

**FACTORS AFFECTING ADOPTION DECISION OF WHEAT ROW
PLANTING TECHNOLOGY: THE CASE OF AGARFA DISTRICT,
BALE ZONE OF OROMIA NATIONAL REGIONAL STATE, ETHIOPIA**

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**Factors Affecting Adoption Decision of Wheat Row Planting
Technology: The Case of Agarfa District, Bale Zone of Oromia
National Regional State, Ethiopia**

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DEDICATION

I dedicate this thesis manuscript to my family and husband for encouraging me with affection and love and for their dedicated partnership in the success of my career.

STATEMENT OF THE AUTHOR

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ABBREVIATIONS AND ACRONOMYS

AfDB	African Development Bank
ARD	Agricultural and Rural Development
ARDOoD	Agricultural Rural Development Office of the District
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ATA	Agricultural Transformation Agency
BoARD	Bureau of Agriculture and Rural Development
CSA	Central Statistical Agency
DA	Development Agent
DAP	Di Ammonium Phosphate
EIRA	Ethiopian Institute of Agricultural Research
FAO	Food and Agricultural Organization
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
FDRE	Federal Democratic Republic of Ethiopia
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GoE	Government of Ethiopia
GTP	Growth and Transformation Plan
HGCA	Home Grown Cereal Authority
ICARDA	International Center for Agricultural Research in Dry Area
LDC	Less Developed Countries
MoFED	Ministry of Finance and Economic Development
MoA	Ministry of Agriculture
OLS	Ordinary Least Squares
SIS	Soil Information System
SNNP	Southern Nations, Nationalities and Peoples Region
SSA	Sub- Saharan Africa
TLU	Tropical Livestock Unit
VIF	Variance Inflation Factors

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Factors Affecting Adoption Decision of Wheat Row Planting Technology: The Case of Agarfa District, Bale Zone of Oromia National Regional State, Ethiopia

ABSTRACT

Ethiopian economy is highly dependent on agriculture, especially crop production takes the major share in economic growth. Hence, supporting the sector through introducing new agricultural technologies, like row planting technology is crucial. However, application of better technologies remained low in Ethiopia and also in the study area due to several factors. Therefore, study was to assess the status of adoption decision of wheat row planting technology and identify factors affecting it in Agarfa district. Two stage sampling procedure was used to collect data. In the first stage, three major wheat producing kebeles were selected purposively from twenty kebeles of the district. In the second stage, 165 household heads were selected randomly from three kebles based on probability proportional to population size. The primary data were collected using an interview schedule and focus group discussions. Various documents were reviewed to collect secondary data. Data were analysed using descriptive and inferential statistics methods and binary logistic regression model was used. The survey result shows that about 53.73% and 47.27% of sample respondents were found to be non adopter and adopter of wheat row planting technology respectively. The result from binary logistic regression model shows that education level of household head, farming experience, availability of family labor, frequency of contact with extension agents, mass media exposure, participation in social organization, off/non-farm activities and perception towards wheat row planting positively and significantly affected adoption decision of wheat row planting technology in the study area. Therefore, Based on the findings of this study it can be concluded that policy and development interventions should give emphasis towards improvement of such economical and institutional support system so as to achieve wider adoption decision of wheat row plating technology, increased production and productivity of smallholder farmer.

Keywords: Adoption, Binary Logistic model, Technology, Wheat row planting, Agarfa.

1. INTRODUCTION

1.1. Background of the Study

Agriculture is the main sector of Less Developed Countries (LDCs) in general and Sub-Saharan Africa (SSA) in particular. The economic development of Ethiopia is highly dependent on the performance of its agricultural sector since it is the major economic support of economic growth of the country. Agriculture contributes 36.5% Gross Domestic Product (GDP), 72% of the employment opportunity, 75% of the export level, and provides 65% of the country raw material demand of the large and medium scale industries found from this promising sector (ATA, 2017). Cereals are the major staple food crops both in terms of area planted and volume of production obtained. In 2013/14 main crop season, cereals were cultivated on 9.9 million hectares of land producing 22 million tons of food grains. This represented 79.38% and 85.81% of the total area and production of food grains in the country, respectively (CSA 2014).

Among cereals, wheat is the second most important food crops in the country behind maize (FAO, 2014a). Dorosh and Rashid (2013) on their study found that 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 yield of wheat. However, increasing yield requires successful adoption of improved agricultural technologies.

Improvement of agricultural productivity provides the main solution in addressing the problems of food insecurity and poverty, and enhancing the development of agriculture in Ethiopia (Yu and Nin-Pratt 2014). The most important goal of the government of Ethiopia within the structure of ADLI strategy is to increase crop yields through a centralized and aggressive extension-based push focusing on technology packages combining improved seeds, fertilizers, credit and better management practices (CSA 2014). One of the technologies in crop production introduced in the recent years is row sowing.

Adoption of row planting by smallholders is considered one of the farming practices for improving wheat yield in the country. Compared to the traditional broadcasting system, row

planting gives better yield with quality of the seed at harvesting period (Joachim *et al.*, 2013). The conventional planting method that is broadcasting seed by hand reduce yield because uneven distribution of the seeds makes hand weeding and hoeing difficult, and plant competition with weeds lowers wheat growth and not allow for better branching out (tillering) of wheat plants. This causes wheat yield reduction. However, row planting with proper distance between rows and plant density allows for sufficient aeration, moisture, sunlight and nutrient leading to proper root system development (ASARECA, 2016).

According to the Ministry of Agriculture and Rural Development row plantation on average increases production by 30% and reduces the amount of seed to one-fifth of existing seed use. It is important increases in crop production need improved agronomic practices in addition to improved hybrids (Tafese 2016). In fact, quick population growth comparative to food production and the shortage of arable land necessitates the application of science based production technologies in agriculture. At present the agricultural policy of Ethiopia gives high priority to increasing food production through the encouragement of improved production technologies among smallholders. In order to increase the production and productivity of agricultural production, the use of modern agricultural technologies are very important, out of which fertilizer, high yielding variety and row planting of crops are the most important technologies to increase the level of crop production (Mekuria 2013).

Increasing yield and meeting the high demand has become the main focus of government's agricultural policy and extension activities. In an effort to improve wheat production and productivity and meet high wheat demand in the country, Ministry of Agriculture (MoA) through Regional Bureau of Agriculture (RBoA) had introduced a wheat row planting technology in 2012 all over the regions. Agricultural extension activities have been concerned with promotion, adoption and scaling up of wheat row planting technologies; and adoption of row planting is seen as some of the factors for wheat yield enhancement in the country. As a result, planting of wheat in rows has become one of the agronomic practices of smallholder farmers in the country (Berihun *et al.*, 2014). However, this technology is not widely accepted as expected and the majority of farmers in different parts of the country are continued to use the traditional broadcasting method of wheat production thereby in the study area.

The largest volume of the main season production of wheat originates from Oromia which constitute around 55% of the country's total wheat production followed by Amhara and SNNP with 29 and 9% respectively. Despite its potential for wheat grain production, Ethiopia falls short of being self-sufficient in wheat production, and is currently a net importer of wheat grain in which much of the domestic wheat demand of flour mill factories is met through imports (FAO STAT, 2014).

Oromia region is one of the wheat producing regions in Ethiopia and Arsi, Bale and Shewa administrative zones of Oromia region are among the major wheat producing areas with 53.4% of the wheat produced in the region coming from these zones (CSA, 2015). Bale zone of Oromia region is included among the wheat belts in eastern Africa. Bale zone constitute about 166,539.45 hectares of land devoted to wheat production, predominantly by subsistence farmers and a few profit oriented state farms (CSA, 2017). The mean wheat yield in the country is estimated to be 2.1 metric ton per hectare (CSA, 2013), which is well below the world mean of 3.0 metric ton per hector (Hawkesford *et al.*, 2013). Low yield due to low adoption of improved agricultural technologies is believed to be the main factor that prevented agricultural production of Ethiopia. For this reason, technological change is commonly considered as one of the major option leading to successful productivity growth in agriculture.

Wheat is one of the most important cereal crops for the Agarfa district which is the main source of food and cash for smallholder farmers. In the district, majority of the farmers have been using tradition way of agricultural practice and using old cultivar that has low production and productivity as well as at risk to disease. There are few farmers who adopt wheat row planting technology (ADRDAO, 2017). This indicates that there are different factors directly or indirectly influencing the adoption of wheat row planting technology.

Therefore, this study was focus on the identification and analysis of major factors affecting the adoption decision of wheat row planting technology in the district.

1.2. Statements of the Problem

Wheat is predominantly grown by subsistence farmers in Ethiopia (Alemu *et al.*, 2014). There are about 4.6 million farm households who are directly dependent on wheat farming as a major source of food and cash in Ethiopia (Shiferaw *et al.*, 2013). Nevertheless, around 29% of Ethiopian population is living under poverty (World Bank, 2014). To alleviate severe poverty, FDRE has initiated a Five Year National Development Plan conceptualized Growth and Transformation Plan (GTP). This plan contains a policy for the Agricultural and Rural Development (ARD) where farmers will make use of modern agricultural technologies in which farmers productivity can be increased and improved (Mekuria, 2013).

Ethiopia is the most important regional producer of wheat in SSA, up till now the country spends more amount of US dollar to import million tons of wheat from abroad (Sarah, 2014). Particularly, when there is limited supply of wheat for the industries engaged in producing flour, spaghetti, macaroni, biscuits and bread over the country (Sarah, 2014). Though the demand for wheat has been increased at least among others due to increase in population, urbanization, and massive expansion of food complex processing industries, but the country has not been able to satisfy the high demand and was obliged to import million tons of wheat to fill the gap by incurring more US dollars (Rashid, 2010). Low technology adoption, low use of improved farm inputs, traditional farming, and rain-fall are the main hinder behind the poor performance of the sector in Ethiopia (Lulit *et al.*, 2012).

Government of Ethiopia has introduced different new agricultural technologies for adoption as policy like fertilizers, certified seeds, irrigation, and row planting techniques (Berhe, 2014). Recent studies conducted in Ethiopia show that yields are very responsive to wheat row planting technology. Compared to the conventional broadcasting technique, for instance, Tolosa *et al.* (2014) found on average 14.6% higher wheat yields with row planting technology. In an effort to improve wheat productivity and production, the Ministry of Agriculture (MoA) through Regional Bureau of Agriculture (RBoA) had introduced a row planting of wheat crop in 2012 all over the regions. However, the introduced technologies are not widely accepted by farmers in different parts of the region as expected (Worku and Yishak, 2016). However there is abundance of agricultural technologies over the country, the

study is only limited to assess factors affecting adoption decision of wheat row planting technology smallholder farms Agarfa District of the Oromia National regional state Ethiopia.

In the District there is limited work in the literature of agricultural technology adoption (wheat row planting technology) at small farm household's level in general. There is also no empirical information in the study area about factors affecting adoption of wheat row planting technology. To the best of the researcher's knowledge, the status of adoption of the recommended technology among the target farmers is not known and factors that limit adoption decision of the wheat row planting technology are not well assessed. To contribute to this knowledge gap, this paper required to contribute to the limited knowledge on the factors affecting adoption decision of wheat row planting technology because this technology is good policy relevance on the enhancement of wheat production on the wheat belt areas of Agarfa district.

1.3. Objectives of the Study

The general objective of this study is to assess the adoption of wheat row planting technology in the study area.

The specific objectives of the study are:

1. To assess the current status of adoption of wheat row planting technology in the study area; and
2. To identify factors affecting the adoption decision of wheat row planting technology among farmers in the study area.

1.4. Research Questions

This study tries to answer the following research question:

1. What is the current status of adoption of wheat row planting technology in the district?
2. What are the factors affecting the adoption of wheat row planting technology in the district?

1.5. Significance of the Study

Farmer's technology adoption decision is difficult and is affected by several factors. Therefore, assessing of factors affecting adoption of wheat row planting technology is important to bring changes to agricultural sector. Generation of such information will help policy makers, development practitioner as well as academicians. The study may also give a base for other studies; that focus on related topic and issues, related to the adoption of wheat row planting in particular and other agricultural technologies. Therefore, the result of this study was help stakeholders (agriculture offices, development partners, research institutions) to identify the crucial issue to address the technologies in attaining the ultimate objectives and identifying factors which affects success or failure of technology adoption has importance to guide future research.

1.6. Scope and Limitations of the Study

This study was undertaken in Agarfa *Woreda*, on adoption decision of wheat row planting technology. The adoption of new technology is influenced by many factors. A factor which is found to increase adoption of a particular technology in one area at one time might be found to hinder it or to be irrelevant for adoption of the same technology in another area at the same or different time for the same or different crops. Therefore, it is difficult to identify universally defined factors either impeding or enhancing adoption of technology. The econometric model used in this study also used only two categories in the response variables for occurrence or non-occurrence of events.

1.7. Organization of the Thesis

This thesis is organized into five chapters. Chapter two presents the literature reviews in which previous studies and reports related to the agricultural technology adoption are reviewed. Chapter three describes the study area and also methodological approach including sampling techniques, methods of data collection and methods used for the analysis of collected data. Chapter four presents the main findings of the study results and discussion of the study. Finally, summary, conclusion and recommendation are presented based on the study area in chapter five.

2. LITERATURE REVIEW

In this chapter, there are included a way that can give an understanding on issues such as basic concepts of technology adoption and row planting technology, wheat production in Ethiopia, empirical studies of previous agricultural technology adoption, analytical framework of adoption and conceptual framework of technology adoption are presented.

2.1. Concepts of Technology Adoption and Row Planting Technology

Loevinsohn *et al.* (2013) define **technology** as the means and methods of producing goods and services, including methods of organization as well as physical technique. According to those authors new technology is new to a particular place or group of farmers, or represents a new use of technology that is already in use within a particular place or amongst a group of farmers. Technology is the knowledge/information that permits some tasks to be accomplished more easily, some service to be rendered or the manufacture of a product (Lavison, 2013).

Adoption is the process of beginning to use something new or different within realistic period of time (Ban and Hawkins, 1996). Adoption is the amount of use of a new technology in the long-run equilibrium when the farmer has full information about the technology and its possible uses (Federet *al.*, 1985). Adoption of technology is not in one step method; it takes time for adoption to complete (Runquist, 1984). On the other hand, adoption is the use or not to use of new technology by a farmer at a given period of time (Rogers, 1985).

Rogers (1983) described the technology adoption decision process, as the mental process from the first knowledge of an innovation to the decision to adopt or reject. The technology adoption decision process is different from the diffusion process. The first takes place within the mind of an individual while the second occurs among the units in a social system or within a region. According to this definition there are five stages in the adoption process. Awareness stage (first hear about the innovation), interest stage (seek further information about an innovation), evaluation stage (weigh up the advantages and disadvantages of using it), trial stage (test the innovation on a small scale), and adoption stage (apply the technology on a large scale in preference to old methods). These stages in the adoption process imply a time lag between awareness and adoption. It is usually measured from first knowledge until the

decision is made whether to adopt or not. Adoption is not a random behaviour, but is the result of sequence of events passing through these adoption stages (Rogers, 1983).

Row planting technology is the growing of plants on a plot of land with enough space between each of the plants so that they can increase their roots and shoots more completely. According to ATA (2012) crop planting with rows starts with growing seedlings in a nursery and planting these in the field with sufficient and equal spacing between each seedling. Or, the seed can be sown in rows with sufficient spacing between the seeds and between the rows. In Ethiopia, it is the most important practiced with crops such as sorghum, maize, wheat and teff. According to Ram and Prashanta (2011) also enough spacing between the plants and sowing of two seed grains at one point facilitates wanted humidity, ventilation, nutrition, and light to the crop roots, as a result; helps faster growth of plants and productivity as well.

In general speaking, there are two main systems of wheat intensification (SWI) principles of crop production. There are Principles of intensive care and Principles of root development. Principles of intensive care: Intensification here is differing to the high number of plant density for each space meaning its appropriate space preservation and taking care of plants very closely. Finally, so as to increase wheat production it needs intensive care in each stage plant development including management of weed, disease, irrigation, and organic manure. Principles of root development: For the sake of appropriate growth of crop plant, it must be well recognized from its rooting system. It's a fact that root development is the first stage of healthy development of any plant. To be achieved requires enough food and space around the plant. From this principle, then conclude that distance between plants and nourishment are decisive things for the better growth and development of crop plants for that matter enhances outputs (Ram and Prashanta, 2011).

2.2. Wheat Production in Ethiopia

Wheat in Ethiopia is grown as a staple food in the highlands at altitude ranging from 1500 to 3000 masl. Wheat is one of the staple and strategic food security crops next to maize, Teff and sorghum in Ethiopia (Zerihun, 2014). At the national level, around five million smallholder farmers are involving in producing wheat and 29.67 quintals per hectare is the national average yield of wheat which implies triple times larger compared to that of eight

quintal per hectare in 1990s production year because of some improvements in technology adoption (CSA, 2017). The main wheat growing areas of Ethiopia are the highlands of the central, south-eastern and north-west parts of the country. Furthermore, more than 41.8% of the annual wheat production comes from only three zones in Oromia and one in Amhara regions.

Table 1: High wheat producing zones in Ethiopia (%)

No.	Name of zone	Production in percent
1.	Arsi	15.7
2.	Bale	10.3
3.	West Arsi	9.7
4.	East Gojam	6.1

Source: CSA (2011-2013)

Wheat is one of the major cereal crops producer region Oromia in region. At present, wheat is produced solely under rain-fed conditions. Of the current total wheat production area, 75% is located in Arsi, Bale and Shewa regions. Small amount is produced in the rest of the north and south regions of the country. Altitude plays an important role in the distribution of wheat production through its influence on rainfall, temperature, and presence of diseases. In Arsi, Bale and Shewa regions, the soil moisture and disease conditions within the range of 1900-2300 are favorable for the production of early and intermediate maturing varieties of bread wheat. This is estimated to comprise 25% of the total wheat production area, while the remaining 75% falls in the 2300-2700. Soil types used for wheat production vary from well-drained fertile soils to waterlogged heavy vertisols (Crop Variety Register, 2016).

2.3. Empirical Studies on Factors Affecting Agricultural Technology Adoption

Numerous studies have related demographic, socio-economic, physiological and institutional characteristics to adoption decision and factor affecting adoption of different technology with

different findings. The following are some of the results of previous studies. In order to increase adoption of suitable row planting, it is important to know the factors that influence the choice of row planting and adoption.

A study conducted by Amare (2018) on determinants of adoption of wheat row planting in the case of Wogera District, Amhara Regional State of Ethiopia number of educated family members, training participation, use of improved seed and extension contact are positively and significantly affect adoption of wheat row planting while, distance from development center and age of household head are negatively and significantly affect adoption of wheat row planting.

A study conducted by Adunea (2017) on factors affecting adoption of row planting technology on wheat production in Munesa District, Oromia Region state of Ethiopia indicated that literacy of farmers, labor availability, frequency of extension contact, credit use, participation in row planting training and availability of improved wheat seed 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 in the study area.

The study conducted by Merga and Urgessa (2014) on determinants of modern agricultural technology adoption in West Wollega; the case of Gulliso district by using logistic regression showed that household heads' education level, farm size, credit accessibility, perception of farmers about cost of the inputs and off-farm income positively and significantly affected the farm households' adoption decision; while family size affected their decision negatively and significantly.

Studies conducted by Hassen *et al.* (2012), found that age of household head, educational status, livestock holding, non-farm income, sex, and information access plays important factors in affecting the decision of farmers to adopt improved technology. Similarly, study conducted by Mahdi (2012) on factors affecting adoption of improved sorghum varieties in Somali Region of Ethiopia, found out that more educated farmers are more likely to adopt improved sorghum varieties in the study area.

Birhun *et al.* (2014), in their study conducted on hybrid adoption and chemical fertilizer, factors that affect the adoption decision has been identified using econometric model. The result shows gender, land ownership, irrigation use, access to credit, contact with extension agent, participation in off farm business activity have positive and significant relation with the adoption decision of chemical fertilizer, while plot distance from the home stead, distance to the nearest market and TLU (Tropical Livestock Unit) has an hindering role in adoption decision.

Study conducted by Leake and Adam (2015) on factors influencing allocation of land for improved wheat variety by smallholder farmers in Adwa district. 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, 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 affecting factors adoption of improved wheat variety.

Using Logit model, Debelo (2015) assessed factors influencing adoption of *Quncho teff* in Wayu Tuqa district of Ethiopia. Results revealed that family labor availability, participation of farmers in agricultural trainings, education level of the household head, livestock holding (TLU), farmer's ability of meeting family food consumption and frequency of extension contact were enhancing the decision to adopt *Quncho teff* While, age of household head and distance from household residence to market center were found to influence adoption of *Quncho teff* negatively.

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 by using Tobit model indicated that 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 probability of improved maize variety and/or chemical fertilizer adoption in maize farming while, distance of development center from residence has a significant negative effect.

Yitbarek (2017) in their study conducted on factors influencing the adoption of legume technologies, factors that affect the adoption decision has been identified using logit model the results shows that access for improved farm inputs, credit accessibility, wealth status of farm households and education level of household head had a significantly influenced on the adoption level of both improved seed and fertilizer technology. On the contrary, high price of improved technology and family size had negatively affected the adoption level of improved farm inputs.

Tolesa *et al.* (2014) conducted a study on socio-economic and institutional factors limiting adoption of wheat row planting in Ethiopia, by applying logit model. The study found that improved seed, agricultural extension services, education, and livestock size are significantly affecting wheat row planting technology. The study showed that row planting of wheat crop better in midland and high land agro ecology than low land. The adoption study conducted by Bekele *et al.* (2013) indicated that the logit analysis revealed that access to credit is an important factor in influencing farmer's decision to adopt improved wheat technologies.

In the study conducted by Tariku (2012) to analyze factor affecting adoption and intensity of adoption of improved wheat production indicated that the relative influence of different variables on probability and intensity of adoption of improved wheat production sex of household head, education of household, ,attending training on improved wheat production, attending field day programs, conducting demonstration, frequency of extension agent contact with household, mass media exposure, farm income, farm size and ownership of livestock positively and significantly influenced adoption and intensity of adoption of improved wheat production.

The study conducted by Behre (2014) on agricultural technology adoption on small farmer yeild, south Tigray, by using econometric analysis revealed that variables like sex of the household head, education, active labor availability, size of cultivated land, total livestock ownership, access to credit, off-farm participation, social participation, and extension service were found to be significant and affects positively to smallholder farmer's adoption of both row-planting and improved wheat seed technologies. Access to media and farmers' field visit days variables were also strongly affects row-planting technology positively.

According to Worku and Yishak (2016) study result using binary logistic regression model show were sex of the household head, education status, household size in adult equivalent, oxen ownership, and participation in agricultural training and demonstrations are positively affected wheat row planting technology of adoption. Tolesa (2015) also identifies that access to improved seed, agricultural extension services, education and livestock size positively and significantly affected adoption of wheat row planting.

2.4. Analytical Framework of Adoption

Adoption decisions can be analyzed with different models. Number of models can also be used to study the adoption behavior of farmers. When a dependent variable is binary, the ordinary least squares (OLS) method can no longer produce the best linear unbiased estimator (BLUE); that is, OLS is biased and inefficient. Consequently, researchers have developed various regression models for binary dependent variables. The nonlinearity of binary dependent variable models makes it difficult to fit the models and interpret their results (Wooldridge, 2002). Binary or categorical dependent variable models adopt the maximum likelihood (ML) estimation method, whereas OLS uses the moment based method.

In analyzing farmer's adoption decision behavior different models are used. Some of analytical tools which are commonly used in adoption studies are descriptive statistics like mean, frequency, t-test and chi-square and qualitative choice models including linear probability function, logistic distribution and normal distribution functions. One purpose of qualitative choice of models is to determine the probability that an individual with a given set of attributes will make one choice rather than alternatives. They are important in analyzing relationships involving a discrete dependent variable (Amemiya, 1985). Such models approximate the mathematical relationships between explanatory variables and the dependent variable that is always assigned qualitative response variables. These tools are often used independently or sometimes in combination with others (Mulugeta, 2000).

Additionally, the two commonly used discrete choice models in the adoption studies are the probit and logit models. The simplest probability, binary logit and probit models have only used for two categories in the response variables (0, 1) for non-occurrence and occurrence of events respectively (Liao, 1994). Because of this and other facilities, both probit and logit

analyses are well-established approaches and most frequently used models in the adoption of technology (Feder *et al.*, 1985). The logistic function is used because it represents a close approximation to the cumulative normal distribution and is simpler to work with. The cumulative normal distribution and the logistic distribution are very close to each other. Gujarati (1995) illustrated that the logistic and Probit formulation are quite comparable. The advantage of these models over the linear probability model is that the probabilities are bound between 0 and 1.

For this study the Logit model was selected, though both Logit and Probit models may give the same result. Logit model is better in estimating the explanatory variables because this model guarantees that the estimated probabilities indeed lay between the logical limits 0 and 1 (Ali and Amin, 2012). Moreover, as Train (1986) pointed out a logistic distribution (Logit) has got advantage over the others in the analysis of dichotomous outcome variable in that it is extremely flexible and easily used function (model) from the mathematical point of view and lends itself to a meaningful interpretation and relatively inexpensive to estimate. The dependent variable which is normally used with these models is dichotomous in nature, taking the values 1 or 0, a qualitative variable which is incorporated into the regression model as dummy variable. In this study logit model was chosen because; it has an advantage that it reveals the relative influence the probability of adoption of the use of the technology.

2.5. Conceptual Framework

Adoption decisions of different technologies across space and time are influenced by different factors and their associations. Factors such as personal and demographic, socio-economic, institutional and psychological factors determine the probability of adoption of wheat row planting technology. It is obvious that different studies have been conducted to look into the direction and magnitude of the influence of different factors on farmers' adoption decision of agricultural technologies. A factor, which is found to enhance adoption of a particular technology in one locality at one time, was found to hinder it or to be irrelevant to adoption of the same technology in another locality. Hence, the following conceptual structure showed the most important variables expected to influence the adoption of wheat row planting technology considering the study area specifically.

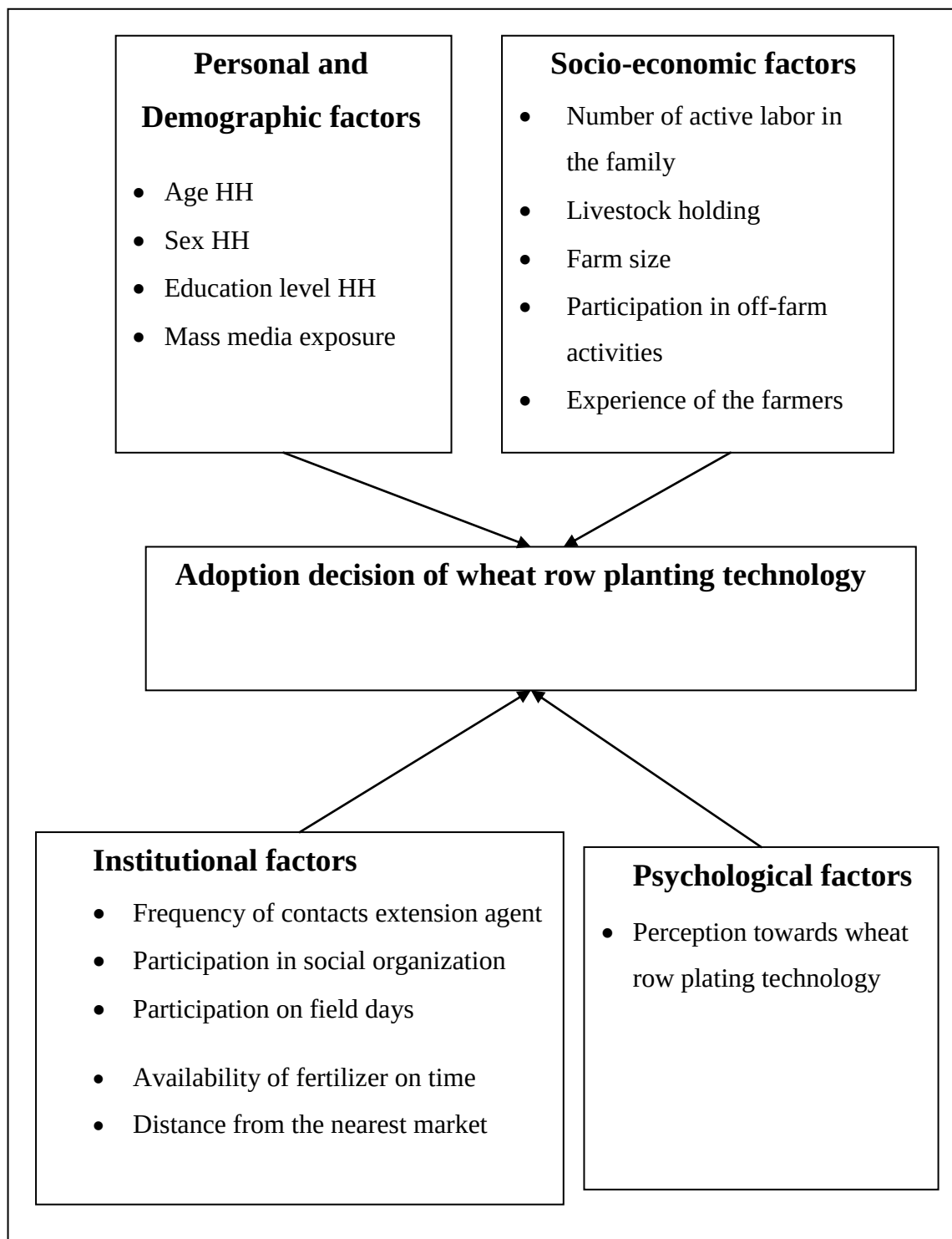


Figure 1: Conceptual framework of the wheat row planting technology

Source: Literature review and adjusted by the researchers

3. RESEARCH METHODOLOGY

In this chapter, description of the study area, sources and method of data collection, sampling technique and sample size determination, methods of data analysis, and definition and hypothesis variables are presented.

3.1. Description of the Study Area

Agarfa district, is one of the districts in the Bale zone of Oromia regional State of Ethiopia, and located in the northwestern corner of the Bale zone. Agarfa is bordered on the south by Sinana and Dinsho, on the west by west Arsi zone, on the north by the Shebelle River which separates it from the Arsi zone and on the east by Gasera and Gololcha. The district is characterized by its mountain, plateau and hills, and has three types of soil such as sandy soil, verity soil and nito soil. This study was conducted at Agarfa district which is located at a distance of about 461 km south east of Addis Ababa and 31 km from Robe the capital of the bale zone. The Latitude between (7 o 06'-7 o 10') N and Longitude (39o 12'-39o 20') E and the altitude ranges from 1,256 to 3,850 masl. The climate of the district is classified into three agro-ecological zones, Highland (*Dega*), Mid-land (*Woiyna dega*) and low land (*Kola*). The average annual temperature and rainfall of the district is 17.50 °C and 800 mm respectively, according to get the data from Agricultural Development Office of the District (ARDOoD, 2018).

The total population for this woreda is 129,785, of whom 52,136 were men and 49,974 were women; 12,907 or 12.64% of its population were urban dwellers. The majority of the inhabitants were Muslims with 71.53% of the population having reported they practiced that belief, while 27.6% of the population Ethiopian Orthodox Christianity. The district is characterized by mixed farming system where crop and livestock production are the main activities, where crops play the dominant role in terms of contribution to farmers income. The dominant crops grown in the district are potato, sweet potato, wheat, barley, teff, maize, field beans, peas, and chickpeas, onion, garlic, enset, fruits etc. Agriculture is the main stay of the district and hence it provides the largest share of the livelihood for the population (BoARD, 2018).

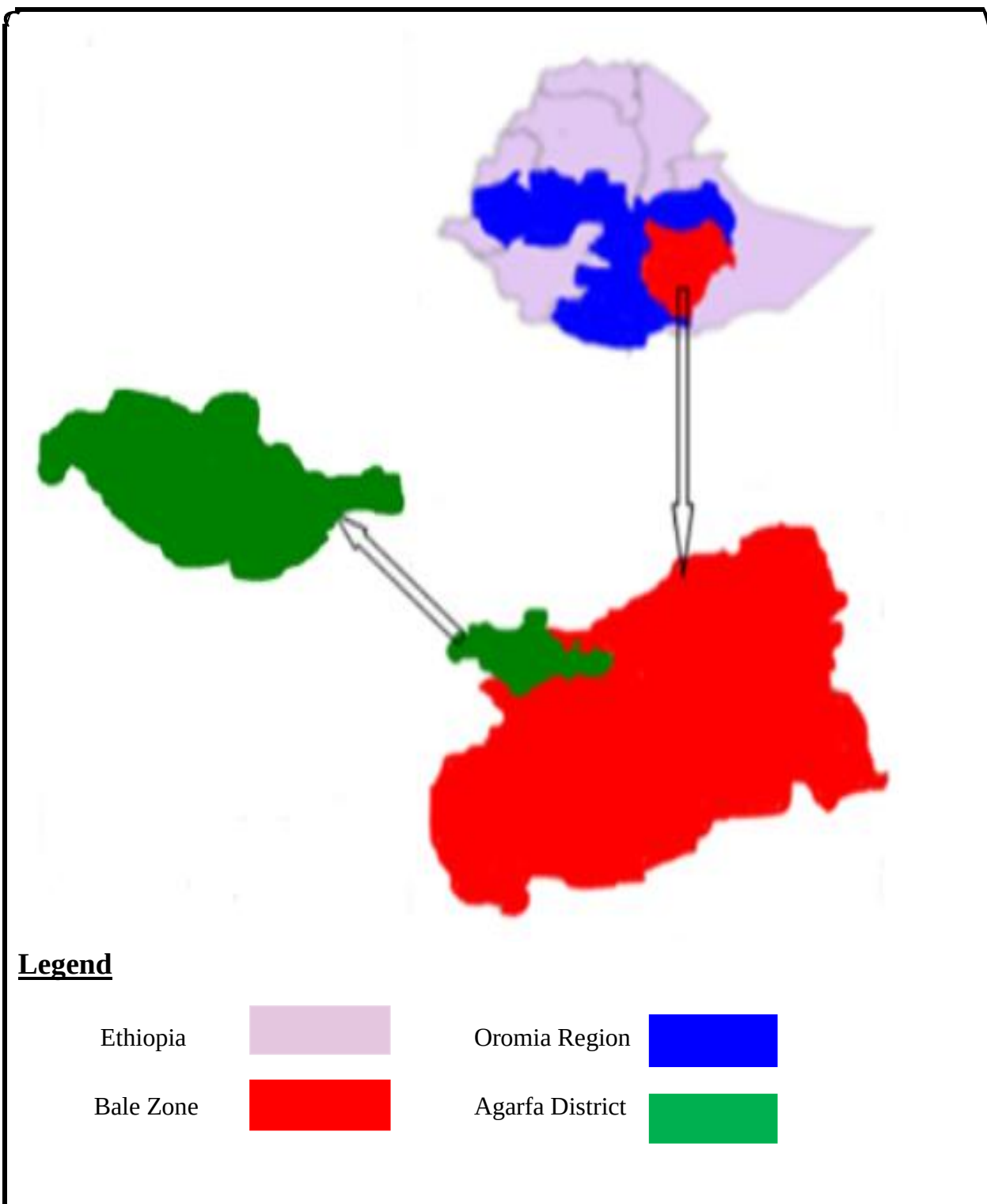


Figure 2: Location map of Agarfa district, Bale zone of Oromia, Ethiopia

Source: Own design with the help of GIS expert

3.2. Sampling Technique and Sample Size Determination

The objective of this study was focused on wheat row planting technology adoption; the populations of the study were those farmers who are engaged in the producing wheat in district. Both Probability and non probability sampling technique were employed to conduct the study. Two-stage sampling technique was used to select the sample. At the first stage, from a total of 20 *Kebeles* of the *Woreda*, the major wheat producing of three *Kebeles* (Ilani, Ali and Elabedu) were selected purposively because of its wheat yield potential and their experience of adopt wheat row planting technology of the District.

At the second stage, the farmers in each *Kebeles* were stratified into adopter and non-adopter categories giving the relative homogeneity of the sample respondents of their adoption status of wheat row planting technology. Hence, in this study, considering those farmers used wheat row planting technology for one and more years as adopters and those not used wheat row planting technology currently as non-adopters 165 sample households were selected randomly based on probability proportional to sample size.

The sample size from each *Kebele* was determined by proportionality formula. The sample selected from each selected *kebele* was proportional to the population in each *kebele* and the formula for this purpose is given by:

$$n_i = \frac{N_i(n)}{\sum N_i}$$

Where n_i - the sample to be selected from i^{th} *kebele* and n - Total sample size

N_i - The total population living in selected i^{th} *kebele*.

$\sum N_i$ - The sum of total population in the selected three *kebeles*

Table 2: Distribution of sample selected from the three *kebeles*

No	Kebeles	Total number of households			Sample selected (non-adopter /adopter)	Proportion
		Adopters	Non-adopters	Total		
1.	Ali	621	819	1,440	57(30/27)	34.545%
2.	Ilani	819	995	1,814	71(37/34)	43.030%
3.	Elabidu	435	514	949	37(20/17)	22.424%
	Total	1,875	2,328	4,203	165(87/78)	100%

Source: ARDoD (2018) and own computation

3.3. Types of Data, Data Sources and Methods of Data Collection

For this study, both quantitative and qualitative data from primary and secondary sources were collected. Primary data were collected with the help of survey by means of structured interview schedule for the quantitative data. The qualitative data were obtained through organizing the focus group discussion, who is supposed to have clear insight about the wheat row planting technology and its local implementation. On the other hand, secondary data are collected from various secondary sources used for this purposes like different publications and unpublished documents like policy documents, official reports from district.

3.4. Methods of Data Analysis

3.4.1. Descriptive and Inferential Statistics

Descriptive statistics were employed for the description of different personal and demographic, socio-economic, institutional and psychological characteristics of the sampled respondents. These are means, percent and frequency, standard deviation. These include mean and percentage of occurrence for the adopter and non-adopter of farmers in wheat row planting in the study district. The inferential statistics like t-test (to see there are significant mean differences between adopter and non-adopter households in relation to continues independent variables) and χ^2 -test (were administered to see if are significant proportion differences between the two groups in terms of categorical independent variables).

3.4.2. Model Specification: Binary Logit Model

The econometric model was used to analyze the factors affecting adoption of wheat row planting technology. One of the purposes of this study was to evaluate the factors that affect the adoption of wheat row planting technology. The dependent variable in this case takes a dichotomous variable, which takes a value of zero for non-adopter households and one for the adopter ones. In this case, the value 1 indicates a farmer who adopted wheat row planting while the value 0 indicates the farmer did not adopt it. Therefore, the logit model was used in the study to identify factors affecting adoption decision of wheat row planting technology in the study area. The logit function for adoption of wheat row planting technology can be specified as follows:

$$p_i = E\left(Y = \frac{1}{X_i}\right) = \beta_0 + \beta_i X_i \quad (1)$$

Where $Y = 1$ means the adoption of wheat row planting, X_i is a vector of independent variable, β_0 is a constant and β_i $i=1, 2, \dots, m$ are the coefficient of the independent variables to be estimated.

The probability of wheat row planting adoption:

$$p_i = E\left(Y = \frac{1}{X_i}\right) = \frac{1}{1 + e^{-(\beta_0 + \beta_i X_i)}} \quad (2)$$

Where: p_i represent the probability that a household is being adopter x_i ,

X_i represents the i th explanatory variable

e = represents the base of natural logarithms (2.718)

β_0 and β_1 are regression parameters to be estimated

$$P_i = \frac{1}{1 + e^{-Z_i}} = \frac{e^{Z_i}}{1 + e^{Z_i}} \quad (3)$$

$$\text{Where, } Z_i = \beta_0 + \sum_{i=1,2,3..}^m \beta_i + X_i \quad (4)$$

If P_i the is probability of being adopter wheat row planting, then $1 - P_i$ represents the probability of being non-adopter it.

$$1 - P_i = \frac{1}{1 + e^{Z_i}} \quad (5)$$

Therefore, the odds ratio can be written as

$$\frac{P_i}{1 - P_i} = \frac{1 + e^{Z_i}}{1 + e^{-Z_i}} = e^{Z_i} \quad (6)$$

So, $\frac{P_i}{1 - P_i}$ is simply the odd ratio in favor of adopting wheat row planting technology. It is the ratio of the probability that the farmer would adopt wheat row planting to the probability that the farmer would not adopt.

Then, if we take the natural logarithm of equation (4) we obtain

$$L = \ln \left[\frac{P_i}{1 - P_i} \right] = Z_i = \beta_0 + \sum_{i=1}^m \beta_i X_i + U_i \quad (7)$$

Before running the specified regressions model for the analysis of data, all the hypothesized exogenous variables were checked for the existence of multicollinerity problems which may arise due to a linear relationship among explanatory variables. It refers to a situation where it becomes difficult to separate effects of independent variables on the dependent variable because of strong relationships among independent variables (Maddalla, 1977). If there is multi-collinarity problem among the exogenous variable, it may cause the estimated regression coefficients to have wrong signs, smaller t-ratios, high R^2 value and it also causes large variance and standard error with a wide confidence interval. Therefore, it is difficult to estimate accurately the effect of each variable (Gujarati, 2004). Among different methods to detect the presence of multicollinearity problem among the explanatory variables, variance inflating factor (VIF) method was used (Gujarati, 2004). VIF for explanatory variable can be calculated as follows:

$$VIF = \frac{1}{1 - R^2} \quad (8)$$

Where, R^2 is the coefficient of correlation among explanatory variable. The larger the value of VIF indicates the more co linearity among one or more model explanatory variables. As a rule of thumb, if the VIF of a variable exceeds 10, which will happen if a multiple R-square exceeds 0.90, that variable is said be highly collinear (Gujarati, 2004).

3.5. Definition and Hypothesis Variables

3.5.1. Dependent Variable

Adoption of wheat row planting technology (Awrpt): Adoption of wheat row planting by farm households is the dependent variable. It is a dichotomous variables representing farmer's adoption decision of wheat row planting technology.

3.5.2. Independent Variables

The explanatory variables of importance in this study are those variables which are thought to have significant effect on farmers' adoption of wheat row planting. These include farmers' personal and demographic, socio-economic, psychological and institutional variables. These explanatory variables are defined as follows.

Credit use (CREDIT): This variable is a dummy variable with values of 1 if the household head ever had an access to credit from any type of credit provider and 0 if the household head has never been borrowed from any lender organization. Credit is an important source of cash which improve farmer capital constraints and enable them to buy agricultural inputs. According to Simtowe *et al.* (2016) credit helps farmers to purchase inputs such as improved seeds, fertilizers and chemicals which are used as input for agricultural production. Therefore, the amount of credit received has affects wheat row planting adoption decision.

Age of the household head (Age): The role of age of framers in explaining technology adoption is somewhat doubtful in the literature. Whatever the condition, it is important to include age as a factor that would help to explain adoption decisions. It is measured in number of years from birth. It is assumed that as farmer age increases the probability of adoption is expected to decrease because as the farmers age increases, it is expected that the farmer becomes conservative and negatively significant the adoption of wheat row planting technology (Amare, 2018). So it is hypothesized that age of the household head is negatively affecting the adoption of wheat row planting technology.

Sex of the household head (Sex): It is dummy variable with the values of either 1 if the household head is male and 0 for female. Male headed households often have better control to the households resources and decisions concerning to adoption of agricultural technologies.

Due to the physical effort exertion that the agriculture in rural economies demands, male-headed households are higher crop production gainers as compared to female headed households (Behre, 2014). Sex of the household head is hypothesized to positively affect the adoption of wheat row planting technology by favor of male.

Education level of the household head (Educl): It represents the level of formal schooling completed or attended by the household head at the time of the survey. It is often assumed that highly educated household heads are better able to process information and search for appropriate technologies to alleviate their production constraints. Hence, educational level of the household head has a positive effect on the status and speed of technology adoption (Sisay, 2016). Education level was expected to have positive effect on the decision of farmers to adopt wheat row planting technology.

Availability of active family labor (Actfmlab): It was interred to in the model as continuous variable. Labor was measured in terms of Man Equivalent (Storck *et al.*, 1991). A farm with larger number of labour is more likely to be in a position to try and continue using a potentially profitable innovation. Household's active family labor availability has positive effect on adoption (Million and Belay, 2004). Hence, it is expected to have a positive effect on the households' probability of adopting wheat row planting technology.

Participation in social organization (Parsorg): It also assumed households who have participation on social organization more likely to adopt wheat row planting technology. Farmers' participating in social organization has a probability to get up-to-date information necessary for their production purpose. It is treated as a dummy variable which is 1= for participant in different social organization and 0, otherwise. Behre (2014) reported social participation should be significant and positively affects smallholder farmer's adoption of both row-planting and improved wheat seed technologies. Hence, it is expected to have a positive effect on the households' probability of adopting wheat row planting technology.

Frequency of contacts with extension agent (frcexta): This refers to the number of days of contact between the household head and extension agent within 2018/2019 production year. The frequency of contact between the extension agent and the farmer is hypothesized to be the potential force, which accelerates the useful dissemination of adequate agricultural

information to the farmers, thereby enhancing farmers' decision to adopt new agricultural technologies. The variable is treated as continuous variable. Empirical results revealed that frequency of contacts with extension agents has positive influence on adoption of new technology (Hassen, 2014). It is hypothesized that it affects the adoption decision positively.

Participation on field days (Partfd): Participation on field days and experience sharing is expected to affect new agricultural technology adoption positively. It is a dummy variable with the value 1 if the household participated on field days and acquires new knowledge and skill practically, and zero otherwise. Participation in field days is expected to increase farmers' adoption of agricultural innovation (Kafle, 2011). Therefore, Participation on field days is expected to positively influence farmers' adoption of wheat row planting technology.

Livestock ownership (Tlu): In agricultural based economies like Ethiopia livestock is the most important source of income and crop cultivation. It is treated as a continuous variable and measured in tropical livestock unit conversion factors (TLU). Lakew and Mohamed (2013) stated that having more units of livestock affects new agricultural technology adoption positively. It is hypothesized to positively affect wheat row planting technology.

Distance from the nearest market (MRKTDIS): It is a continuous variable and measured in minutes of walk which the time farmers travel to sale their *wheat* produce to the market. Farmers located in a village or distant from the market is weakly accessible to the market, the closer to the market the lesser will be the transportation cost and time spent. Adunea (2017) market distance negatively affected adoption and intensity of use of wheat row planting technology. Thus, distance from nearest market was hypothesized to affect wheat row planting technology negatively.

Farming experiences (FEXP): It is a continuous variable and measured in number of years as a respondent started farming on his own. Experience of the farmers is likely to have a range of influences on adoption. Farmers with higher experience appear to have often full information and better knowledge and were able to evaluate the advantage of the improved seed technology. Abera (2013) indicated farming experience of the household positively influenced adoption and intensity of adoption of improved wheat varieties. Hence it was hypothesized to affect adoption of wheat row planting technology positively.

Mass media exposure (Mmexpo): Mass media exposure (radio, TV and mobile phones) play a vital role in disseminating awareness regarding different activities including adoption decision of new agricultural technologies by households. It is treated as a dummy variable with a value of 1, if the farmer has mass media exposure and 0, otherwise. Vaughan (2015) indicated that mass media exposure such as radio, television and mobile phones are important sources of information for new farm technology and hence have the likelihood of increasing the level of technology adoption. It is hypothesized to influence adoption of wheat row planting technology positively.

Availability of fertilizer on time (Avilfer): In this study, the availability of fertilizer affects the adoption of wheat row planting technology. Unavailability of fertilizer on time forces farmers to drop totally the use of wheat row planting and the inverse is true for availability of fertilizer on time. Availability of fertilizer is a dummy variable which takes a value 1, if fertilizers are available on time, 0 otherwise. Fertilizer availability on time determines adoption decision of new wheat varieties (Teferi, 2003). Availability of fertilizer on time affects positively the decision to adopt row planting technology.

Participation in off/non-farm activities (Offfarm): This is a measure of whether the household member participated in off/non-farming activities and generated an income in ETB. It is a dummy variable that takes a value 1 if the household participates in off/non-farm activity and 0, otherwise. Participation in off/non-farm activities promotes the capacity to invest in new agricultural technologies. The study by Olalekan and Simeon (2015) indicated that participation in off/non-farm income activities has a positive influence on the adoption new technology. It is hypothesized to positively affect wheat row planting technology.

Farmers' perception about the technology (Farmper): Perception with the way the attribute of innovation is perceived and the respondent's awareness of the technology attributes relative advantages and disadvantages. It is important to measure farmer's perception towards wheat row planting in the sample households. Farmer's perception is a dummy variable (1= for good perception, 0= for bad perception on wheat row planting technology) which measures how the respondents perceive relative advantages and disadvantages about the wheat row planting technology. If farmers' perception is positive towards the advantage of technology it enhances decision in favor of adoption of the

technology. Good perception towards the technology was expected to positively influence the adoption of wheat row planting technology. The study by Belete (2015) proves this hypothesis.

Farm size (Farmsz): Refers to the area of farm land that the farm household owned and measured in hectare. Farm size is an indicator of wealth and social status and influence within a community. It is important factor to adopt wheat row planting technology to increase its production and productivity. Farmers with large farm size can adopt more agricultural technology and; large farm size provide good opportunity for investment on agricultural production and the reverse is true for small farm size holding farmers (Aberham, 2012). Therefore, it is treated as a continuous variable which is hypothesized that to influence adoption of wheat row planting technology positively.

Table 3: Summary of definition of independent variables and hypothesis

Variables	Description of the variables	Type	Expected sign
Sex	Sex of household head	Dummy (1= Male, 0= Female)	+
Credit	Credit use	Dummy (1=Use, 0=If not use)	+
Age	Age of household head in years	Continuous	-
Educl	Education level of the household head	Continuous	+
Tlu	Number of livestock holding in (TLU)	Continuous	+

Offfarm	Participation in off/non-farm activities	Dummy (1= If participated, 0= If not participated)	+
Actflab	Availability of active family labor	Continuous	+
Mrktdis	Distance from the nearest market	Continuous	-
Partfd	Participation on field days	Dummy (1= If participated, 0= If not participated)	+
Parsorg	Participation in social organizations	Dummy ((1= If participated, 0= If not participated)	+
Fexp	Household's farm experience in years	Continuous	+
Fqcexta	Frequency of contacts with extension	Continuous	+
Avilfer	Availability of fertilizer on time	Dummy (1= If available, 0= If not available)	+
Farmsz	Farm size	Continues variables	+
Mmexpo	Mass media exposure	Dummy (1= If mass media exposure, 0=If not exposure	+
Farmper	Farmers perception towards wheat row planting technology	Dummy (1= If good perception, 0= If bad perception	+

4. RESULTS AND DISCUSSION

This chapter presents the findings and discussion of the descriptive statistics and model outputs. The main findings of the study are presented in to three sections. First section contains level of Adoption of wheat row planting technology. Second section contains analysis related with the description of variables in terms of descriptive and inferential statistics. Third

section displays and deals with the findings from the logistic regression model on factors affecting the adoption of wheat row planting technology.

4.1. Current Level of Adoption of Wheat Row Planting Technology

In this study, farmers who did not apply/use wheat row planting technology during the survey were considered as non-adopters while the farmers who applied/used wheat row planting technology were considered as adopters. As a result, out of 165 sample respondents, 78 (47.27%) were adopters of wheat row planting adoption categories and the rest 87 (52.73%) were non-adopter households. This shows that the percentages of adopters are less than non-adopters because farmer's adoption technologies in variable level, this different level of adoption may be related to several reasons or factors.

4.2. Descriptive and Inferential Analysis Results

4.2.1. Descriptive and inferential statistics of continuous variables

The mean comparison between adopters and non-adopters showed that there is a statistically significant difference between the two groups in terms of some variables. Results showed that adopters are having large farm size, higher education level, more contact with extension agents and have many active family members than non-adopters in the study area. The discussion of each of the continuous variable is given below.

Education level of household head (Educl): The mean years of formal education of adopters were to be 4.24 with a standard deviation of 3.22 and 1.9 years with a standard deviation of 2.46 for non-adopters. Results indicate that there are significant differences between the two groups in terms of education level at 1% significant level. Education is very important for farmers to understand and interpret the information coming from any source. Farmers' education is also essential for the active work of extension personnel because if the farmer has better education level he/she can have the ability to understand and interpret the information transferred to them easily.

Frequency of contact extension agents (Fqcextag): The results indicated that the mean annual of extension contacts with the farmers were 3.70 with a standard deviation of 1.83 for

adopters, and 1.78 with a standard deviation of 2.03 for non-adopters and 2.69 with a standard deviation of 2.16 for the whole sample respondents (Table 4). This indicates that adopters had relatively a better frequency of extension contact than non-adopters. The mean difference between the two groups (adopters and non-adopters) was statistically significant at 1% significance level; showing that there are strong discrepancies between adoption groups based on the frequency of extension contacts with extension agents.

Availability of active family labour (Actflab): The mean of availability of active family labor in sample households in terms of man equivalent (ME) was found to be 3.03. The mean of availability of active family labour for non-adopters was 2.47 while it was 3.66 for adopters (Table 4). Therefore, the availability of active family labor shows that, there is statistically significant mean difference between adopters and non-adopters at 1% significance level. Therefore, the influence of active labor availability on technology adoption depends on the characteristics of the technology to be adopted. When the new technology in relation to the present ones are more attractive and labor intensive, farmers with more family labor availability would tend to adopt those technologies.

Farm size (Farmsz): Farm size is important factor for agricultural production and adoption of agricultural technology for the households. In this study, the mean farm size of sample respondents was found to be 3.75 hectares with a standard deviation of 2.06 hectares. (Table 4). The mean farm sizes for adopter group was 4.45 hectares with a standard deviation of 2.39 while that non-adopters group is 3.12 with a standard deviation of 1.47 hectares. The t-test analysis result shows that there are significant differences between the two groups at 1% level of significance. This implies that, households with large farm size holding had adopted wheat row planting technology than those with small farm size households.

Farm experience of the household (Frexpr): The mean of farming experience for all sample households was found to be 1.60. The mean of farming experience for non-adopters was 0.781 while it was 2.42 for adopters (Table 4). Therefore, farming experience shows that, there is statistically significant mean difference between adopters and non-adopters at 1% significance level. Farmers who have long involvement in any agricultural extension activities are expected to use wheat row planting technology than with less experience of household head.

Table 4: Descriptive and inferential statistics of continuous variables

Adoption categories							
Variables	Adopter =78		Non-adopter = 87		For total observation		
	Mean	SD	Mean	SD	Mean	SD	t-value
Age	43.54	6.58	45.23	6.54	44.33	6.60	<i>-1.650</i>
Farmsz	4.45	2.39	3.12	1.47	3.75	2.06	<i>-4.338***</i>
Educl	4.24	3.22	1.90	2.46	3.01	3.07	<i>-5.252***</i>
Frexpr	2.42	1.55	0.78	0.96	1.60	1.25	<i>-8.265***</i>
Fqcext	3.70	1.83	1.78	2.03	2.69	2.16	<i>-6.350***</i>
Livestoc (Tlu)	9.22	3.47	9.41	3.29	9.32	3.37	0.796
Actflab	3.66	0.93	2.47	1.68	3.03	1.49	<i>-5.496***</i>
Mktdis	95.29	100.08	78.85	90.97	87.07	95.53	<i>-1.105</i>

Source: Own computation from the survey data, 2019. ***, indicates significant at 1% level of significance.

4.2.2. Descriptive and Inferential Statistics of Dummy Variables

The proportion comparison between adopters and non-adopters showed that there is a statistically significant difference in terms of some categorical variables. Results showed that adopters are participated in social organization, participated in off/non-farm activities, participated in field days, more mass media exposure, have good perception on wheat row planting technology than non-adopters in the study area. The discussion of each of the dummy variable is given below.

Mass media exposure (Mmexpo): The result also shown that 60 (76.92%) of has mass media exposure and 18 (23.08%) of no mass media exposure households headed are found in adopter categories and the 34 (39.08%) of mass media exposure and 53 (60.92%) of no mass media exposure headed households are found in non-adopter categories. When we compared the mass media exposure of the household headed 94 (56.97%) had mass media exposure whereas, 71 (43.03%) had no mass media exposure which had statistically significant with $\chi^2=$

24.025, $p=0.000$ at 1% level of significance (Table 5). Therefore, the farmers who had mass media exposure have a chance to adopt wheat row planting technology easily than those who have not; because it is important to mind full farm households on wheat row planting technology.

Participation of social organization (Parsorg): The importance of participation in social organization is supposed as a willingness and ability to work together. Out of 165 sample farmers interviewed, 91 (55.15%) of them had participated in social organization while 74 (44.85%) did not participate in social organization like *idir*, *equib*, farming cooperatives /unions, trade unions, religious associations, women and youth association to share their own common values and experience. The result also shown that 49 (62.82%) were participated in social organization and 29 (37.18%) of were no participated households headed are found in adopter categories and the 42 (48.28%) of participated in social organization and 45 (51.72%) of no participated in social organization headed households are found in non-adopter categories which had significant relationship with the adoption of wheat row planting technology with ($\chi^2=3.517$; $p=0.061$) at 10% level of significance in Table 5. Therefore, this implies that, respondents participated in social organization had role on adopting wheat row planting technology than in the district.

Participation in off/non-farm activity (Offfarm): Out of 165 total sample household heads, 84 (50.91%) were involved in off-farm activities, while 81 (49.09%) are not involved in off farm activities (Table 5). Among the sample respondents, 46 (58.97 %) participated in off-farm activities and 32 (41.03%) no participated in off farm activities were found in adopter categories whereas, 38 (43.68%) participated in off-farm activities and 49 (56.32%) no participated in off farm activities were found in non-adopter categories. The analysis of chi-square test result indicated that participation in off-farm activities ($\chi^2=3.850$, $p=0.050$), there is significant difference among adoption categories. It is one of the mechanism by which farmers decrease their income limitations in agricultural technology adoption. In the study area, petty trade, daily labor on different activities, house making and horse drawn cart were found to be among off-farm activities in which sample households are participating in as a source of income.

Participation on field day (Partfd): It is important for making people to be used to with the essential knowledge and skill on wheat row planting technology. The sample adopter and non-adopter sample households selected for the study were 50 (64.10%) and 37 (42.53%) participated on field day respectively. Among the sample respondents, 50 (64.10%) participated on field days and 28 (35.90%) no participated on field days were found in adopter categories whereas, 37 (42.53%) participated on field days and 50 (57.47%) were found in non-adopter categories. Therefore, participation on field day show that, there is significant difference with both adoption categories with ($\chi^2 = 7.679$; $p=0.006$) at 1% level of significance (Table 5). Therefore, farmers participated on field day had an opportunity to get reliable information on the technology need to adopt than farmers who did not participated on field days.

Farmer's perception (Farmper): The sample respondents' perception towards wheat row planting technology was 49.70% had a bad perception for toward wheat row planting technology and 50.30% had good perception for towards wheat row planting technology. The result shows 26.92% and 73.08 of had bad perception and good perception on wheat row planting technology were found in adopters respectively; and 70.11% and 29.89% had a bad and good perception on wheat row planting technology were found in non-adopters categories respectively. Therefore, the chi-square result indicates that there is highly significant difference in the perception of respondents towards wheat row planting technology (30.69; $p=0.000$) at 1% level of significance. Perception toward adoption of wheat row planting technology by farmer is one of the factors affecting for decisions making on adoption. Mostly, peoples living in same environment share a common understanding of various circumstances and from more or less similar perception about certain situation. However, the degree of perception varies from individual to individual due to different factors. Farmers perception towards wheat row planting technology is described and measured based on the agreement level of the respondents perceived during the data collection.

Table 5: Descriptive and inferential analysis results of dummy variables

Adoption categories						
Variables	Responses	Adopter	Non-adopter	Total	Chi ² – Value	P-value

		N	%	N	%	N	%		
Sex	Female	11	14.10	17	19.54	28	16.97	0.863	0.353NS
	Male	67	85.90	70	80.46	137	83.03		
Avilfer	Yes	63	80.77	69	79.31	132	80.00	0.054	0.815NS
	No	15	19.23	18	20.56	33	20.00		
Parsorg	Yes	49	62.82	42	48.28	91	55.15	3.51	0.061*
	No	29	37.18	45	51.72	74	44.85		
Offfarm	Yes	46	58.97	38	43.68	81	49.09	3.850	0.050**
	No	32	41.03	49	56.32	74	50.91		
Credit	Yes	16	20.51	23	26.44	39	23.64	0.799	0.371NS
	No	62	79.49	64	73.56	126	76.36		
Partfd	Yes	50	64.10	37	42.53	78	47.27	7.679	0.006***
	No	28	35.90	50	57.47	87	52.73		
Mmexpo	Yes	60	76.92	34	39.08	94	56.97	24.02	0.000***
	No	18	23.08	53	60.92	71	43.03		
Farmper	Bad	21	26.92	61	70.11	82	49.70	30.69	0.000***
	Good	57	73.08	26	29.81	83	50.3		

Source: Computed from survey data, 2019

Note: ***, ** and * Significant at 1%, 5% and 10% level and NS=Not Significant

4.3. Results of the Econometric Model

Table 6: Logit model estimates of factors affecting the adoption decision of wheat row planting technology

Variables	Coefficients (B)	S.E	Significance Level	Marginal effects (dy/dx)
Constant	-14.011	2.909	0.000	-
Sex	-0.628	0.754	0.415	-0.155

Age	0. .048	0.045	0.305	0.012
Edulev	0.312	0.099	0.002***	0.077
Frexpr	0.990	0.238	0.000***	0.246
Farmsz	0.210	0.186	0.268	0.052
Avilfertz	-0.845	0.787	0.315	-0.207
Parsorg	1.583	0.632	0.016**	0.373
Partfd	0.751	0.637	0.272	0.184
Offarm	2.004	0.689	0.007***	0.461
Mmexpo	2.088	0.641	0.002***	0.473
Fqcextagt	0.523	0.172	0.003***	0.130
Farmper	1.846	0.658	0.007***	0.430
Livestock (TLU)	-0.018	0.075	0.814	-0.004
Actflab (ME)	0.498	0.498	0.056*	0.124
Mrktdis	0.003	0.003	0.342	0.000
Credit	0.087	0.704	0.907	0.021
<hr/>				
Number of obs.	= 165	Correctly predicted = 90.30%		
LR chi2 (16)	= 145.88	Non-adopters predication =90.80%		
Prob > chi2	= 0.000***	Adopters predication = 89.74%		
Log likelihood	= -41.182064	Pseudo R2	=	0.6391

Source: Econometric model output, 2019.

Note: ***, ** and * represents Significant at less than 1%, 5% and 10% probability level respectively.

The logistic model was applied to all sample farmers (both adopters and non-adopters) to find the factors affecting the farmers' decision to adopt or not to adopt wheat row planting technology. Before going on to see the relation of variables by using the logit model, it was found important to look into the problem of multi-collinearity or linear association among the hypothesized independent variables. Variance inflation factors (VIF) was used to check the multi-collinearity problem with all variables. It was concluded that there were no multi-collinearity and association problems between all variables, as the particular coefficients were very low (VIF less than 5 for all variables) (Appendix Table II).

Lastly the eight continuous and the eight dummy variables were entered into the logistic regression analysis. The various goodness of-fit measures were employed to check and validate that the model fits the data well. The chi-square goodness-of-fit test statistics of the model show that the model fits the data with significance at the 1 % level. This shows that the independent variables were relevant in explaining the farmers' decision to adopt wheat row planting technologies. The model predication result also shows that about 89.74% of the adopters and 90.80% of non-adopters were correctly predicted by the model. Generally, the correct prediction of all sample (count- R^2) is 90.30% of the overall sample cases. Thus, the model prediction was good for both adopters and non-adopters of wheat row planting technology.

The logistic regression results shows, the presence of relationship between the dichotomous dependent with the explanatory variables for the continuous and dummy variables for the study. The factors considered are related to demographic, socio-economic, institutional and psychological factor related to the adoption of wheat row planting technology. Among the 13 variables used in the model, eight variables were significant with respect to adoption of wheat row planting technology with less than 1%, 5% and 10% the probability levels. These variables include education level, frequency of contact with extension agent in the year, perception towards on wheat row planting, participation in field days, mass media exposure, participation of social organization, availability of active family labor and participation of off farm activities, whereas the rest five explanatory variables were found to have no significant influence on the adoption of wheat row planting technology. The influence of the significant explanatory variables on adoption of wheat row planting technology in the study area is interpret and discussed below:

Availability of active family labor (Actflab): Availability of active family labour had influenced the adoption of wheat row planting technology positively at 10% level of significance. The result of marginal effect indicates as increase the number of active family labor in one man equivalent, the probability of adopting wheat row planting technology increases by 12.4% holding other factors constant. This is because wheat row planting technology is labour intensive and hence the households with high labour availability use the technologies on their farm plots better than others. On the other hand, households with more active family

labor availability is expected to ease labour constraints, thereby enhancing the farm households more likely to register better adoption of wheat row planting than others. The result was consistent with the finding of Ahrhaley (2016) and Tadele (2016).

Farming experience (Fexpr): - It is significantly affected the adoption decision of wheat row planting technology at 1% significance level. This implies that farmers who have longer years of experience in using wheat row planting technology or farming have adopted wheat row planting technology than those who have the lower years of experience in using wheat row planting. Therefore, the result of marginal effect indicates as increase the farming experience by one year, the probability of adopting wheat row planting technology increases by 24.6% holding other factors constant. This may be due to relatively farmers who have longer years of experience may develop the confidence in handling the risk lovers, skills in technology application. This result agrees with Abera (2013) have reported farming experience positive and significant relation with adoption.

Frequencyof contact extension agents (Fqtext): Frequency of contacts with extension agents is important for creating farmers technically skillful and confidential on running agricultural production in a sustainable way. Frequency of contact with extension agents as measured in frequency of extension agents contact with farmers per year during the agricultural production season were positively and significantly affected the adoption of wheat row planting technology at 1% significance level, indicating that farmers who had commonly contacted with extension agents during the agricultural cropping season was allocated more of their farm size for wheat row planting and are technically more competent on the application of row planting on farm plots than those who had less frequency of contacts with extension agents. The result of marginal effect indicates as increase the frequency of contacts with extension agents by one day, the probability of adopting wheat row planting technology increases by 13% holding other factors constant. Thus, farmers' who more contacts with extension agents are believed to be exposed to different, new and update information that help them to quickly adoption of wheat row planting on their farm lands. The result was similarly with the finding of Moti *et al.* (2013) also found that the number of extension contact agents has a significant positive effect on adoption of agricultural technologies.

Mass media exposure (Masexpo): Mass media exposure is important to make farmers aware of new agricultural technologies to proceed for the next step of considering the advantage and limitation of the technology and positively influencing the adoption of wheat row planting with at 1% level of significance. The result of marginal effect of this variable 0.47 reveals that the predicted probability of using wheat row planting technology increases by 47.3% for the farmer's mass media exposure as compared to the farmers who do not mass media exposure. This is because of the farmers who were utilizing mass media gains better knowledge and information on agricultural technology than no mass media exposures which contributes to adopt wheat row planting in the district. The finding of this research is similar with Tariku (2012).

Perception towards wheat row planting (Farmper): The perception towards wheat row planting technology has significant and positive relationship with the adoption of wheat row planting at 1% level of significance. The model result indicated that those farmers who have good perception towards to be more adopters as compared to those farmers who have bad perception towards wheat row planting technology. The result of marginal effect of this variable 0.43 reveals that the predicted probability of using wheat row planting technology increases by 43.6% for the farmer's perceived wheat row planting technology as a good compared to those who perceived it as bad. The result of this research is similar with Ragasa (2016).

Education level of household head (Educl): Education level of the household head is one of the important indicators of human capital. Moreover, education enhances farmers' to make independent decision and to act on the basis of the decision and increase the households ability to acquire, analyze, interpret and use information relevant to the adoption of enhanced agricultural technologies. It is positively and significantly influenced the adoption of wheat row planting at 1% probability level. The result of marginal effect indicates as education level of household head increases by one year, the probability of adopting wheat row planting technology increases by 7.7% holding other factors constant. Because educated household head can understand agricultural guidelines easily, have better access to information and higher tendency to adopt better agricultural technologies than uneducated household heads. This result similar with the studied done by Tolesa *et al.* (2014) and Yonas (2014).

Participation in off/non-farm activities (Offarm): Participation in off/non-farm income activities was found to have positive and significant influence on the adoption of wheat row planting. Other things held constant, the result of marginal effect 0.46 reveals that the predicted probability of using wheat row planting technology increases by 46.1% for the farmer's participated in off/non-farm activities as compared to those who do not participated. This implies that the more a farmer participates and earns from off/non-farm activities, the higher the likelihood of taking a continued use decision, of wheat row planting. This could be linked to the possibility of using money from off/non-farm activities for purchasing of inputs and hiring labor necessary to continue sowing wheat by row. This was consistent with the findings of Hassen (2014).

Participation in social organizations (Partsorg): In this study also, social participation was considered to influence adoption of wheat row planting technology positively at 5% significant level. It is a social asset that creates an opportunity to share experience and exchange information on new technology in the farming community. The model indicated that farmers who have participation in social activities were hypothesized to have more opportunity of getting access to information and adopting technologies better than the non-participants. Other things held constant, the result of marginal effect 0.37 reveals that the predicted probability of using wheat row planting technology increases by 37% for the farmer's participated in social organizations as compared to those who do not participated. This is imply that strong social participation lead to have better access of information and technologies then lead to adopt technology. This was consistent with the findings of Aberham (2012).

5. SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1. Summary

This study assessed the status of adoption of wheat row planting and identifies factors affecting adoption decision of wheat row planting technology. A two stage sampling and probability proportional to sample size techniques were used to obtain sample respondents. Therefore, the study used a primary data collected through pretested structured interview

schedule from selected sample respondents 165 from selected three *Kebeles* (Ali, Ilani and Elabidu) in Agarfa district of Bale zone. In addition, qualitative data were collected from FGD to get detailed information about adoption of wheat row planting technology. Also, secondary data from district agricultural office, published and unpublished sources were reviewed for this study research.

The collected data were analyzed using descriptive statistical tools such as mean, standard deviation, to describe the respondents characteristics based on the presented explanatory variable in relation to the level adoption of wheat row planting technology. Furthermore, inferential statistics like χ^2 -test and t-test were also used to see the standard deviation, frequency, percentage and mean difference between the adopter and non-adopter of the sample household's. Result from inferential analysis of chi-square test and t- test indicated that more of the variables hypothesized to influence farmers' adoption decision were significantly related with adoption of wheat row planting technology. So results shows that adopters of the wheat row planting technologies were better on education level, mass media exposure, have more active family labor, participated more in off farm activities, participated more on field days, participated in social organization, frequency of contact with the extension agents and had good perception towards wheat row planting technology than the non-adopters.

On the other hand, the econometric binary logit model was employed to estimate factors affecting adoption of wheat row planting technology. Accordingly, availability of active labor in the family, education level of household head, farming experience, participation on field days, frequency of contact with extension agents, participation of social organisation, participation in off/non- farm activities, mass media exposure and farmers' perception towards row plating technology had significant relationship with adoption of wheat row planting. From 16 explanatory variables included in the Logit model, eight variables had shown significant relationship with adoption of wheat row planting and the rest eight explanatory variables had no significantly affect adoption of wheat row planting technology.

5.2. Conclusion and Recommendations

Wheat is one of the most important cereal crops for the Ethiopia which is the main source of food and cash for smallholder farmers. Growth of the production of wheat crop encouraged

through technological change is expected to support higher calorie intake and improve household's food security. The mostly rain fed wheat production in Ethiopia is still low and lagging behind many African countries and is also deficient in terms of production to meet the national requirements. The performance of wheat production has been give attention in recent years. It is understood that there is various potential for further productivity growth in wheat crop through the adoption of row planting technology which is important to meet the growing demand and food deficit particularly in the study area, hence reduce poverty and countries dependence on wheat import and then encourages economic growth of the country.

Wheat contribution to household's nutrition, income and food security is very high. It also provides job opportunities for youth and the landless poor and for merchants and poor urban dwellers who are engaged in its processing activities. As its contribution, however, the emphasis given nationally to the sector is relatively low compared to other food crops. As a result, out of 165 sample respondents, 47.27% were adopters of wheat row planting adoption categories and the rest 52.73% were non-adopter households. As a result of this, availability of active labor in the family, education level of household head, participation on field days, frequency of contact with extension agents, participation of social organisation, participation in off farm activities, mass media exposure and farmers' perception towards wheat row plating technology are significantly affected the adoption of wheat row planting technology. Based on the research findings of this study, the following significant variables are recommended to encourage farmers' adoption of wheat row planting technology.

Education was found to have positively and significantly affected adoption decision of wheat row planting technology. Therefore, due emphasis has to give towards strengthening farmers informal education at different levels for households using farmers training centres. Promotion of adult and youth education among the society and creating experience sharing event to simulated best practice is recommended.

Labor availability of the family was influenced adoption decision of wheat row planting technology positively. Wheat row planting technology practice needs more labour for activities during sowing wheat by row. Hence, different wheat row planting technology with relatively less labor requirements should be designed. Hence, to improve this, wheat row planter machine should be produced and provided to the farmers.

Mass media exposure is significantly influencing adoption decision of wheat row planting positively. It is important to influence adoption decision of farm households to create an awareness to show an interest to adopt the technology on which organizing farmers to share and discuss ideas from different mass media sources like radio, magazines and television with their own local development group is important to fill the available information gaps.

Frequency of contacts with extension agent positively influenced the adoption decision of wheat row planting technology. The district agricultural office should strengthened the present extension service facility as to improve farmers' number of contact with extension agents through increasing the number of extension workers and improving educational performance of the extension agents is important to improve farmers adoption of wheat row planting technology.

Perception towards wheat row planting technology is positively and significant affects the adoption decision of wheat row planting technology. Information about the profits of the new technology should be given to farmers to increase farmer's awareness about the technology and to develop a farmer's better perception towards the technology. Improved farmers to use wheat row planting technology to get advisable change in the agricultural production and development.

Participation in off/non-farm activities positively and significantly influences the adoption decision of wheat row planting technology. This additional income from participation in off/non-farm activities increased financial capacity of farmers to purchase farm inputs, hiring labor and also have a confidence. As a result, good attention is needed for the development of income generating activities.

Participation in social organization has positively and significantly influences the adoption decision of wheat row planting technology. Therefore, participation of farmers in different formal and informal social organization like farmers association, informal associations (*Ider*, *Ekub*, *Mahber* and others), farmer's cooperatives and women's association has to be strengthened so as to improve farmers' access to information and adoption of technologies.

Farming experience has positively and significantly influences the adoption decision of wheat row planting technology. More experienced household are better in adopting wheat row planting technology. Therefore, should be able to increase the awareness of household head through experience sharing events in order to increase the adoption of wheat row planting technology.

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7. APPENDIX

Appendix Tables

Table 1: Conversion factor of Tropical Livestock Unit (TLU)

Livestock Category	TLU	Livestock Category	TLU
Camel	1.25	Donkey (young)	0.35
Ox	1.00	Horse	1.10
Cow	1.00	Sheep (adult)	0.13
Bull	0.34	Sheep (young)	0.06
Heifer	0.75	Goat (adult)	0.13
Calf	0.25	Goat (young)	0.06
Donkey (adult)	0.7	Poultry	0.013

Source: Storck, *et al.*, 1991

Table 2: Result of variance inflation factor for continuous explanatory variables

Variable	VIF	1/VIF
Numext	1.46	0.686064
Farmsz	1.36	0.733904
Age	1.30	0.770079
Actflab	1.27	0.784401
Partfd	1.19	0.841577
Avilfer	1.18	0.850928
Educl	1.18	0.849366
Tlu	1.20	0.836240
Parsorg	1.10	0.905514
Sex	1.12	0.894124
Mmexpo	1.08	0.925983
Offarm	1.06	0.941182
Farmper	1.12	0.891423
Mean VIF	1.20	

Source: Computed from own survey, 2019

Table 3: Conversion factor used to compute man equivalent (Labour Force)

Age group	Male	Female
-----------	------	--------

< 10	0.00	0.000
10-13	0.20	0.200
14-16	0.50	0.40
17-50	1.00	0.80
>50	0.70	0.50

Source: Strocket *al.* (1991)

Appendix 6. Questionnaire

General Identification information Dear respondent!

This survey questionnaire is designed with the objective of collecting information on the technology adoption of farmers. It therefore meant only for research purposes. For this purpose your genuine responses to each of the survey questions are highly useful. We highly appreciate for your willingness to participate as a respondent in this survey. For all closed type questions please Circling on number and please strictly follow the instruction given in each part of the questionnaire.

Instruction for Enumerators

1. Introduce yourself before starting interview and tell the purpose of the study.
2. Fill the interview schedule according to the farmers reply (do not put your own feeling).
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.
5. Circle on number all closed questions when answered by respondents and write additional answers in the space provided.

1. Interviewer (Enumerator) Name: _____
2. Tell phone number: _____
3. Name of PA: _____ code; _____
4. Name of the respondent: _____ Household head code number ____
5. Checked by supervisor _____ Signature _____ Date _____
6. Adoption status of household head: 1= Adopter 0= Non adopter

I. Household demographic characteristics questions (circling)

1. Sex of the household head? 1. (1=Male) 2. (0= Female)
2. Age of the household headyears old.

3. Marital status: 1. Single 2. Married 3.Divorced 4.Widowed
4. Education level of household head (completed years of formal schooling) _____ or
1. Illiterate 2. Adult education
5. Did you have wheat row planting experience during last production year?
1. (1=Yes) 2. (0=No)
- 6.1 If “YES”, how many years of wheat row planting experiences do you have? _____
6. Occupation of the household head? 1= Farming 2= Animal rearing 3= Trading
4= others (specify) _____
7. What is the house you owned and live in?
1. Grass roofed and muddy wall 2. Corrugated tin roof and muddy wall
3. Corrugated tin roof and Bullock wall 4. Other (please specify)

II. Information about Agricultural Activity

1. What type of agricultural production do you practice? (Rank if you have multiple answers)
1. Crop production only 2. Livestock production only 3. Mixed agriculture
4. Others (Specify) _____
2. Do you produce wheat in your farm? 1. (1=Yes) 2. (0= No)
3. If your answer for question number 2 is “yes”, do you use row planting technology?
1. (1=Yes) 2. (0= No)
4. If no, why you are not using wheat row planting technology? (Rank if you have multiple answer)
1. Lack of active labor force 2. Shortage of farm land 3. Lack of access market for output
4. I do not need it 5. Lack of information accessibility 6. Others specify _____

III. Socio-economic Characteristics

A. Land holding and Livestock ownership

1. Farm size of household head (ha)

S. No	Land Type	Size in hectare	Rental value per hector in birr
1	Currently farmed		

1.1	Own (A)		
1.2	Rented in		
1.3	Shared in		
1.4	Shared out (B)		
1.5	Rented out (C)		
2	Homestead land (D)		
3	Fallow land (E)		
4	Other (F)		
Total own land (A+B+C+D+E+F)			

2. What are the main crops you cultivate in your farm and how much area is allocated for each crops? Please fill the requested information here below:

No.	Main Crop	Area Cultivated (ha)in 2010/2011 E.C			
		Belg	Meher	Belg	Meher
1.	Maize				
2.	Teff				
3.	Barely				
4.	Wheat				
6.	Potato				
5.	Haricot bean				
7.	Other specify_____				

2.1. From your total hectare of crop production, how many hectares you allocate for wheat crop production?

2.2. If you use row planting technology for wheat production in 2008/9 E.C, how many hectare you allocate for wheat production through row planting from total area of wheat?

Please specify it_____

2.3. Do you think that shortage of land is the major production constraint for you to practice row planting technology? 1, No 2, Yes

3. How many of the following types of livestock do you have? Please fill in the head count column.

S.No.	Types of livestock	Number	TLU	Remark
1	Cow			
2	Oxen			
3	Bull			
4	Heifer			
5	Calf			
6	Mules			
9	Donkey			
10	Goats			
11	Sheep			
12	Chicken			
13	<i>Other specify</i>			

4.2. What is the area of land allocated for animal husbandry? _____(hectares)

5. The number of oxen you own during the last crop season _____

7. Did you face any shortage of oxen during the last crop season? 1. (1=yes) 2. (0=No)

7.1. If yes, how did you solve the problem?

1. Hiring oxen 2. Cooperating with others 3. Using hand tools 4. Others specify _____

8. How did you become aware of the use of wheat row planting technology?

1. From extension agent 2. From neighbors 3. From traders 4. From contact farmers

5. From local leaders 6. From NGOs 7. If others, specify _____

9. Have you ever used wheat row planting technology in your sowing time?

1. (1=Yes) 2. (0=No)

9.1. If yes, when did you start using? _____

10. Did you use wheat row planting during the last cropping season?

1. (1=Yes) 2. (0=No)

10.1. Question 10 if “NOT”, why did not you use?

1. No information about the technology 2. Assumed to be not profitable
 3. No willingness to use 4. Need more labor 5. Others, specify_____

11. What was the most important factor in your decision to not use wheat row planting technology _____

12. What are the sources of labor for wheat row planting?

1. Family labor 2. Hired labor 3. Relatives 4. Labor pooling mechanism (*Debbo*) 5. Other specify_____

12.1. What's your active family labor? _____

No	Age group	Male	Female	ME	Total
1	<10				
2	10-13				
3	14-16				
4	17-50				
5	>50				

13. Did you get fertilizer on time? 1. (1= Yes) 2. (0= No)

13.1 If question number 13 No why? _____

B. Participation in Social Organization and Field days

1. Have you participated in any activities of social organizations in your area? 1. (0= No) 2. (1= Yes)

1.1. If your answer is "YES" for the above question, which of the community association do you involve?

1. Idir 2. Equib 3. Farming cooperatives /unions 4. Religious associations
 5. Trade unions 6. Women and youth association 7. Other please specify_____

1.2. What services do you get from social organization organizations you belong to?

1. Education/ information 2. Loans/ credit 3. Seeds/seedling 4. Agricultural inputs
 5. Labour 6. Others (specify) _____

2. Have you participated in field days? 1. (0=No) 2. (1=Yes)

2.1. If "YES" please fill the following table.

No.	research/extension activities	1=participant 0=non-participant	Number of times participated in a year	Who arranged the activity to you?	Remark
1.	Participate on field days				

C. Mass Media exposure on Agricultural Programs

1. Do you contact any mass media? 1. (0= No) 2. (1= Yes)

1.1. If yes, do you listen or see to any agricultural education program? 1. (0=No) 2. (1= Yes)

1.2. If No for 1.1, why?

IV. Institutional Characteristics

1. What is the distance from home to market you mainly sale your wheat produce? _____ min.

1.1. What is the distance from your home to the market for the following activity 2010/2011 E.C?

No.	Market place for	To nearest market (in minutes of walk)	To alternative market (in minutes of walk)
1.	wheat produce (to sale)		
2.	wheat seed (to purchase)		
3.	Fertilizers (to purchase)		

2. Do you get advisory services from extension agents? 1. (1= Yes) 2. (0=No)

2.1. If your answer for question number 1 is “YES”, which of the following extension services have you ever heard or know about? (rank if you have multiple answers)

1. Short-term training 2. Marketing and networking 3. Technical assistance

4. Counseling and information 5. Raw material provision 6. Others, specify _____

2.2. If no, why you are not getting the service from extension agents on wheat row planting?

2. 3. Do you have contact with extension/ development agent? 1, Yes 2, No

2.3.1. How frequently do extension agents visit you?

3. When does extension agent contact you? (rank if you have multiple answers)
 1. During land preparation 2. During fertilizer demand 3. during sowing
 4. When disease/ pest occur 5. During harvesting 6. Others (Specify) _____
4. What is the most common place where you usually contact extension agents?
 1. In your farm field 2. In your home 3. In market 4. In his office
 5. At the demonstration center 6. Others, specify _____
5. From whom do you get advice on wheat row planting technology and methods other than extension agents?
 1. From NGOs 2. From woreda agricultural office 3. From Zone experts
 4. From local leaders 5. Others specify _____
6. What kind of advice do you get from these sources? _____
7. Is there any credit institution/sources in your area? 1. (1= yes) 2. (0=No)
- 7.1. If “yes” Q7. what is the source of your credit? 1, Banks 2, Friends\relative
 - 3, Micro finance institutions 4, if others specify
- 7.2. Did you get access to credit? 1. (1= Yes) 2. (0=No)
- 7.3. If “yes” Q7.2, do you received credit for the agricultural production?
 1. (1= Yes) 2. (0=No)
- 7.4. If “yes” questions #7.3, for what purpose you use the credit received from the sources?
 - 1) To buy modern farm inputs like fertilizers 2) To purchase oxen 3) To buy improved seeds
 - 4) for household consumption 5) To construct house 6) To pay another debit 7) to hire labor for agricultural activities 8) all 9) If other, please specify

V. Physiological Characteristics

1. What type of planting method do you prefer to use for wheat production?
 1. Broadcasting method 2. Row planting method 3. Transplanting method
2. Do you prefer row planting methods? 1. (0=No) 2. (1=yes)
- 2.1. If yes question number 2 why you are prefer this method?
 1. It increases yield 2. It saves time 3. It use few seeds per hector
 4. It saves labor 5. others specify _____

2.2. If No, for question number 2 why you are not prefer wheat row planting method? (rank if you have multiple answer) 1. I do not need it 2. Lack of active labor force 3. It is reduce the output 4. Shortage of farm land 5. Lack of information accessibility 6. Others specify _____

3. What is your perception towards row planting methods? 1. Bad 2. Good

4. Did you have an access market for your production to sale? 1. (1=Yes) 2. (0=No)

4.1. If your answer to question number 4 is yes, what is the advantage you get from it? (rank if you have multiple answers) 1. Increase sales 2. No impact 3. Reduce time spent on road between homes to market 4. To get good source of price for product 5. Reduce costs of transporting 6. Others specify _____

1. Checklist Used for Conducting Focused Group Discussion.

As you probably know, agricultural office is trying to promote row planting technology, which is believed to increase the output of wheat production for farmer. In addition, DA is supporting the farmers in different method to increase adoption of wheat row planting. But, Most of the farmers are not adopting the practice still.

- ❖ What are the main reasons?
- ❖ Why are a small number of farmers adopting the row planting technology for wheat production?
- ❖ Is the row planting make profitable to farmers or not? If yes how? If not why?
- ❖ Do the farmers knowledgeable difficulty in practicing row planting technology for wheat production?
- ❖ What are the general imitations about wheat row planting technology
- ❖ Which method of wheat planting did you use mostly in your area and why?
- ❖ What type of the wheat variety you prefer to practice row planting technology and why reasons?

2. Interview Checklist for Development Agents (Experts)

- ✓ What are the reasons only few farmers adopting the wheat row planting technology in the district?
- ✓ What are the major problems you have seen that farmers are facing while using row planting technology to wheat?
- ✓ How and when do you help wheat row planting users?

- ✓ Are you given training for the farmers as regards to the application of wheat row planting technology and at what time given the training for the farmers?
- ✓ What are the systems you use to solve the problem concerning the use and adoption level of wheat row planting technology?