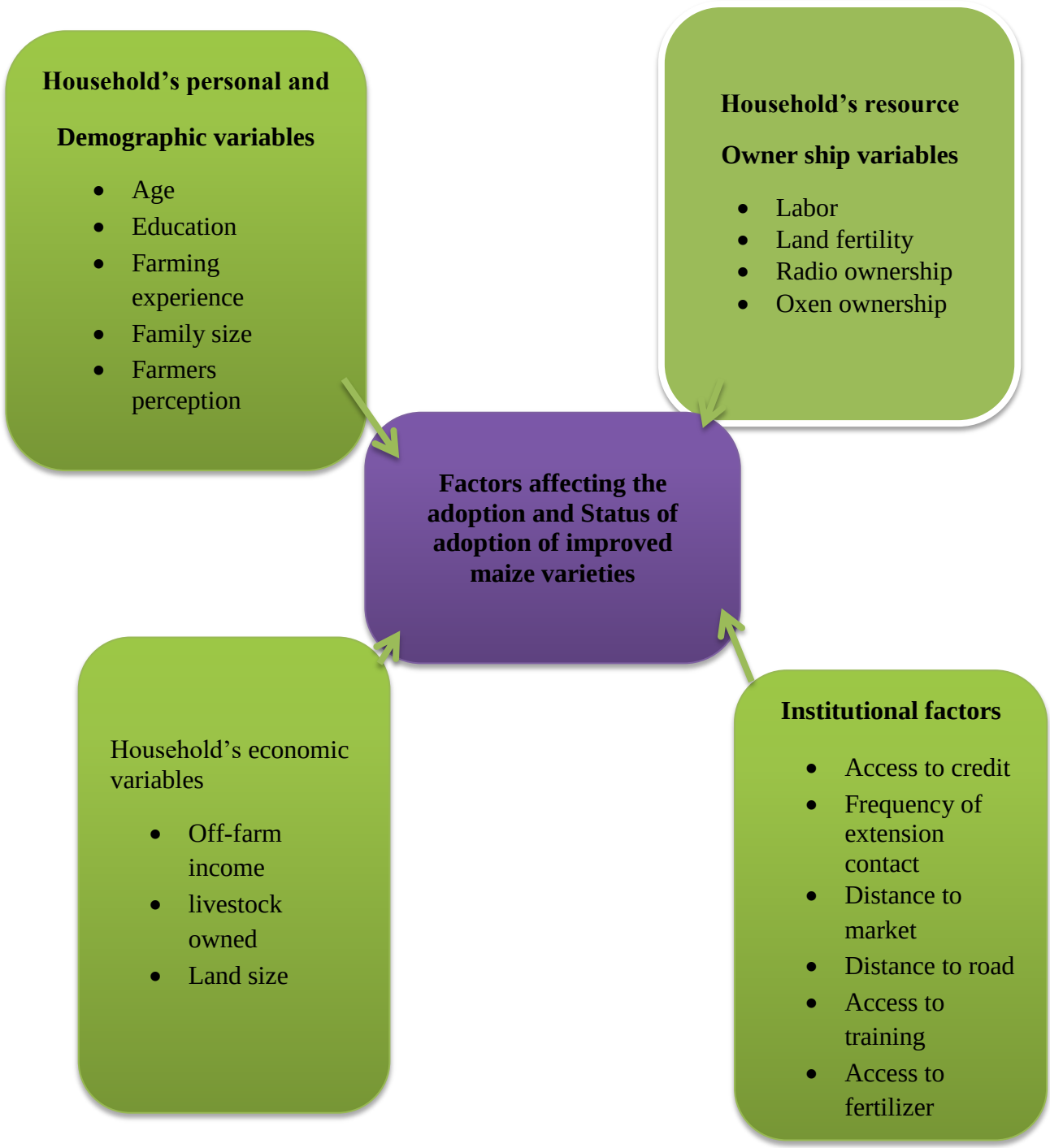

Figure: Factors affecting the adoption and status of adoption improved maize varieties

3. METHODOLOGY

3.1. Description of the Study Area

The study is conducted in Woliso district of oromiya region. It found in Southwest Shoa zone and far about 114 km from Addis Ababa. Its astronomical location is 32' north latitude and 37 º 58' east longitudes with an elevation of 2063 meters above sea level. Woliso district is located in tropical climate zone and the climate condition is medium that the altitude of the land is waynadega. The relative location or visional position of the district has physically contacts with four woreda, namely Bacho, Goro, Wanchi, and Saden- Sodo woreda and one region namely SNNP. In terms of these woreda location, Woliso woreda is boarded in the North by Bacho, in the west by Wanchi, in the south west by SNNP, in the south by Goro and in the east by Sadden sodo woredas. The total population of Woliso woreda in rural and urban are 183391 from those, male and female are 91622 and 91769 respectively. In those, population 95% are living in rural area and economic activities of these woreda is mixed farming system. The total area of the woreda is approximately around 70238-hectare (Woliso woreda Agricultural and Land protection Bureau, 2018).

3.2. Data Type and Source

The study utilized both primary and secondary data. Primary data were collected from a sample household heads through semi-structured questionnaire. Secondary data were collected from annual reports, documents, annual report of disaster prevention and preparedness commission office and economic journals.

3.3. Sampling Techniques and Sample Size

The study employed two-stage random sampling method to select sample maize producing household heads. In the first stage, out of five maize producing kebeles in the district, two kebeles (namely, Kume Koricha and Bakaa Ciraachaa) were randomly selected. In the second stage, after obtaining list of maize producing farmers, a total of 89 sample household heads were selected based on probability proportion to the number of maize producing households in each sampled kebeles. Accordingly, 44 households from Kume Koricha kebele and 45 households from Bakaa Ciraachaa kebele were drawn.

This study applied a simplified formula provided by Yamane (1967), in order to determine the required sample size at 90% confidence level.

$$n = \frac{\mathrm{N}}{1+\mathrm{N}(e)^2} = \frac{815}{1+(815x0.1^2)} = 89 \qquad (1)$$

Where n = designates the sample size, N= designates total number of maize producing household heads in the selected kebeles and e= designates maximum variability or margin of error (10%).

3.4. Method of Data Analysis

Descriptive statistics and econometric models were used to analyze the collected data.

3.4.1. Descriptive Statistics

Descriptive statistics such as mean, percentage and standard deviations were used to assess the socioeconomic characteristics of the sample households and farmer's response for adoption of improved maize varieties.

3.4.2. Econometric Analysis

3.4.2.1 Model Specification

The data analysis, interpretation and discussion was depend on the dependent and independent variables that were listed in the following econometric model parts to analyze the factors affecting the adoption of improved maize varieties.

3.4.2.2 Probity Model

To analyze factors affecting farmer's adoption of improved maize varieties, the study used binary probit model. When the response (dependent) variable is dichotomous variable taking two values binary logit and binary probit model are the appropriate models used for estimation. In most applications the models are quite similar, the main difference being that the logistic distribution has slightly fatter tails but, there is no compelling reason to choose one over the other. These probit and logit models are appropriate when the dependent variable is a binary variable. In this study the response (dependent) variable is dummy variable taking two values, **1** if adopters and **0** if non- adopters. Probit model is one of the most, which to estimate the factors affecting the adoption of improved maize varieties by some explanatory variables.

The standard normal cumulative distribution function (probit model) is econometrically too specified as following ways.

$$Yi = \begin{cases} 1 & if\ Yi^* > 0 \\ 0 & if\ Yi^* < 0 \end{cases} \quad \text{where,} \quad Yi^* = Xi\beta + Ui \qquad (2)$$

Where: Y_i* is the latent (unobserved) variable, Y_i is the observed variable, X_i is vector of explanatory variables, U_i is a vector of error terms and β is a vector of parameters to be estimated.

3.4.3. Description of variable

3.4.3.1. Description of dependent variable

In this study, the dependent variable is farmers' adoption of improved Maize varieties. It is a dummy variable taking a value of 1 if the farmers are adopter of improved maize varieties and 0, otherwise.

3.4.3.2. Description of the explanatory variable

The independent variables: The independent variables that were hypothesized to affect farmers' adoption decision of improved maize varieties are combine effects of various factors such as: household characteristics, socioeconomic characteristics and institutional characteristics in which farmers operate.

Sex of the household head: It is a dummy variable used as (1 if male, 0 female). Gender difference is found to be one of the factors influencing adoption of new technologies. Due to many socio-cultural values and norms, male has freedom of mobility and participation in different extension programs and consequently have greater access to information (Mesfin, 2005; Teha, 2007). Therefore, it was hypothesized that male farmers are more likely to adopt a new technology.

Age of the household head: It is a continuous variable and measured in number of years from birth. The role of a framer's age in explaining technology adoption is somewhat controversial in the literature.. It is assumed that as farmer age increases the probability of adoption is expected to decrease, because as the farmer's age increases, it is expected that the farmer becomes conservative (Techane et al., 2006). Contrary to this Hailu (2008) reported positive relationship between age and adoption which enables easy adoption of new technologies. In this study it was hypothesized to affect improved maize variety adoption positively or negatively.

Educational level of the household head: This is a continuous variable measured in years of schooling. Education level increases farmer's ability to get process and use information and increase farmers' willingness to adopt a new technology. According to Binod (2010), education level is assumed to increase farmer's ability to obtain process and use the information relevant to adoption. Therefore, this variable was hypothesized to positively influence improved maize variety adoption.

Family size of the household: It is a continuous variable measured in number; that refers to the number of family members of a given household. The family members are important in the operation of farm activities, such as weeding and harvesting. Family size had a positive and significant relation with adoption of improved maize varieties (Motuma et al., 2010). Previous research result reported by Tesfay and Alemu (2001) shows that family size influence adoption of new technology positively. Therefore, family size was hypothesized to influence the adoption of improved maize varieties positively.

Farm size of the household head: It is a continuous variable measured in hectares. Land is one of the most important and scarce resources in agricultural production. Research result by Nega and Sanders (2006) and Hassen et al. (2012) found a positive and significant relationship

between farm size and improved maize varieties adoption. Therefore, farm size was hypothesized to influence the adoption of improved maize varieties positively.

Land fertility: This is a dummy variable that takes a value of **1** when the land is fertile and **0** otherwise. A difference in fertility of land could also have a bearing in the decision of the farmer to adopt a new crop technology or not. Farmers with a relatively fertile land tend to be more receptive to improved crop technologies, as they supplement a relatively minimum quantity of commercial fertilizers, than those with poor fertility of lands. Therefore, in this study, it was hypothesized that land fertility would have positive correlation to adopt improved maize varieties.

Number of oxen owned: This is a continuous variable that refers to the number of oxen the household owns. In the study area oxen are the most important means of land cultivation. Farmers need at least one pair of oxen to be able to prepare their land well (Endrias, 2003). Teressa and Heidhues (2006) reported that adoption of improved agricultural technology has been positively influenced by oxen ownership. Therefore, in this study, it was hypothesized that oxen ownership influence improved maize variety adoption positively.

Improved maize seed availability: is a dummy variable that takes 1 if improved *maize* seed is available and 0 otherwise. In order to make use of the technologies, farmers should be able to get seeds either in the formal or informal distribution systems. Ghimire (2015) showed that institutional variables such as seed availability significantly and positively affect the incidence of adoption improved technologies. Thus, improved seed availability was hypothesized to positively influence the adoption and intensity of use of improved *maize* varieties.

Access to fertilizer: This is a dummy variable, which takes a value of **1** if the farm household has access to fertilizer and **0** otherwise. As availability of fertilizer supply at the sowing time increases, farmers' use of improved maize varieties will be enhanced. On the contrary, if maize seed and fertilizer supply are not adequate at the time of sowing, farmers allot their land to other crops. Fertilizer availability determines adoption decision of new maize varieties (Asfaw et al. 2007; Teferi, 2003). Availability of fertilizer on time to the farmers' increased, adoption/intensity of adoption is expected to increase. Therefore, in this study access to fertilizer was hypothesized to positively influence adoption of improved maize varieties.

Access to credit for improved maize varieties: It is a dummy variable, which takes a value of **1** if the farm household had access to credit and **0** otherwise. Adoption of new agricultural technology with complementary inputs required considerable amount of capital for purchase of inputs (seed, fertilizer). Salasya et al. (2007); Mugisha and Diiro (2010) in their studies on factors influencing adoption of improved maize varieties and its effects on yields among smallholder maize farmers found that access to credit relaxes income constraints of famers hence enabling them to have access to key inputs as well as in hiring of labor. In this study it was hypothesized that access to credit would influence adoption of maize technology positively.

Frequency of extension contact: It is continues variable and measured by number of contact with extension agents. Empirical results revealed that extension services play important role in the implementation and diffusion of innovation and has positive and significant influence on adoption of new agricultural technology (Solomon *et al*., 2011). Extension agent acts as agent for change and as a communication media who builds the gap between farmers and the innovation (Tura *et al*., 2010; Mignouna *et al*., 2011; Akpan *et al*., 2012).Following this argument; in this study extension contact was hypothesized to influence farmers' decision to adopt improved maize varieties positively and significantly.

Distance to the nearest market: It is a continuous variable measured in kilometer. It refers to the distance between the farmers' residence and the nearest market center. It shows access to the market to buy input and/or to sell output. Previous result reported by (Alemitu, 2011; Kidane, 2001) revealed that market distance negatively and significantly influence adoption of Agricultural technology. Therefore, in this study it was hypothesized to affect adoption of improved maize varieties negatively.

Total livestock owned by the farm household: This refers to the total number of livestock measured in tropical livestock unit (TLU). Livestock is important source of income, food and draught power for crop cultivation in Ethiopian agriculture. Therefore, in this study it was hypothesized that higher TLU would have positive and significant influence on the adoption of improved maize varieties. Previous research result reported by Tesfaye et.al. (2001) confirmed that livestock holding have positive influence on agricultural technology adoption.

4. RESULTS AND DISCUSSIONS

4.1. Descriptive Statistics of Socio economic and institutional characteristics

Age of the household head: The average age of sample respondents was 47.29 years. The mean age of adopters and non-adopters were found to be 46.06 and 48.6 years respectively. The mean difference in age between adopters and non- adopters was insignificant at 10% significance level. This implies that adopters are younger than non-adopters.

Table 1

```
. ttest Age, by(Respondent) level(90)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[90% Conf.	Interval]
non adop	43	48.60465	1.619763	10.6215	45.88029	51.32902
adopter	46	46.06522	1.432677	9.716886	43.65914	48.47129
combined	89	47.29213	1.079714	10.186	45.49727	49.087
diff		2.539434	2.155915		-1.044898	6.123766

```
    diff = mean(non adop) - mean(adopter)                         t =   1.1779
Ho: diff = 0                                     degrees of freedom =       87

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.8790         Pr(|T| > |t|) = 0.2421          Pr(T > t) = 0.1210
```

Family size of the household: The average family size of the sample farmers in the study area was 6 persons. The average family size of the adopters and non-adopters were 6 and 5 respectively. This was found to have statistically significant mean difference between the two groups at 10% significant level. The result shows that adopter's households have higher family than non-adopters households.

Table 2

```
. ttest Famsize, by(Respondent) level(90)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[90% Conf.	Interval]
non adop	43	5.372093	.3750574	2.459416	4.741264	6.002922
adopter	46	5.673913	.3305015	2.24157	5.11886	6.228966
combined	89	5.52809	.2481236	2.340794	5.115621	5.940559
diff		-.30182	.4983254		-1.130315	.5266746

```
    diff = mean(non adop) - mean(adopter)                         t =  -0.6057
Ho: diff = 0                                     degrees of freedom =       87

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.2732         Pr(|T| > |t|) = 0.5463          Pr(T > t) = 0.7268
```

Farm size of the household head: The farm size of sample households in hectare with an average holding of 5.4 hectares. The average size of land for adopters was 5.43 while that of non-adopters was 5.37. Statistically, there was insignificant difference between adopters and non-adopters related to farm size holding.

Table 3

```
. ttest Farmsize, by(Respondent) level(90)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[90% Conf.	Interval]
non adop	43	5.377907	.3354073	2.199413	4.813768	5.942046
adopter	46	5.43913	.2961913	2.008867	4.941699	5.936562
combined	89	5.409551	.2216725	2.091254	5.041052	5.778049
diff		-.0612235	.446091		-.8028753	.6804284

```
    diff = mean(non adop) - mean(adopter)                         t =  -0.1372
Ho: diff = 0                                     degrees of freedom =       87

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.4456         Pr(|T| > |t|) = 0.8912          Pr(T > t) = 0.5544
```

Number of Oxen Owned; The average number of oxen owned by adopters was 3.65 whereas for non-adopters was 4.06 The mean difference in oxen holding was found to be statistically significant at 10% significance level. The result shows non- adopters have more oxen than adopters.

Table 4

```
. ttest Oxen, by(Respondent) level(90)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[90% Conf.	Interval]
non adop	43	4.069767	.2691098	1.764671	3.617138	4.522397
adopter	46	3.652174	.1818249	1.233196	3.346812	3.957536
combined	89	3.853933	.1610348	1.5192	3.586236	4.121629
diff		.4175935	.3209923		-.1160747	.9512617

```
    diff = mean(non adop) - mean(adopter)                         t =   1.3009
Ho: diff = 0                                     degrees of freedom =       87

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9016         Pr(|T| > |t|) = 0.1967          Pr(T > t) = 0.0984
```

Frequency of contact with extension agents: It was observed that sample households in the study area. With regard to the frequency of extension contact among the total respondents the average number of extension contact was 1.91 time per month. The mean frequency of extension contact for adopter was 1.86 and for non-adopters households were 1.95 per month. There was statistically insignificant difference between adopter households and non-adopter households in terms of frequency of extension contact at 10% significance level.

Table 5

```
. ttest Ext, by(Respondent) level(90)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[90% Conf.	Interval]
non adop	43	1.953488	.2328348	1.5268	1.561871	2.345105
adopter	46	1.869565	.1691373	1.147145	1.585511	2.153619
combined	89	1.910112	.1417104	1.336893	1.67454	2.145685
diff		.0839232	.2850651		-.3900139	.5578602

```
    diff = mean(non adop) - mean(adopter)                         t =   0.2944
Ho: diff = 0                                     degrees of freedom =       87

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.6154         Pr(|T| > |t|) = 0.7692          Pr(T > t) = 0.3846
```

Distance to nearest markets:. The survey result indicated that the average distance of respondents' home from the nearest market place is 6.53 km. On average adopters were located about 6.71 km distances whereas non-adopters were about 6.34 km far away from the nearest market. The result also revealed that mean difference of distance to market was statistically insignificant.

Table 6

```
. ttest Dis, by(Respondent) level(90)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[90% Conf.	Interval]
non adop	43	6.343023	.2960172	1.941115	5.845136	6.84091
adopter	46	6.719565	.4185277	2.838593	6.016678	7.422452
combined	89	6.53764	.2586591	2.440185	6.107657	6.967623
diff		-.376542	.5190111		-1.239428	.4863437

```
    diff = mean(non adop) - mean(adopter)                         t =  -0.7255
Ho: diff = 0                                     degrees of freedom =       87

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.2350         Pr(|T| > |t|) = 0.4701          Pr(T > t) = 0.7650
```

Total livestock owned by the farm household; the mean of TLU kept by farm householder of the adopters and non-adopters during the study period was 10 and 11.86, respectively. There was significant difference between the two groups in terms of livestock holding.

Table 7

```
. ttest TLU, by(Respondent) level(90)

Two-sample t test with equal variances

   Group |     Obs        Mean    Std. Err.   Std. Dev.   [90% Conf. Interval]
---------+--------------------------------------------------------------------
non adop |      43    11.86047    .7879079    5.166658    10.53524    13.18569
 adopter |      46          10    .7135676    4.839651    8.801615    11.19839
---------+--------------------------------------------------------------------
combined |      89    10.89888    .5362367    5.058847    10.00746    11.79029
---------+--------------------------------------------------------------------
    diff |            1.860465     1.06064                .0970898     3.62384
------------------------------------------------------------------------------
    diff = mean(non adop) - mean(adopter)                         t =   1.7541
Ho: diff = 0                                     degrees of freedom =       87

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9585         Pr(|T| > |t|) = 0.0829          Pr(T > t) = 0.0415
```

Socio-economic characteristics of (Adopters and non- Adopters) continuous Variables.

Table 8

Variables	Adopters (N=46) Mean	Non-Adopters (N=43) Mean	Total (N=89) Mean	t-value at 90% significance level.
Age of the household head	46.06	48.6	47.29	1.177
Family size of the household	5.6	5.3	5.5	-0.605
Farm size of the household head	5.4	5.37	5.4	-0.17

Number of Oxen Owned	3.65	4.06	3.85	1.3
Frequency of contact extension	1.87	1.95	1.91	0.29
Distance to nearest markets	6.71	6.34	6.53	-0.725
Total livestock owned	10	11.8	10.89	1.754

Sex of the household head: The survey result indicated that 55.81% of the non-adopters, 58.7% of the adopters and 57.3% of the total respondents were female headed and 44.19% of the non-adopters, 41.3% of the adopters and 42.7% of the total respondents were male headed.

Table 9

Respondent	Sex female	male	Total
non adopter	24	19	43
	55.81	44.19	100.00
adopter	27	19	46
	58.70	41.30	100.00
Total	51	38	89
	57.30	42.70	100.00

Pearson chi2(1) = 0.0754 Pr = 0.784

Educational level of the household head; The survey result indicated that the total households of non-adopters and adopters were 4,19,15,5 and were 4,14,23,5 are illiterate,read&write,primary and high schools respectively. it is statically insignificant at 10% significant level.

Table 10

Respondent	Educ illitirat	Read&writ	Primary s	Highschoo	Total
non adopter	4	19	15	5	43
	3.9	15.9	18.4	4.8	43.0
	0.0	0.6	0.6	0.0	1.2
adopter	4	14	23	5	46
	4.1	17.1	19.6	5.2	46.0
	0.0	0.5	0.6	0.0	1.1
Total	8	33	38	10	89
	8.0	33.0	38.0	10.0	89.0
	0.0	1.1	1.2	0.0	2.3

Pearson chi2(3) = 2.3433 Pr = 0.504

Land fertility: Difference in fertility of land could also have a bearing in the decision of the farmer whether to adopt a new crop technology or not. From the survey result 60.87% of the adopters' and 46.51% of the non- adopters have fertile soil, and 39.13 %, of the adopters and 53.9% of the non-adopters have less fertile land.it is statically significant at 10% significant level. **Table 11**

Respondent	Landferti not ferti	fertile	Total
non adopter	23	20	43
	53.49	46.51	100.00
adopter	18	28	46
	39.13	60.87	100.00
Total	41	48	89
	46.07	53.93	100.00

Pearson chi2(1) = 1.8441 Pr = 0.174

Access to fertilizer: As shown on table below 52.81% of the total household gets fertilizer on time. When we see the two groups 60.87% of the adopters and 44.19% of the non-adopters get fertilizers on time. The result shows significant mean difference between the two groups at 10% significant level. The result implies that adopters have better access to fertilizer than non-adopters.

Table 12

Respondent	Acfertilize: not acces	access	Total
non adopter	24	19	43
	55.81	44.19	100.00
adopter	18	28	46
	39.13	60.87	100.00
Total	42	47	89
	47.19	52.81	100.00

Pearson chi2(1) = 2.4822 Pr = 0.115

Access to credit: The survey result indicated that 48.84% of non- access and 51.16% of access at the non-adopters, and 36.96% of the adopters at non-access and 63.04% of the adopter's access of the total respondents had access to credit in 2010 production year. This was found statistically insignificant at 10% significance level. This implies that adopters had better access to credit compared to non-adopters.

Table 13

Respondent	Acc: not acces	access	Total
non adopter	21	22	43
	48.84	51.16	100.00
adopter	17	29	46
	36.96	63.04	100.00
Total	38	51	89
	42.70	57.30	100.00

Pearson chi2(1) = 1.2822 Pr = 0.257

Improved maize seed availability: The survey result indicated 39.53% non- availability and 60.47% of availability at non-adopters, and 43.48% of non-available and 56.52% of available at adopters. This was found statistically insignificant at 10% significance level.

Table 14

Respondent	Impseed not avail	Impseed Available	Total
non adopter	17	26	43
	39.53	60.47	100.00
adopter	20	26	46
	43.48	56.52	100.00
Total	37	52	89
	41.57	58.43	100.00

Pearson chi2(1) = 0.1423 Pr = 0.706

4.2. Econometric Results

4.2.1. Factors affecting adoption of improved maize varieties.

This part presents the Probit econometric model estimates that factors affecting adoption and Status of adoption of improved maize varieties in the district. The factors considered were related with socio-economic and institutional variables relevant to the adoption and status of adoption of improved maize varieties. In the model 13 explanatory variables are estimated from them five variables were found significantly influencing probability of adoption and status of use of improved maize varieties. They include; Family size of the household, Land fertility, Access to fertilizer, Number of oxen owned and Total livestock owned; from them Family size of the household, Land fertility and Access to fertilizer were positively influence. Whereas, Number of oxen owned and Total livestock owned by household were negatively influence the probability of adoption of improved maize varieties.

Family size of the household; The result of this study indicated that, Family size of the household was positively and significantly related to adoption and status of use of improved maize varieties at 10% significance level. As a result estimated by a model the probability of adoption of improved maize varieties increases by 8.99% as family size increases by one units. The result shows that, the farm household that has medium family size were expected to have better information about the technology and have high probability to adopting improved maize varieties. The result was consistent with the result of (Yishak and Punjabi, 2011).

Land fertility: As result of this study indicated, land fertility was positively and significantly related to adoption and status of use of improved maize varieties at 10% significance level. As a result estimated by a model the probability of adoption of improved maize varieties increases by 27.01% as land fertility increases by one unit. This result was consistent with the finding of (Teferi, 2003).

Access to fertilizer: As result of this study indicated, access to fertilize was positively and significantly related to adoption and status of use of improved maize varieties at 10% significance level. As a result estimated by a model the probability of adoption of improved maize varieties increases by 32.3% as access to fertilizer increase by one unit. This implies that the supply of fertilizer at the sowing time increases, the use of maize varieties would be enhanced. This result was consistent with the finding of (Teferi, 2003).

Oxen ownership: Result of this study indicated that, oxen ownership was negatively and significantly related to adoption and status of use of improved maize varieties at 10% probability level of significance. As a result estimated by a model the probability of adoption of improved maize varieties decreases by 9.13% as numbers of oxen increases by one unit. The study is inconsistent with the finding of (Yishak and Punjabi, 2011, Teressa and Heidhues ,1996).

Total livestock owned by the farm household; Result of this study indicated that, total livestock owned by the farm household was negatively and significantly related to adoption and status of use of improved maize varieties at 10% probability level of significance. As a result estimated by a model the probability of adoption of improved maize varieties decreases by 3.08% as total livestock owned by the farm household increases by one unit. The study is inconsistent with the finding of (Yishak and Punjabi, 2011, Teressa;2006).

Tables of Probit regression and Marginal effect after probit estimation

Table 15

Probit regression — Number of obs = 89
LR chi2(13) = 21.53
Prob > chi2 = 0.0632
Log likelihood = -50.876829 — Pseudo R2 = 0.1746

Respondent	Coef.	Std. Err.	z	P>|z|	[90% Conf.	Interval]
Sex	0.078	0.325	0.239	0.811	-0.457	0.613
Age	-0.014	0.018	-0.801	0.423	-0.044	0.015
Educ	0.081	0.227	0.357	0.721	-0.292	0.454
Famsize	0.226	0.089	2.540	0.011	0.079	0.372
Farmsize	0.019	0.074	0.254	0.800	-0.104	0.141
Landferti	0.691	0.322	2.144	0.032	0.161	1.220
Acfertilize	0.834	0.332	2.510	0.012	0.287	1.380
Acc	0.504	0.338	1.494	0.135	-0.051	1.060
Oxen	-0.229	0.120	-1.914	0.056	-0.426	-0.032
Ext	0.031	0.115	0.269	0.788	-0.158	0.220
Dis	0.064	0.067	0.948	0.343	-0.047	0.175
TLU	-0.077	0.036	-2.128	0.033	-0.137	-0.018
Impseed	0.096	0.332	0.290	0.772	-0.450	0.642
_cons	-0.692	1.271	-0.544	0.586	-2.782	1.399

. mfx

Marginal effects after probit
y = Pr(Respondent) (predict)
= .51612352

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
Sex*	.0309528	.12948	0.24	0.811	-.222819	.284725	.426966
Age	-.0057765	.00721	-0.80	0.423	-.019911	.008358	47.2921
Educ	.0322942	.09048	0.36	0.721	-.14505	.209638	1.5618
Famsize	.0898916	.03542	2.54	0.011	.020466	.159317	5.52809
Farmsize	.0075321	.02967	0.25	0.800	-.050626	.06569	5.40955
Landfe~i*	.2701292	.12108	2.23	0.026	.032825	.507434	.539326
Acfert~e*	.3231203	.12153	2.66	0.008	.084921	.561319	.52809
Acc*	.1990752	.1305	1.53	0.127	-.056698	.454849	.573034
Oxen	-.0913624	.04773	-1.91	0.056	-.184908	.002183	3.85393
Ext	.0123105	.04575	0.27	0.788	-.077365	.101986	1.91011
Dis	.0254712	.02685	0.95	0.343	-.02715	.078092	6.53764
TLU	-.030807	.01448	-2.13	0.033	-.059193	-.002421	10.8989
Impseed*	.0383734	.13221	0.29	0.772	-.220748	.297495	.58427

(*) dy/dx is for discrete change of dummy variable from 0 to 1

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusion

This study was conducted in Waliso district, which is located in North west shoa of Oromia Regional state Ethiopia . In the area, maize is an important crop, which serves as a source of food and cash. The main theme of this study was to assess factors affecting adoption and status of use of improved maize varieties. A total of 89 (46 Adopters and 43 Non-adopters) sample households were selected from 2 kebeles of the district and interviewed using structured interview schedule.

The analysis was undertaken using both descriptive statistics and econometrics analysis. Result of descriptive statistics using t-test and chi-square tests indicated there were significant mean and proportion difference between adopters and non- adopters in terms of age of the households at 10%(t=1.177), family size at 10%(t=-0.605), farm size at 10%(t=-0.372),numbers of oxen 10%(t=1.300), Frequency of contact extension at 10%(t=0.294), Distance to nearest markets at 1%(t=-0.725) and the Total livestock owned at 10%(t=1.754) and sex of household at 10%(chi-square=0.0754), education of household 10% (chi-square=2.343),land fertility 10%(chi-square=1.844),access to fertilizer 10%(chi-square=2.482),access to credit 10%(chi-square=1.282) and improved seed availability 10%(chi-square=0.1423).

The Probit econometrics model was employed to estimate the effects of hypothesized independent variables on dependent variable. The study tried to investigate the status of adoption and factors influencing farmers' adoption behavior. Variation in adoption among the sample household was assessed in view of various factors categorized as household, demographic economic and institutional.

The results of the econometric model also pointed out the influence of different variables on Probability and status of adoption of improved maize varieties. A total of 13 variables were included in the Probit model of which 5 of them had shown significant relationship with adoption of improved maize varieties. Accordingly, ownership of oxen, access to fertilizer, family size, total livestock owned, and land fertility were found to have positive and negative significant influence on probability of adoption and status of adoption of improved maize varieties.

The result of this study reviled that land fertility, family size, and access to fertilizer affect probability of adoption and use of improved maize varieties positively and significantly, whereas numbers of oxen owned by households and total livestock owned by farm households affect probability of adoption and use of improved maize varieties negatively and significantly

5.2. Recommendations

Based on the findings of this study, the following points are recommended to improve the adoption of improved maize seed varieties so as to enhance its production and productivity.

In the study area family size determines the adoption of improved maize verities by affecting positively and significantly. Thus, it is recommended that the Government should give attention to advice farmers to have medium family size.

In the study area access to fertilizer determines the adoption of improved maize verities. The timely availability of fertilizer related with availability of cash on hand. Most of the time farmers save some amount of cash for the purpose of buying inputs for the coming season. The result of this study also reviled that access to fertilizer affect probability of adoption and use of improved maize varieties positively and significantly. Thus, it is recommended that the Government and other stockholders such as cooperative unions should work together to provide the needed fertilizer in each cropping season on time for the farmers.

In the study area Land fertility determines the adoption of improved maize verities by affect probability of adoption and use of improved maize varieties positively and significantly. Thus, it is recommended that the Government should advice the farmers to keep their land fertility.

In the study area numbers of oxen owned and total livestock owned by farm household determines the adoption of improved maize verities by affect probability of adoption and use of improved maize varieties negatively and significantly. Thus, it is recommended that the Agricultural extension should advice the farmers to rationalize livestock production according to their farm size they holds.

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7. Appendixes

COLLEGE OF AGRICULTURE AND NATURAL RESOURCE

DEPARTMENT OF AGRICULTURAL ECONOMICS

QUESTIONNAIRE

Title: Factors affecting of Adoption Of improved Maize Varieties in Waliso district.

General identification

1. Date of interview…….
2. Name of respondent…….
3. Kebeles of respondent…….

A. **General information**

1. Sex of the household head i. Male ii. Female
2. Marital status, 1. Single 2.Married 3.Divorced 4.Widowed
3. Age of the household head in years(_____years)
4. Education level of the household head (_____years of schooling)
5. Household size in numbers?

a. below 15 years old a. Male_____ b. Female_____ c. Total_____

b. aged between 15 and 64 a. Male_____ b. Female_____ c. Total_____

c. above 65 years old a. male_____ b. Female_____ c. Total_____

B. Production and Natural Resource Data

1. What is the total area of your farm land in hectares? (_____hectare/s)
2. What is the fertility status of your land? a. fertile b. medium c. less fertile
3. What the total area of your land is allocated for maize production? (_____hectares)
4. Have you adopted new varieties of maize last year? a. yes b. no
5. If you use improved varieties give the name and indicate the time you start usingthem and the area you cultivate:

Name of the varieties	Time of using	Area
1.		
2.		
3.		

6. Give reasons why you decided to use Improved varieties (early maturing maize varieties)?(Tick where appropriate)

i. Resistance to drought ii. Taste good iii. High yielding ability iv. Resistance to pest

v. Resistance to disease vi. Mature early vii. Others(specify)……

7. On which types of farm activity your female family members participated?

i. Weeding ii. Harvesting iii. Ploughing iv. Trashing v. Others specify------

8. Do you grow other crops? i. Yes ii. No

9. If yes what other crops do you grow? (Tick where appropriate)

i. Sorghum ii. Teff iii. Wheat iv. Others (Specify)……

10. What are the crops usually consumed by your family?

i. Wheat ii. Maize iii. Barely iv. Others ----------

11. What are the major problem of the existing Maize seed supply system?

i .High input price ii. Lack of credit iii. Shortage of supply

iv. Poor quality v. No problem vi. Other specify ---

12. Where did you get improved maize seed? (Tick where appropriate)

i. Cooperatives ii. District Agriculture Office iii. Research institutes

iv. Market v. Others (specify)

13. What problems did you face? (Tick where appropriate)

i. Not available on time ii. Not available in required time

iii. Price is high iv. No problem v. Others (Specify)

14. Do you keep livestock? i. Yes ii. No

15. If yes what type livestock do you own?

S.No.	Types of livestock	Number
1	Ox	
2	Cow	

3	Heifer	
4	Calf	
5	Sheep	
6	Goat	
7	Horse	
8	Donkey	
9	Other specify	

C. Institutional Factors

1. Households distance from the nearest market(_____km)
2. Frequency of extension visit last year(_____number of visits)
3. Do you have confidence on the extension services given by extension units? a. yes b. no
4. Do you receive any credit? (Tick one) i. Yes ii. No
5. If yes where did you get the credit?

   i. Cooperatives ii. Banks iii. Microfinance iv. Others (Specify)
6. Are you a member of cooperatives? a. yes b. no