DETERMINANT OF ADOPTION OF IMPROVED MAIZE VARIATIES IN CASE OF CHAHE WOREDA GURAGE ZONE ETHIOPIA

A research project submitted to the department of agricultural economics in partial fulfillmt of the requirement for the award of the degree of (bsc) in agricultural economicens

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LIST OF ACRONYEM AND ABBRIVIATION

ATA	Agricultural Transformation Agency
BH	Bako High Breed
CSA	Central Statistical Agency
EARO	Ethiopian Agriculture Research Organization
ESE	Ethiopian Seed Enterprise
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
Ha	Hectare
ICRISAT	International Crop Research Institute for Semi-Arid Tropics
KM	Kilo Meter
Masl	Meter above sea level
MLM	Multinomial Logit model
IMWIC	International Maize and Wheat Improvement Center
MoANRO	Ministry of Agriculture and Natural Resource Office
MoA	Ministry of Agriculture
MoFED	Ministry of Finance and Economic Development
NARS	National Agricultural Research System
NGOs	Non-Governmental Organization
PVS	Participatory Variety Selection
RSE	Regional Seed Enterprise
SARC	Sirinka Agricultural Research Centre
SCM	Stated Choice Model
SNNPR	South Nation Nationality People Region
TLU	Tropical Livestock Unit
UNDP	United Nation Development Program
VIF	Variance Inflation Factor

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ABSTRACT

The aims of this study: identify factors influencing adoption of improved maize varieties at household level; large numbers of technologies have been generated over the last many years. However, the adoption of these technologies by small holder farmers was limited. The adoption of new maize varieties, under varying contextual setting, is influenced by many socio-economic, institutional and demographic factors of the farm households. So, it is vital to be aware and there is a need to understand the contextual factors affecting the adoption of new maize varieties in order to generate and disseminate appropriate maize varieties to farmer. For this research data *was collected from 70 households using a multi-stage sampling technique from three sample kebeles in cheha district. For the study, both primary and secondary data were employed. Descriptive statistics such as percentage, mean, and standard deviation and inferential statistics such as independent t-tests and chi-square tests were used. STATA statistical computer software program was used to analyze the collected data. The result of the model revealed that the explanatory variables education, farm size, total active household labor in man equivalent, income, contact extension agent, off farm, were statistically significant and positively influence adoption of improved maize varieties. Whereas age and market distance were found to have a significant and negative influence on the adoption decision of improved maize varieties. The result from this survey suggests that implementation of well-established extension package, formation of compatible rural credit institutions, improvement of infrastructure and collective action of farmers, researchers, development agent, and entire stakeholders are helpful.*

1. INTRODUCTION

1.1. Background of the Study

According to the World Bank (2021), the agriculture sector contributed 32.5% to Ethiopia's GDP, down from 36.7% in 2016. The sector continues to provide the majority of employment, with 65.2% of the total employed population working in agriculture as of 2021 (World Bank, 2023). Despite such outstanding potentials roles, currently, the productivity of the agricultural sector in Ethiopia has been limited and challenged due to many determinants (Ketema, 2017).

Lack of appropriate and affordable new agricultural technologies, poor infrastructure, inefficient marketing systems, land degradation, rapidly expanding population, and inaccessibility to agricultural inputs and low adoption rate toward new agricultural technologies are important determinants that have limited the productivity of agricultural sector (Muzari, 2012; Bekabil, 2014; Zebib, 2014; Bihon, 2015 and Macauley, 2015); Bihon, 2015).

Currently, Ethiopia is the second largest producer of maize in Africa, producing approximately 9.4 million metric tons. Within the east Africa region, Ethiopia remains the largest producer of maize. African region (FAO, 2021). It is also significant that Ethiopia produces non-genetically modified (GMO) white maize, the preferred type of maize in neighboring markets. This strategy envisions exports markets being a significant part of the demand sink for Ethiopian maize. Maize is largest cereal commodity in terms of total production, acreage, and the number of farm holdings. It ranks second after teff in area coverage and first in total production (FAO 2021).

In Ethiopia, maize grows under a wide range of environmental conditions between 500 to 2400 meters above sea level. Maize in Ethiopia’s leading cereal in terms of production, with 6 million tons produced in 2012 by 9 million farmers across 2 million hectares of land (CSA 2011/12, Meher season). Over half of all Ethiopian farmers grow maize, mostly for subsistence, with 75 % of all maize produced being consumed by the farming household. Currently, maize is the cheapest source of calorie intake in Ethiopia, providing 20.6 % of per capita calorie intake nationally (Rashid, 2010).

In Ethiopia cereals account for about 80% of the annual crop production and maize is the first in total production and yield per unit area and second in area coverage among all the cereals. Total area covered by maize during the 2006/07 growing season was 1.7 million ha and the national average yield was about 2.2 t ha-1 (CSA, 2014).

In southern region from the total land size of 1,066,825.51 hectares planted to all grain crops, cereals covered 859,340.71 hectares with a total production of 14,801,477.56 quintals. Maize improvement in Ethiopia started half a century ago. During the late1960s and early 1970s, several promising hybrids and composite varieties of East African origin were introduced and evaluated at different locations. These resulted in the recommendation of several maize varieties for the maize growing regions of the country (Abdurahman, 2009).

Maize is an important crop for overall food security and also used for making local beverages. Additionally, the leaves and stoves are International Food Policy Research Institute used to feed animals and the stalks are used for construction and fuel. A small quantity of the grain produced is currently used in livestock and poultry feed, and this is expected to increase with the development of the livestock and poultry enterprises in the country. The green fodder from thinning and topping is an important source of animal feed and the dry fodder is used during the dry season. Moreover, the crop has potential uses for industrial purposes, serving as a starch, a sweetener for soft drinks, an input for ethanol fuel production and oil extraction (FAO, 2012).

As compared to other cereals, maize can attain the highest potential yield per unit area. The average yield in developing countries is 2.5 t/ha. In Ethiopia the national average yield is about 3.6 t/ha (CSA, 2016). While significant gains have been made in maize production over the past decade, there remains large potential to increase productivity. From 2001 to 2011, maize production increased by 50%, due to increases in both per hectare yields (+25%) and area under cultivation (+20%). However, estimates indicate that the current maize yield could be doubled if farmers adopt higher quality inputs and proven agronomy best practices. At present, only 17% of maize farmers representing 30% of maize planted area make use of improved varieties of seed and only 30% of farmers use the recommended rates for fertilizer application (ATA, 2017).

The results of the year (CSA, 2016), Meher season postharvest crop production survey indicate that total land areas of about 12,558,444.55 hectares were covered by grain crops. Out of the total grain crop areas, 81.27% (10,144,252.30 hectares) was under cereals. Of this maize covered 16.98% (about 2,135,571.85 hectares) and average yield Q/t/ha (3.67) and gave 78,471,146.57quintals (CSA, 2016/17). The productivity of is very low as compared the developed counties 6.2t/ha because of lower utilization of improved agricultural technologies such as improved maize variety and chemical fertilizer among maize producing farmers.

Maize is mainly grown in the four big regions of the country: Oromia, Amhara, SNNP, and Tigray. Oromia contribute to almost eighty percent of the maize produced in 2012 (CSA, 2015/2016). Maize is among the major food crops widely produced and consumed by smallholder farmers in Ethiopia in general and in cheha district in particular.

Area under maize during 2016/17 main cropping season in Ethiopia was about 2.1 million ha, which makes maize to be the second in area coverage out of cereals. During the same period, maize ranks first among cereals in terms of total production accounting for about 7.8 million tons. During the same period South Omo Zone average productivity of maize about 2.5tons in that order which is below the national average of about 3.6 tones ha-1 (CSA, 2016).

The low productivity of maize is attributed to many factors like frequent occurrence of drought, declining of soil fertility, low rates of adoption of improved varieties, poor management practice, limited use of input, insufficient technology generation, lack of credit facilities, poor seed quality, disease and pests (Muzari, 2012; Govind et al., 2015). This study will be conducting by examining the determinants of adoption of improved maize variety, in Cheha woreda Gurage Zone Centeral Ethiopial Regional State.

1.2. Statement of the Problem

The adoption of agricultural innovation in developing countries including Ethiopia has attracted Considerable attention because it can provide the basis for increasing production and productivity. Have been stated that adoption is the process of a decision to make full use of a technology as the best course of action available and consists of three stages namely pre-adoption, adoption, and post-adoption. It is apparent that agricultural productivity improvements

will be improved among farmers through improved agricultural technologies which had developed at the research centers and disseminated to farmers' mainly through extension services (Stephen et al., 2014). On the other hand, the farmers' integration of these improved agricultural technologies into their farms is greatly influenced by socio-economic, institutional, attitude and perceived technology attributes (Bihon,2015).

The limiting maize productivity include production and market risks, low level of crop management practices, weeds, pest and diseases, erratic rainfall, erosion, low soil fertility, poor infrastructure, and post-harvest crop losses (Sisay., 2016).

In the study area During 2009-2010 meher cropping season maize covered a total of 4500 ha of land from these 2700 ha was covered by local maize varieties and 35100 quintal of maize was obtained while 1800 ha of land was covered by improved maize varieties and 43200 quintal of maize was obtained. The productivity of maize crop is very low because of lower utilization of improved agricultural technologies such as improved maize variety, poor management practices, seed quality, disease and pest infestation and chemical fertilizer among maize producing farmers.

Thus, research in this area is vital for understanding the problems related to the improved maize variety production, adoption level of improved maize technologies. Therefore, with the above-mentioned gaps, the research Was intended to conduct examining the determinants of improved maize variety, adoption level and recommended with a view to filling the existing knowledge gap into the study area.

1.3. Objectives of the Study

1.3.1. General objective

To identify determinants of adoption of improved maize variety in case of Cheha Woreda Gurage Zone.

1.3.2. Specific objectives

1) To know the adoption level of improved maize variety at household level.

2) To identify determinants of adoption of improved maize variety in the study area.

1.4. Research Question

1. What is current adoption level of the improved maize variety in the study area?
2. What are determinants that affect the adoption of improved maize variety in to the study area?

1.5. Significance of the Study

Maize is selected for this study due to its importance for food consumption, agronomic purpose and agro-ecological suitability to grow in to the study area. In the study area, the new agricultural technologies are often adopted slowly and several aspects of adoption remain poorly understood despite being seen as an important route out of poverty and famine. Thus, research into study this area is so vital for understanding the problems related to the maize production and level of adoption of improved maize variety.

All farmers, Agricultural experts, NGOs and policymakers should be understanding and diagnose the determinants that affect the adoption of improved maize variety production in order to target and extend appropriate technologies to farmers. To the end, the output of this research is expected to help as a reference material for others who want to conduct research on the same topic and indicate future areas of research.

1.6. Scope and Limitations of the Study

This study was conducted in Cheha district of the Gurage zone Centeral Ethiopia Region State. The study is a micro level limited to three kebeles in Cheha. The district is selected from many maize growing districts of the zone as it is the major maize producing area. Therefore, the study was limited coverage from the zone in particular and from maize growing areas of Gurage in general. Moreover, the study was use cross sectional data of only one cropping season. Therefore, the nature of the data (cross-sectional data) would enable us to understand and capture various dynamisms of the subject under interest. The study was carried out by surveying a

sample of randomly selected farm households from three kebeles. due to limited time and resources availability, it is not possible to study the entire farming population in the district.

2. LITERATURE REVIEW

2.1. Concept and Definition of Adoption

The adoption of an innovation within a social system takes place through its adoption by individuals or groups. Adoption may be defined as the integration of an innovation into farmers‟ normal farming activities over an extended period of time (Feder et al., 1982). However adoption is not a permanent behavior, this implies that an individual may decide to discontinue the use of an innovation for a variety of personal, institutional, and social reasons one of which might be the availability of another practice that is better in satisfying farmers‟ needs (Adesina, 1993) Diffusion **of innovations** refers to the spread of abstract ideas and concepts, technical information, and actual practices within a social system, where the spread denotes flow or movement from a source to an adopter, typically via communication and influence (Rogers, 1995).

Adoption can be classified as an individual (farm level) adoption and aggregate adoption. Adoption at the individual farmers‟ level is defined as the degree of use of new technology in long-run equilibrium when the farmer has full information about the new technology and its potential. In the context of aggregate adoption behaviors, they defined diffusion process as the spread of new technology within a region. This implies that aggregate adoption is measured by the aggregate level of specific new technology with a given geographical area or within the given population (Rogers and Everett, 1985).

Adoption can be defined as the mental process through which individual passes from first hearing about an innovation or technology to final adoption. This indicates that adoption is not a sudden event but a process. Farmers do not accept innovations immediately; they need time to think about things before reaching a decision. The rate of adoption is defined as the percentage of farmers who have adopted a given technology (Rogers and Everett, 1983).

The adoption or rejection of an innovation is the consequence of the diffusion of an innovation (Kidane et al., 2016). Diffusion is a process by which new ideas are communicated to the members of a social system. Diffusion and adoption are thus closely interrelated even though

they are conceptually distinct (Lievrouw and Pope, 1994) not all innovations diffuse at the same rate. The differences in the diffusion rates of innovations in a community can be largely explained by the differences in the traits of innovation, as perceived by potential adopters such as relative advantage, compatibility, complexity, trial ability, and observability (Rogers and Everett, 1983).

Rate of Adoption: This term refers to the speed at which new technologies, practices, or innovations are embraced by users or a population. It is typically measured by the proportion of individuals or households that adopt a new method or technology within a specified time frame, often expressed as a percentage.

Intensity of Adoption: This concept describes the extent to which users engage with or implement a newly adopted technology or practice. It goes beyond whether adoption occurred to evaluate how thoroughly the technology is used; for instance, it might assess the frequency and depth of use among those who have adopted it.

Technology: Technology encompasses the tools, systems, and methods created by humans to solve problems or enhance capabilities. In agriculture, this can include machinery, software, chemical inputs, and biological techniques used to improve productivity and efficiency.

Maize: Commonly known as corn, maize is a cereal grain that originated in southern Mexico over 10,000 years ago. It is one of the most widely cultivated crops globally and serves as a staple food for many cultures. Maize can be consumed directly, processed into various food products, or used as animal feed and in industrial applications.

Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system. It is a special type of communication, in that the messages are concerned with new ideas (Ray, 2001). An innovation diffuses within a social system through its adoption by individuals and groups. The spread of innovations across social groups over time is referred to as the diffusion of innovations (Stoneman, 2002).

Rogers differentiates the adoption process from the diffusion process in that the diffusion process occurs within society, as a group process; whereas, the adoption process is pertaining to an individual. And he also defines "the adoption process as the mental process through which an individual passes from first hearing about an innovation to final adoption".

Some other authors tried to show the similarity and difference between adoption and diffusion. Diffusion and Adoption are thus closely interrelated even though they are conceptually distinct. Katungi (2007) indicates that, the unit of analysis in adoption study is an individual decision maker (farmer) or decision-making unit (farm household). Diffusion studies refer to the cumulative adoption path or distribution of adoption (percentage of farmers, percentage of area) over time or space with the community, region, nation or another geographical scale as the unit of analysis.

Diffusion takes time for an innovation to diffuse throughout a social system (Dasgupta, 1989). Because, new ideas and ways of doing things do not necessarily take hold all at once, but often spread gradually through social networks. That means from the early adopters of the technology to family, relatives and friends, neighbors and then to villagers as well as other communities.

2.1.1. Economic importance and status of maize production in Ethiopia

According to police and performance Ethiopian cereal markets; Agriculture continues to be the dominant sector in Ethiopia's economy, with cereals playing the central role. Grain production and marketing are particularly important: studies show that cereals account for 65 percent of the agricultural value added, equivalent to about 30 percent of the national GDP.

According to advance in crop science and technology, Research efforts have been made to generate and release improved varieties of maize seed and a number of varieties have been disseminated among small-scale farmers through different extension organization such as MoA and NGOs. The seed system in Ethiopia can be classified as formal and informal. The formal seed system is called formal because it is mainly a government-supported system and several public institutions are also involved in it. The major actors of the formal system are National Agricultural Research Systems (NARS), Ministry of Agriculture (MoA), Ethiopian Seed

Enterprise (ESE) and private seed companies specializing on specific crops like Pioneer. Recently, regional seed enterprises (RSE) were also established as public seed enterprises (such as Oromia Seed ESE and RSEs) are playing key roles in the mass production of improved seeds.

The informal seed system, also known as local system or sometimes as "farmers" system, is called informal because it operates under non-law regulated and characterized by farmer-to-farmer seed exchange. According to (Elizabeth & Turner, 1992), five key features distinguish the informal from the formal system. These are, the informal system is traditional, semi-structured, operate at the individual community level, uses a wide range of exchange mechanisms, and usually deal with small quantities of seeds often demanded by farmers.

2.1.2. Agriculture in the Ethiopian Economy

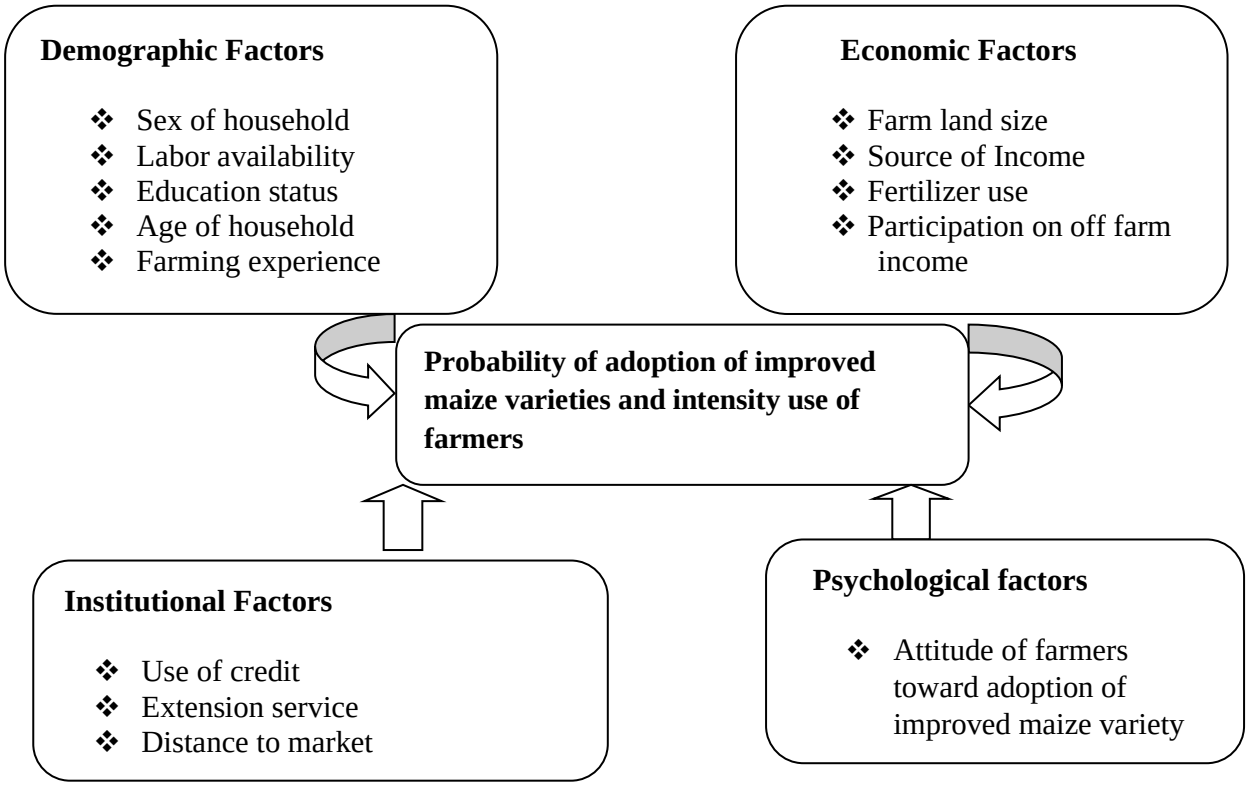
Ethiopia is the second most populous African nation (population estimated to be 84 million) occupying 1.12 million square km (Central Statistical Agency, 2011). The county's economy relies heavily on agriculture. The sector contributes about 41% of the GDP and employs 83% of the economically active population (National Bank of Ethiopia, 2011). The major cereal crops cultivated in the country are teff (2,761,190 ha), maize (1,963,179 ha), sorghum (1,897,733 ha), wheat (1,553, 240 ha), and barley (1,046,555 ha). Pulses are important grain crops for cash earning as well as for food production (Central Statistical Agency, 2011). Although farming 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 tef, maize, sorghum and wheat were 1.26, 2.54, 2.08 and 1.84 tons per hectare respectively (Central Statistical Agency, 2011) while the potential of those crops is two to three times higher Food insecurity has been a persistent issue in the country where the recurrent drought considerably affects crop production of its numerous villages7 (Dercon et al., 2005).

2.1.3. Conceptual Framework

Adoption decisions of different technologies across space and time are influenced by different factors and their associations. Factors such as Demographic, socioeconomic, institutional and

psychological factors determine the probability of adoption improved technologies (Rogers and Everett, 1983).

Figure 1: Conceptual framework



Source, Edilegnaw (2024)

2.3. Empirical Review

According to (Gecho and Punjabi, 2011) Farming experience is one important aspect related to adoption of improved maize variety at household level related to variable that have relationship with adoption. Longer farming experience implies accumulated farming knowledge and skill, which has the contribution to adoption. Many studies supported this argument. In the same line (Habtemariam, 2004; Tura, 2010 and Sisay, 2016) also reported that more the experience of growing maize, the higher the adoption of new varieties. Such a pattern is expected because more experienced farmers may have better skills and access to information about improved

technologies. In contrary, farming experience is to have negative relationship with over all dairy adoption. However, reported that farming experience has no statistically significant relationship with adoption (Jaleta et al., 2013 and Rahmeto, 2007).

According to (Temesgen et al., 2015; Gbegeh and Akubilo, 2013; Isaiah et al., 2013) and Tariku, 2012) reported that the existing gap among male headed and female-headed households in terms of participation in maize and wheat production technology. The low participation of female-headed households in maize and wheat production technology may be related to their access to information and other resources. They also further mentioned that being a male-headed household increases the probability of adoption.

According to (Degefu, 2017) Sex of the household head was found negatively influencing adoption of the technology. The result indicated that if the household head is male, the chances of adoption of wheat technology package decrease by the factor of 0.116 as compared to a household headed by the female, and the result was statistically significant at 10% level of significance.

According to Salifu *et al*. (2015) Education is associated with the technology adoption because of it is assumed that increase farmers‟ ability to obtain and analyze information that helps him/her to make the appropriate decision.

According to Mekuria *et al.* 2013) study were examined the relationship between education status and technology adoption the year of education increases the probability of adoption of improved seed.

Active family labor is also one of an important variable for the technology accepting easily. The study conducted by (Owoeye, 2017; Abdi et al., 2015; Mekuria, 2013; Gecho and Punjabi, 2011) were examined the relationship between the availability of labor force and technology adoption. A study conducted by (Nkonya et al., 1997; Woldemariam and Gecho, 2017; Ebojei et al., 2012 and Alemu et al., 2008) size of farmland is expected to influence the adoption of agricultural technology positively as those operating larger farms tend to have greater financial resources, incentives, and more land to allocate to the improved agricultural technologies. On the contrary (Rahmeto, 2007) reported that landholding was not significant in the adoption of improved

haricot bean and onion technology package respectively. The farm size shows that farm size is among the major positive determinants of wheat technology package adoption and the result is statistically significant at the 5% level. Accordingly, allocation of one more hectare of the farmland to wheat production increases adoption of wheat technology package by a factor of 0.285, other factors kept constant. This could be expected because, in reality, the economic gain (productivity and profitability) from the production of crops like wheat is better on the relatively large size of land than on small plots of land unlike the cases for other crops such as potato and other vegetables.

According to (Yu and Nin-pratt, 2014; Birhanu et al., 2014 and Govind et al., 2015) contact with extension workers positively affects adoption of chemical fertilizer and statistically significant at 10% level of significance. Farm income is one important variable for adoption decision. The amounts of household income obtained from the sale of crop and animal, after household consumption met helps to purchase agricultural inputs. The income obtained from farm selling crops and selling of livestock such activities help farmers to purchase farm inputs.

According to Yu and Nin-pratt, 2014; and (Kassa et al., 2013) reported that household income had a positive and significant effect for technology adoption. The output for annual income shows that it was among the determinants of adoption of wheat technology package in the study area. Accordingly, an increase in household annual income by one Birr would lead to an increase in the likelihood of wheat technology adoption by a factor of 0.004, keeping other factors constant. This could happen because a household with sufficient annual income could not be financially constrained and prohibited from the timely use of the wheat technology packages.

Total Livestock size is an important indicator of households‟ wealth position. Livestock is also an important source of generating income that helps to purchase agricultural inputs. Usually, it has a positive association with technology adoption decision. According to (Woldemariam and Gecho, 2017; Kassa et al., 2013; Abadi, et al, 2015; Mekuria, 2013 and Rahmeto, 2007) prove this hypothesis. It has a positive effect on the status, intensity, speed of technology adoption and decision to adopt recommended agronomic practices in maize farming.

According to (Tariku, 2012) in their study reported that the availability of reliable information sources will enhance communication process and had significant associations with the adoption

of improved technologies. Access to credit is very important for technology adoption. The study conducted by (Sisay, 2016) reported that use to credit had a significant and positive influence on the adoption of improved and high yielding maize technology in major maize growing regions of Ethiopia. Distance to the main market, distance to main road and distance to agricultural office are usually inversely affected for technology adoption decision.

According to (Hagos and Zemedu, 2015; Tadesse, 2008 and Rahmeto, 2007) on adoption of improved onion and haricot bean technology respectively have shown the significant relationship to nearest market distance. However, reported that the distance to market is negatively related to chickpea adoption. Participation in extension training will enable farmers to get more information and improve their understanding of the available packages, which may intern leads to a change in their knowledge, attitude, and behavior. According to (Abdi et al., 2015 and TariKu, 2012) attending of agricultural training is positively and significantly related to the adoption of improved maize technologies. Attendance on extension events is very necessary for a decision of technology adoption (Mesfin, 2017; Feleke and Zegeye, 2006) showed that significant effect of this variable on technology adoption.

According to (Hagos and Zemedu, 2015) Distance to the main market was found to be negatively significantly correlated with the likelihood of adoption. and also noted the negative and significant association of market distance with the adoption of improved maize in southern Ethiopia. This positive and significant effect implies that farmers who do not have cash and access to credit may find it very difficult to adopt new technologies while those who have access to credit can overcome their constraints and be able to buy inputs.

According to (Govind et al., 2015; Obayelu et al., 2017) Credit can facilitate farm households to purchase the needed agricultural inputs and enhance their capacity to effect long term investment in their farms. Credit access in some countries where female-headed households are discriminated against by credit institutions, prevent women who are into agriculture from adopting yielding-raising technologies.

According to (Salifu et al., 2015; Gbegeh and Akubilo, 2013) reported significant the logit results show that the probability of adoption of improved maize varieties is directly related to years of the farmers‟ exposer to maize production. Adoption behavior and production efficiency

were hypothesized to be a function of personal and environmental factors, which in turn are divided into independent and intervening variables identified by (Habtemariam, 2004). Empirical evidence provided by (Ogunsumi, 2011) on the role of perception on behavior and behavioral consequences supports the assumption that the influence of the independent variables becomes manifested in behaviour via the intervening or mediating variables. Subsequent findings by (Robert et al., 2011) have reaffirmed that the mediating function of perception together with needs and knowledge.

Farmer's perception of an innovation largely depends upon their knowledge and information about the innovation, socio-economic conditions and agro-ecological variables. Farmers‟ knowledge on improved agricultural technology can be accelerated with the help of extension agents and farm information sources. Preference of short-maturing or intermediate or long maturing varieties depends upon farmers‟ evaluation on yield and total benefit accrued from the variety within one year. So, sometimes farmers can prefer intermediate and even long maturing varieties as reported in the studies of (Ogunsumi, 2011; Kidane et al, 2016; Cavane, 2011 and Kaliba et al., 2000). The findings indicated that the adopters of improved sorghum varieties had a positive attitude towards improved sorghum varieties when compared to the non-adopters (Egge et al., 2012).

3. RESEARCH METHODOLOGY

3.1. Description of Study Area

The study was conduct in the Cheha woreda, which is one of the Guraghe Zone, Central Ethiopia Regional State, Ethiopia, located at 188km South of Addis Ababa on the way to Wolkite town, the capital of the zone. its geographical coordinates are 8° 00' 18.9" to 8^0 15’ 28.53” North, and 37° 35' 46.48" to 38^0 03’ 59.59” East. The total area cover is 44,072 hectares and its altitude ranges from 1200m a.s.l in the lowlands and 2600m a.s.lin the highlands. The annual rainfall of the area ranges from 800 to 1200mm. Enemor Ener woreda borders in the South, Oromia region in the West, Ezha woreda in the East, Gumer and Geta in the Southeast, and Wabe river, which separates it from Abeshege, and Kebena in the North. The woreda constitutes 40 rural kebeles (the lowest administrative unit) of which 39 are rural and 1 is rural town. According to census of 2007 the district population 178,250 of whom 87,042 were Male and 91,208 Female; and 168,750 of its population were Rural dwellers and 9500 were Urban dwellers

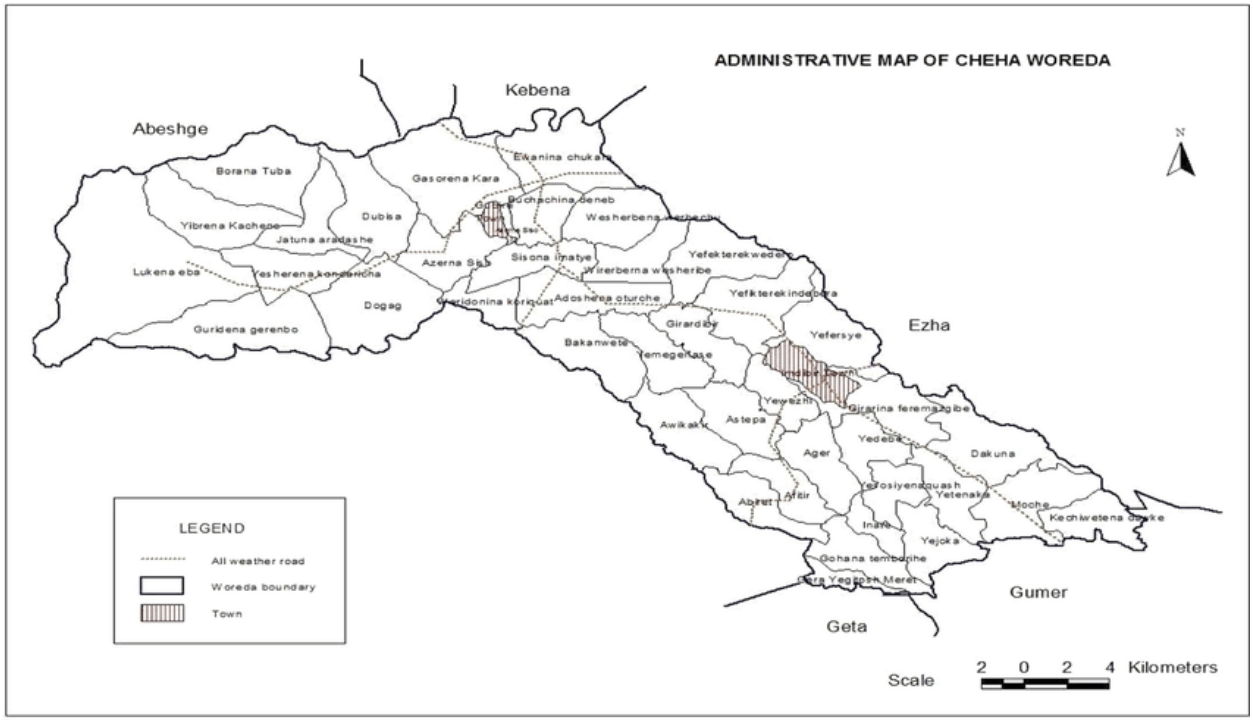


Figure 2) map of study area

3.2. Type and Source of Data Collection

This study was used both primary and secondary data sources. The primary data was collected from sample of respondents and key informants. But the secondary was collected from experts (natural resource expert), books, statistical reports (like the Ministry of Agriculture and Rural Development and CSA) and official documents.

Secondary data is the data that are already available i.e., the data which have already been collected and analyzed by someone else before. Secondary data for this study obtained from the book, journals, published and unpublished documents from the district level of Agricultural and Natural Resource office report, kebeles administrative office, and different offices within woreda who have useful sources, internet, and other related sources to supplement primary data.

3.2.1. Methods of data collection

Questionnaires: Both closed and open-ended semi-structured questionnaires were prepared to generate the required information. Firstly, semi-structured questionnaires were tested at the farm level on 5 randomly select farm households. In the light of pre-testing, essential amendments would make on such things as ordering and wording of questions and coverage of the interview schedule. Furthermore, the pre-test enables to know whether farmers clearly understand the interview schedule.

Focus Group Discussion: In each of the selected kebeles, four group discussions was conduct using a checklist prepared for this purpose. The participants in the focus group discussions comprised of 8-12 farmers of which about 4–6 was women. The participants of group discussion 35 (23 male and 12 female) were selected by the aid of development agents in the kebeles considering their age and experience in introduced in new agricultural technologies and maize production practices. Specifically, they were drawn from farmers and kebele leaders.

3.3. Sampling Technique and Sample Size (Sampling Procedure)

A multi-stage sampling method was used to select sample households of the study. In the first stage Cheha were selected purposively by its potential of maize production in Gurage Centeral Ethiopia Regional State. In the second stage from the 40 maize growing kebeles, 3 kebeles (endebira,wodiro and yegrar) was identified randomly by its the potential of maize production. Finally, sample of households from thus kebeles was selected by using proportional random sampling method for the interview.

Table 1: Distribution of populations in the three kebeles

Target kebeles	No household
Endebira	800
Wodiro	647
Yegrar	500
Total	1947

Source: own communication

After reviewing different literatures for determination of scientifically acceptable sample size, the sample size was determined by following a formula developed by Yemane, 1967. The

Formula is;

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

Where: n = statistically acceptable sample size

N = Total size of target population

e = level of precision (error level) at 90% confidence level (0.1).

$$n = \frac{1947}{1 + 1947(0.1)^2} = 95$$

But using this formula, the number of sample size is too large. The researcher decides to take a sample of 70 respondents due to shortage of time and respondents are more homogeneous so that 70 respondents were representing the target population. So, their proportional size of sample is 29, 23 and 18 for Endebira, Wodiro and Yegrar kebeles respectively.

3.4. Method of Data Analysis

This study was conducted by using both descriptive statistics and econometric method for data analyses. I was used the STATA version 16 software packages for analysis the data.

3.4.1. Descriptive statistics

The collected data were analyzed by descriptive statistics such as average, percentages, and frequencies; maximum and minimum was applied to describe farmer's adoption level maize variety production in to study areas while by using STATA (Version, 16).

3.4.2. Econometric analysis

The econometric model, Logit, was used to analyze the determinants of adoption and intensity of use of improved maize varieties among sample households. Factors affecting adoption and the intensity of use of improved maize varieties are estimated by examining their influence on proportion of maize area planted with improved maize varieties. The proportion of area planted with improved maize seed has a censored distribution since it is zero for those not adopting (here after called non-adopters). This suggests that ordinary least squares regression is not appropriate and that logit estimation was used.

The most important variables that could determine adoption of improved maize varieties include age of the household, sex of the household head, active family labor, education status, cultivated farm size, distance from production area to market, source of income, credit, fertilizer use, extension services, participation of the household head in off-farm and farming experience of farmer. The selection of those explanatory variables for the model was done through literature review of previous similar works.

Specification of Model

The logit regression model was used to determine the factors that influence the adoption of improved maize variety in the study area.

Theoretically, the logit model is expressed as

$$Y = \beta_o + \beta_1 X_1 + \beta_2 X_2 + - - - - - \beta_n X_n + \varepsilon$$

Where Y = Likelihood of Adoption

βo = Intercept

$\beta 1$ - - - - n = estimated parameters

X1 - - - - n = set of independent variables

ε = error term

Adoption Index

To estimate the level of adoption, Adoption index was estimated for each of the maize variety grown in the area and consequently for local and improve maize varieties in the area. Adoption index was computed for individual famers where by adoption index (βv) is given by;

$$\beta v = \sum_{1=1}^{n} Ri \div \sum_{i=1}^{n} RT$$

Where:

βv = The adoption rate of maize variety v

V = Maize variety

Ri = Land area grown to maize variety v by individual farmer (hectare)

RT = Total land area grown to maize farm (hectare)

i = (1…. n)

3.5. Definition of Variables and Hypotheses

3.5.1. Dependent variable

Dependent variables: The dependent variables had dichotomous in nature representing farmer's adopting improved maize variety takes value of 1 for the household that cultivated improved maize variety during survey time and 0 for household that did not cultivate improved maize variety (local maize producers).

3.5.2. Independent variables

Age of the household head According to study published in the journal of agriculture economics in 2021; the age of the household head significant impact on productivity of improved maize varieties. The study found that household with younger heads were able to achieve higher yields from improved maize cultivate compared to household with older heads. These was attributed to younger household heads more receptive to adopting new agriculture technology and physical capacity to effectivity. The study recommends targeted extension service and credit

support to facilitate the adoption of improved maize technology among older household head to enhance their productivity (Ajayi et al., 2021).

Sex of the household head: sex is an important explanatory variable that explains adoption and intensity of use of new technologies. Various societies differ in values, roles and responsibilities that they share among social members. Different studies such as Doss and Morris (2001) reported that sex of the household head affected adoption of agricultural technologies in favor of male. Therefore, it is hypothesized that being a female headed household was have a negative influence in intensity of use of improved maize varieties.

Labor availability: Labor was measured in terms of Man Equivalent (Stock et al., 1991). Availability of labor is likely to influence the adoption of improved agricultural technology. Those farmers who have labor availability are expected to adopt more than those who lack labor force since improved technologies required more labor. Based on this assumption, this variable was hypothesized to have positive relationship with adoption of the improved maize variety (Alene *et al*., 2000).

Education status of the household head: Level of education was assumed to increase farmer's ability to obtain, process, and use information relevant to the adoption of improved maize production. Education is therefore expected to increase the probability of adoption of improved maize production. The variable in this study is a dummy variable defined as literate and illiterate based on the ability to read and write. Studies suggested that education level to have positive impact on adoption of new technologies (Million and Belay, 2004). It is hypothesized that education status of household heads positively influences their improved maize adoption and use intensity.

Farming experience: it is a continuous variable measured in a number of years since a respondent started farming on his own. Experience was improving the farmers‟ skill in production operations. Higher skill increases the opportunity of not undertaking the traditional enterprise. Farmers with higher experience appear to have often full information and better knowledge and are able to evaluate the advantage of the technology. It is hypothesized that farmers having more experience is expected to adopt improved maize varieties (Tura, 2010; Sisay, 2016).

Farm land size: this is a continuous variable measured in hectare indicating the amount of land operated in the survey year. From literature, the effect of farm size on technology adoption is mixed. Some of the literatures such as (Million and Belay, 2004) argue that farm size affect technology adoption positively while some others such as (Abrhaley, 2006) argue that small farms are efficient as they intensively utilize technology and labor. This study follows the later argument and hypothesized a positive relation between cultivated farm size and improved maize varieties adoption and intensity.

Distance from production area to market: This is a continuous variable measured in kilometer which was included in the model to indicate the distance of household from the market place. As the crops are bulky the proximity to the market place will matter the farmers need to produce and participate in the farming of marketable commodities. There is no doubt that transport is of great importance for adoption and intensity.

Income: It is a cash equivalent received from work, livestock and off-farm actives. It affects positively because if the farmers have more income, they can adopt maize varieties. It iscontinous variable.

Access to credit: The accessibility of credit from appropriate sources helps farmers to increase their adoption of agricultural technologies. Previous research results by (Mekonnen, 2007) reported a positive role of credit on technology adoption. It is dummy variable with a value of one if a household head has access to access to credit and zero otherwise; hence, having access to credit is hypothesized to influence adoption and extent of use of improved maize varieties.

Fertilizers use: it is dummy variable fertilize is any material of natural or synthetic origin that is applied to soils or plants. It affects positively when there is accessibility and negatively when there is less accessibility.

Extension service: it is dummy variable extension is a way of building the human capital of farmers by exposing them to information that reduces uncertainty. Public Extension service is a crucial component of government's agricultural supports in Ethiopia. It is through this service that major share of inputs required by the farmers reach to the production process. The quality and accessibility of this service therefore will have a positive effect on adoption (Degnet and

Belay, 2001). It is from this bases that is hypothesized in this study that extension service would have a positive effect on adoption and intensity of use of improved maize varieties positively.

Participation of the household head in off-farm: It is a dummy variable which take 1 for participation in off-farm activities and 0 for non-participation. Participation in such activities avail cash for purchase of inputs such as improved seeds. A study of by (Habtemariam, 2004) suggested a positive effect of off-farm participation on technology adoption. Therefore, it is with this premises that is hypothesized in this study as participation in off-farm activities wasl positively affect adoption and intensity of use of improved maize varieties.

Proportion of maize area: It is continuous variable measured in hectare that is the share of maize area in the survey year from the total cultivated farm land. The more the share of the maize area, the more attention the farmers give to the crop and the more likely they adopt new varieties in higher extent.

Table 2: Definition, measurement and hypothesis of the variable

Variables	**Type of variable**	**Measurement**	**Expected sign**
Dependent variable	Dummy	Nominal	
Explanatory variable			
Age	continuous	Scale	+/-
Sex	Dummy	Nominal	+/-
Labor availability	continuous	Scale	+
Educational statues	Dummy	Nominal	+
Farm land size	continuous	Scale	+
Distance of market	continuous	Scale	+/-

Income of household	continuous	Scale	+
Extension service	Dummy	Nominal	+
House hold credit access	Dummy	Nominal	+
Fertilizer use	Dummy	Nominal	+/-
Farming experience	continuous	Scale	+
Participation of off farm activity	Dummy	Nominal	+
Proportion of maize area	continuous	Scale	+

4. RESULTS AND DISSCUSION

This chapter mainly presents the findings of the study with an appropriate level of discussion. It is divided in to two sub-headings that could give a brief account of the subjects that were being investigated by the study. The first sub-heading presents the descriptive analysis socioeconomic characteristics of sample households. The second subheading is left for econometric model result which deals with determinants of adoption and intensity of use of improved maize varieties.

4.1. Descriptive analysis Socioeconomics Characteristics of Sample Households.

4.1.1 Analysis of continuous variables.

Age: Age of the sample households in the study ranged from 25 to 66 years. The average age of the respondents in the sample was 43.5 years old. Adopters were 40.04 years old while non-adopters 54.29 years on average. The result in table 1 also showed statistically a significant mean difference between adopter and non-adopter farmers in terms of age. This is due to older farmers are more conservative and avers to risk associated with new technologies and their perception towards improved maize variety is indigenous. They prefer local rather than improved one. An independent sample t-test has shown that statistically significant age difference among adopters and non-adopters at 1% level of probability.

Farming experience: The average farming experience of households was found to be 26.05 years. Adopters have an average farming experience of 22.28 years and non-adopter were 29.82 years on average of farming experience. This is due to long farming experienced farmer highly based on traditional way of farming. The mean difference between the groups was also statistically significant at less than 5% level of probability.

Number of active labors: household active labor members ranged from 2 to 8 persons and they have an average of active members of 4.61. Although not statistically different, adopter and non-adopter households had a mean of 4.62 and 4.59 active members respectively. An independent sample t-test showed no statistically significant difference among adopters and non-adopters in terms of proportion of active family members.

Cultivated farm: land was calculated as a sum of “owned land”, “rented-in” and “shared-in” farm land less “shared-out” farm. It is an effective farm land amount used by sample households

to undertake agricultural production. Sample households were found to hold a mean of 2.00 ha of cultivated land in the survey year. Adopters and non-adopters held a mean of 1.93 and 2.22 ha respectively. An independent sample t-test comparison also showed that non-adopters are superior to adopters in terms of their cultivated land holding at 10% probability level. This finding is in the line with other study results such as (Endrias, 2013).

On the other hand, a mean of 0.85 ha land was allocated by sample households for maize plantation. Land allocated for this crop by sample households ranged from 0.5 to 1.5 hectares. Adopters were tending to allocate meager amount of land on average (0.82 ha) as compared to the non-adopter farmers (0.88 ha). There was no significant difference in allocation of land for maize between adopter and non-adopter farmers. Hence the mean level of adoption reached 75.71%.

Income sources of sample households: Table 1 summarizes income level of sample households in adoption status groups. As a result, the income difference between adoption groups was statistically significant at 5% level of probability. Finally, a mean total income of 17587.14 ETB was generated by sample households. Adopters and non-adopter farmers generated an average total income of 20439.62 ETB and 10803.23 ETB respectively per annum. The use of improved technologies is directly or indirectly related with the level of income of the users. Rich farmers are usually observed as the first movers to try new technologies. This important status of wealthy farmers entails the better risk-taking behavior of such farmers in technology uptake. In contrary, poor farmers are usually characterized by their slow movement towards trying new technologies. This is mainly due to fear to fail to harvest lower yield than basic required amount for their subsistence. The statistical analysis is the same with the premise that is hypothesized in this study as there would be a significant difference in income level among adopters and non-adopters.

Distance from production to market: Sample households were located at a mean distance of 4.98 kilometers away from the nearest main market. Adopters were far a mean of 4.54 kilometers away from their main market while non-adopters were 5.42 kilometers far. A mean difference of market distance between adopters and non-adopters was found to be insignificant when tested with an independent sample t-test.

Table 3 Description analysis of continuous variables in sample households by and improved maize varieties adoption and intensity use.

Continuous variables	Category	Mean	Std. Dev.	Min	Max	t-value
Age of household	Adopter	40.04	9.19	25	65	
						-5.69*
	non-adopter	54.29	8.31	40	66	
	Total	43.5	8.75	25	66	
Active labor force	Adopter	4.62	1.63	2	8	
						0.08
	non-adopter	4.59	.87	3	6	
	Total	4.61	1.25	2	8	
	non-adopter	29.82	10.96	10	47	
	Total	26.05	10.94	5	47	
Income of household	adopter	20439.62	10803.23	62000	2200	
						4.27*
	Non-adopter	10803.23	5960.34	25009	2000	
	Total	17587.14	11042.1	62000	2000	
Cultivated farm size	Adopter	1.93	.58	3.75	1	-1.71***
	non-adopter	2.22	.67	3	.75	
	Total	2.00	.61	3.75	.75	
Proportion of maize land from total cultivated	Adopter	.82	.28	1.5	.5	-0.93
	non-adopter	.88	.13	1	.75	

	Total	.85	.25	1.5	.5	
Distance from production to market	Adopter	4.54	2.00	11	1	-1.60
	non-adopter	5.41	1.80	8	2	
	Total	4.75	1.98	11	2	

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

Sex of household: Table 2 describes that out of 70 sample respondents 48 (68.57 %) of sample were male and the rest 22(31.43 %) were female household heads. A chi-square comparison between categories of adopters and non-adopters in terms of their sex however showed no evidence to conclude any systematic association between sex and improved sorghum varieties adoption. Besides, among 53 adopter respondents 13(24.53%) and 40 (75.47 %) of the adopters were found to be female headed and male headed households respectively. On the other hand, 9 (52.94 %) of female headed and 8 (47.06 %) of male headed households were found to be non-adopters of improved sorghum varieties from the total of non-adopters. This clearly shows the existing gap among male headed and female headed households in terms of participation in improved maize production. The low participation of female-headed households in maize production technology may be related to their access to information and other resources.

Education: Table 2 summarized that education status of sample households. Out of 70 sample households, 16 household heads (22.86%) were illiterates, whereas 54(77.14 %) literates (could at least read or write). A chi-square test comparison with at 1 % level of probability showed a significant difference in ability to read or write between adopters and non- adopters. Among the 53 adopters 48 (90.57 %) could at least read and write while only 35.29 % of the 17 non adopter farmers did the same. Educated farmers are better able to process information and search for appropriate technologies to alleviate their production constraints. The result of this study is a with agreement the studies conducted by) who reported significant relationship between education and the adoption of improved maize production package. Hailu (2018)

Extension: Table 4 also summarizes access and utilization of extension services by sample households. From the total sample household heads, 20 (28.57%) reported that they haven't ever

got an extension service of whom 9 (16.98 % from adopter group) household are adopters and 11(64.71 % from the group) are non-adopters and 50(71.43%) have got an extension service of whom 44(80.02 % from adopters) households were adopt improved maize variety. A chi-square comparison between adopters and non-adopters' groups in this regard showed a systematic association at 1% probability level that mean extension contact enhanced the household to adopt improved maize varieties. This may be related to their access to information and other inputs.

Access of credit of respondents; Respondents were also asked whether they had been used credit or not. The data indicated that 50(71.43%) of the respondents were use credit of which 46(86.79% from the adopters) were adopters and 20(28.57%) percent of the respondents were not used credit of which 13(76.47% from the non-adopter) were also adopt improved maize variety. This implies credit users were more adopters than non-user. The reason for this is that credit was enabling them to finance/purchase external inputs such as improved maize inputs. The test of association was significant at 1% probability level.

Fertilizer use respondents: Respondents were asked about their use of fertilizer for their adoption. The response which is presented in table 2 shows that 17.14% of the respondents were not used fertilizer of which 12.86% were non adopters and 4.29% were adopters and the remaining 82.86% were use fertilizer for their adoption. The chi-square shows a significance difference between adopters and non-adopters of adoption and intensity use of improved maize variety in use of fertilizer. This is due to fertilizer increase productivity.

Off-farm activities: Many farmers can earn additional income by engaging in various off-farm activities. This is believed to raise their financial position to acquire new inputs. Out of the total households interviewed only 29(41.43%) had participated in off-farm activities, while 41(58.57%) had not participated (Table 3). Unlike priori expectation, participation in off-farm activities had insignificant relationship with adoption of improved maize variety, indicated that there is no association between off farm activity and adoption of improved maize variety. The result of this study confirms the findings of Habtemariam (2004) and Teshale(2006).

Table 4 Descriptive analysis of categorical variables in sample households by improved maize varieties adoption and intensity use

Variables		Adopter		non-adopter		Total		X^2- value
		No	%	No	%	No	%	
Sex of household	female	13	24.53	9	52.94	22	31.43	4.82**
	male	40	75.47	8	47.06	48	68.57	
Education	illiterate	5	1 9.43	11	64.71	16	22.86	22.30*
	literate	48	90.57	6	35.29	54	77.14	
Extension	access	44	83.02	6	35.29	50	71.43	14.37*
	Not-access	9	16.98	11	64.71	20	28.57	
Credit	user	46	86.79	4	23.5	50	71.43	25.24*
	non-user	7	13.21	13	76.47	20	28.57	
Fertilizer	use	50	94.34	8	47.06	58	82.86	
	Not-use	3	5.66%	9	52.94	12	17.14	20.26*
Participation in off-farm	yes	21	39.62	8	47.06	29	41.43	0.29
	no	32	60.38	9	52.94	41	58.57	

, * and** significant at 1% and 5%, levels respectively.

4.2. Econometric Model Results

In the previous section a description of sample households' important characteristics and their relation with adoption of improved maize varieties was thoroughly presented. However, a simple look at the relation and association of those variables by itself is not enough to reach on conclusion. In this section therefore, results and discussions from an econometric model analysis is presented. Accordingly, an econometric (logit) model was used to determine the influence of

various socio-economic, institutional, and farmers' preference variables on adoption and intensity of use of improved maize varieties.

4.2.1 Multicollinearity test

Multi-collinearity is a situation where we encounter an association among the explanatory variables. It refers to a situation where it becomes difficult to separate effects of independent variables on the dependent variable because of strong relationships among independent variables (Maddalla, 2013). Before running the logit model, an assessment for an existence of multi-colinearity was tested using VIF and contingency coefficients (CC).

VIF method is used to detect multicollinearity problem among continuous dependent variables. According to Maddala (1992), it can be computed using the formula,

$VIF\ (xi) = 1/1\text{-}R^2$

Where R^2 is the squared multiple correlation coefficient between Xi and the other explanatory variables. As a rule of thumb, a VIF value of more than 10 is said to be highly collinear (Gujarati, 1995). Similarly, the existence of association among discrete explanatory variables is tested using contingence coefficient method. A value of 0.75 or more indicates a stronger relationship as cited in Destaw (2013).

Prior to the estimation of the model parameters, it is crucial to look into the problem of Multicollinearity or association among the potential candidate variables. To this end, the variance inflation factor (VIF) was used to test the degree of Multicollinearity among the continuous variables.

The values of VIF for continuous variables were found to be small (i.e., VIF values less than 10). To avoid serious problem of Multicollinearity, it is quite essential to omit the variable with value 10 and more from the econometric analysis. Based on the VIF result, the data have no serious problem of Multicollinearity.

Similarly, the contingency coefficients, which measure the association between various discrete variables based on the chi-square, were computed in order to check the degree of association among the discrete variables. The values of contingency coefficient ranges between 0 and 1, with

zero indicating no association between the variables and values close to 1 indicating a high degree of association. Accordingly, the results of the computation reveal that there was no serious problem of association among discrete explanatory variables. As a result, all the 13 explanatory variables were retained and entered into logit analysis.

4.2.2. Goodness of fit

The techniques used to assess the goodness of fit of the model are pseudo R2 and prob>chi2. This means that as the table 4 shown below, the pseudo R2 (0.9860) is between 1 and 0 and the prob>chi2 (0.000) is significant at1% significant level. This indicates that the model is good or adequate. The test is used to accept or reject the alternative hypothesis "the model adequately describes the data ". If the significance level of the test is less than 0.05, it indicates that the alternative hypothesis is rejected and the null hypothesis is accepted. In the case of this study the model is good or adequate.

4.2.3. Determinants of adoption and intensity of use of improved maize varieties

This section presents maximum likelihood estimates of logit model to identify determinants of adoption and intensity of use of improved maize varieties. The dependent variable for the logit model is the proportion of farm size covered by improved maize varieties from the total maize area. A total of 13 explanatory variables, of which 7 dummy and 6 continuous, were included in the model. Maximum likelihood estimates of Logit model are summarized in Table 3 The model was significant at less than 1% level implying the appropriateness of the model to estimate the relationship between the dependent variable with at least one independent variable. From the model, a total of 7 variables were found to significantly determine adoption and intensity of improved maize varieties. The significant variables were age of household, family active labor, education status, and income of household, credit access, fertilizer use and proportion of maize farm from the total cultivated farm. The following table shows maximum likelihood estimates of the Logit Model.

Table 5 Maximum Likelihood Estimates of the Logit Model.

Variables	**estimated coefficient**	**t-ratio**	**p-value**
Age	-.0113858	-1.88	0.066 ***
Sex	-.0145906	-0.19	0.849
Active labor	.078478	2.49	0.016**
Education	.315986	3.03	0.004*
Cultivated farm	.0587641	0.67	0.506
Distance from market	-.0092265	-0.51	0.610
Income	7.24e-06	2.52	0.015**
Credit	.3355311	3.67	0.001*
Fertilizer	.2109363	1.93	0.059 ***
Extension service	.0469721	0.54	0.594
Proportion of maize area	.3898505	2.09	0.042 **
Participation on off-farm	.0706564	1.04	0.304
Farmer experience	-.0034182	-0.87	0.388
_cons	-.8489587	-2.49	0.016 **

Number of obs = 70 Prob > chi2 = 0.0000
LR chi2(15) = 96.27 Pseudo R2 = 0.9860
Log likelihood = -.68206437
Obs. Summary: 17 left-censored observations at profscbisv<=0
53 uncensored observations 0 right-censored observations

Source: own survey result 2025, *, ** and *** significant 1% 5%, and 10% levels.

Age of household: The maximum likelihood estimates of Logit model revealed that the age of the respondent affected adoption and intensity of use of improved maize varieties negatively and significantly at less than 10% level of probability. This result was found as per the prior expectation of the study. The result would tell us status of improved maize utilization among different age of household. It implies that more adult farmers use improved maize technologies more than old age farmers. The result enhances the validity of an argument which states that young aged households were efficient as they are wise in resource use and intensify the use farm technologies. This was because of young farmers having had more education and therefore, had

more access to information and they are sensitive to use new technologies and older farmers are more conservative and avers to risk associated with new technologies. The result is in agreement with findings by (Bayissa, 2011; and Alemitu 2012).

Active labor: The model result revealed that active labor force was significant at less than 5 % probability level. The relation of the variable with adoption and intensity of improved maize varieties was found to be positive. The result is same with the prior expectation. Plenty of adoption studies also found out a positive impact of family labor on technology adoption such as (Techane 2002; Bayissa, 2011 and Solomon et al., 2011). The possible explanation for the result obtained in this study could be that improved maize technologies uses a greater number of labor force at every stage of its operation to get expected yield and so a greater number of labors are required for monitoring and bird scaring as improved maize varieties being early maturing compared to the local. Mean that they can supply the required labor for different operations.

Education status of the household head: As expected, the maximum likelihood estimates of the Logit model revealed a positive and significant relation between education and maize adoption at less than 1% level of probability. The result is same with the prior expectation. In this regard, the adoption and intensity of improved maize production technology by farmers who were literate is likely to be greater than farmers who were illiterate. This suggests that being literate would improve access to information, capable to interpret the information, easily understand and analyze the situation better than illiterate farmers. So, farmer who are literate were likely to produce improved wheat and use maize production package properly than those illiterate farmers. This result has supported by other previous studies such as Techane (2012) and Yitayal (2014).

Total income: As expected, income of house hold was found out positively significant related variable with adoption and intensity of improved maize variety. The regression coefficient between income and adoption was significant at 5%. In addition to this the positive sign of the parameter shows that a person who had high income was adopter than those who had less income. The possible reason this is that when farmers have higher income, they can buy improved maize varieties and other inputs regardless of their price and also, they are less likely risk averse.

Access to credit: As expected, credit had positive and significant effect on adoption and intensity of maize of improved varieties at 1% level of probability (Tables 4). From this result it can be stated that those farmers who have access to formal credit are more likely to adopt improved maize technology than those who have no access to formal credit. The serious cash shortages faced by farmers partly due to deteriorating output prices and increasing external input prices makes availability of credit to be an important determinant of farmer's adoption decisions. So, cash enable them to finance/purchase external inputs such as improved maize varieties and fertilizer. Cash shortage faced by farmers is a constraint to farmers' ability to purchase and use improved inputs and affect optimal applications (Techane et al., 2016).

Fertilizer use: result show level of fertilizer utilization is found to be a critical variable influencing the degree of adoption and intensity of improved maize varieties 10% level of probability. The positive sign is an indicator of its influence in affecting status. The possible explanation is that those farmers who have access to fertilizer use are more likely to be adopter and high degree of use of improved maize varieties than those who have no access to it because as they use fertilizer, they have got better yield. This initiated the farmer to use improved maize varieties without fear of risk.

4.2.4. Effects of changes in explanatory variables on adoption

A change in explanatory variables from a logit model could be decomposed in to changes due to probability of adoption and changes due to intensity of use as suggested by McDonald and Moffit (1980). Accordingly, the marginal effect of significant explanatory variables in explaining adoption and intensity of use of improved maize varieties is summarized in table 4. Out of the seven significant explanatory variables, one of them was found to have a negative effect while the rest six have positive effect on the dependent variable. adoption and intensity of use of improved maize variety was affected by age of household negatively while active labor force, education status of household, income, credit access, fertilizer use and proportion of maize area which positively affected adoption and intensity of use of improved maize varieties.

A marginal effect summary in Table 6 showed that on average an increase in age of household by a year results a reduction in adoption by 0.4% and reduction intensity of use of improve maize varieties by 0.96% other variables keep constant.

Similarly, an increase in the number of productive family labor in adult equivalent in one unit would result in rise in adoption and intensity of use of improve maize technologies by 2.84% and 6.64% respectively of which much percentage (6.64%) is due to rise in intensity of use of adopters.

Additionally on average adoption and intensity of use of improve maize technologies is increase by 23.20% and 23.37% respectively as a farmer household has ability to read and write. This indicates that improvement in educational level would improve access to information so that the farmer can easily understand the benefit of improved maize production technology and increases the probability of adoption and intensity of adoption.

In other words, larger annual income also affects the probability of adopter by providing the source of cash flow to buffer the risk associated with crop failure due to bad weather condition. The interpretation of the marginal effect analysis implies that, if other factors are held constant, the probability of being adopter increases by a factor of 262.0e-06% as the farmers get unit of income and intensity of use of improved maize varieties by 613.0e-06%. As farmer household heads access credit service, adoption and intensity of use of improved maize varieties increased by 23.00% and 25.31% respectively.

This is due to the fact that, access to credit service commands the farmers‟ financial resources to buy inputs for maize production by offsetting the financial shortfall of the households.

On the other hand, as farmer gets a better access to the use of fertilizer would result in an increase of adoption and intensity of use by13.48% and 16.11% respectively. An increase in proportion maize area allocated by a hectare would also increase adoption by 14.10% and intensity of use of improved maize varieties by 33.01%, ceteris paribus.

Table 6 the marginal effects of significant variables

variables	Change in probability	Change in intensity	Total change
Agehh	.0041	.0096	.0114
Actfl	.0284	.0664	.0785
Edushh	.2320	.2337	.3160
Soui	2.62e-06	6.13e-06	7.24e-06
Accc	.2300	.2531	.3355
Feru	.1378	.1611	.2109

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

The government of Ethiopia has been implementing growth and transformation plan in order to boost the national economy. Agricultural production has been planned to have enormous contribution to overcome the problem of food security, shortage of export earnings, and provision of employment creating incomes and improving the livelihood of the population. Having these facts, participating and implementing a sustainable and knowledge-based utilization of improved technologies are critical to enhance growth and productivity in general and particularly agriculture is one of the focusing area. Maize is the first crop in terms of production and area coverage in Ethiopia and it is playing a critical role on the reduction of food security problem throughout the country and different researchers has provided substantial and better attention on this crop. This situation makes to transfer improved maize varieties to smallholder farmers‟ level for the enhancement of productivity. However, the availability of potential land could not execute as planned because of several political, economic and social impediment consequently, only small proportion of the farmers adopted these improved verities. Therefore, it is appropriate to identify the specific factors affecting the adoption decision of smallholders and determine the current rate and pattern of adoption of improved maize varieties and this was expected to suggest possible area of intervention for improving the proficiency of agricultural technology generation and dissemination. The study was conducted in Cheha Woreda Gurage zone,Centeral Ethiopia regional state. It was selected on the basis of maize growing potential. The main objective of this study was to determine factors affecting adoption decision of smallholders and to see adoption level of farmers in the study area. A sampling procedure was applied to draw the required number of sample units for the study. In the 1st stage, three potential maizes producing Kebeles were selected purposely in Cheha district. In the 2nd stage using the sample frame of the sampled Kebeles, list of sample farmers was selected for the interview. Data were obtained from 70 randomly selected respondents using personal interview, Focus group discussion (FGD). Moreover, the study was used different secondary sources of data like, different related literatures, MOARD, Journals and articles. The collected data were analyzed and presented in quantitatively using different statistical methods such as

frequency, percentage, and tabulation. Qualitative data were analyzed using explanation, interpretation, summarizing of ideas and concepts. The logit econometric model was used to estimate the effect of hypothesized independent variables on the dependent variables, probability of adoption and STATA software package were employed for statistical analysis. The study area adoption level with regards to improved maize varieties was registered that, the sample size of the study were 70 respondents. From the total interviewed households 48 (68.57%) was male respondents and the remaining 22 (31.43%) was female. Factors that affect the adoption decision of improved maize varieties for both adopters and non-adopters were found significantly different, of which some of the variables were demographic, socio-economic, institutional such as education, family size, farm size, off farm income, availability of credit, farm income, extension visit, and market distance. Finally, the output of the model showed the independent variables like education, farm size, family size, income, credit availability, off-farm income, and contact extension agent, were important variables which had positive and statistically significant on adoption decision of improved maize varieties, whereas age and market distance were found to have significant and negative influence on the adoption decision of improved maize varieties.

5.2. RECOMMENDATIONS

Enhance Educational Programs: To improve the adoption of improved maize varieties, it is crucial to implement targeted educational initiatives that focus on increasing literacy among farmers. By providing access to information about the benefits of modern agricultural practices and improved maize varieties, farmers will be better equipped to make informed decisions. Workshops and training sessions should be organized to deliver hands-on experiences and practical knowledge, thereby enhancing farmers' capacity to understand and adopt these innovations effectively.

Labor Support Initiatives: The availability of an active labor force significantly influences the adoption of improved agricultural practices. Therefore, developing initiatives that support farmers in accessing additional labor during critical planting and harvesting seasons is essential. Encouraging the formation of community labor groups can facilitate resource sharing and mutual assistance, allowing farmers to collectively adopt new agricultural technologies and practices.

Financial Assistance Programs: Access to adequate income is a key determinant for the adoption of improved maize varieties. Establishing financial assistance programs or subsidies can help farmers purchase necessary inputs such as improved seeds and fertilizers, particularly for those from low-income households. Additionally, promoting income diversification strategies, including off-farm activities, can enhance overall household income, making it easier for farmers to invest in improved agricultural practices.

Microfinance Solutions: Expanding access to microfinance and credit facilities tailored specifically for smallholder farmers is vital for enabling investments in improved agricultural inputs. These financial solutions should be complemented by training on financial literacy, educating farmers about the importance of credit for agricultural development. By providing knowledge on effective borrowing and repayment, farmers can make informed decisions that enhance their agricultural productivity.

Subsidy Programs: To encourage the use of fertilizers alongside improved maize varieties, implementing fertilizer subsidy programs can significantly reduce costs for farmers. This financial support will incentivize greater fertilizer use, which is essential for maximizing crop yields. Strengthening agricultural extension services to offer guidance on optimal fertilizer application will also ensure that farmers understand the benefits of fertilizers, thus promoting better agricultural outcomes.

Encourage Maize Cultivation: Promoting maize as a staple crop through awareness campaigns can encourage farmers to allocate more land for maize production. Highlighting the nutritional and economic benefits of maize will help farmers recognize its value. Additionally, investing in research and development to create high-yield maize varieties that are well-suited to local conditions will further incentivize farmers to increase the proportion of their land dedicated to maize cultivation, ultimately enhancing productivity and food security in the region.

By implementing these comprehensive recommendations, stakeholders can effectively facilitate the adoption of improved maize varieties, contributing to enhanced agricultural productivity and food security for smallholder farmers.

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APPENDEX 1

WOLKITE UNIVERSITY

COLLEGE OF AGRICULTURE AND NATURAL RESOURCE

DEPARTMENT OF AGRICULTURAL ECONOMICS

Questionnaire On Determinant of Adoption of Improved Maize Varieties: The Case of Cheha woreda Gurage Zone Central Ethiopia Regional State

Dear Respondent,

Good morning/good afternoon. Thank you for your interest in talking with me today. I am _____. This interview schedule is designed to find out *the determinants of adoption of improved maize varieties in the study area*. The objective of the study is purely academic and the interview is prepared to collect relevant data which is believed to come up with valuable recommendation for problems we observed. So, your value support in responding to the questions raised is very important for the success of my study. Your name will not be written on this form, and will never be used in connection with any of the information you tell me.

Your honesty in responding the right answer is vital for the research outcome to be reliable. Thank you in advance for your kind cooperation and dedicating your time. The interview will take 25- 30 minutes.

General Direction:

The enumerators are required to fill the questionnaire according to the direction and training given to them. Circle the letter that you choose and write on the space provided for the essay part.

I. General Information of Household

1. Questionnaire code/Household No: _____

2. Name of kebele: _____

3. Age of the respondent (years) _____

4. Gender:

Male □ Female □

5. Marital Status: Married □ Single □ Divorced □ Widowed □

6. Educational status: Literate □ Illiterate □

7. How many persons belong to your household (HH members)?

Male_____ Female_____ Total_____

8. Do you have land? Yes □ No □

9. If your answer is yes, what size of land do you own in timed (ha)? _____

10. How many of land allocated for maize production?

11. Have you ever attended in non- farm training? Yes □ No □

12. If yes, specify the benefit obtained from non-farm training? _____

13. How far is the distance from your home to the market? Minuit _____

14. Have you ever had credit access? Yes □ No □

15. if your answer is yes,----------

II. Income sources of family

1. What is the main source(s) of your income?
    a. Crop production _____
    b. Livestock rearing _____
    c. other (specify) _____

2. Did your sale your crop and livestock last year and this year? 1. Yes 2. No

    a. If say yes, fill the following tables:

Amount of income obtained from selling crop products and bi product in 2013/2014

No.	Type of crop or crop bi product	Amount in quantity	Unit price	Total income (birr)

1	Maize			
2	Sorghum			
3	Teff			
4	Wheat			
5	Others (specify)			
6	Total			

2. Amount of income obtained from livestock and livestock products in 2013/2014

No	Type of livestock and livestock products	Amount in quantity	Unit price	Total income (birr)
1	Milk			
2	Butter			
3	Hides			
4	Eggs			
5	Others (specify)			
6	Total			

3. Total income obtained from crop cultivation and livestock _____
4. Did you or any member of your household engage in non-farm activity? 1. Yes2. No
5. If your answer is yes, what type of activity do you or your household member performs?

Activities	Hours worked	Wage per day	Total income (birr)
Manufacturing			
Construction			
Transport			
Others			
Total			

I. Participation of non-farming income

6.

7. Why did you start your non-farm activity?
   a. Family tradition
   b. Small investment is required

c. To be self-employed e. Others (Specify) ----------

d. No other alternative for incomes

8. Who initiated and helped you to start the non- farm activity?

a. Myself

b. My family's

c. My friends d. others (specify)

9. Which is better for you in terms of generating income?

a. Farming activities

b. Non-farm activities

C,Neutral

□ No □

Household member's sex and age from the house hold head to the youngest

	1	2	3	4	5	6	7	8	9	10	11	12
Sex												
Age												

.11,Do you have access of extension service? Yes □ No □

12. If your answer is yes, how many times do you contact with agricultural extension during crop production?

12,Have you ever had fertilizer use? Yes □ No □

If your answer is yes, mention the amounts of fertilizer used for the production year

Name of inputs		Quantity in kg	Price per kilogram	Total cost incurred
Fertilizer	DAP			
	UREA			

13,Have you ever had farming experience? Yes □ No

Demographic factors

Socio economic factors

Institutional factors

APPENDEX 2

LOGIT REGRESSION RESULT

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logit Adoption Age Sex ActiveLabor Education FarmSize MarketDistance Income Credit Fertilizer Extension MaizeProportion
OffFarm Experience

Iteration 0:  log likelihood = -48.123456
Iteration 1:  log likelihood = -32.987654
Iteration 2:  log likelihood = -30.567890
Iteration 3:  log likelihood = -30.123456
Iteration 4:  log likelihood = -30.098765

Logistic regression                     Number of obs   =         70
                                        LR chi2(13)     =      96.27
                                        Prob > chi2     =     0.0000
Log likelihood = -30.098765             Pseudo R2       =     0.9860

------------------------------------------------------------------------------
    Adoption | Coefficient  Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         Age |   -.0113858   .0060453    -1.88   0.066    -.0232341    .0004625
         Sex |   -.0145906   .0765432    -0.19   0.849    -.1646126    .1354314
  ActiveLabor |   .078478   .0315432     2.49   0.016     .016654     .1403021
   Education |   .315986   .1043212     3.03   0.004     .1115201    .5204519
    FarmSize |   .0587641   .0876543     0.67   0.506    -.1130346    .2305628
MarketDstn |   -.0092265   .0180987    -0.51   0.610    -.0446994    .0262464
      Income |   7.2406     2.8706      2.52   0.015     1.6106      .0000129
      Credit |   .3355311   .0912345     3.67   0.001     .1567151    .5143471
   Fertilizer |   .2109363   .1098765     1.93   0.059    -.0043976    .4262702
   Extension |   .0469721   .0876543     0.54   0.594    -.1249876    .2189318
MaizeProp|   .3898505   .1865432     2.09   0.042     .0242321    .7554689
     OffFarm |   .0706564   .0678901     1.04   0.304    -.0624056    .2037184
  Experience|  -.0034182   .0039456    -0.87   0.388    -.0111514    .0043151
       _cons |   -.8489587   .3410987    -2.49   0.016     -1.517499   -.1804184
------------------------------------------------------------------------------
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