DETERMINANTS OF ADOPTING AND IMPROVED BREAD WHEAT VARIETIES: THE CASE OF LEMO WOREDA HADIYA ZONE, SNNPR ETHIOPIA

MSc. THESIS

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By

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MSc. Thesis

Submitted to Jimma University College of Agriculture and Veterinary Medicine, Department of Rural Development and Agricultural Extension, in partial fulfillment of the requirements for the MSc specialization in Agricultural communication and innovation.

Major Advisor; Dereje Hamza (PhD)

Co-Advisor; Simon Seyoum (PhD scholar)

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DEDICATION

I dedicate this thesis manuscript to my family for their continuous prayer in my academic success and life, especially, to my mother Tadelach Tuloro who sacrificed much to bring me up to this level.

STATEMENT OF AUTHOR

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

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BIOGRAPHICAL SKETCH

The author, Degefa Egiso Amano was born in Misha woreda, Hadiya Zone, SNNPR in 1987. He attended his elementary school at *Wesgebeta* primary school and completed his high school study in *Morsito* secondary school and he was completed his preparatory school in *Wachemo* comprehensive senior secondary school in 2007. He then joined the Wolaita Sodo University in 2008 and graduated in 2010 with a BSc degree in Rural Development and Agricultural Extension. Soon after graduation, he worked in Shashogo District Cooperative and Marketing Office 2011 to 2016 as input supply, market linkage and facilitator expert and he served also in Lemo District Trade and Industry Development Office until he joins Jimma University. He joined the School of Graduate Studies of Jimma University in October 2017 for his post-graduate studies in the field of Agricultural Communication.

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LIST OF ABBREVIATIONS AND ACRONYMS

CC	Contingency Coefficient
CIMMYT	International Maize and Wheat Improvement Center
CSA	Central Statistics Agency
DAs	Development Agents
DH	Double Hurdle
EIAR	Ethiopia Institute of Agricultural Research
ETB	Ethiopia Birr
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
Ha	Hectare
GDP	Gross Domestic Product
IBWS	Improved Bread Wheat Seed
JUCAVM	Jimma University College of Agriculture and Veterinary Medicine
LWADO	Lemo Woreda Agriculture and Natural Resource Office
LWFEDO	Lemo Woreda Finance and Economy Development Office
LWLFO	Lemo Woreda Livestock and Fisher Office
MoANR	Ministry of Agriculture and Natural Resource
NBE	National Bank of Ethiopia
NGO	Non-Governmental Organization
SNNPR	South Nation Nationalities Peoples Region
SPSS	Statistical Package for Social Science
SSA	Sub-Saharan Africa
TLU	Tropical Livestock Unit
VIF	Variance Inflation Factor

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ABSTRACT

Adoption of improved technologies is one of the most promising ways to reduce food insecurity in Ethiopia. However, the adoption and dissemination of these technologies is constrained by various factors. The objective of this study was therefore, to identify factors that determine adoption and intensity of improved bread wheat varieties adoption and to examine the farmers' perception towards the adoption of improved bread wheat varieties in Lemo woreda Hadiya zone. Multi- stage sampling procedure was followed to select peasant associations and households head for the study. The woreda was purposively selected. Three peasant associations were selected randomly, and 178 households were randomly selected using probability proportional to size. Structured interview schedule was developed, pre-tested and used for collecting the essential quantitative data for the study from the sampled households. Focus group discussion was used to generate qualitative data. In addition, secondary data were collected from relevant sources such as journals, zonal and district level agriculture and rural development offices. Likert scale level of farmers ranking of varieties preference criteria and double hurdle model were employed to identify farmers' perception on adoption and to identify factors that influence the adoption decision and intensity of improved bread wheat varieties adoption respectively. The findings of this study indicated that, about 53.9% are adopters and 46.1% are non- adopters in the study area. The result of preference ranking showed that high yielding potential, disease resistance capacity, early maturity, and environmental adaptability of varieties relatively best performance of varieties in the study area. Double hurdle model analysis results showed that improved bread wheat varieties adoption decision of farm households has positively and significantly determined by education, land size, membership in cooperatives, improved bread wheat seed availability on time, and frequency to extension contact. With regard to the intensity of improved bread wheat varieties adoption, was affected by sex of household head, membership in cooperative and credit access positively and significantly, but total livestock unit and off/non-farm income were affected negatively and significantly. The overall finding of the study underlined the high importance of institutional support in the areas of strengthening farmers' cooperatives, facilitating formal credit service, improving seed access, strengthening the existing extension service to enhance adoption and intensity of improved bread wheat varieties adoption. Furthermore, high yielding, disease resistance and early maturity varieties should get attention in order to improve the current adoption level of improved bread wheat varieties in the area.

Keywords: Adoption, Bread wheat, Double-hurdle model, Hadiya, Lemo, Intensity, Perception.

1. INTRODUCTION

1.1. Background of the Study

Globally, agricultural development is expected to have the potential of supporting in sinking poverty for 75% of the world's poor, who live in rural areas (World Bank, 2013). Wheat (*Triticumaestivum L.*) has played a significant role in feeding a hungry world and improving global food security (Ketema and Kassa, 2016). The demand for wheat is expected to increase strongly shortly as a result of global population growth and dietary changes (Kelemu, 2017). Hence, how to increase wheat production is one of the major challenges that agriculture now faces, especially as there has been a global decline in the growth of wheat yields since the mid-1990s, potentially threatening global food security (CENEB and CIMMYT, 2012).

Agriculture is the backbone of most African countries (World Bank, 2013). The average wheat productivity in SSA is 1.7 tons/ha, nearly 50% below the world average (FAO, 2014). The enhancement of crop production is considered important for improving the welfare of small-scale farmers in these countries. With a rapidly growing population rate and limited cultivable farmland, in the agriculture sector, technological involvement seems to be the only viable option for developing economies to feed the increasing population and generate employment (World Bank, 2007; Kassie *et al*., 2011).

The economic development of Ethiopia is highly dependent on the performance of its agricultural sector since it is the main pillar of the economic growth of the country. Based on the 2017/2018 data on agriculture provides about 34.9% of the gross domestic product (GDP) and 83.9% of total exports (NBE, 2018). Ethiopia is the second-largest wheat producer in Sub-Saharan Africa next to South Africa. It is the fourth important cereal crop with an annual production of about 3.43 million tons cultivated on an area of 1.63 million hectares (CSA, 2014). According to the CSA data wheat occupies about 17% of the total area in the country. However, its national average yield is about 21 quintals per hectare. This is a low yield compared to the global average of 40 quintals per hectare (CSA, 2015). Wheat an important staple cereal crop in Ethiopia and accounts for about 15% of the total cereals production and 20% of the cereals consumption (Wageningen, 2016).

Bread Wheat (*Triticumaestivum.*) is one of the most important staple cereals that imported abroad. Most of humanitarian food aid and commercial imports take the form of wheat (Gashaw *et al.*, 2014; Nigussie *et al*., 2015).Bread wheat is mainly grown in the highlands of Ethiopia, which lie between 6 and 16^0 N and 35 and 42^0 E, at altitude ranging from 1500 to 2800 meters above sea level and with mean minimum temperatures of 6^0c and 11^0c (MoANR, 2015/2016). The low yield has made Ethiopia unable to meet the high demand and the country is net importer of wheat (Rashid, 2010). The demand for wheat has been increased due to growing population, urbanization and the expansion of food processing industries in the country. If the country is to feed the rapidly growing population and meet the high demand, it needs to increase the production and yield of wheat. However, increasing yield requires successful adoption of improved agricultural technologies (Dorosh and Rashid, 2013)

Adopting full wheat production packages such as row planting, improved wheat varieties, seeding rate, fertilizer amount, time of fertilizer application, time of weed control, space between rows, plowing frequency, have been increasing wheat yield in Ethiopia (Tolesa *et al*., 2014). Meeting the current and fast-growing future demand for food in Ethiopia will require adopted better high yield, better crop-breeding, better crop resistance to diseases, pest, resilience and adaption to climate shocks and reduced use of external inputs is expected to improve household food security (Shiferaw *et al*., 2011 ; Shiferaw *et al*., 2013). In Ethiopia, there are 16 major wheat-producing zones in the four regions they have been account for 83% of the country wheat production, eight zones from Oromia region; six-zone from Amhara region; South west Tigray zone from Tigray region and Hadiya zone from South Nation Nationalities and Peoples Region (CSA, 2015/2016). Among these potential areas, this study is planned to be carried out in Hadiya Zone which is located in SNNPR.

There are different stakeholders participating in the regional farmers based improved bread wheat varieties or seed multiplication; like Areka Agricultural center, South Nation Seed Enterprise, Licha Hadiya Union and woreda Office of Agriculture and Natural Resource and the farmers themselves. The improved bread wheat varieties which have been disseminated in the study area by different institutions However, study on the adoption and intensity of use of these improved varieties and farmers' perception adoption of improved bread wheat varieties were not conducted in the study area so as to know the gap. In order to improve production

and productivities of wheat, identifying factors affecting adoption and intensity of adoption was found to be important. Therefore, this study was initiated to identify determinants of adoption and intensity of adoption of improved bread varieties in Lemo district of hadiya zone.

1.2. Statement of the Problem

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 (Yu, 2014). This is possible if improved agricultural technologies are properly transferred and disseminated to farmers to deepen and intensify their production (Assefa and Gezahegn, 2010). In spite of the widespread technology generation and dissemination efforts, yields of major crops such as wheat, maize and Teff are still low averaging 2.45 ton/ha, 3.25 ton/ha, and 1.47 ton/ha, respectively, suggesting the country has not fully tapped the benefits of the investments made on agricultural technology generation and dissemination efforts (CSA,2014). Ethiopia is one of the developing economies which are not realizing its full agricultural potential, as the sector is dominated by subsistence-oriented, the low adoption rate of technology and farm inputs, a traditional type of farm practices and rain-fed farming systems (Berhane, 2009; Alemitu, 2011; Susan, 2011).

In addition, different area-specific pieces of evidence indicate that intensity and adoption decision to improved bread wheat varieties in the country is low and as well as in the study area. The low yield has made Ethiopia unable to meet the high demand and the country is net importer of wheat (Rashid, 2010). This low rate of adoption decisions of farmers is usually determined by various factors that can be specific to socio-economic, institutional, demographic and psychological.

To increase the production and productivity of agricultural output, to raise income and to enhance food security, the uses of improved agricultural inputs are very important out of which high yielding crop variety is very essential (Tsegaye and Bekele, 2012; Setotaw, 2013; Berihun *et al*., 2014). Therefore, Hadiya zone is one of the wheat production potential areas in SNNPR. The total land covered by wheat crop is 37,149 hectare and average productivity is

27.5 q/ha (CSA, 2016). The productivity is lower than West Arsi zone of Oromia regional state 32.97 q/ha.

With this understanding, a number of improved bread wheat varieties have been introduced for the smallholder farmers of the study area over the last years. The improved bread wheat varieties which have been disseminated in the study area by different institutions like Areka Agricultural center, South Nation Seed Enterprise, Licha Hadiya Union and *woreda* Office of Agriculture and Natural Resource were Digalu, Kakaba, Shorima, Hidase, Oglcho, Danda'a, Taye and Bobicho that promoted to beneficiaries with recommended packages since long period of time.

In spite of such intervention, the adoption of improved bread wheat varieties in the study area is still low and farmers grow both the improved and local varieties, information with regard to adoption of cereal crops in general and bread wheat production in particular, on locally specific factors that influence adoption and variation among farmers in their intensity of adoption of improved bread wheat varieties are not well known. In addition to this, information about farmers' perception of the technologies and related problems as well as psychological factors which are responsible for poor adoption and intensity of improved bread wheat varieties is also found to be insufficient and are not well understood in the study area. There were no studies conducted on the adoption and intensity of use of improved bread wheat varieties and farmers' perception toward adoption of improved bread wheat varieties characteristics previously in the study area. Hence, this study is intended to fulfill these information gaps on the determinants of adoption and intensity of improved bread wheat varieties adoption in the study area.

1.3. Objectives of the Study

1.3.1. General objective

The general objective of the study was to analyze the determinants of adoption of improved bread wheat varieties: in Lemo district, Hadiya zone SNNPR, Ethiopia.

1.3.2. Specific objectives

- To identify factors affecting the decision of farmers in adopting of improved bread wheat varieties in the study area.

- To analyze factors affecting the intensity of improved bread wheat varieties adoption in the study area.
- To examine the farmers perception towards the adoption of improved bread wheat varieties in the study area

1.4Research Questions

- What are the factors affecting the adoption of improved bread wheat varieties in the study area?
- What are the factors influencing the intensity of adoption improved bread wheat varieties in the study area?
- What are the farmers' perceptions regarding the adoption of improved bread wheat varieties in the study area?

1.5. Significance of the Study

Adoption studies can provide research and extension staff, rural development institutions, and policy makers with valuable information that improve the efficiency of communication among them in promoting available technologies. Apart from this, acquired information from such study will enhance the efficiency of agricultural research, technology transfer, input provision, and agricultural policy formulation. All development partners including extension educators, technical assistants, NGOs, and other development agents involved in agricultural development must be aware and understand the factors affecting the adoption of improved bread wheat varieties to target and appropriate technologies to farmers. The present study would attempt to reveal those underlying factors which may account for the observed variations in the adoption and intensity of adoption improved bread wheat varieties and farmers' perception regarding improved bread wheat varieties characteristics on local varieties among the farmers in Lemo *woreda*.

To this end, the findings of this study will be expected to render very valuable information for further promotion of this important crop in the study area. Furthermore, farmers' technology adoption would help researchers to develop technologies appropriate to the local situation and in line with the farmers' interests. The key findings from this study can help to fine-tune extension in such a way that the technical and socioeconomic constraints on improved bread

wheat can be addressed. Such information would suggest interventions that may help to improve the efficiency of agricultural research and extension.

1.6. Scope and Limitation of the Study

This study is undertaken in one district, namely Lemo. The adoption of new technology is influenced by many factors. Therefore, it is difficult to identify universally defined factors either impeding or enhancing the adoption of technology. Therefore, it might be restricted to identifying the determinants of adoption and intensity of adoption of improved bread wheat varieties and the perception of farmers in the study area. Substantial qualitative and quantitative information on determinants to adopt improved bread wheat varieties might be gathered in the study area. Because of these factors and the methodological limitation of some, sampling methods, data collection methods and analytical tools (e.g. probit and truncated regression models), the results of the study would not be free from error.

2. LITERATURES REVIEW

2.1. Definition of Adoption and Related Concept

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). It can be considered a variable representing behavioral changes that farmers undergo in accepting new ideas and innovations in agriculture anticipating some positive impacts of those ideas and innovations.

Many authors have defined the term adoption at different times. As defined by Rogers (1962), adoption is the decision-making process in which an individual passes from first hearing about an innovation to final adoption. Adoption is a mental process through which an individual passes from first knowledge of an innovation to the decision to adopt or reject and to confirmation of this decision (Van den Ban and Hawkins, 1996). According to Feder *et al.* (1985) adoption refers to the decision to use a new technology, method, practice, etc.by a firm, farmer or consumer. It is defined as the degree of use of a new technology in long run equilibrium when a farmer has full information about the new technology and it's potential.

As indicated by Dasgupta (1989), adoption is not a permanent behaviour. An individual may decide to discontinue the use of an innovation for different reasons such as personal, institutional or social, and the availability of an idea or practices that is better in satisfying his or her needs. However, adoption is either at a farm-level (individual) or at an aggregate level. Adoption at the individual's level is defined as the degree of use of a new technology in the long-run equilibrium when the farmer has full information about the technology and its potential uses while aggregate adoption is measured by the aggregate level of use of a specific new technology with in a given geographical area or within a given population. Therefore a distinction exists between adoption at the individual farm level and aggregate adoption within a targeted region (Feder *et al*., 1985).

Intensity of agricultural technology adoption

Intensity of adoption is defined as the level of use of a given technology. When technology is adopted it is important to understand the extent to which the technology has been used by the intended group. Shiferaw *et al*. (2007) stipulated intensity of adoption as a measure of depth

of adoption in terms of parameters such as the number of hectares planted with improved seed or the amount of fertilizer applied per hectare. The concept is necessary as adopters may claim that they have adopted the technology but comparatively they have not met the required standards (CIMMYT, 1993).

2.2. Theoretical Review

The concern of agricultural technology adoption by smallholder farmers is one of the development focuses in low income countries. This is mainly due to its contribution to improve agricultural production and productivity, income and food security of farm households. Hence, exploring the drivers for agricultural technologies adoption of smallholder farmers is believed to be vital to speed up the uptake and diffusion of the practices. However, understanding adoption is still a challenge and drivers of adoption were poorly understood. This is both at farmers' level, which practices were adopted and which is not. But also looking at vertical scaling, adoption takes place in the more institutional setting. Adoption accelerates to utmost when about half of the individuals in the system have adopted (Blazy *et al*., 2010).

Households' level of adoption considers the decision made by the household head to comprise new or improved variety in usual farming practice. The decision made to adopt or otherwise depend on different factors. Farmers' decision to adopt improved agricultural technologies is assumed to be the product of a complex preference comparison made by a farm household. To adopt or not to adopt a technology or innovations is often a discrete choice (Guerre and Moon, 2006). These innovations consists of new ideas, methods, practices or techniques that provide the means of achieving sustained increase in farm productivities and income. The innovation may not be new to people in general but, if individual has not yet accepted it, to that person it is an innovation (Ray, 2001).

In wide ranging, farmer adoption decision of a given cultivar is usually a process, which passes through several stages. The first step is for the farmers to get to know the variety. Upon an initial assessment of the expected returns from the technology, the farmer may then decide to try out the technology. Depending on the performance of the technology, the evaluation by the farmer may take several growing seasons. If the technology is found attractive in terms of either increased profitability or reduced risk for risk-averse farmers, and if socioeconomic

constraints do not limit the decision process, the farmer will decide to switch from the old to the new technology. Otherwise, the farmer will decide to reject the technology (Bekele *et al*., 2007).

2.3. Determinants of Adoption of Technology

Factors determining technology adoption differ from one sector to the other and from one region to the other in the same sector. Especially, dealing with agricultural technologies where the sector has its own peculiar characteristics like seasonality of production and its high dependence on the vagaries of natures makes it different from the other sectors. Moreover, there is a significant difference in terms of the characteristics of agriculture in developing and developed countries. In developing countries, the agricultural sector is characterized by its high dependence on natural phenomenon, highly constrained by shortage of resources and undertaken by less educated farmers. Adoption levels of improved technology were measured by the proportion of farmers who adopted such technology in different areas. While the recommended levels of some technology components, were easily identified for estimating adoption levels or intensity (Abera, 2013).

A variety of studies are aimed at establishing factors underlying adoption of various technologies. As such, there is an extensive body of literature on the economic theory of technology adoption. Several factors have been found to affect technological adoption. These include government policies, technological change, market forces, environmental concerns, demographic factors, institutional factors and delivery mechanism. These can be categories in to four forces, such as Market forces:- availability of labor, technology resource requirements, cultivated land size, level of expected benefits, and level of effort required to implement the technology; Social factors:- Age of potential adopter, social status of farmers, education level and gender-related aspects, household size, and farming experience; Management factors:- membership to organizations, the capacity to borrow, and concerns about environmental degradation and human health of farmers; and Institutional/technology delivery mechanisms:- information access, extension services, and prior participation in, and training in pest control practice (Daniel,2002).

Therefore, in this study determinants of adoption decision and intensity use of improved bread wheat varieties can be influenced by their current status of demographic factors:- age of

household, sex of household, family size, educational level of household and farm experience, institutional factors:- extension contact, access to credit, availability of seed on time, membership in cooperative and distance to market, socio-economic factors:- farm income, farm size, off-farm income and livestock ownership.

2.4. Farmers' Perception on Adoption of Improved Crop Varieties

Perception: defined perception is a process by which we receive information or stimuli from our environment and transform it into psychological awareness (Van den Ban and Hawkins 1998). In this study, farmers receive and gather stimuli that indicate the attributes of improved wheat varieties are superior over local. Technologies are viable only when farmers use them. No matter how well the new technologies work on research stations, if farmers do not have them for use their development would be unsuccessful (Oladele and Fawole, 2007). According to Jeffrey Pickens (2005), perception is the process that organizes and interprets by our sensory in order to give meaning about the environment. It is the set of processes by which an individual become aware of and interprets information about the environment. The person interprets the stimuli into something meaningful based on their past experiences. However, an individual interprets or perceives may be different from reality.

Farmers' criteria vary greatly between households, depending on the productive resources controlled by the household. However, the criteria also vary within a household (van Veldhuizen *et al*., 1997).The division of responsibilities and tasks is socially defined according to gender and age. This means that different household members evaluate a technology according to different criteria, which are related to their role and functions in the household (Bunders *et al*., 1996). Characteristics of the varieties play a vital role in adoption of improved crop varieties. Accordingly, if the characteristics of the varieties satisfy the need and interest of the farmers they eventually adopt the improved crop varieties (Van Veldhuizen *et al*., 1997).

Therefore, in this study farmers' perception towards adoption of improved bread wheat varieties was assessed in terms of their evaluative perceptions on their yield characteristics, Environmental adaptability, early maturity, stayed for long time, marketability, disease resistances, and water lodging characteristics were used to know farmers perception.

2.5. Empirical Studies

2.5.1. Empirical studies on technology adoption and improved bread wheat varieties

A number of empirical studies have been conducted by different people and institutions on farmers' adoption behavior both outside and inside Ethiopia using econometric models. The results of various empirical studies confirmed that adoption of a new technology offers opportunities for increasing productivity, output quality, market supply, and income. The empirical studies have witnessed the significant contribution of using improved agricultural technologies to the productivity and welfare (income) of farming communities.

A study conducted by Regasa (2018) using probit, Tobit and PSM model adoption of high yielding wheat varieties and its impact on farm income of smallholder farmers in Mao-Komo district of benishangul-gumuz region, Ethiopia. This study used cross-sectional data collected from sample of 174 farm households selected through two-stage stratified random sampling techniques. The probit model result depicted that land holding size, tropical livestock unit, access to agricultural information, frequency of extension contacts, off/non-farm income, and perception of farmers toward attributes of high yielding wheat varieties affected the likelihood of adoption of high yielding wheat varieties positively and significantly. But, sex of household heads, and affiliation/membership to organizations had negative and significant effect on the likelihood of adoption of high yielding wheat varieties.

Study conducted by Gebremariam and Hagos (2018) on determinants of intensity of bread wheat packages adoption in Tigary, Northern Ethiopia. The study was used a cross sectional data collected from selected sample households. Random sampling technique was employed to select 300 wheat producers from four sample Kebeles in the study area. Using Tobit model indicated that sex, TLU and crop production objective were found to have positive significant effect on the adoption and intensity of use of bread wheat technology package. On the other hand, age, farm size, annual off & non-farm income, location and FTC distance had shown negatively and significant influence on the intensity of use of bread wheat technology package.

Another study conducted by Amare (2018) by using Tobit model determinants of adoption of wheat row planting: In Wogera district, north Gondar zone, Amhara regional state, Ethiopia.

The study was used a cross sectional data collected from selected sample households. Systematic random sampling technique was employed to select 154 wheat producers from three sample Kebeles in the study area. The model output indicated that the adoption of wheat row planting by farmers in the study area was affected positively and significantly influenced by number of educated family member, use of improved seed and extension contact, but age of household and distance from development centers affected negatively and significantly adoption of wheat row planting.

Another study conducted by Chandio *et al.* (2018) using probit model on factors influencing the adoption of improved wheat varieties by rural households in Sindh, Pakistan. The results showed that the adoption of improved wheat varieties by farmers in the study area was affected positively and significantly influenced by education, farming experience, landholding size, tube-well ownership, extension contact, access to credit, while age, distance and Tractor ownership were negatively and significantly related to adoption.

A study conducted by Degefu *et al.* (2017) on determinants of adoption of wheat production technology package by smallholder farmers: evidence the Eastern Ethiopia by using logit model. The model, result, indicated that age of the household head, education status of the household head, farm size, and distance to FTC (Farmers' Training Centers), cooperative membership, dependency ratio, and annual income of the households were found to positively and significantly affect the adoption of wheat technology packages. But variation in district, gender, and distance to market, were found to negatively and significantly affect the adoption of wheat technology packages.

Another study conducted by Adunea (2017) using Tobit model factors affecting adoption of row planting technology on wheat production in Munesa district, Oromia region, Ethiopia. The study was used a cross sectional data collected from selected sample households. Systematic random sampling technique was employed to select 140 wheat producers from three sample Kebeles in the study area. The model result indicated that literacy of farmers, labor availability, frequency of extension contact, credit use, participation in row planting training and availability of improved wheat seed on time do positively and significantly

influenced were as livestock size and market distance do negatively and significantly affected adoption and intensity of use of wheat row planting technology.

Study conducted by Susie (2017) using double hurdle model determinants of adoption of improved teff varieties by smallholder farmers: the case of kobo district, north wollo zone, Amhara region of Ethiopia. The study was used a cross sectional data collected from selected sample households. Systematic random sampling technique was employed to select 150 Teff producers from four sample *Kebeles* in the study area. The result of double-hurdle model shows that educational level of household head, participation on crop production demonstration, distance from the nearest market, frequency of extension contact, off/non-farm income, proportion of cultivated land allocated for teff, livestock holding, improved teff seed availability, and perception on better yielding capacity of the new varieties over local varieties were found to be significantly influencing households adoption decision, whereas, sex, age, family labor, membership to an organization, off/non-farm income, frequency of extension contact and proportion of cultivated land allocated for teff were found to be positively and significantly influencing the intensity of adoption of improved teff varieties.

Another study conducted by Musba. (2017) using double hurdle and propensity score machining models adoption and impact of improved soybean (belessa-95) variety among smallholder farmers in Bambasi woreda, Benishangul Gumuz regional state, Ethiopia. The study was used a cross sectional data collected from selected sample households. Random sampling technique was employed to select 134 Soyabean producers from three sample Kebeles in the study area. Regression results showed that improved soybean (Bellesa-95) adoption decision of farm households has been determined by sex of household head, distance to the nearest market, being member of cooperatives, number of oxen, participation in training and demonstration and intensity of improved soybean adoption is determined by sex of household head, frequency of visit, farm income and asset ownership affected positively and significantly.

The study conducted by Sisay.(2016) on agricultural technology adoption, crop diversification and efficiency of maize-dominated farming system in Jimma Zone of South-Western Ethiopia. This study used cross-sectional data collected in 2013/14 production season from a sample of 385 farm households selected through multi-stage sampling techniques. using

Tobit model indicated that age, family size, level of education, family education, ownership of mobile phone, extension services, cooperative membership, livestock holding and land holding size have positively and significantly influenced the probability of improved maize variety and/or chemical fertilizer adoption in maize farming while, distance of development center from residence were showed significant and negative effect.

Study conducted by Leake and Adam (2015) on factors influencing allocation of land for improved wheat variety by smallholder farmers in Adwa district. The study was used a cross sectional data collected from selected sample households. Random sampling technique was employed to select 160 wheat producers from four sample kebeles in the study area. They pointed out adopters had high family labor, high number of tropical livestock unit, large land size, high frequency of extension contact, access to credit, access to education, access to nearest to main road and market as compared to non-adopters. They also indicated that education level of household head, family size, tropical livestock, and distance from main road and nearest market, access to credit service; extension contact and perception of household toward cost of the technology have to be significantly and positively affecting factors adoption of improved wheat variety.

Similarly, Gebresilassie and Bekele, (2015) on the study of factors determining allocation of land for improved wheat variety by smallholder farmers of northern Ethiopia indicate that TLU affects the adoption level of farmers positively and significantly at 1% level of significance. From this result the authors conclude that being owner of more livestock increase the level of adoption of improved agricultural technology.

The study conducted by Bayissa (2014) use double-hurdle model to estimate the improved teff planting decision and intensity use of households in Diga district of East Wollega Zone. This study used cross-sectional data collected in 2012/13 production season from a sample of 140 farm households selected through multi-stage sampling techniques. Results of double-hurdle model confirmed that both adoption and intensity use of improved teff were positively and significantly influenced by sex of the household head, farming experience, participation on crop production training, educational level, yield superiority and maturity period of new varieties. While, the author found that distance to the nearest market place had negative and significance influence on the adoption and intensity of use of improved teff varieties.

The study conducted by Dereje (2006) on assessment of farmers' evaluation criteria and adoption of improved bread wheat varieties in Akaki, Central Ethiopia, the result of descriptive statistics Logit and Tobit model analysis show that household leadership position/status, experience in extension and distance of DA-office from the farmers' home) related with adoption of improved bread wheat varieties significantly and positively. But market access, related with adoption of improved bread wheat varieties negatively and significantly and sex, age, education, health status, off-farm income, extension service, distance of DA office from farmers' home showed statistically significant and positively related with intensity of adoption of improved bread wheat varieties. But, size of farmland holding related with the intensity of adoption of improved bread wheat varieties negatively and significantly.

2.5.2. Empirical studies on farmers perception towards improved technologies

Farmers' perception towards technology characteristics were also very important to disseminate improved varieties to the farmers that are usually omitted in most of agricultural technology adoption studies. Adoption (rejection) of technologies by farmers may reflect rational decision making based up on farmers' perceptions of the appropriateness (inappropriateness) of the characteristics of the technology under investigation (Adesina and Zinnah, 1993). Few studies have revealed the importance of such variables in explaining technologies adoption.

Study conducted by Milkias and Abdulahi (2018) on determinants of agricultural technology adoption: in the improved highland maize varieties in Toke Kutaye District of Oromia Regional State, Ethiopia. The level of agreement result showed that perception on diseases resistance of varieties, high yielding early maturity of varieties, agro ecological suitability and availability of seed on time and quality of varieties showed relatively best performance of varieties. Whereas, perception on technological availability varieties indicates relatively poorest agreement to all other characteristics level of agreements considered.

Study conducted by Galmesa (2017) adoption of improved soyabean varieties: the case of Buno Bedele and East Wollega zones of Oromia Region, Ethiopia. Farmers perception for

improved soyabean varieties were about 97.37%, 52.63%, 78.95%, 38.89%, 28.95%, 68.42% and 60.53% respondents perceived that yield, drought resistance, early maturity, shattering, marketability, disease resistance, and non-logging of the improved soya bean varieties are superior to the local one.

Anne *et al*. (2014) on the perception of farmers variety attributes showed that improved varieties had desirable production and marketing attributes while the local varieties were perceived to have the best consumption attributes. Evidence further indicated that the major sorghum variety attributes driving rapid adoption are taste, drought tolerance, yield, ease of cooking, and the variety's ability to fetch a price premium. Early maturity, a major focus of research was found to have no effect on the adoption decision.

Study conducted by Ermias (2013) on adoption of improved sorghum varieties and farmers' varietal trait preference in Ethiopia found positive and significant effect of perception on adoption and intensity of use of improved sorghum varieties. He explained that farmers are more responsive in adopting new technologies if they perceive those new technologies as compared to the existing one gives better results.

Moreover, Timu *et al*. (2012) confirmed that improved sorghum varieties in Kenya had desirable production and marketing attributes while the local varieties were perceived to have the best consumption attributes. Evidence further indicates that the major sorghum variety attributes driving rapid adoption are taste, drought tolerance, yield, ease of cooking and the variety's ability to fetch a price premium. Early maturity, a major focus of research however has no effect on adoption. Similar studies conducted in many parts of Ethiopia have also showed the importance of those perception variables in explaining improved crop varieties adoption and intensity of use of technology.

2.6. Conceptual Framework of the Study

Adoption of improved bread wheat varieties can be influenced by their current status of socio-demographic, institutional, and economic variables. The conceptual framework of the factors, which consist of key concepts of variables, is shown in figure 1.The dependent elements that include the framework for this study are adoption and intensity of adoption of improved bread

wheat varieties. The explanatory variables proposed to determine adoption and intensity of improved bread wheat varieties are: demographic variables such as: age of household head, sex of household head, family size, and educational level of the household head. Socio-Economic variables: Livestock ownership and off/non-farm income. Institutional variables: distance to market, Participation in cooperative society, availability of inputs on time, use of credit service and frequency of extension contact.

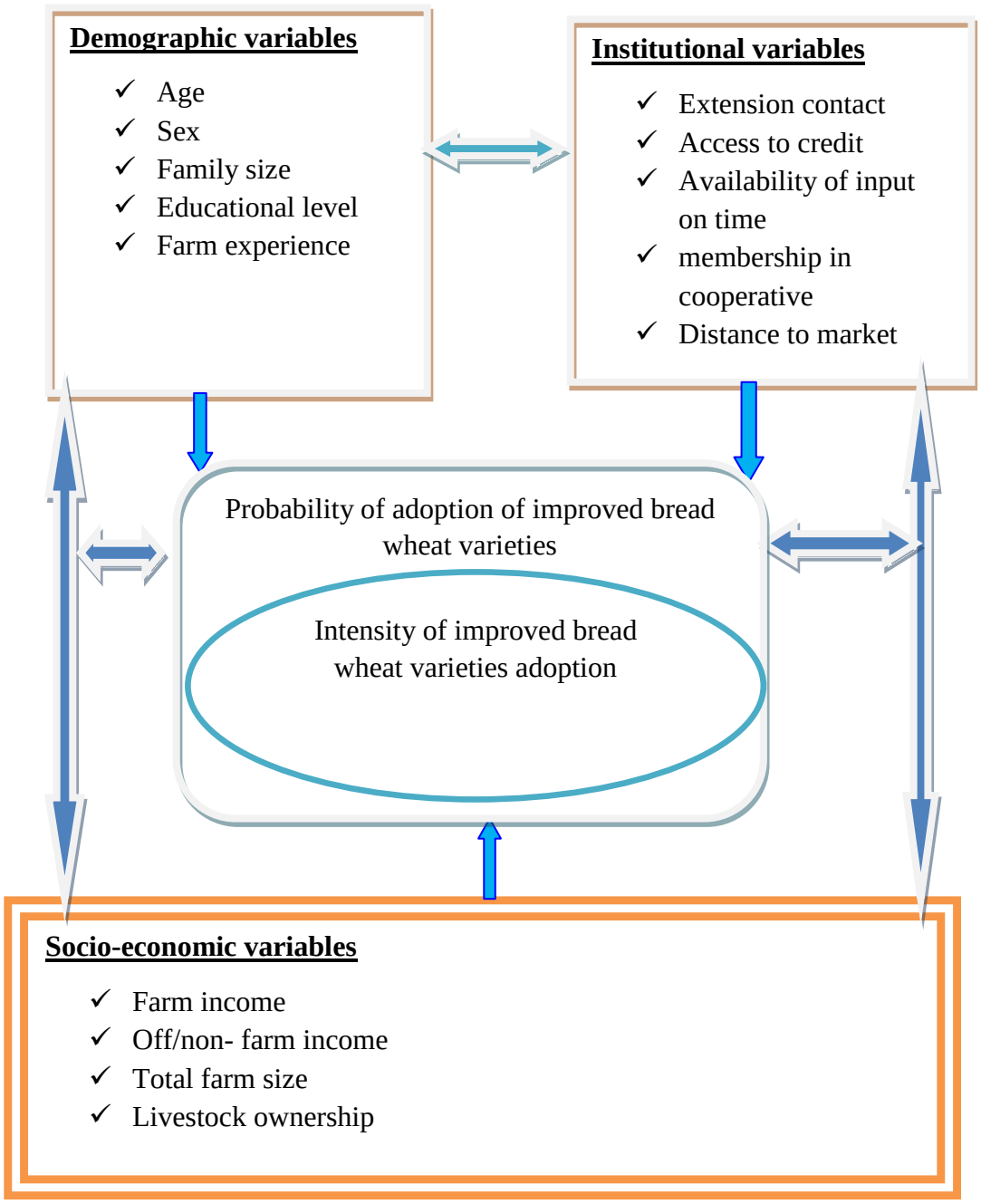


Figure 1 Conceptual frame work for the study.

Source: Developed by the researcher based on similar studies conducted.

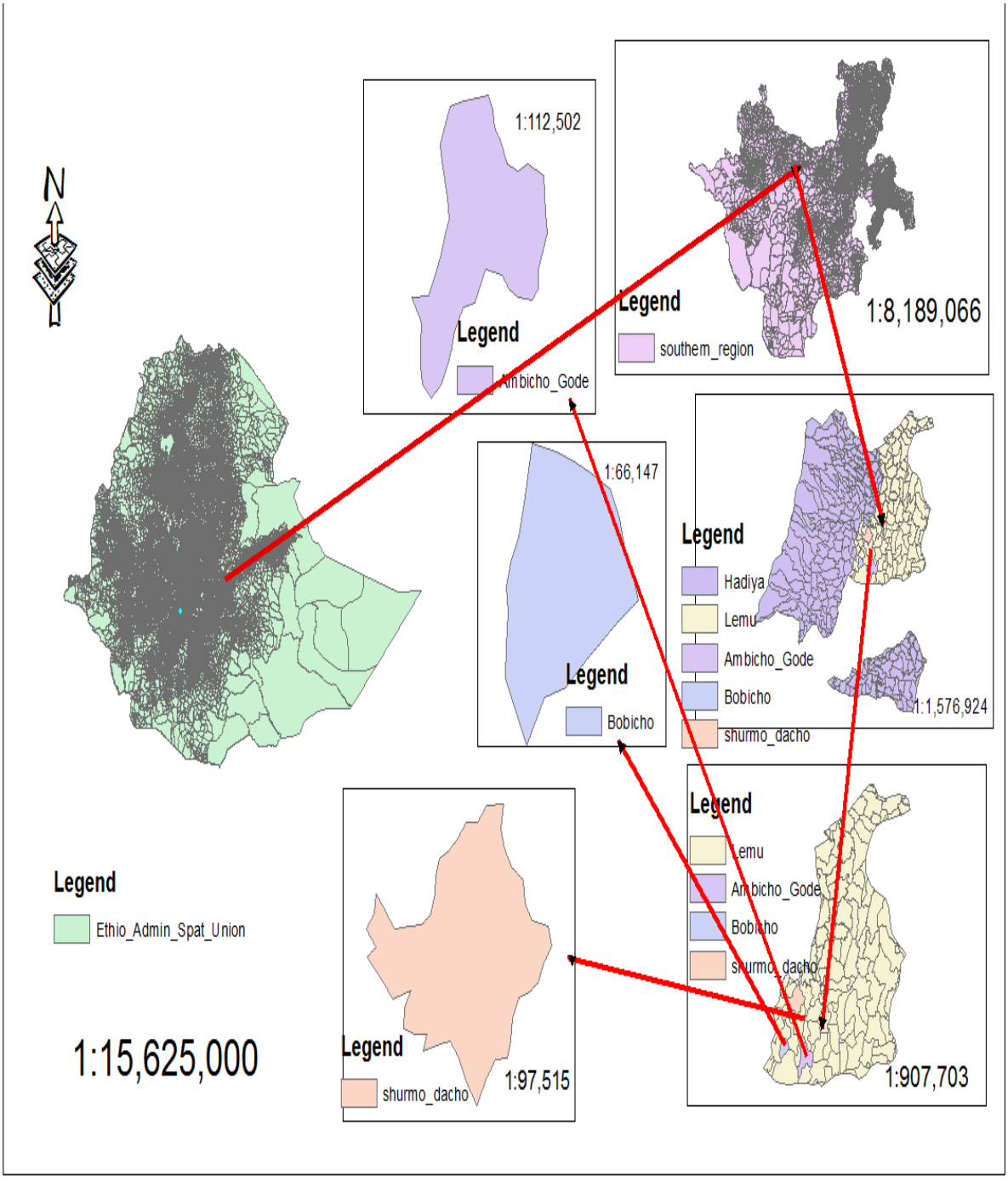
3. RESEARCH METHODOLOGY

3.1. Background of the Study Area

3.1.1. Location and agro-ecologies

The study was conducted in Lemo *Woreda* of Hadiya Zone, SNNPR of Ethiopia. This area is located 232 km far from Addis Ababa and 200 km far from Hawassa. The study area border in the North, Misha *Woreda* and Silite zone, in the South, Soro *Woreda* and Kembata Tembaro zone, in the East, Ann Lemo *Woreda* and Shashego *Woreda*, and in the West Gombora *Woreda*. The *woreda* was approximately located between 37^0 50'' - 37^0 55'' East latitude and $7^0$35'' – 7^0 30'' North longitudes. Annual rainfall is between 900mm and 1400mm, which are suitable for the production of cereal crops. The minimum and maximum temperature is 12^0c and 26^0c respectively. The minimum and maximum altitude of the study area is 1990 and 2720m above sea level respectively (LWFEDO, 2019).

The woreda is densely populated within two agro- ecological zone and covers an area of 34695 hectares. There are Woina-dega 93% including 29 *Kebeles* and Dega 7% including 4 *kebeles*. The total population of the study area has an estimation of 178902 out of 88493 are male and 90409 are female. Population land ratio of 0.67 ha. This indicated that an extreme shortage of land when compared with the population. According to experts of Lemo *Woreda*, land is not sufficient even for subsistence farming in such an area where a rural person is high (LWFEDO and LWANRO, 2019).



Source: Ethiopia-GIS, 2019

Figure 2 Map of the study area

3.1.2. Agriculture

Wheat is the most dominant crop produced in the *woreda*. As report of Lemo *woreda* Agricultural and Natural Resource Office, the area is the most suitable for wheat production because it is found in temperate climatic zone. Agriculture is the economic base of Lemo district. Agriculture is mainly rain-fed and is characterized by low productivity. Agriculture which includes crop and livestock production. The majority of the residents depend on agriculture for their livelihood. The farmers are using traditional technologies and with limited accesses to agricultural inputs. Moreover, the sector in the zone is characterized by low-level use of farm inputs, traditional farm practice, and other related problems. Farmers of the study area produce agricultural crops for consumption and commercial purposes. The major crops produced in the area include wheat, teff, maize, vegetables and fruits like cabbage of different sort, tomato, and banana, roots like potato, *enset* and wheat are the dominant products of the district (LWANRO, 2019).

3.1.3. Recommended improved bread wheat varieties in the study area

Agronomic practice: land preparation, planting time, seed rate, fertilizers type, fertilizer rate, row planting, improved wheat varieties, weed control and cropping systems are essential agronomic practice in wheat production. Seeding rate using improved seed, appropriate seeding rate, and right time of planting are the most important practices in wheat production. Over or under application of seed will result in poor lead to low production. The recommended seeding rate of wheat in the study area is in row planting 125kg/ha and 150kg/ha in broadcasting. Fertilizer rate fertilizer is an important input for improving production and increasing crop yields. Recommended fertilizer rate in the study area for wheat is 100 kg DAP and 150 kg UREA per hectare (MoANR, 2015/2016)

Table 1: List of some improved bread wheat varieties that were released at different time in the study area.

No	Variety name	Released year	Maturity period days	Suitable topography above sea level	Suitable agro-ecology
1	Digalu	2005	100-120	2000-2600	Woina- dega and dega
2	Taye	2005	104-130	1900-2800	Woina- dega and dega
3	Danda'a	2010	110-145	2000-2600	Woina- dega and dega
4	kakaba	2010	90-120	1500-2200	Kola and woina-dega
5	ogana	2011	121-170	2200-2600	Woina- dega and dega
6	Shorima	2011	105-150	1900-2600	Woina- dega and dega
7	Ogolcho	2012	102	1600-2100	Kola and woina-dega
8	Hidase	2012	121	2200-2600	Woina- dega and dega
9	Huluka	2012	133	2200-2600	Woina- dega and dega

Source: Lemo *Woreda* Agriculture and Natural Resource Office, (2018/2019)

In the study area, wheat is the most important source of food for consumption next to *Kocho*, but it is consumed as a major and common food especially from December, the time of harvest to June, the beginning of sawing. Since June to the next harvest consumption almost all depends on *enset* and other agricultural products for the shortage of wheat this time. From fiber crops Hadiya in general and Lemo *woreda* dwellers in particular depend on in (*enset* Ventrilo 'sum). The plant is also called ' False banana 'for its structure looks like banana. Without reservation every households of Hadiya have *Enset* around their village regard less of production. Informants express *Enset* as an ' ever green plant' to explain it is resistant to drought and maintenance of green color and of products even in periods of hot climate (LWANRO, 2019).

Enset has multi-products and multi benefits that are used for both to human and animals. The major products include *Haammicho* (the root part), *Wasa ' Kocho*'(chased from the main parts), and *Bu ' lla* (condensed from the steam). These products primarily used for

consumption especially, they are staple foods from June to December, where other products are very scant and other by product known as *Meachoo*, used as forage for animals and used as raw material for different materials in the household. Other types of agricultural products mainly used for consumption (LWANRO, 2019).

Table 2: Land use pattern of Lemo *woreda*, Hadiya, Ethiopia, 2010/11

Number	Types of land use	Coverage in (Ha)
1	Arable land	29441
2	Forest land	349
3	Grazing land	1559
4	Governmental institutions	1079
5	Covered by cooperatives	606
6	Others	1661

Source: Lemo *Woreda* agricultural Development and Natural Resource, 2019

Table 3: the types of livestock in the study area

No	Types of Livestock reared in the study area	Number of livestock
1	Cattle	84232
2	Sheep	29783
3	Goat	27667
4	Donkey	10462
5	Horse	6498
6	Mule	548
7	Poultry	140984

Source: LWLFO, 2019 (Lemo *Woreda* Livestock and Fishery Office)

3.1.4. Institutions and organizational set up of the *woreda*

Lemo district has 33 rural *kebeles* and two rural municipal towns under its administrative hierarchy. Formal institutions are organized for the best of the people's decision making and involvement process in dual effect of decentralization. Formally, there are *woreda* head administration and other different sectors such as Agriculture and Natural Resource, Finance & Economic Development, Education, Health, Water Development, Babies-Youth and Women Development, Police and Justice, Information & People's Relation, Trade Enterprises & Transport, and Civil Service Sector at *woreda* level.

Local Idir and religious institutions such as Protestant, Orthodox and Muslim churches and their followers are available, and they are organized by the local community's interest. On the way to deal with social institutions and infrastructures, the LWFEDO (2019) repot indicated that there are about 35 primary and 24 secondary schools under, education sector, about 33 health posts, three health centers, six rural drug stores and 11 private treatment centers under health sectors, about 23 animal health posts, a veterinary clinic, 30 Farmers Training Center, and 10 multi-purpose small scale cooperatives under Agricultural & Natural Resource sector.

3.2. Research Design

This study was applying a cross-sectional research design where data were collected at a time. The researcher was used mixed methods of research which involve qualitative and quantitative approaches. Quantitatively, the research was used as a sample survey research method. Qualitatively, Focus group discussions and key informant interview was employed to collect relevant qualitative data. To this end, descriptive statistics and econometric model was employed for analysis.

3.2.1. Sampling technique and sample size determination

Multi-stage sampling procedure was employed to select representative sample households. In the first stage of sampling procedure, Lemo district from Hadiya zone was purposively selected based on wheat production potentials and dissemination of the improved bread wheat technologies and area coverage of the crop. In the second stage, three *Kebeles* were selected randomly from wheat producing *Kebeles* of the district. Then, the farmers in each randomly selected *Kebeles* were stratified into adopters and non-adopters categories giving the relative homogeneity of sample respondents' adoption status. Lists of all respondents were found from the *kebele* administration with the help of *kebele* leader and development agent of the respective *kebeles*. Random sampling technique was applied in each stratum to select the respondents. Hence, in this study, those farmers used any of improved bread wheat varieties during the 2018/2019 production season were considered as adopters and those who did not used any of improved bread wheat varieties in the same year were considered as non-adopters.

Finally, from each stratum of the randomly selected *Kebeles*, 178(150 male headed households and 28 female headed households) representative sample respondents were

selected randomly using probability proportional to size sampling technique, due to heterogeneity of the population (adopters and non-adopters).

In this study, to determine the sample size Yemane (1967) formula was employed. It was selected than other sample size determination techniques; due to its simplicity ease application as well as easiness to increase or decrease the sample size based on the research resource availability.

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

$$n = \frac{1425}{1+1425(0.07)^2}$$

n=178

Where n is the sample size for the study, N is the total household heads of the three *kebeles* which is 1425, e is the maximum variability or margin of error or which is 0.07 in this study, 1 is the probability of the event occurring. The sample size from each *kebeles'* would be determined based on their proportion to population size in each *kebeles*.

Table 4: Number of respondents in each selected rural *kebeles*

Name of kebele	Number of household head					Sample taken						
	Adopter		Non-adopter		Total	adopter		Non-adopter				Total
	M	F	M	F	T	M	F	T	M	F	T	
Shurmo Dacho	200	35	197	28	460	29	2	31	20	6	26	57
Bobicho	210	32	204	26	472	30	3	33	20	7	27	60
Ambicho Gode	200	41	216	36	493	29	3	32	22	7	29	61
Total	610	108	617	90	1425	88	8	96	62	20	82	178

Source: office of Lemo *woreda* agriculture, 2019, M= male, F= female, T= total

3.2.2. Types and sources of data

Both quantitative and qualitative data were collected using different data collection methods. Data for the study was gathered from two sources which are primary and secondary. The majority of primary data were collected from respondents through structured interviews. Also,

focused group discussion (FGD) and Key informant interviews were used for data collection. Secondary sources of data that support primary data were also used for this study purpose; published and unpublished documents like official reports, articles, journals about the adoption of technology.

3.3. Methods of Data Collection

3.3.1. Household survey

The major instrument used for primary data collection from sample respondents for this study was a structured interview schedule with questions that are carefully constructed. The interview questions mainly focused on demographics :-age, sex, family size, farm experience, education level, socio-economic:-land size, livestock ownership, off/non-farm income, and farm income, institutional:-extension contact, availability of wheat seed on time, membership in cooperative, access to credit and market distance, and farmers perception towards adoption of improved bread wheat varieties.

Before the data collection process started pre-testing the questionnaires in the randomly selected three *kebeles* deep communication was conducted with *kebele* leaders and DAs, necessary amendments were made before conducting the formal survey. After pre-testing, two days training was given to the 6 enumerators on briefings of the objectives, contents of the interview schedule and to acquainted them with the basic techniques of data gathering and interviewing techniques and on how to approach respondents. The enumerators for the data collection were selected based on their educational background, local knowledge and ability to speak the local language (Hadiyisa) and culture of the study area. Subsequently, the survey was conducted under the close supervision of the researcher.

3.3.2 Focused group discussion

Focused group discussions were held in each *kebeles* to understand farmers' varietal preferences and the specific traits that influence a farmer's decision to grow improved bread wheat varieties, and the major constraints affecting adoption and intensity of adoption of improved bread wheat production and the purpose of focused group discussion held to cross check the third objective. One FGD was conducted in each *kebeles* and each group was composed of 6-8 purposively knowledgeable and experienced wheat growers both males and

females were selected by the help of development agents. Checklists were developed and used to guide focused group discussions with farmer groups and individual key informants. The time used for focused group discussion was one hour in each group. The farmers were encouraged to use the local language that they were most familiar with. The researcher most familiar with the local language facilitated group discussions. During the discussion, the farmers were asked to list wheat varieties they grow and to identify the traits that they used in the selection of the varieties, and list the main constraints limiting wheat production.

3.3.3. Key informant interview

Purposively knowledgeable respondents were selected to provide detail information regarding the factors affecting adoption, the intensity of usage, the problems that wheat grower farmers face to adopt the improved bread wheat varieties. Key informants were two development agents, two model farmers from each randomly selected *kebeles*, two *kebele* chairperson and two experts from the district agriculture and natural resource office.

3.4. Methods of Data Analysis

Following data collection, the collected data were coded, edited and made ready for data entry. Based on the objectives of this study, both descriptive and inferential statistics; Double-hurdle econometric model was applied for data analysis.

3.4.1. Descriptive and inferential statistics

Descriptive statistics such as mean, standard deviation, percentage, minimum and maximum were used for describing the data using SPSS -20 software package. Chi-square and t-test was used as inferential statistical tools to compare adopters and non-adopters in terms of the different explanatory variables.

3.4.2. Data analysis for perception

Farmers' perception toward improved bread wheat varieties are described and measured based agreement level of the respondents perceived during the data collection. Perception was measured using Likert scale with items developed for the purpose of this study. Responses of the sample respondents on the perception related were analyzed by using Likert scale. Accordingly, the ratings such as strongly disagree (1) disagree (2) neutral (3) agree (4)

strongly agree (5) were used to measure the respondents perception to the improved bread wheat varieties and the larger value(5) indicated how farmers perceived the characteristics being presented for evaluation being embodied and 4,3,2 and 1 in decreasing manner. A value less than three indicated how farmers perceives characteristics under evaluation as poor or negatively. The relative agreement was computed by dividing the mean of each variable to the total mean and multiplied by 100%.

3.4.3. Analysis using Econometric model

Description and specification of econometric model

According to Cragg's model, a farmer faces two hurdles while deciding on improved bread wheat cultivation. The first is to decide whether to cultivate improved bread wheat. The second hurdle is related to the level of adoption, or how much land or capital to allocate to bread wheat production. The most important underlying assumption of the model is that these two decisions are made in two different stages. At the beginning of a cropping season a farmer may decide to cultivate improved bread wheat without making exact plans about the quantity of land. Many factors can influence a farmer's decision afterwards, i.e., price and availability of inputs, potential to cultivate competing crops, information about production technology (Berhanu and Swinton, 2003).

Various adoption studies have used Tobit model to estimate adoption relationships with limited dependent variables. Tobit model is, however, statistically restrictive because it assumes that the same set of variables determine both the probability of adoption and intensity level, but due to different factors farmers affected by different variables Tobit model limited consideration of these factors. A key limitation to the Tobit model is that the probability of a positive value and the actual value, given that it is positive, are determined by the same underlying process (i.e., the same parameters). In this case, the appropriate approach is to use double-hurdle model. This model assumes farmers faced with two hurdles in any agricultural decision making processes (Cragg, 1971).

Accordingly, the decision to participate in an activity is made first and then the decision regarding the level of participation in the activity follows. In this study, thus, double-hurdle model was chosen because it allows for the distinction between the determinants of adoption

and the intensity of adoption in wheat production through two separate stages. This model estimation procedure involves running a probit regression to identify factors affecting the decision to participate in the activity using all sample population in the first stage, and a truncated regression model on the participating households to analyze the extent of participation, in the second stage. This study, were applied the first stage of double hurdle model to examine the factors determining the decision to adopt improved bread wheat varieties and it is analyzed by a means of the probit.

According to Burke (2009), double hurdle model is useful because it allows a subset of the data to pile-up at some value without causing bias in estimating the determinants of the continuous dependent variable in the second stage, hence you can obtain all the data in the remaining sample for the participants. Thus, in double hurdle model, there are no restrictions regarding the elements of explanatory variables in each decision stages. That means it is possible to separately analyze the determinants of adoption of improved wheat decision and the intensity of adoption decisions. Due to this separablity, the estimates of adoption decisions can be obtained by a means of probit regression and that of the level of adoption decision can be analyzed by use of a truncated regression. According to Burke (2009), the separablity in estimation may not be mistaken for separablity in estimation is possible.

Double hurdle model is the modification of Tobit model and Heck man model because it is more flexible. Although, Heckman (1979) model addresses the problem associated with the zero observations by considering the respondents' self-selection, means that all the zero comes from the respondents' deliberate choices. This model differs from Tobit model by assuming that, sets of different variables could be used in the two-step estimations, however, this makes Heckit model similar to the DH model. Also the Heckman and DH model are similar in identifying the rules governing the discrete outcomes, which are determined by the selection and level of use decisions.

However, the Heckit assumes that there will be no zero observations in the second stage once the first-stage selection is passed. In contrast, the DH model considers the possibility of zero outcomes in the second-hurdle which arise from the individuals' deliberate choices or random circumstance. However, if sample selection bias is an issue, the Heckit model is favored over

the DH model but the sample-selection bias is not an issue in this study as Mills ration is insignificant appendix table 5, and the Tobit model structure cannot handle the situation in which adoption decision and land allocated may be a separate decisions, thus the Cragg DH model is optimal.

Therefore, the first decision (adoption hurdle) of the households is formulated as:

D_i^*=$Wi'\alpha + Ui$(Adoption decisions) …….2

$D_i = 1, if\ D_i^* > 0$

$D_i = 0$ Otherwise

Where, $D_i^*$is the latent variable describing the household's decision of whether or not to adopt improved bread wheat varieties that takes the value "1" if farmers adopt improved bread wheat varieties in 2018/2019 production year and "0" otherwise Di is the observed variable which represents the household's adoption decision, Wi is a vector of explanatory variables influencing household's initial adoption decision, α is a vector of parameters to be estimated and Ui is the error term.

In the second stage of double-hurdle model examine factors affecting the intensity of use improved bread wheat varieties, conditional on adoption decision, which is implemented using the truncated regression analysis. Thus, it involves the truncated regression that can be specified as:

$\mathrm{Y} = \mathrm{Y} * \text{if}\, \mathrm{Y} *> 0\ and\ Y = 1$ (Intensity equation)…….3

Y=0 other wise

From this, can specify the reduced form of the truncation model as:

Y = βo + βoiZi + Ui

Then can derive the likelihood function for the standard double hurdle model as follows:

$$\mathrm{L} = \mathrm{L}(\alpha, \beta) = [1 - \Phi(\rho i\alpha)\Phi\left(\frac{xi\beta}{\sigma}\right)[\left(\left(\frac{\Phi(\rho \text{if}}{\sigma}\right)\left(\frac{\mathrm{Q}(\mathrm{Q1}-\mathrm{X}\prime\mathrm{L}\beta}{\sigma}\right)\right)] \ldots\ldots\ldots\ldots 4$$

Where Φ denotes the standard normal cumulative density function is the univariate standard normal probability density function, and σ is the variance of error terms. The first portion (top line) is the log-likelihood for a probit, while the second portion (bottom line) is the log-

likelihood for a truncated regression, with truncation at zero value of the continuous dependent variable in the second stage (the amount of land allocated in the survey year, this study. Therefore, the log-likelihood from the Cragg type double hurdle model is the sum of the log-likelihood from a probit and a truncated regression. More useful, is the fact that these two component pieces are entirely separable, such that the probit and truncated regression can be estimated separately (Burke, 2009).

Multicollinearity test

Before running the double hurdle model all the hypothesized explanatory variables were checked for the existence of multi-collinearity problem. Two measures namely, variance inflation factor (VIF) and contingency coefficients were used to test multicollinearity problem for continuous and dummy variables, respectively.

According to Maddala (1992), VIF can be defined as: VIF ($X_{i)} = \frac{1}{1-R_i^2}$, where $R_i^2$is the squared multiple correlation coefficient between Xi and the other explanatory variables. The larger the value of VIF is the more troublesome. As a rule of thumb, if the VIF of a variable exceeds 10 (this will happen if R_i^2 exceeds 0.95), that variable is said to be highly collinear (Gujarati, 1995).

Similarly, contingency coefficients are computed for dummy variables using the following formula.

$$C = \sqrt{\frac{x^2}{n+x^2}}.$$

Where,

C is contingency coefficient,

x^2 Is chi-square value and

n = total sample size.

For dummy variables if the value of contingency coefficient is greater than 0.75, the variable is said to be collinear (Healy, 1984 as cited in Mesfin, 2005).

Test for Model Appropriateness: Double-hurdle versus Tobit model

A hypothesis test for the double-hurdle model against the Tobit model was made. The test can be done by estimating three regression models (Tobit, truncated and probit regression models) separately and then conducting a likelihood ratio test that compares the Tobit with the sum of the log-likelihood functions of the probit and truncated regression models. The LR statistic can be computed using the formula developed by Greene (2003) as:

$$\Gamma = -2[lnL_T - (nlL_P + nlL_{TR})] \sim X^2 k \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 5$$

Where, LT= likelihood for the Tobit model; LP= likelihood for the probit model; LTR= likelihood for the truncated regression model and k is the number of independent variables in the equations. Rejection of the null hypothesis ($\Gamma > X^2 k$) argues for superiority of the double-hurdle model over the Tobit model and establishes that the decisions about adoption and level adoption are made in two different stages.

3.5. Definition of Variables (dependent and independent variables)

Dependent variable for first double hurdle model (probit)

Adoption decision: Adopter and non- adopter categories were identified based on the adoption of improved bread wheat variety. In this study, the data 2018/2019 year on area allocated to improved bread wheat varieties and the continues use of improved bread wheat varieties for long period of time up to present were used to categorize the two groups. Adopters or participants are those that allocated land to improved bread wheat varieties for two or more years while non- adopters or non-participants are those who did not allocate land for these varieties at all. It is equal to one if the farm household has adopted the varieties and zero otherwise.

Dependent variable for second double hurdle model (truncated regression)

Land allocated for improved bread wheat: It is a continuous variable, which refers to the land allocated for improved bread wheat varieties. It was used in the second hurdle model as dependent variable to analyze the factor affecting the intensity of use of improved bread wheat. It is measured in hectare.

Independent Variables:

The independent variables are important elements in this study and variables those are determining factors that affect adoption and intensity of adoption of improved bread wheat varieties; these include demographic variables, socio-economic variables and institutional variables. Based on the founding of past studies and the nature of the study area, the following variables that hypothesized to affect improved bread wheat varieties adoption and intensity of adoption for this study.

Sex of the household head: This is a dummy independent variable indicating sex of the household head. It takes the value 1 for males and 0, otherwise. The gender difference is found to be one of the factors influencing adoption of new technologies. According to (Samuel *et al*., 2017; Gebremariam and Hagos,2018) female headed households are not efficient and able to adopt new technology as compared to male counterpart, since male headed household they are exposed to new information and tend to be risk takers. This study hypothesized that male household head adoption decision and intensity of adoption of improved bread wheat varieties correlated positively.

Age of the household head: Age is a continuous variable and is one of the factors that affect adoption and intensity of adoption of improved bread wheat varieties. The direction of influence is not, however, very clear and there are always mixed results from empirical analysis. Older farmers may have more experience, resource, or authority that would allow them more possibilities for trying new technologies. It may be that young farmers are more likely to adopt new technologies, because they may have more schooling than older farmers and have been exposed to new ideas and hence more risk takers (Assefa and Gezahegn, 2010). In this study, age of the household head is hypostasized to have negative effect on the adoption decision and intensity of adoption of improved bread wheat varieties.

Educational Level: in this study educational level is a continuous variable measured in year of schooling households might be determining the new agricultural technology adoption. This is due to the fact that educated person can gain better skill, experience, knowledge and this again helps them to adopt bread wheat production technology. Who have higher formal year of education are expected to analyze information and adopt earlier than the uneducated one; farmers with relatively higher education level are eager to take new ideas and to try the technology by allocating some proportion of their land (Amare, 2018; Leake and Adam

2015). In this study education level expected to have positive effect on adoption decision and intensity of adoption of improved bread wheat varieties.

Family Size: Refers to the number of members who are currently living within the family. According to Behailu (2014), large family size may have a more chance of adopting new technology. This variable is a continuous variable and it measured by number and in this study large family size expected to have positive effect on adoption decision and intensity of adoption of improved bread wheat variety application.

Size of farm land owned: It is a continuous variable measured in hectares. Farm size is an indicator of wealth and social status and influence within a community. This means that farmers who have relatively large farm size will be more initiated to adopt new technologies and the reverse is true for small size farmers. As stated by (Chandio *et al*., 2018; Sisay, 2016) those farmers with large cultivated land size could adopt and use more improved technologies mainly to increase productivity. Therefore, in this study large total farm size expected positively associate with adoption decision and intensity of adoption of improved bread wheat varieties.

Distance to market: It is a continuous variable measured in kilometers. Market distance is one of the determining factors in the adoption of technology. Better access to the market can influence the use of output and input markets, and the availability of information. It is expected that farmers living near the market would easily access market for their farm produce hence readily adopt and intensively use new technology (Afework and Lemma 2015; Hassen *et al.,* 2012). When the farmer is far away from market places, the likelihood of adopting the technology will decrease. Therefore, this study hypothesized that the farmer is far away from market is negatively relate to adoption decision and intensity of adoption of improved bread wheat varieties.

Access to credit: It is a dummy variable that takes a value of 1 if households have access to credit and 0, otherwise. Farmers who have access to credit may overcome their financial constraints and therefore buy inputs. The credit availability positively affects the adoption of improved technologies (Tiamiyu *et al*., 2014; Leake and Adam, 2015). Therefore, it is

expected in this study that access to credit increase the probability of adoption decision and intensity of adoption of improved bread wheat varieties.

Livestock ownership: This refers to the total number of animals possessed by the household measured in tropical livestock unit (TLU). According to (Hailu, 2008; Gebresilassie and Bekele, 2015; Leake and Adam, 2015) found positive relation between livestock ownerships with adoption. This variable expected to have a positive relationship with probability of adoption decision and intensity of adoption improved bread wheat variety adoption of farmers.

Frequency of extension contact: It is a continuous variable measured in terms of per month the frequency of contact between the extension agent and the farmers is hypothesized to be the potential force, which accelerates the effective dissemination of adequate agricultural information to the farmers, thereby enhancing farmers' decision to adopt new crop technologies. According to (Regasa, 2018; Adunea, 2017) contact with extension agents has positively influenced the adoption of high yielding wheat varieties and row planting of wheat. A similar study of Hassen *et al.* (2014) indicated that, more contacts with extension agents would increase farmers' adoption of technologies. Therefore, in this study it hypothesized that contact with extension workers increase a farmer's likelihood of adoption decision and intensity of adoption of improved bread wheat varieties.

Farm income: It is a continuous variable and refers to the total annual cash earning to the families from selling of crops, livestock and livestock products after meeting family's requirements. This is believed to be the main source of capital for purchasing agricultural inputs. Thus, those households with a relatively higher level of farm income are likely to purchase improved seeds or other essential agricultural inputs (Tesfaye, 2014). It is measured by the amount of Ethiopian birr obtained from sale of farm produces. Thus, this study also hypothesized that higher level of income increase adoption decision and intensity of adoption improved bread wheat varieties.

Off/non-farm income: It is a continuous variable that represents an annual income earned and measured in ETB from off/non-farm economic activities through external labor supply,

rentals of ox power, pack animals and land, handicrafts, petty trade, and so on (Hassen *et al.*, 2012). The more off/non-farm income the farmer generates, the higher resolves financial constraints, the faster to adopt improved bread wheat varieties. Thus, this study also hypothesized that higher off/non-farm income increase the adoption decision and intensity of adoption of improved bread wheat varieties.

Bread wheat farming experience: It is a continuous variable measured in years of bread wheat production. It is expected that farmers who have adequate farm experience more likely to adopt new technologies than less experienced farmers. Aman and Tewodros (2016) indicated that farm experience affect intensity adoption of improved barley varieties positively. Therefore, in this study it expected that the farm experience is positively related to adoption decision and intensity of adoption of improved bread wheat varieties.

Availability of improved bread wheat seed on time: it is dummy variable indicating the timely availability of improved bread wheat seed 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. If the improved bread wheat seed not available on time, they are likely to spend the money on other things. Moreover, improved bread wheat seed unavailability on time forces farmers to drop totally and it force to use of local wheat. Improved bread wheat seed availability on time determines the adoption decision of new technologies positively and significantly (Adunea, 2017; Susie, 2017). Therefore, in this study availability of improved bread wheat seed on time to the farmers' increased, probability of adoption decision and intensity of adoption expected to increase.

Membership in cooperative: This variable is included in the study because it has been shown that farmers within cooperative organization learn from each other how to grow and market new crop varieties. A farmer-based organization is a network of farmers who inter-depend among themselves in sharing information and learning from one another. It is a dummy variable which takes a value of 1 if the household is member of cooperative society and 0 otherwise. Cooperatives serve as an important source of rural credit. Due to this, a farmer who is member of cooperative has more chance to get credit. Formal as well as informal associations, such as marketing cooperation groups, enforcing widely agreed

standards of behavior, and uniting people with bonds of community solidarity and mutual assistance (Musba *et al*., 2017; Sisay *et al.*, 2016) .Therefore, being member of cooperative was expected to have positive and significant relationship with adoption decision and intensity of adoption of improved bread wheat varieties.

Table 5: Units of measurement of dependent and independent variables used for analyses

variables	Type of variable	Unit of measurements	Expected sign
Dependent variables			
1. Adoption of IBWV	Dummy	1=adopter,0=non-adopter	
2. Area of IBWV cultivated	Continuous	Hectare	
Independent variables			
Age of Household Head	continuous	years	-ve
Sex of Household Head	dummy	1=Male 0= female	+ve
Household Size	Continuous	Number	+ve
Total farm size	Continuous	hectare	+ve
Educational level	Continuous	Years of schooling	+ve
Livestock Ownership	Continuous	TLU	+ve
Access to Credit Service	Dummy	1=Yes 0=not	+ve
Availability of inputs on time	Dummy	1=Yes 0=not	+ve
Bread wheat farm experience	Continuous	years	+ve
Frequency of Extension Contact	Continuous	per month	+ve
Distance to market	continuous	Kilometer	-ve
Membership in cooperative	Dummy	1=yes o= not	+ve
Off/non-farm income	Continuous	ETB	+ve
Farm income	Continuous	ETB	+ve

4. RESULT AND DISCUSSIONS

4.1. Result of Descriptive Analysis

In this chapter, the overall findings of the study are presented under different sections. Next, to the description of the status of adoption and intensity of use of improved bread wheat varieties, the influence of different personal, demographic, social, economic, institutional and psychological factors on adoption and intensity of use of improved bread wheat varieties discussed consecutively. In this section of analyses, descriptive statistics such as mean, standard deviation, frequency and percentage, inferential statistics such as t-test and chi-square test were employed using SPSS version 20 software programs.

4.1.1. Adoption and land allocated for improved bread wheat varieties

In this study, adoption refers the respondents who have cultivated improved bread wheat varieties and continued growing at least one of the distributed improved bread wheat varieties in the study area during the survey year and in any one of the year before the survey year of this study are considered as adopters. Farmers who never adopted and those who discontinued from growing improved bread wheat varieties are categorized as non- adopters.

Table 6: Rate of adoption and area covered by improved bread wheat varieties by sample households

categories	number	percentage		
Adopter	96	53.9		
Non-adopter	82	46.1		
Total	178	100		
Land allocated to improved bread wheat varieties in hectare/ Timad/				
		minimum	Maximum	Average(mean)
		0.25	1.00	0.625ha /2.5 *Timad/*

Source: own survey result, 2018/2019

The rate of adoption is the percentage of sample farmers who have adopted improved bread wheat varieties. As indicated in table 6, a total of 178 sample respondents were included in the survey, out of this which 96(53.9%) and 82(46.1%) were found to be adopters and non-adopters of improved bread wheat varieties respectively. Accordingly, the rate of adoption of

improved bread wheat varieties by sample households in the study area was found to be 53.9% during the survey year.

The intensity of adoption (in terms of the proportion of farm land allocated to improved bread wheat varieties) is measured in the proportion of area covered by improved bread wheat variety to total farm land. The area coverage was varied among wheat-growing sample households. As indicated in Table 6 the total sample households' average area proportion coverage was 0.625 hectares/2.5 *timad/*. The minimum and maximum area coverage by adopters sample households range from 0.25 to 1.00 hectare.

During the survey time their reasons why they were not adopting improved bread wheat were interviewed their response had summarized in Table 7.

Table 7: Reasons given for not using improved bread wheat varieties (from non-adopters)

Reasons not adopting improved bread wheat varieties	No (82)	Percent	Rank
Shortage of land	30	36.6	1^{st}
High price of seed	19	23.2	2^{nd}
High price of fertilizer	13	15.8	3^{nd}
Low disease resistance problem	12	14.6	4^{th}
Lack of timely input availability	8	9.8	5^{th}
Total	82	100	

Source: own survey data result, 2018/2019

There are many factors that are directly or indirectly affect adoption and intensity of adoption of improved bread wheat varieties. From table7 closed to 36.6%, 23.2%, 15.8%, 14.6% and 9.8% of the respondents from the survey replied that because of shortage of land, high price of seed, high price of fertilizer, low disease resistance problem and lack of timely input availability respectively are the major constraints that negatively affect the rate of adoption and intensity of adoption of improved bread wheat varieties were identified during the current study.

During the focused group discussion farmers told that the shortage of farmland especially in some villages due to the expansion of urban and degradation of farmland influence the cultivation of improved bread wheat varieties. Besides this, an increasing number of family members per household in the area enforce farmers to share their farmland to children that reduce the already low farmland size and made an influence on the adoption and intensity of adoption of improved bread wheat varieties.

The other point that was discussed in the focus group discussion was most of the farmers in the study area pointed out the cost of improved wheat seed and fertilizer was too expensive and not affordable for them. During FGD, farmers mentioned that they were forced to use fertilizer below the recommended level due to the high price of fertilizer. Those farmers who were participated in the FGD were critically mentioned that the most problem to adopt wheat varieties, the susceptibility of improved bread wheat variety to wheat rust disease and price of input especially fertilizer was increasing time to time.

4.1.2. Improved bread wheat varieties growing in the Study district

Improvement in production and productivity of a given crop depends among other things on presence and use of better and improved varieties. In line with this objective, a lot of efforts have been made by the research system to generate improved varieties of bread wheat and as a result, many varieties have been released. The improved wheat varieties still widely grown by farmers in the district are Digalu, Hidase, Taye, Shorima, Danda'a, oglcho, Bobicho and kakaba are the major ones. Hence, for this study Hidase, Shorima and oglcho considered as improved bread wheat varieties. Other varieties Wane, Mandoyu and Dambal on demonstration sites before dissemination to the farmers in different agro ecology of the district. Figure 3 data result show that the status of adoption of improved bread wheat varieties, the survey result indicated that 55.2% of adopters are currently growing Hidase (ETBW 5795) variety, while 35.4% are growing Shorima (ETBW 5483), and 9.4% are Oglcho (ETBW 5520) variety during survey year 2018/2019. According to the respondents, Hidase was preferred for its high yield per hectare, but it is susceptible to yellow rust. Shorima and Oglcho were preferred for their resistance to yellow rust and early maturity as compared to Hidase.

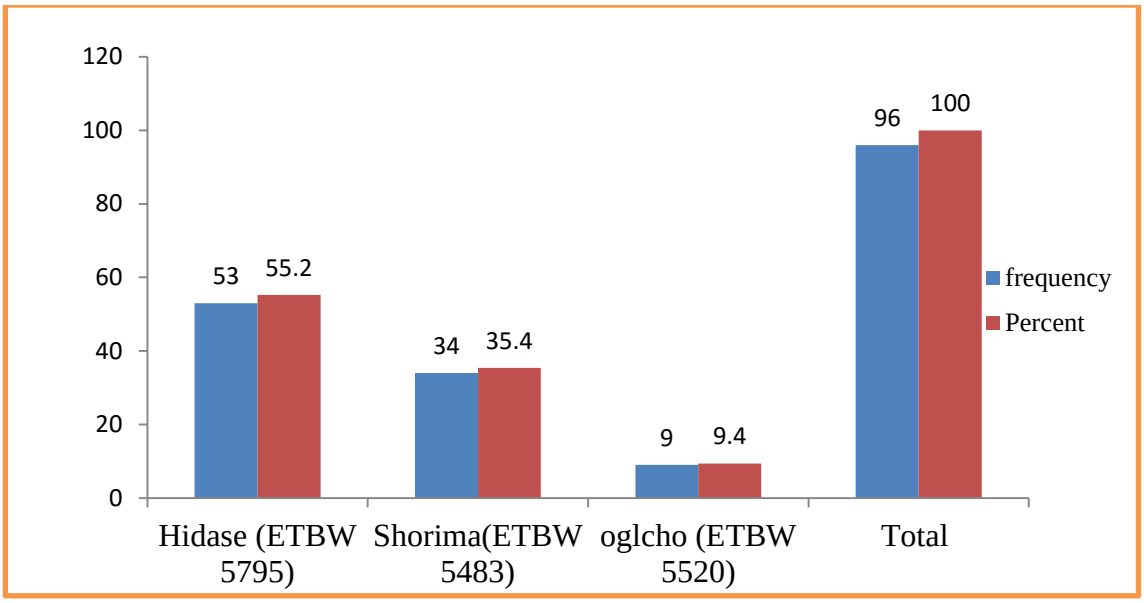


Figure 3: improved bread wheat Varieties cultivated in the study area

Source: based on data from the survey

4.1.3. Sample households' demographic characteristics

In order to understand the sample household, it is very important to describe their demographic characteristics. The number of household head respondents was from three randomly selected rural *kebeles* administrations namely, Shurmo Dacho, Bobicho and Ambicho Gode. From 178 total sample household 150 (84.3%) were male and 28(15.7%) were female. Out of 150 male 88(91.7%) were adopters and 62(75.6%) were non- adopters and out of 28 female 8(8.3%) were adopters and 20(24.4%) were non- adopters as presented in the table 8. The sample house hold head covered in this study from Shurmo Dacho kebele were (31) 32.3% adopters and (26)31.7% were non-adopters with total of (57) 32.0%, the sample house hold head covered in this study, from Bobicho kebele were (33) 34.4% adopters and (27)32.9% non-adopters with total (60)33.7% and The sample house hold head covered in this study from Ambicho Gode kebele were (32)33.3% adopters and (29)35.4% were non-adopters with total of (61) 34.3% of the total sample as presented in the table 8.

Table 8: Sample household heads distribution by sex, kebele and adoption categories

Sample	Adopter(96)		Non- adopter(82)		Total(178)	
	No	%	No	%	No	%
Male -sample	88	91.7	62	75.6	150	84.3
Female- sample	8	8.3	20	24.4	28	15.7
Total	96	100	82	100	178	100
Shurmo Dacho	31	32.3	26	31.7	57	32.0
Bobicho	33	34.4	27	32.9	60	33.7
Ambicho Gode	32	33.3	29	35.4	61	34.3
Total	96	100	82	100	178	100

Source: 0wn survey result, 2019

Table 9: Marital status of sample respondents

Marital status	Adopters(96)		Non- adopters(82)		Total (178)		x^2 −value
	No	%	No	%	No	%	
Married	93	96.9	76	92.7	169	94.9	
Divorced	3	3.1	-	-	3	1.3	9.66***
Widowed	-	-	6	7.3	6	3.4	
Total	96	100	82	100	178	100	

Source: 0wn survey result, 2019

The marital status of respondents survey result show in the table9 as (169) 94.9% married, (1) 1.3% divorced and (6) 3.4% are widowed. The chi-square test (x^2=9.66, p=0.008 of marital status between the adopters and non-adopters was found to be significant at 1% significant level.

4.1.4. Descriptive statistics for continuous variables

The descriptive and inferential results presented in table 10 show that there was a statistically significant mean difference between adopters and non-adopters in terms of education level the

household, Frequency of extension visit, TLU, farm income, off/non/- farm income and distance to market in favor of the adopters. On the other hand, adopters did not make significant difference in terms of age of household, farming experiences, and total family size with compared to non-adopters. The descriptive and inferential result of each variable is interpreted as below:

The overall age for sample household is 46.69 and the mean age of household head for adopters and non-adopters are 46.42 and 47.00 years respectively. An independent sample t-test was conducted to see if there was significant difference in the mean age of adopters and non- adopters. The t-value (t= -0.56, p=0.571) showed statistically not significant in the mean age of adopters and non-adopters. This result indicated that there was no relationship between adoption of improved bread wheat variety and age of the household.

Education can influence the productivity of producers and the adoption of newly introduced technologies and innovations. The overall mean grade completed for sample household is 4.37 and the mean grade completed of the household head for adopters and non-adopters is 5.86 and 2.63 years respectively. To check whether there is a significant mean difference in grade completed between adopters and non-adopters t-test statistics was run. The t-test (t=11.85, p=0.000) shows that there was a statistically significant mean difference among adoption categories.

In this study, household size was considered as number of individuals who live in the respondent's house. Large household size is assumed as an indicator of labor availability in the family. By considering this the household size was hypothesized to have positive and significant relationship with adoption and intensity use of improved bread wheat varieties. The overall household size for sample household is 5.69 and the mean household size of household head for adopters and non-adopters are 5.76 and 5.60 years respectively. The results showed that there is no significant difference among the adoption categories in family size. Independent t-sample test (t=0.65, P=.512) shows that there is statistically non-significant mean difference between adoption categories

Experience refers bread wheat farming experience of household in wheat production. More experienced farmers may have better information to evaluate the advantage of improved

variety. The average experience of sample respondent was 19.72 years. The average farming experience of the adopters and non-adopters were 19.70 and 19.74, respectively. To analysis whether there is a significance mean difference in farming experience between adopters and non-adopters t-test statistics was run. The t-test (t=-0.38, p=0.970) showed statistically not significant in the mean farming experience of adopters and non-adopters. This result indicated that there was no relationship between adoption of improved bread wheat varieties and farming experience of the household.

The land is a very important resource, as it is the base of for any economic activities especially in rural society. The minimum and maximum cultivated land sizes were found to be 0.25 hectare and 2.5 hectares, respectively in the study area. From the total sample farmers in the woreda the overall mean landholding is 0.78ha of land. The average total cultivated land size was 0.84ha for adopters and 0.72ha for non- adopters. To check the association between farmland size and adoption of improved bread wheat varieties t-test (t=2.92, P=0.004) analysis was carried out and the result showed that there was statistically significant mean difference among adoption categories.

Table 10: Descriptive statistics for continuous explanatory variables

Variables	Adoption category				Total sample		T-test
	Adopter(96)		Non adopter(82)				
	Mean	St dv	Mean	Stdv	mean	stdv	
Age	46.42	6.86	47.00	6.56	46.69	6.71	-0.56
Educational level	5.86	1.97	2.63	1.60	4.37	2.42	11.85***
family size	5.76	1.44	5.60	1.59	5.69	1.51	0.65
farm experience	19.70	6.15	19.74	6.28	19.72	6.19	0.38
Total farmland size	0.84	0.33	0.72	.22	0.78	0.29	2.92**
Frequency to extension contact	9.15	4.18	7.03	2.70	8.17	3.72	4.06***
TLU	5.17	1.30	5.91	2.12	5.54	1.77	-2.98***
Farm income	10659.60	5338.15	4822.80	2731.78	7970.7	5217.43	9.73***
Off/non-farm income	3152.80	2315.00	1786.90	1315.67	2523.60	2033.41	4.92***
Market distance	6.11	1.63	6.87	1.65	6.46	1.68	-3.07***

Source: own survey result, (2018/2019) **, *** significant at5%, 1% probability level.

Extension service is an important institutional service that is required to increase agricultural productivity through the adoption of new technologies. The overall mean of extension contact per month for samples household is 8.17 and the mean of extension contact per month for adopters and non-adopters are 9.15 and 7.03 respectively. To check whether there is a significant mean difference in extension contact between adopters and non-adopters t-test statistics was run. The result of t-test (t=4.06, p=0.000) also revealed that there is statistically significant mean among adopters and non-adopters concerning frequency extension contact with farmers at a 1% probability level.

Livestock holding is an indicator of a household's wealth position in the rural context. The overall mean TLU for sample household is 5.54 and the mean TLU of the household head for adopters and non-adopters are 5.17 and 5.91 respectively. To help the standardization of the analysis, the livestock number was converted to a tropical livestock unit (TLU). The conversion factors used were based on Storck, *et al*. (1991) and it is shown in Appendix - Table 1. To analysis whether there is a significant mean a difference in TLU between adopters and non-adopters t-test statistics was run. The t-test (t= -2.98, p=0.003) showed statistically significant in the mean TLU of adopters and non-adopters at a 1% significant level in the study area.

The annual average total income earned by sampled households was 7970.70 birr. From the survey result that adopter farmers earned 10659.60ETB farm incomes during the survey year, while non-adopters earned 4822.80ETB. The t-test (t=9.73, p=0.000) reveals that, from sample farmers, there was a significant mean difference between the farm income of adopters and non- adopters at a 1 % significant level in the study area.

The annual average total off/ non-farm income earned by sampled households was 2523.60ETB. From the survey result, it was learned that adopter farmers earned an average of 3152.80ETB off/non-farm income during the survey year, while non-adopters earned 1786.90ETB. The t-test (t=4.92, p=0.000) showed that off/non-farm income between adopters and non-adopters was found to be significant. That means there was a statistically mean difference between adopters and non-adopters in terms of off/non-farm income in the study area.

The overall market distance for sample household is 6.46kilo meters and the mean market distance of household head for adopters and non-adopters are 6.11and 6.87 kilo meters respectively. To analysis whether there is a significant mean the difference in market distance between adopters and non-adopters t-test statistics was run. The t-test (t= -3.07, p=0.002) analysis showed that statistically mean difference between adopters and non-adopters in terms of market distance at a 1% significant level.

4.1.5. Descriptive statistics for dummy explanatory variables

The sex of the household head can influence agricultural production activity. As indicated in the table 11 out of 178 sample respondents, 150(84.3%) of headed households were male, while 28(15.7%) of households were female-headed. The proportion of male-headed households was 91.7% for adopters and 34.1% for non-adopters. Whereas, the proportion of female-headed households of the adopters (8.3%) was less than the non-adopters which was 65.9%. The result of chi-square analysis (x^2=8.60, p=0.003) revealed that there is a significant relationship between sex and the adoption of improved bread wheat varieties at 1% significant level.

Credit service is an important source of finance for poor farmers to buy inputs for agricultural production and ultimately to adopt new technologies. Out of the total sample respondents, about 56.2% got credit service from different sources of credit service delivering institutions to buy their agricultural inputs. On the other hand, 43.8% of the total sample households were not credit users. Additionally, 67.7% adopters and 42.7% of non-adopters sample households had access to credit service during the survey year. The remaining 32.3% of the adopters and 57.3% of non-adopters had not accessed to credit service. The chi-square (x^2=11.25, p=0.001) analysis result revealed that the association between the two groups concerning this variable was found to be statistically significant at the 1% probability level.

Table 11: Descriptive statistics for Dummy Explanatory variables

variables	Adopter		Non-adopter		Total		x^2 −value
Sex	N	%	N	%	N	%	
male	88	91.7	62	34.1	150	84.3	8.60***
female	8	8.3	20	65.9	28	15.7	
Access credit							
Yes	65	67.7	35	42.7	100	56.2	11.25***
No	31	32.3	47	57.3	78	43.8	
Membership in cooperative							
Yes	62	64.6	30	36.6	92	51.7	13.88***
No	34	35.4	52	63.4	86	48.3	
Availability of wheat seed on time							
Yes	76	79.2	21	25.6	97	54.5	51.15***
No	20	20.8	61	74.4	81	45.5	

Source: own survey result, (2018/2019) *** significant at 1% probability level

Membership cooperative societies are one of the important institutions in rural and agricultural development which serve as an important source of rural credit. Out of 178 sample respondents, about 51.7% sample households were members to cooperative while 48.3% of sample respondents were not members cooperative. About 64.6% of the adopter and 36.6% of non-adopter sample households were members of cooperative. While 35.4% of the adopter and 63.4% of the non-adopter sample respondents did not participate in the cooperative. The chi-square (x^2=13.88, p=0.000) analysis result of the study revealed that the percentage association among adoption categories was statistically significant at 1% probability level.

Improved bread wheat seed availability was one of the institutional variables and it is important to the farmers to adopt improved bread wheat varieties and to improve their production potential. Out of 178 sample household heads, 54.5% of farmers have reported the availability of improved wheat seed on time with the required quantity and the remaining 45.5% of farmers reported unavailability of improved wheat seed on time. About 20.8% of the adopters and 74.4% of the non-adopters reported that they were not getting improved bread varieties on time. While About 79.2% of the adopters and 25.6% of the non-adopters reported that they were getting to improved bread wheat variety on time. The result of chi-square (x^2

=51.15, p=0.000) showed that there was strongly association between adoption categories concerning the availability of improved wheat seed on time at 1% probability level.

4.1.6. Source of improved bread wheat varieties in the study area

According to sample respondents about 24% obtained improved bread wheat varieties from cooperative/farmers group, about 13.5% obtained from Ethiopian seed enterprises, about 59.7% from government subsidy program, while about 3.1% respondents obtained improved bread wheat varieties from research center (table12).

Table 12: source of improved bread wheat varieties

source of seed	Freq.	Percent
Cooperatives/farmers groups	23	24
Ethiopian seed enterprises	13	13.5
Gov't subsidy program	57	59.4
Research center	3	3.1
Total	96	100

Source: own survey, 2018/2019

4.1.7. Farmers perception of improved bread wheat varieties adoption

Perception toward attributes of improved bread wheat varieties by smallholder farmers is one of the determinant factors for decisions making on the adoption of improved bread wheat varieties. Understanding farmers' technology preference criteria is an important issue in the technology generation and dissemination process. In most cases, technologies fail to be adopted by users due to a mismatch in preference criteria between technology promoters and end-users (farmers). Mostly, peoples living in the same environment share a common understanding of various circumstances and from more or less similar perception about a certain situation. However, the degree of perception varies from individual to individual due to different factors. They consider the consequence of using improved bread wheat on local ones from different angles. Technical, economic and social factors influence and/or determine the possibility and the extent of use of the new ideas and practices.

Similarly, in this study, there is a need to consider the perceived nature of the improved bread wheat varieties. Farmers' perception toward improved bread wheat varieties are described and measured based agreement level of the respondents perceived during the data collection. Perception was measured using Likert scale with items developed for the purpose of this study. Responses of the sample respondents on the perception related were analyzed using Likert scale. Accordingly, the ratings was strongly disagree (1) disagree (2) neutral (3) agree (4) strongly agree (5) were used to measure the respondents perception to the improved bread wheat varieties. The larger value(5) indicated how farmers perceived the characteristics being presented for evaluation being embodied and 4,3,2 and 1 in decreasing manner. A value less than three indicated how farmers perceive as poor or negatively.

As shown in the above table 13, farmers' perception on improved bread wheat varieties adoption on average based on the seven items, showed that on average their perception is 3.11, which means a little bit above the neutral and closer to the positive perception towards improved bread wheat. Farmers' in this regard, they agree positively to adopt improved bread wheat, although they have positive perception, their agreement is not strong. Hence, strong extension service and farmers' training on improved technologies including improved bread wheat is strongly advisable. From the level of agreement of improved bread wheat varieties, high yielding potential of varieties, disease resistance capacity of varieties, early maturity of varieties, environmental adaptability of varieties and marketability showed relatively best performance of varieties in the study area. Whereas, water lodging capacity of varieties and stayed for long time of varieties indicates relatively poorest agreement compared to all other characteristics of level of agreements considered (table13). Similar results were reported by Milkias and Abdulahi (2018) which indicated perception on diseases resistance of varieties, high yielding, early maturity of varieties, agro ecological suitability and availability of seed on time and quality of varieties showed relatively best performance of varieties. Whereas, perception on technological availability varieties indicates relatively poorest agreement to all other characteristics level of agreements considered.

Table 13: farmers' perception on improved bread wheat varieties adoption

Characteristics of improved bread wheat varieties	Distribution of respondents' perception categories (%)					Mean	Level of agreement (%)	Rank
	Strongly disagree	Disagree	Neutral	agree	Strongly agree			
Early maturity of varieties	12.4	30.9	7.9	26.4	22.5	3.16	14.53	3^{rd}
Diseases resistance capacity	11.2	10.1	15.7	27.0	36.0	3.66	16.83	2^{nd}
High yielding potential of varieties	10.1	8.4	14.0	35.4	32.0	3.71	17.05	1^{st}
Environmental adaptability of varieties	17.4	24.7	13.5	23.6	20.8	3.15	14.48	4^{th}
Marketability of varieties	18.5	25.8	16.3	20.8	18.5	3.01	13.84	5^{th}
water-lodging capacity of varieties	18.5	59.6	11.2	3.9	6.7	2.67	12.27	6^{th}
Stay for long time	69.5	6.2	14.0	6.2	3.9	2.41	11.08	7^{th}
Sum of mean						21.75		
Grand mean						3.11		

Source: survey result, 2019

The information on selection criteria or perception of improved bread wheat varieties of the farmers in the study area assessed by focused group discussion. Farmers gave various reasons for choosing the wheat varieties they were using. High yielding was the most important reason given by sample respondents and FGD. From an economic point of view, the farmers preferred high yielding varieties to achieve increased output and hence profits. The other point that was discussed in the focus group discussion was most of the farmers pests and diseases resistance as a reason for the preferred bread wheat varieties was reported by sample respondent farmers and FGD economic point of view, the aspect of wheat variety being pests and diseases resistant is important, as it cuts down on the cost of production. Farmers choose the varieties they were using based on the variety being resistant to pests and diseases.

The other point that was discussed in focused group discussion was most of the farmers were selected early maturing as the reason for preferred wheat varieties were reported sample respondents and FGD. This was a reasonable decision given that, rainfall is unreliable in the study area and therefore, farmers understand the need to grow wheat varieties that take short time to mature to take advantage of whatever rainfall that may be available. Other reasons for the preferred wheat varieties were wheat environmental adaptability, marketability, water lodging resistance, and stay for a long time in the study area.

Table 14: Farmers responses on shortcoming of improved bread wheat varieties

Farmers' Responses on shortcoming of improved bread wheat varieties	adopters		Non adopters		Total	
	No	%	No	%	No	%
High price	22	22.9	52	63.4	74	41.6
Easily attacked by disease	20	20.8	22	26.8	42	23.6
No shortcoming	54	56.3	8	9.8	62	34.8

Source: own survey data, 2019

Some of the farmers perceive improved seed negatively because of its high price and easily attacked by disease. Grain of improved variety cannot stay for long time in storage, due to susceptibility to storage pest. These were the two negatively perceived drawbacks on improved bread wheat variety. About 22.9% of adopters and 63.4% of non-adopters put high price of seed as its weak side; while about 20.8% of adopters and 26.8% of non-adopters

perceived that easily attacked by disease of improved seed, whereas about 56.3% of adopters and 9.8% of non-adopters perceived that no shortcoming of improved bread wheat varieties (table14).

4.2. Result of Econometric Models

In the previous section we have deal mostly with description of sample household farmers and test of existence an association between independent variables to identify factors affecting adoption and intensity of adoption of improved bread wheat varieties. Identification of these factors is however not enough unless the relative influence of each factor is known for priority intervention. This section explains the double-hurdle econometric model estimate of determinants of the adoption and intensity adoption of improved bread wheat varieties. The factors considered were related to socio-demographic, economic and institutional variables on the adoption and intensity of adoption of improved bread wheat varieties. The impact of these variables on the adoption decision and intensity of use of improved bread wheat varieties are discussed below:

Before running the double hurdle model all the hypothesized explanatory variables were checked for the existence of multicollinearity problem. For continuous variables VIF was used to check multicollinearity problem and for dummy variables contingency coefficient was used. As the rule of thumb VIF values less than 10 is said to be weak association among explanatory variables. Accordingly, the VIF values displayed in the Appendix Table 2 shows that all the continuous explanatory variables had no serious multicollinearity problem. Similarly, the values of contingency coefficient were also low as shown in Appendix Table 3 which is less than the rule of thumb of 0.75 implying that a weak degree of association among the variables considered. Therefore, based on the above tests all the hypothesized continuous and dummy explanatory variables were kept in the respective models for further analysis.

The test statistics of the double-hurdle versus the Tobit model indicated the rejection of Tobit model and acceptance of the double-hurdle model. The test result in Appendix Table 4 revealed that the calculated statistical value of likelihood ratio was 91.06 which was greater than the tabulated or critical value of X^2 (14) =22.99 at 1% level of significance. This shows the existence of two separate decision making stages during the adoption process. This result

provides an empirical result of farmers' independent decisions making regarding the adoption and intensity of use of improved bread wheat varieties in the study area.

In general, the estimated results for D-H model shows some variables appearing in both equations have opposite influences in terms of both signs and level of significance. For instance, education level of household head, availability of wheat seed on time, frequency to extension contact, sex of household head, access to credit service, TLU, and off- farm income have conflicting signs in the adoption and intensity of use equation. However, membership in cooperative has significant effect on the adoption decision and intensity of improved bread wheat varieties adoption. The significance level in explaining for both at 1%level.

4.2.1. Factors affecting adoption decision of improved bread wheat varieties

This section presents maximum likelihood estimates of the probit model to identify determinants of the adoption of improved bread wheat varieties. The dependent variable for the probit model is the adoption decision of the sample household. A total of fourteen explanatory variables of which ten continuous and four dummy were included in the model. The estimated results of the probit model are summarized in the table15 below. Out of fourteen independent variables, five variables were significantly determined adoption of improved bread wheat varieties at 1%, 5% and 10% significant levels. These significant variables were an educational level of the household, total land size of household, membership in cooperative organization, availability of improved seed on time and frequency to extension contact (Table 15).

Education level: education level of the household head, which is one of the important indicators of human capital, has a positive and significant relationship with the adoption of improved bread varieties at a 5% significance level, implying that the likelihood of adoption of improved varieties may increase with farmers' formal education level. As years of schooling of the household head increases by one year, the probability of adopting improved bread wheat varieties would also increase by 13.4% of marginal effect. This may be due to relatively educated farmers have more access to information and they become aware to new technology and this awareness enhances the adoption of technologies. This result is consistent with the research results of Amare (2018) and Degefu *et al*. (2017) indicated that more

educated smallholder farmers show higher tendencies to adopt new improved wheat varieties compared to less educate.

Total farm land size: the independent variable farm size has affected adoption of improved bread wheat varieties positively and significantly at a 1% significance level. This implies that farmers with large farm sizes are more likely to adopt the improved bread wheat varieties than those farmers who have small land size. As observed in the study area farm is a very important resource to invest the improved bread wheat varieties, because farmers on their small land grow different crops, rear different animals and thereby likely to generate sufficient income, which could help them to buy agricultural inputs. The marginal effects indicated that as land holding of household increases by one hectare, farmers' adoption of improved bread wheat varieties increases by 59.7% as compared to less land size. This result is similar with the finding of (Chandio *et al*., 2018; Degefu *et al*., 2017; Sisay., 2016; Berihanu, 2014). Their founding indicated that positive effects of farm size on the adoption of the new wheat varieties.

Membership in cooperative: Participation in cooperative society had a positive and significance relation with adoption of improved bread wheat varieties at 1% significance level. The variable accounted for 63.0% of the variation in probability of adoption of improved bread wheat varieties. Hence, participation in cooperative as membership improves the probability of improved bread wheat varieties adoption decision of farmers by 63.0% as compared to farmers who are not participated membership. Organizing of farmers to be a member of cooperative society would facilitate access to credit, access to extension information and access to market. A possible reason for this positive relation result to fact that cooperative organization found in the study area was actively participated in the providing inputs like improved bread wheat varieties, credit service, buying their product and fertilizers for their members. Cooperative members were found to be better in access to and use of credit services. The study is similar with (Musba, 2017; Degefu *et al*., 2017; Sisay *et al*., 2016) indicated membership in cooperatives affect adoption positively and significantly. Contrary to this, the study by, Regasa (2018) Memberships to organization have found negative and significant relation with adoption of high yielding wheat varieties implying that farmers who are members of different organizations are less likely to adopt high yielding wheat varieties.

Table 15: Probit estimates of the factors affecting adoption decision of improved bread wheat varieties

Variable	coefficient	Std. Err.	Marginal effect	z	P>z
AGE	-0.1162	.0901	-0.0314	-1.29	0.197
HHSEX	1.2054	1.1116	0.4113	1.08	0.278
EDUCATION	0.4986	.2006	0.1348	2.49	0.013**
HHSIZE	-0.0591	.2137	-0.0159	-0.28	0.782
FARMEXPR	0.1308	.1030	0.0353	1.27	0.204
TOTALLANDSIZE	2.9084	1.0934	0.5979	2.65	0.005***
COOP	2.3311	.8389	0.6304	2.78	0.005***
ACCTOCRD	0.3747	.5507	0.1032	0.68	0.496
TLU	-0.3329	.2443	-0.0900	-1.36	0.173
FARMINCOME	0.00005	.00006	0.00001	0.77	0.441
OF/NON-ARMINC	0 .0023	.0021	0.0006	1.12	0.262
INPUTONTIME	1.0914	.5772	0.3030	1.89	0.059*
FEQEXTCONCT	0.1725	.0984	0.0466	1.75	0.080*
DISTOMARK	0.0078	.1887	0.0021	0.04	0.967
CONS	-.3178264 ***	.1830813	-	-2.48	
Log likelihood	-16.779493				
LR chi2 (14)	212.10				
Prob > chi2	0.0000				
Pseudo R2	0.8634				
Number of ob	178				

Source: model output, *, ** and *** represents 10%, 5% and 1% level of Significance respectively.

Improved bread wheat seed availability on time: availability of improved bread wheat varieties was found to be positive and significantly related to a probability of adoption of improved bread wheat varieties at a 10% significance level. Other variables held constant, timely availability of improved bread wheat varieties brings about a 30.3% increase in the

probability of adoption of improved bread wheat varieties. The result implied that those who get improved bread wheat varieties on time are more likely to adopt improved bread wheat varieties than those who do not have access to improved bread varieties. This is expected as farm households residing in remote areas hardly get reliable sources of improved seeds, magnifying the importance of the availability of seed in the local area. The result is consistent with studies by Adunea (2017), Susie (2017), and Tolesa (2015), who found that the on-time availability improved wheat, seeds the more the probability of adopting improved wheat varieties.

Frequency of extension contact: this variable represents the number in which extension agents visit farmers' fields of production per month. As expected these institutional variable factors affect the adoption of improved bread wheat varieties of farmers of this study area positively and significantly at a 10% significance level. From this marginal effect, a unit increases in the frequency of contact with extension agents increases the probability of being adopted by 4.6%. The result indicated a higher probability of farmers with more contact with extension agents in adopting than farmers with less contact. The possible justification for this is that farmers who have more frequency of extension contacts with development agents update themselves on the availability and get information about improved bread wheat varieties and aware of its application techniques than those less visited by development workers. The finding of this research result is also in line with the research result reported by (Regasa, 2018; Adunea, 2017; Tolesa, 2015; Hassen *et al.,* 2014). Result of their studies indicated that contact with extension agent was positively and significantly related to the adoption of wheat row planting and improved wheat varieties.

4.2.2. Factors determining the intensity of improved bread wheat varieties adoption

This section focuses on factors determine the intensity of farmers' wheat production participation conditional on the decision to adopt improved varieties. In this case, the truncated regression model was used to identify factors determining the intensity of wheat production. The dependent variable for this model was the land size (ha) allocated for improved bread wheat varieties in 2018/2019 production season. Out of thirteen explanatory variables, five variables have significantly affected the intensity of adoption of improved

bread wheat varieties. The significant variables were the sex of household head, membership in cooperative, access to credit, total livestock holding and off-farm income (table 16). The Wald chi-square result of the analysis revealed that the overall fitness of the model was found to be at a 1% significance level.

Sex of the household head: Sex of the household heads was found to be positively and significantly influenced the intensity of use of improved bread wheat varieties at a 1% level of probability. Keeping all other variables constant, as compared to female-headed households, the area coved by improved bread wheat varieties for male-headed households increased by 0.15ha. The estimated coefficient for this dummy variable reveals the existence of different levels of bread wheat production participation based on the sex of the household head. The result suggests that those male-headed households are more likely to allocate a larger amount of land to improved bread wheat varieties than their counterparts. This could be attributed to various reasons, which could be the problem of the economic position of female-headed households, including the shortage of labor, limited access to information on improved varieties and required production inputs due to social position. This result is consistent with the findings of Musba. (2017) and Bayissa, (2014) that showed that male-headed households are more likely to allocate a larger amount of land to improved soyabean and teff varieties than female households head.

Membership to cooperative: In this study, in conformity with the hypothesis, membership to cooperative was positively and significantly influenced intensity of adoption at a 1% level of significance. Keeping other variables constant, as compared to non-membership to cooperative, being membership in cooperative organizations would increase the allocation of land for improved bread wheat varieties by 0.08ha. Farmers' organization could serve as a platform for accessing and dissemination of new information and improved technologies. Hence, the result of the study implied that farmers belonging to organizations have easy access to information, credit, labor, and inputs such as fertilizer, improved seeds and chemicals and are expected to allocate more hectares of land to improved varieties. The result is in line with previous study, Susie (2017) being a member of cooperative would increase the allocation of land for improved teff varieties by 0.10ha as compared to non-membership to cooperative.

Access to credit: The results the study provided empirical evidence of positive impact of credit service on intensity of use of improved bread wheat varieties. The result of truncated model revealed that the intensity of use of improved bread wheat varieties is positively and significantly affected by access to credit at 5% significance level. This suggests that access to credit to paramount importance in intensification of improved bread wheat varieties and fertilizer. Hence if farmers get credit access, they can buy more improved bread wheat and the rent additional land for improved bread wheat varieties. That means, if the farmers have obtained the credit for agricultural production, the intensity of use of improved bread wheat varieties would increase by 0.122ha. This result is similar to the finding of Leake and Adam (2015) and Hassen *et al*. (2012) who found farmers' access to credit service more likely to allocate land for improved wheat variety.

Table 16: Truncated regression estimates for intensity of improved bread wheat varieties adoption.

Variables	coefficient	Std. Err.	z	P>z
AGE	-0.0010	0.0038	-0.28	0.779
HHSEX	0.1578***	0.0529	2.98	0.003
EDUCATION	0.0099	0.0076	1.30	0.195
HHSIZE	-0.0116	0.0108	-1.07	0.283
FARMEXPR	0 .0056	0.0043	1.31	0.189
COOP	0.0857***	0.0258	3.32	0.001
ACCTOCRD	0.1224**	0.0562	2.18	0.030
TLU	-0.0199*	0.0112	-1.78	0.085
FARMINCOM	-2.33e-06	2.89e-06	-0.81	0.420
OF/N-FARMINCO	-0 .00019 **	0 .00009	-2.06	0.040
INPUTONTIME	-0.0331	0.0345	-0.96	0.338
FEQEXTCONCT	-0.0020	0.0035	-0.57	0.567
DISTOMARK	0.0210	0.0288	0.73	0.218
Limit: lower = 0				
upper = +inf				
Log likelihood	58.400389			
Number of obs	96			
Wald chi2(13)	210.25			
Prob > chi2	0.0000			

Source: model output, *, ** and *** represents10% 5% and 1% level of Significance respectively

Livestock holding (TLU): Contrary to the expected livestock holding negatively and significantly related to the intensity of adoption of improved bread wheat varieties at a 10% significance level. This means that a one TLU increase in the household's livestock holding would decrease land allocation for improved bread wheat varieties by 0.01ha. A possible reason for the result obtained in this study could be that the household with large livestock size allocates small land for the cultivation of crops due to the shortage of land. This is because as livestock size increase, the grazing land allocated for livestock production also increases and this intern decrease generally the land allocated for crop production specifically the land for wheat production. The result is in line with the findings of (Adunea, 2017; Tolosa *et al*., 2014; Laduber *et al.,* 2016) the result indicated that livestock size increases land allocation for wheat production decreases. But it contrary, with study conducted by Gebresilassie and Bekele, (2015) the result the authors conclude that being owner of more livestock increase the level of adoption of improved wheat variety.

Off/non-farm income: contrary to the hypothesis off/non-farm income found to be negatively and significantly at a 5% significance level, a one birr increases in household's off-farm income would decrease allocation of land to improved bread wheat varieties by 0.009ha. A possible reason for this negative sign most of the households in the study area have limited land holing and engage themselves in other non-farm activities this might be due to the shift in non-agricultural tasks. This result goes along with the previous studies by Gebremariam and Hagos, (2018) the result indicated that an increase in off-farm income by one birr reduced the intensity of wheat packages adoption by 0.07ha. It, however, contradicts the findings of a study conducted by (Regasa, 2018; Dereje, 2006). In their studies, they found that an extra income obtained through participation in off/non-farm activity enhances the farmers' ability to allocate more of their land to improved bread wheat varieties.

5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary

This study aimed at analyzing the determinants of adoption of improved bread wheat varieties in Lemo district, Hadiya zone SNNPR, Ethiopia with the specific objectives of the identifying factors affecting adoption decision and intensity of adoption of improved bread wheat varieties and to identify farmers' perception of improved bread wheat varieties adoption in the study area.

The study employed cross-sectional data to analyze the effect of farmers' demographic, socio-economic and institutional factors on the probability and intensity of use of improved bread wheat varieties. For this study, Lemo district was selected purposively based on its higher improved bread wheat production from Hadiya zone. Then, three *kebeles* were selected using random sampling technique and stratified in to adopter and non-adopter categories. Finally, 178 sample households were selected using probability proportional to size sampling technique. Selected sample households were interviewed to generate data for the 2018/19 cropping season using a semi-structured questionnaire that encompasses questions related to demographic, institutional, and socioeconomic and perception related variables. Moreover, secondary data obtained from various relevant sources were used in this study.

The study used descriptive statistics, inferential statistics both t-test for continuous variables and chi-square for dummy variables and econometric models were used for data analyses. Descriptive statistics such as mean, standard deviations, frequencies and percentages as well as the probability levels of all explanatory variables were used to analyze and interpret the data and responses of the sample respondents on the perception related were analyzed by using Likert scale of their characteristics of high yield, disease resistance, early maturity, marketability, environmental adaptability, stay for long time and water lodging by using the categories of accordingly, the ratings such as strongly disagree (1) disagree (2) neutral (3) agree (4) strongly agree(5).

The result of descriptive analysis has shown that 53.9% of sample respondents are adopters and 46.1% are non- adopters of improved bread wheat varieties during the survey year in the

study area. Hidase was the most popular improved bread wheat varieties grown by the farmers and followed by Shorima and Oglcho, respectively. The main reasons why non-adopters did not grow improved bread wheat varieties were due to the shortage of land, the high price of seed, the high price of fertilizer, low disease resistance problem were the four most important reasons that limit farmers from adopting improved bread wheat varieties in the study area. Results of descriptive analysis also showed that adopters were allocated an average of 0.625ha/2.5 *timad*/ of land to improved bread wheat varieties.

The result from the descriptive statics and t-test and chi-square test indicated that some of the variables hypothesized to influence farmers' adoption behavior were a significant association with the adoption and intensity of adoption of improved bread wheat varieties. These significant variables were education level of the household, total farm size, farm income, frequency of extension contact, off/non-farm income, TLU, distance to market, sex of household, membership in cooperative, access to credit and availability of seed on time. Regarding farmers' perception, an important observation for the study area is that farmers are interested in varieties which are high yield, disease resistance, early maturity, and environmental adaptability of varieties relatively compared to other characteristics.

The result of a double-hurdle econometrics model showed that the level of education, total land size, membership in cooperative, improved bread wheat seed availability on time and frequency to extension contact affect adoption decision of improved bread wheat varieties positively and significantly. Whereas, sex of household head, membership in the cooperative and access to credit were found to be positively and significantly influenced intensity of improved bread wheat varieties adoption. But TLU and off/non-farm income were found to be negatively and significantly influenced intensity of improved bread wheat varieties adoption in the study area.

5.2. Conclusions

Improved bread wheat varieties are one of the agricultural technologies being introduced for many years. Despite such institutional support services and disseminations, utilization of improved technologies remained low in Ethiopia and in the study area. Hence, this study is

conducted to identify factors influencing adoption and intensity use of improved bread wheat varieties and farmers perception toward the adoption of improved bread wheat varieties.

In general, the study concluded the high importance of institutional support in the areas of strengthening farmers' cooperatives, facilitating formal credit service, improving seed access, strengthening the existing extension service to enhance adoption and intensity of improved bread wheat varieties adoption in the study area. These factors play a crucial role in influencing the farmers' adoption decision and allocation of land for improved bread wheat varieties. Regarding to farmers perception towards the adoption of varieties, high yielding, disease resistance and early maturity varieties should get attention in order to improve the current adoption level of improved bread wheat varieties in the area.

Furthermore, this research did not focus on the assessment of the impact of adoption of improved bread wheat varieties on the income of smallholder farmers therefore; further research on this subject should be done to explore issues that were not captured by this study.

5.3. Recommendations

Based on the research findings of this study, the following recommended improving farmers' adoption of improved bread wheat varieties to enhance production and productivity in the study area.

In the study area, education was found to be positively and significantly influencing likelihood of adoption of improved bread wheat varieties. The dissemination of technology thus needed to be facilitated through educated farmers to be used as contact farmers so that they can use the available inputs more efficiently under the existing technology. In this regard, the district office of education, the regional and local governments need to strengthen the existing provision of formal and informal education through facilitating all necessary materials.

Land is a limiting factor of production in agriculture. Farmers with more land are more likely to adopt and allocate a relatively higher share of their land for improved bread wheat varieties. Thus, adoption becomes more difficult in the farms with relatively small land size. However, increasing the size of landholding cannot be an option to increase improved bread

wheat varieties adoption since land is a finite resource. Therefore, intervention aimed to improve land fertility status, convince farmers to use intensive agricultural practice and increasing productivity of land through proper utilization of available land resource is required.

The result of this study also indicated that, membership in cooperative societies, shows strong significant relationships with the adoption decision and intensity of adoption improved bread wheat varieties. Therefore, it is, necessary to strengthen cooperative institutions in the area and to encourage farmers to become members to these institutions so that adoption and intensity use of bread wheat varieties could be enhanced.

Improved seed availability on time had a positive and significant influence on the probability of adoption of improved bread wheat varieties. In the study area, thus, emphasis needs to give to increase adoption of improved bread wheat varieties by making better access to improved bread seeds timely at affordable price. Further, the *woreda* government including research centers, NGOs, district of agriculture and farmers cooperatives prevailing in the seed systems need to support the public and private seed companies and improvement of infrastructure development.

Frequency of extension contact was found to be positively and significantly influencing the adoption of improved bread wheat varieties as it enhances the ability of farmers acquire and use the information required for existing and newly developed improved bread wheat varieties and practices. More demonstration sites for improved technologies, including improved wheat varieties and other agricultural practices, should be organized to increase awareness of the improved bread wheat adoption among farmers in the study area.

As a result of this study, sex of the household head was positive and significant on the intensity of improved bread wheat varieties adoption, government and other stakeholders should give high focus to empower women to improve their bread wheat varieties adoption and productivity as well as participation on wheat production by addressing the resource and information constraints of female headed households.

Credit access has positively and significantly related intensity of adoption. Therefore, credit service should be made available to farmers at an affordable rate to improve their credit uses and intensity of improved bread wheat varieties adoption.

Livestock size was found to affect allocation of land for improved bread wheat varieties negatively. Due to the limitation of land for both crop production and livestock rearing in the study area, farmers reduce the livestock size to a manageable size and creating awareness adoption of improved forage so that they can invest the income from livestock for the purchasing of different agricultural inputs.

Regarding to farmers perception, yield is one of the preferred traits/characteristics of the varieties in influencing its adoption. The diseases resistance, early maturity and environmental adaptability of improved varieties were also an important characters considered by farmers in their adoption process. Research efforts should, therefore, give emphasis on varieties that can be yield well, disease resistance characteristics, early maturity and environmental adaptability of varieties.

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7. APPENDIX

Appendix I: Tables

Appendix table 1 Conversion factors used to estimate tropical livestock unit

Animal categories	TLU	Animal categories	TLU
Cow and oxen	1.00	Donkey(adult)	0.70
Calf	0.25	Donkey(young)	0.35
Weaned calf	0.34	Sheep & goat (adult)	0.13
heifer	0.75	Sheep & goat (young)	0.06
horse	1.10	Chicken	0.013

Source: storck, et al., 1991.

Appendix table 2 Multicollinearity test result for the continuous explanatory variables

Variables	Collinearity Statistics	
	VIF	1/VIF
AGE	3.65	0.273854
FARMINCOME	1.46	0.683850
EDUCATIONL	1.44	0.695472
TOTALLANDS	1.36	0.733404
OF/NON-ARMINCOME	1.04	0.958270
TLU	1.09	0.917408
HHSIZE	1.09	0.915795
DISTOMARK	1.12	0.896127
FARMEXPRIA	3.70	0.270178
FREQUENCEEX	1.07	0.933036
Mean VIF	1.70	

Source: own survey data result, 2018/2019

Appendix table 3 Contingency coefficient for dummy variables

variables	HHSEX	COOP	INPUTONTIM	ACETCRT
HHSEX	1.0000			
COOP	0.1050	1.0000		
INPUTONTIME	0.2869	0.3962	1.0000	
ACCESCRDT	0.1471	0.1796	0.2161	1.0000

Source: own survey result, 2018/2019

Appendix table 4 Test statistics of Double-hurdle model

	Double hurdle		Tobit
	Probit	Truncated	
Wald/LG x^2	212.10	210.25	298.53
Prob > chi2	0.0000	0.0000	0.0000
LOG-L	-16.779493	58.400389	-1.9491678
Number of observation	178	96	178

x^2-Test Double Hurdle versus Tobit:ɼ=91.06> x^2(14)=22.99

Source: survey result, 2018/2019

Since x^2-Test Double Hurdle versus Tobit:ɼ=91.06> x^2(14)=22.99, double hurdle is appropriate model than Tobit model for this study

Heckman model out put
Number of obs=178
Censored obs = 82
Uncensored obs= 96
Wald chi2 (14) = 181.57
Prob >chi2 =0.000

Appendix table 5: Heckman model out put

variable	Coef.	Std. Err.	z	P>z	[95% Conf.Interval]	
landallocatedimbrwh						
AGE	-.0008921	.0039536	-0.23	0.821	-.008641	.0068568
HHSEX	.1570901	.0521051	3.01	0.003	.0549659	.2592143
EDUCATION	.0091187	.0080331	1.14	0.256	-.006626	.0248634
HHSIZE	-.0117041	.0107532	-1.09	0.276	-.03278	.0093717
FARMEXPR	.0054612	.0043394	1.26	0.208	-.0030439	.0139664
COOP	.0832974	.0279197	2.98	0.003	.0285759	.1380189
ACCESCRDT	-.0056235	.0311865	-0.18	0.857	-.0667479	.0555009
TLU	- .011462	.0112279	-1.02	0.095	-.0205443	.0234682
FARMINCO	-2.49e-06	3.00e-06	-0.83	0.407	-8.36e-06	3.39e-06
OFFARMINCOME	-.0001934	.0000935	-0.97	0.333	-.0003767	-.0000101
INPUTONTI	-.0335363	.0346508	-0.97	0.333	-.1014506	.034378
FRQUNCY	-.0022671	.0036909	-0.61	0.539	-.0095012	.004967
DISTOMARK	.0210449	.0288164	0.73	0.217	.003765	.0383247
_cons	-.2953737	. 1949945	-1.51	0.130	-.6775558	.0868084
adoption						
AGE	-.11625	.0901795	-1.29	0.197	-.2929987	.0604986
HHSEX	1.205499	1.11161	1.08	0.278	-.9732161	3.384214
EDUCATION	.4986958	.2006534	2.49	0.013	.1054224	.8919691
HHSIZE	-.0591137	.2137542	-0.28	0.782	-.4780643	.3598369
FARMEXPR	.1308642	.103013	1.27	0.204	-.0710394	.3327678
LANDSIZE	2.908434	1.093447	2.65	0.005	1.805353	10.01151
COOP	2.331152	.838975	2.78	0.005	.6867912	3.975513
ACCESCRDT	.3747451	.5507481	0.68	0.496	-.7047014	1.454192
TLU	-.3329	.2443071	-1.36	0.173	-.8117331	.1459331.
FARMINCO	.0000537	.0000697	0.77	0.441	-.0000829	.0001904
OFFARMINCOME	.0023926	.0021336	1.12	0.262	-.0017893	.0065744
INPUTONTI	1.091459	.5772153	1.89	0.059	-.0398623	2.22278
FRQUNCY	.1725516	.0984093	1.75	0.080	-.0203271	.3654303
DISTOMARK	.0078553	.1887987	0.04	0.967	-.3621835	.377894
_cons	-11.68435	4.710398	-2.48	0.013	-20.91656	-2.452144
mills **_lambda**	-.0170781	.0728742	-0.23	**0.815**	-.1599089	.1257528
rho	-0.12945					
sigma	.13192681					

Source: model output, 2019

1st hurdle and 2nd hurdle together
Number of obs = 178

Wald chi2 (14) = 22.99
Log likelihood = 41.620896 Prob > chi2 = 0.000

Appendix table 6 Result of 1st hurdle and 2nd hurdle together

variable	Coef.	Std. Err.	z	P>z	[95% Conf.Interval]	
Tier1						
AGE	-.11625	.0901795	-1.29	0.197	-.2929987	.0604986
HHSEX	1.205499	1.11161	1.08	0.278	-.9732161	3.384214
EDUCATION	.4986958	.2006534	2.49	0.013	.1054224	.8919691
HHSIZE	-.0591137	.2137542	-0.28	0.782	-.4780643	.3598369
FARMEXPR	.1308642	.103013	1.27	0.204	-.0710394	.3327678
LANDSIZE	2.908434	1.093447	2.65	0.005	1.805353	10.01151
COOP	2.331152	.838975	2.78	0.005	.6867912	3.975513
ACCESCRDT	.3747451	.5507481	0.68	0.496	-.7047014	1.454192
TLU	-.3329	.2443071	-1.36	0.173	-.8117331	.1459331.
FARMINCO	.0000537	.0000697	0.77	0.441	-.0000829	.0001904
OF/NO-ARMIN	.0023926	.0021336	1.12	0.262	-.0017893	.0065744
INPUTONTI	1.091459	.5772153	1.89	0.059	-.0398623	2.22278
FRQUNCY	.1725516	.0984093	1.75	0.080	-.0203271	.3654303
DISTOMARK	.0078553	.1887987	0.04	0.967	-.3621835	.377894
_cons	-11.68435	4.710398	-2.48	0.013	-20.91656	-2.452144
Tier2						
AGE	-.0010895	.0038858	-0.28	0.779	-.0087055	.0065266
HHSEX	.1578212	.0529488	2.98	0.003	.0540434	.261599
EDUCATION	.0099716	.0076896	1.30	0.195	-.0050997	.0250429
HHSIZE	.0116561	.0108481	-1.07	0.283	-.032918	.0096057
FARMEXPR	.0056515	.0043031	1.31	0.189	-.0027823	.0140854
COOP	.0857304	.0258107	3.32	0.001	.0351423	. 1363185
ACCESCRDT	.1224674	.0562917	2.18	0.030	.0121377	.2327971
TLU	- .0199856	.0112279	-1.78	0.085	-.0205443	.0234682
FARMINCO	-2.33e-06	2.89e-06	-0.81	0.420	-8.00e-06	3.33e-06
OF/NO-ARMIN	-.0001929	.0000938	-2.06	0.040	-.0003767	-9.02e-06
INPUTONTI	.0330951	.0345703	-0.96	0.338	-.1008516	.0346613
FRQUNCY	-.0020112	.0035154	-0.57	0.567	-.0089012	.0048789
DISTOMARK	.0209245	.0288095	0.73	0.218	.0036582	.0381908
_cons	-.3178264	.1830813	-1.74	0.083	.0036582	.0381908
sigma _cons	.1323515	.0096766	13.68	0.000	.1133858	.1513172

Source: model output, 2019

Appendix II: Survey Questionnaire

Determinants of Adopting Improved Bread Wheat Varieties: The Case of Lemo Woreda Hadiya Zone, SNNPR, Ethiopia

Dear, interviewee this is questionnaire to collect data/information/ only for academic purpose: The personal profile obtained from respondents with regard to the theme will be kept confidential and will not have any consequence on the respondent in any ways. Please give right answers to the following questions.

Instructions to Enumerators

1. Make brief introduction before starting any question, introduce yourself to the farmers, greet them in local ways and make clear the objective of the study.
2. Read clearly the question for the respondents to understand and reply clearly
3. Ask each question clearly and patiently until the farmer gets your points.
4. Please do not use technical terms and do not forget local units.

1. Respondent and Site Identification/General Information

Study area: Lemo district

Kebele _____ Village_____

Date of interview_____ Enumerator name_____

2. Demographic factors of the sample households

1. ID number_____
2. Age of household's----------year
3. Sex of households 1= male 0=female
4. Marital status: 1. Married 2. Single 3. Divorced 4. Widowed
5. Educational level of household head _____years?
6. What is your total family size (only those who eat from the same pot) _____
7. How many people stay on the farm activities? _____ (in number)
8. How many/farm experience_____ years

3. Socio economic variables

Land holding size during the 2010/11 cropping season

9. Total farm size _____*timad* (hectares)
10. Total cultivated land_____ *timad* (hectares) in 2010/11 cropping season

11. Out of total cultivated area, how many hectares are allocated for wheat crop _____ *timad* (ha)?

12. Total area of land planted under improved bread wheat varieties during the 2010/11E.C cropping season_____ *timad (*hectares).

13. What are the main uses of improved bread wheat varieties in 2010/2011 E.C? 1. for consumption 2. For sale 3. Source of livestock feed 4. Improving soil fertility 5. For other purpose (*Please Specify*) _____

Livestock ownership

14. Total number of livestock _____numbers

No	Types of livestock	Numbers	TLU	No	Types of livestock	Numbers	TLU
1	Ox			8	Horse		
2	Cow			9	Mule		
3	Calf			10	Goats (young)		
4	Bull			11	Goats (adult)		
5	Horse			12	Sheep (young)		
6	Donkey(adult)			13	Sheep (adult)		
7	Donkey(young)			14	Chicken		
					Total		

Farm Income

15. Total annual income from farm activities_____ birr

Farm income from sales of crop production in 2010/11 E.C						Income from sale of livestock products/2010E.C/2011 E.C			
Types of Crops grown	Total annual harvest	consumed	Sold		Total price	Animal type	Number sold	Unit price	Total sale price
			Amount	Unit price					
Local wheat						Ox			
Improved wheat						Cow			
Wheat						Calf			
Barley						Bull			
Enset						Horse			
bean						Donkey			

Pea						Goats			
Fruits						Sheep			
Maize						Chicken			
Vegetables						total			
Others(specify)									
Total									

Off/non-farm income of 2010/2011) E.C

16. Do you have any sources of income besides farming? 1. Yes 0. No

17. If yes, on what type of off/non-farm income activities you are involved in last year?

1. Hand craft 2.Trading 4.Daily labor 5 .Remittance 6. Selling beverage

3. Causal labor 5. Others, specify_____

18. Total annual income from off/non-farm activities in Br_____

19. For what purpose do you use the income from off-farm activities?

1. To purchase farm input 2. To buy food 3. Clothing 4. To purchase household items 5. Others/specify

20. Reason for not participating in non-farm activities

1. I do not have extra time for non-farm activity 2. Non-farm income is less attractive 3. No starting capital 4. There is no employment opportunity 5. Other reasons, specify

4. Adoption of improved bread wheat varieties

21. Are you aware of any improved bread varieties of wheat? 1. Yes 0. No

22. Did you produce improved bread wheat variety(s) seed last year (2010 E.C)? 1. Yes 0= No

23. If yes, which improved bread wheat variety have you first grown? 1. Hidase (ETBW 5795) 2.Shorima (ETBW 5483) 3. Bobicho (HAR-2419) 4. Ogolcho(ETBW 5520) 5. Others (specify) _____ *1---2---3---4----

24. What are your reasons for preferring it? (Rank or prioritize them) 1. High yield 2. Seed color and size 3. Resistance to disease 4. Early maturity 5. Resistance to lodging 6. adaptability7. Taste in bread 8. Other (specify) _____ *1---2---3---4---5-----6---7—8—9----

25. If you are not adopting improved bread wheat varieties what are reasons ?: 1. Not available of improved wheat varieties 2. High price of seed 3. Lack of credit to buy seed 4. Shortage of land 5. Timely availability of fertilizer 6. High price of fertilizer 7. Lack of credit to buy fertilizer 8. Lack of market information 9. Yield decline /low productivity 10. Low disease resistance problem 11. Low price for product/output 12. Low soil fertility *1-------2-----3----4-----5----6----7----8----9----10---11-------12----------

26. What do you think are the desirable characteristics of good seed? 1. Good grain filling 2. Diseases free 3. No impurities 4. High germination rate 5. Adapted to local condition 6. Other (specify)

27. What were the main crop types you have grown in your farm during the last crop season? 1.Wheat 2. *Teff,* 3.Barely 4.Maize5.Pea6.Bean7.Sorghum8.*Enset*9.Others,specify_____ _____ put the number in its order) *rank according to land allocation 1—2---3---4---5—6---7---8----

5. Institutional Factors

Access to credit service

28. Is credit service available in your area? 1. Yes 0. No

29. If yes, have you ever used farm credit? 1. Yes 0. No

30. If you used credit, what is your source of credit?

1. Bank 4. Cooperatives 7. Merchants
2. NGO 5. Lemo Credit & Saving Institute 8. Relatives
3. Friends or neighbor 6. Office of Agriculture and RD 9. Others

31. For what purpose did you use the credit?

1. To pay school fee 2. To pay tax 3. To buy agricultural inputs 4. To cover house hold expenditure 5.To buy livestock 6.Others (specify) _____

32. How far is from your home to credit office (in Km) _____

33. Do you have any problems in getting credit? 1. Yes 0. No

34. If yes, what is the nature of your credit problems?

1.) Bank loans not available 2.) Do not have required collateral 3.) Loans from informal sources not available 4.) Repayment terms are unfavorable 6.) Interest rates are too high 7.) Others (specify) _____

Availability of improved bread wheat seed on time

35. Is improved bread wheat varieties (seed) available on time? 1. Yes 0. No

36. What are Main sources of improved bread wheat varieties (seed)?

1. Cooperatives/farmers groups 2. Ethiopian seed enterprises, 3. Gov't subsidy program, 4. Research center. 9. Own seed

37. If inputs are not available on time, why? 1. Unavailability of transport 2. Short age of supplier 3. Distance 4. Others (specify) _____

38. Is fertilizer available on time in your area? 1. Yes 0. No

39. Do you have problems related to fertilizer? 0 = No, 1 = Yes

40. If yes, what are your problems in using fertilizer (set in order) 1.High fertilizer price 2.Lack of credit to purchase fertilizer 3.High interest rate of credit to use credit to purchase fertilizer 4.Far distance of distribution center 5.Poor quality (mixed with impurities and caked) 6.Shortage 7.Lately arrival 8.Lengthy process & complicated format 9 Poor distribution processes

Frequency to extension contact

41. Did the extension agent visit/contact your farm last year? 1. Yes 0. No

42. If yes, how many times? (Number of contact per month) _____

43. (In question 41), if yes, what type of advice did you get on improved bread wheat varieties?

1. Land preparation 2. Seed and sowing 3. Application of seeds and fertilizers 4. Use of credit 5. Application of herbicides and insecticide 6.harvesting 7. Any other [specify]

44. In question 41, if no, why?

1. Extension agent not available 2. No willingness to get advice

3. Possessed the required information 4. Availability of contact farmers in the area 5. Others, specify_____

45. Does higher price of inputs hinder your using improved bread wheat varieties? 1. Yes 0. No

Market distance

46. How long it takes (on foot, one way) to reach to the nearest market from your house walking _____ in kilometer?

47. Where do you often go to sell and purchase the Agricultural products? 1=Village 2 = Market 3 = other town

48. To whom do you mostly sell your wheat produce? 1. Consumers 2. Retail traders 3. Whole sales 4. State trading companies 5. Cooperatives 6. Other farmers 7. NGO 8 .Others

49. What were the major problems in wheat marketing in your area in 2010/2011 E.C crop year? 1 Low selling price 2. High input purchase price3. Exploitation by middle- men. 4. Other (Specify) _____,

50. How do you see access to market in your area? 1. Poor 2. Medium 3. Good

51. If poor, why?

1. Lack of improved infrastructure 2. Distant

3. Lack of transport 4. Others, specify_____

Participation in cooperative society

52. Are you member of cooperative society 1) Yes 0 No

53. If yes, when you first became member? Year: ----------

54. What services you are getting being member of the cooperative society 1. Credit in cash 2. Improved bread wheat seed 3. Farm inputs (Fertilizer, chemicals, others) on credit base 4. Market information 5. Other (specify)

Source agricultural information

55. Have you ever attended agricultural training program organized by woreda agricultural office in the past 1. Yes 0. No

56. If yes, in what aspects you were given training?

1. Application of fertilizer 2 row planting of improved bread wheat varieties 3. Storage 4. Others, specify_____

57. What was the duration of training? _____days/months.

58. Do you have a radio? 1. Yes 0. No

59. If yes, How Often do you listen agricultural program?

1. Rarely 2. Sometimes 3. Frequently

60. If you do not listen to agricultural program, why?

1. No time to listen 3. Is not important 5. Others

2. Not aware about the program 4. Transmission Time is not convenient

61. What are your Sources of Agricultural information? 1) Research Center (2) Extension Agent (3) Cooperatives (4) Fellow Farmer (5) Market (8) others

6. Psychological variables

Farmers' Perception related improved bread wheat varieties

62. farmers perception on adoption improved bread wheat varieties

Level of agreement	Distributed							
	Strongly disagree(1)	Disagree (2)	Neutral (3)	Agree(4)	Strongly agree(5)	mean	Level %	Rank
High yield per hectare								
Resistance diseases								
Short time to maturity								
Environmental adaptability								
marketability								
Non-logging								
Stay for long time								

63. why you prefer improved bread wheat varieties over the local one? 1. It has better price 2. Stay for long time when storing 3. Short time to maturity 4. High yield per hectare 5. Resistance diseases and lodging 6. If others specify

64. What is poor (weak) side you observed from improved bread wheat varieties?

1. High price 2. Easily attacked by disease? 3. No weak side 4. Others ---------- (Specify

Appendix III: checklist for focused group discussion and key informants

1. Checklist used for conducting focused group discussion.

1. What are the general constraints that affect adoption of improved bread wheat varieties?
2. Why are so few farmers adopting the improved bread wheat varieties for wheat production and why others not adopting?
3. What are your selection criteria or perception of improved bread wheat varieties?
4. Can you get improved wheat seed in required quantity at the right time?
5. Which one of the variety (local seed or improved seed) you prefer to practice what are the reasons to prefer over local one?

2. Interview checklist used for key informants.

1. When the improved bread wheat varieties introduced to your district?

2. What is current performance of adopting improved bread wheat varieties in the district?

3. What are common problems faced by farmers while adoption of improved bread wheat varieties and what actions have been taken to solve the problems for the farmers in the district?

4. What kind of support does district agricultural office is providing to improve the adoption level of improved bread wheat varieties by farmers?

I thank you for your time and valuable responses!!