ST. MARY'S UNIVERSITY
SCHOOL OF GRADUATE STUDIES

FACTORS AFFECTING ADOPTION OF WHEAT ROW PLANTING TECHNOLOGY THE CASE OF HAGERE MARIAMNA KESEM WOREDA, NORTH SHEWA ZONE, AMHARA REGION,ETHIOPIA.

BY

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MAY, 2018

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INSTITUTE OF AGRICULTURE AND DEVELOPMENT STUDIES

FACTORS AFFECTING ADOPTION OF WHEAT ROW PLANTING TECHNO LOGY THE CASE OF HAGERE MARIAMNA KESEM WOREDA,NORTH SHEWA ZONE, AMHARA REGION,ETHIOPIA.

A THESIS SUBMITTED TO THE SCHOOL OF GRADUTE STUDIES OF ST.MARY'S UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQU IREMENTS FOR THE DEGREE OF MASTERS OF SCIENCE IN AGRICU LTURAL ECONOMICS.

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APPROVAL OF BOARD OF EXAMINERS

This is to certify that the thesis prepared by Bizunesh Mulugeta in titled "Factors Affecting Adoption of Wheat Row Planting Technology: The Case of Hagere Mariamna Kesem Woreda, North Shewa Zone, Amhara Region and submitted in partial fulfillment of the requirements for the degree of Masters of Science in Agricultural Economics complies with the regulation of St.Mary's University and meets the accepted standards with respect to originality and quality.

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DECLARATION

I declare that this MSc. thesis is my original work, has never been presented for a degree in this or any other university and that all sources of materials used for the thesis have been duly acknowledged.

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ENDORSEMENT

This thesis has been submitted to St. Mary's University School of Graduate Studies for examination with my approval as a university advisor.

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Advisor Signature and Date

ACKNOWLEDGMENT

Above all, I praise and glorify God, for his immeasurable help and blessing, and for giving me the stamina required to successfully complete this work.

I want to forward my sincere acknowledgments to all who were around me during my thesis work. To this regard my first gratitude goes to my advisor, Dr. Wondmagegn chekole for his invaluable academic support in developing this thesis.

I also express my gratitude to my Twin Wagaye Mulugeta for his very valuable guidance and useful comments and provision of working materials. I would also like to express my heartfelt thanks to St.May's University for providing me the opportunity to participate in the Master's Program and Testing Center top management members for their support.
I am grateful to the staff of Hagere mariamna kesem woreda Agriculture and Rural Development in North Shewa Zone, for providing me with the necessary information for my study and the staff of Nefaseameba, Kumdengaye, and Debiretsege kebels for all the kind assistance provided during data collection. I also wish to thank all interviewed farmers for their time and patience in providing the required information to enumerators.

Last but not least I would like to thank to my Mother Tiruwork and my Father mulugeta prayers for my welfare and success and also thanks to all my Brothers and Sisters for their moral support, and encouragement.

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ACRONYMS AND ABBREVIATIONS

ATA	Agricultural Transformation Agency
CSA	Central Statistical Agency of Ethiopia
FAO	Food and Agriculture Organization of United

Nations

FGD	Focus Group Discussion
FTC	Farmers Training Centers
GAIN	Global Agricultural Information Network
GDP	Gross Domestic Product
GTP	Growth and Transformation Plan
Ha	Hectare
HYV	High Yield Variety
MoA	Ministry of Agriculture
MoARD	Ministry of Agriculture and Rural Development
RboA	Regional Bureau of Agriculture
SWI	System of wheat intensification
VIF	Variance Inflation Factors
SPSS	Statistical Package for Social Science

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ABSTRACT

This study was conducted in North shewa Zone, northern Ethiopia. Its aim was to find out the status of to assess factors affecting adoption of use of row planting technology on wheat production. The study applied three*-stage sampling techniques, i.e.* purposively, *stratified and random sampling techniques. In order to achieve these objectives, 147 rural households were selected randomly following probability proportional to sample size technique.*

Both primary and secondary data were used. The data were analyzed by using descriptive statistics like mean, standard deviation, percentages and frequency distribution. Inferential statistics such as t-test and chi-square (χ^2) tests were also used to describe characteristics of adopter and non adopter households. The survey result shows that about 54.42% and 45.58% of sample respondents were found to be adopter and non adopter of wheat row planting technology respectively.

The study employed logistic regression model to analyze and find out the status of to assess factors affecting adoption of use of row planting technology on wheat production in the study area. And, according to the econometric result, out of 13 explanatory variables five were found to have significant. These were Age of the household head, cultivated farm size, oxen ownership, Soil type and Family size while the remaining 8(eight) explanatory variables namely; sex of the house hold, farming experience, educational level, extension contact, participation in training, credit use, fertilizer application and distance to the market.

Keywords: *Row planting technology, Adoption, Wheat, Binary Logistic Regression model.*

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

Wheat is one of the most important cereal crops of the world and is a staple for about one third of the world's population. It is primarily used as a staple food providing more protein than any other cereal crop .Crop production is a subsector on which the country has unfailingly depended on to bring about a livelihood transformation by the poor.

Wheat is one of major staple and strategic food security crops and most widely cultivated and consumed in Ethiopian.In2012/2013,It was cultivated on 1,627,647.16 hectares of land and has the production of 34,347,061.22 quintals with the productivity of 21.10 quintals/hectare in Ethiopia (CSA), 2013).The challenges of globally low and fluctuating wheat production, rising consumer demand and higher food prices require efforts that dramatically boost farm-level wheat productivity and reduce global supply fluctuation. Productivity growth is considered to be one of the long term solutions to these challenges (Diao et al., 2008).

Agricultural technologies include all kinds of improved techniques and practices which affect the growth of agricultural output (Jain et al., 2009).According to loevinsohn et al. (2012), the most common areas of technology development and promotion for crops include new varieties and management regimes; soil as well as soil fertility management; weed and pest management; irrigation and water management. By virtue of improved input/output relationships, new technology tends to raise output and reduces average cost of production which in turn results in substantial gains in farm income (Challa, 2013). Adoption of improved agricultural technologies has been associated with: higher earnings and lower poverty; improved nutritional status; lower staple food price; increased employment opportunities as well as earnings for landless laborers (Kasirye,2011). Adoption of improved technologies is believed to be a major factor in the success of the green revolution experienced by Asian countries (Ravallion and Chen,2004).on the other hand, non-adopters can hardly maintain their marginal livelihood with socio-economic stagnation leading to deprivation (Jain et al., 2009).

In Ethiopia, according to central statistical Authority (CSA, 2011).average national productivity of wheat is 1.84 ton/hectare which low compared to the potential productivity of 4 to 8 ton/hectare at farmers' field. In an effort to improved wheat productivity and production, the

Minister of Agriculture (MoA) through Regional Bureau of Agriculture (RBoA) has 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 part of the country as expected. The same thing is also true for the study area. There are different factors directly or indirectly influencing the adoption of technologies that believed to bring change in smallholder farmers' productivity. The focus of this study was to assess the status to which the wheat row planting technology is adopted by farmers, and to identify the factors influencing adoption of recommended technology.

1.2. Statement of the Problem

Wheat is one of the prominent food and cash crops for smallholder farmers and ranks third in total production and fourth after Teff, Maize and Sorghum in area coverage in Ethiopia. In spite of these efforts, productivity gains are not as such adequate in the country. Low level of adoption of agricultural technology is among the major factors contributing to low productivity in the country (Ahmed *et al.,* 2014). This low level of adoption holds true for row planting technologies in wheat production as well. We would Compared to the traditional broadcasting system, row planting gives better yield with quality of the seed at harvesting period (Joachim *et al.*, 2013). Recent studies conducted in Ethiopia show that yields are very responsive to this improved technology.

By comparison to the conventional broadcasting technique, for instance, Tolosa *et al.* (2014) found on average of 14.6% higher wheat yields with row planting technology while Vandercasteelen *et al.* (2014) found an increase in *teff* yields between 12 and 13% in farmers' experimental plots and 22% in demonstration plots managed by extension agents. Nevertheless, sizeable improvement in production and productivity depends on the extent to which a household has adopted this improved technologies. In addition, in United States, planting wheat in wide rows in combination with inter-row cultivation reduced weed density by 62% and increased yield by 16% (Lauren *et al.*, 2012).Moreover, according to the Ministry of Agriculture and Rural Development (MoARD,2012) row planting on average increases production by 30%s and reduces the amount of seed consumption to one-fifth of existing seed use.

To improve production and productivity of smallholder farmers and meet GTP goals, the government of Ethiopia is also doing its best by complementing the existing technologies with new technologies (row planting technology). Despite this fact, the introduced technologies were not widely accepted as expected in different parts of Ethiopia there by in the study area. Essentially, the observed failure of farmers to adopt row planting technology and fully put into practice could be attributed to various factors which appeared to have some bearing on the farmers' decision to adopt the technologies. In Ethiopia, studies on adoption of row planting technology on crop production are scanty and less focused on adoption of wheat row planting and its intensity of usage. However, his study lack emphases on wheat row planting. Moreover, Worku and Yishak (2016) conducted study on factors influencing adoption of wheat row planting technology by using binary Logistic regression model, but they did not see level of use of wheat row planting.

To the best of the researcher’s knowledge though factors affecting adoption of use of wheat row planting technology were not assessed. To contribute to this knowledge gap, therefore, this study tried to analyze factors affecting adoption of use of row planting technology on wheat production.

1.3. Objective of the Study

The general objective of the study is to assess factors affecting adoption of Use of row planting technology on wheat production in the study area.

The specific objectives of the study include:

- To assess the level of adoption of row planting technology on wheat production in the study area.
- To identify determinants of adoption of use of row plant technology on wheat production in the study area.

1.4. Research Questions

A. What is the current level of adoption of row planting technology on wheat production in the study area?

B. What were the problems faced by the local people in the application of row planting on Wheat?

1.5. Significance of the Study

The application of new agricultural technology on the ground extremely depends on the farmers' adoption of technology. Therefore, the result of the study is believed to draw attention of policy-makers towards enhancing new technology adoption among smallholder farmers' and tries to provide adequate and reliable information to potential researchers, increase awareness of extension agents and others related development institutions which are aimed at improving agricultural production and productivity. This study will also intend to identify factors that influence farmer's decision on adoption of use of row planting technology on wheat production. It is also expected that development planners and policy makers would use as a base line in terms of designing development plan and formulation of policies.

1.6. Scope and Limitations of the Study

In technology adoption process, a factor which is found to enhance adoption of a particular technology in one locality at one time might be found to hinder adoption of the same technology in another locality at the same or different time. Therefore, it is difficult to identify universally defined factors either enhancing or hindering adoption of new agricultural technologies. This study was restricted to identifying factors affecting adoption of use of row planting technology on wheat production in Hagermariamna kesem district by collecting data from 147 respondents due to the limited time and money required to accomplish the thesis. The study also focuses only on representative sites in the district and considers wheat grower farmers in the area to collect substantial qualitative and quantitative information for the study.

1.7. Organization of the Study

This study was organized in to five chapters. The first chapter provides with an overview which attempts to address and achieve the end results. The second part presents related literature reviews in which previous studies and reports related to the agricultural technology adoption are reviewed. The third part illustrates the characteristics of the study area and also describes the methodological approach including sampling techniques, methods of data collection and tools used for the analysis of collected data .In the fourth part, the main findings of the study are discussed and finally, part five presents summary, conclusion and possible recommendations based on the results of the study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

In this chapter, a review of relevant literature on row planting technology, basic concepts and theoretical foundation of agricultural technology adoption, technological change and agricultural developments, paradigms on agricultural technology adoption, empirical reviews of previous agricultural technology adoption studies, Overview of agricultural technology adoption and conceptual frame work of technology adoption.

2.1. Row Planting Technology

Row planting technology involves the growing of plants on a plot of land with sufficient space between each of the plants so that they can develop their roots and shoots more fully. 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 mainly 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 needed moisture, aeration, nutrition, and light to the crop roots, as a result; helps faster growth of plants and productivity as well. It’s antonyms to the traditional broadcasting sowing method that contributes positively to the low crop yield. In general speaking, there are two main systems of wheat intensification (SWI) principles of crop production. Namely; principles of root development and intensive care. Principles of root development: For the sake of proper growth of crop plant, it must be well established from its rooting system. It's a fact that root development is the first stage of healthy growth 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. Principles of intensive care: Intensification, here is contrary to the high number of plant density per unit space meaning it's proper space maintenance and taking care of plants very closely. Finally, so as to increase wheat yield it needs intensive care in each stage plant development including management of weed, insect, disease, irrigation, and organic manure (Ram and Prashanta, 2011).Overall, a study made by Ram and Prashanta (2011) showed that wheat crop reacts positively to seed priming and row planting. Less plant population increased spacing (20cm * 8cm) is important for increasing the number of tillers per plant, plant height, and spike length as well.

2.1.1. Advantage and Disadvantage of Row Planting Technology

Row planting has a lot of advantage and preferred as it avoids uneven stands, improves tillering and creates enough spaces between rows for easy weeding and the elimination. It makes the farmers easer to identify off-type plants, decrease plant completions, lodging and immature tillers. Thus plants grow better and yield high quality seeds(MoA, 2016).Row planting had linearly increasing effect on the performance of individual plants as they draw more nutrients from surrounding and more solar radiation for better photosynthetic process which inter produces more effective tiller numbers and longer panicle length per each tillers than dense once. Row planting also has advantage in reducing the input seed consumption, controlling weeds, especially mechanical control by inter cultivation and management of the crop and maintaining optimum density of seedlings relative to the commonly used conventional and broadcast planting methods. Therefore, adopting row planting agricultural technology over wheat crop increases more yield of wheat as compared to the aforementioned commonly applied methods by smallholder farmers even in Ethiopia (Attaullalh et al., 2007).

As explained, the row planting has a lot of advantages; however it is tedious, time taking, needs qualified person/labor intensive and effort than broadcasting method of crop production. Row seeding of germinated seeds could also be done but it is practiced on limited scale because of its costs and difficulty in obtaining implements. However, broadcasting method has the advantage of being up to four times faster than row planting method and drilling and is of particular value for sowing large hectare of winter cereals. Broadcast method of planting is also less expensive and less time taking than row planting method of crop production (Hunt, 1999).

2.2. Basic Concepts and Theoretical Foundation of Technology Adoption

Agricultural technology plays an important role in economic development of one country by boosting the production and productivity of the sectors. Adoption and diffusion of these technologies are two interrelated concepts. Many researchers belonging to different disciplines have defined the two concepts in relation to their own fields. Adoption commonly refers to the decision to use a new technology or practice by farmers on a regular basis.

For instance, Feder et al.(1985) define adoption as the integration of an innovation into farmers' normal farming activities over an extended period of time. It is also noted that adoption, however, is not a permanent behavior. This implies that an individual may decide to discontinue the use of an innovation for a variety of personal, institutional, and social reasons. This is because there might be another practice that is relatively better in satisfying farmers' needs.

However, adoption does not necessarily follow the suggested stages from awareness to adoption; trial may not be always practiced by farmers to adopt new technology. Farmers may adopt the new technology by passing the trial stage.

In some cases, particularly with environmental innovations, farmers may hold awareness and knowledge but because of other factors affecting the decision making process, adoption may not occur (Ray, 2001).Furthermore, Bahadur and Siegfried (2004) defined adoption as a mental process through which an individual passes from hearing about an innovation to its adoption that follows awareness, interest, evaluation, trial, and adoption stages. It can be considered a variable representing behavioral changes that farmers under go in accepting new ideas and innovations in agriculture anticipating some positive impacts of those ideas and innovations. Dasgupta (1989) found that farmers often reject an innovation instead of adopting it; non adoption of an innovation does not necessarily mean rejection. Farmers are sometimes unable to adopt an innovation, even though they have mentally accepted it, because of economic and situational constraints.

With regard to the relationship of technological attributes with farmers' adoption decision, Rogers (1995) identified five characteristics of agricultural innovations, which are important in adoption studies. These include: relative advantage (the degree to which an innovation is perceived as better than the idea it supersedes), compatibility(the degree to which the farmer perceives an innovation to be consistent with his/her cultural values and beliefs, traditional management objectives, the existing level of technology and stages of development, complexity (the degree to which an innovation is perceived to be complex to understand and use by farmers, trial ability (the degree to which the innovation could easily be tried by farmer on his/her farm, and observability (the degree to which results of innovation are visible to farmers).

Adoption decision involves the choice of how much resource to be allocated to the new technology and the old technology if the technology is not divisible (like mechanization, irrigation). However, if the technology is divisible (like improved seed, fertilizer, row planting and herbicide), the decision process involves area allocation as well as intensity of use of the technology (Feder et al., 1982).Therefore, the process of adoption includes the simultaneous choice of whether to adopt or not to adopt and the intensity of use technology. Them measurement of intensity of use of agricultural technology needs to identify whether the technology is divisible or not. The intensity of use of divisible technologies can be measured at the individual level in a given period of time by the share of farm area under the new technology or quantity of input used per hectare in relation to the agricultural research recommendations (Feder et al.,1982).

On the other hand, the extent of adoption of non-divisible agricultural technologies such as tractors and combine harvesters at the farm level at a given period of time is dichotomous (uses or not use) and the aggregate measure becomes continuous. Aggregate adoption of a non-divisible technology can be measured by calculating the percentage of farmers using the new technology within a given period of time.

Diffusion often refers to spatial and temporal spread of the new technology among different users. Rogers (1983) define diffusion (aggregate adoption) as the process by which a technology is communicated through certain channels over time among the members of a social system. This definition recognize the following four elements:

(1) the technology that represents the new idea, practice, or object being diffused,

(2) communication channels which represent the way information about the new technology flows from change agents to final users or adopters,

(3) the time period over which a social system adopts a technology, and

(4) the social system.

2.3. Technological Change and Agricultural Development

Agricultural technology refers to innovations of new ideas, methods, practices or techniques of production that provide the means of achieving sustained increase in farm productivity (Abate, 1989). Despite various attempts to transform agriculture by the developing countries, the sector has still remained in its traditional state. The reason behind the conventional wisdom in the 1950s and early 1960s was to lay the blame for the non-adoption of improved technologies on the perceived rigid adherence of peasant producers to tradition, their ignorance and their lack of education (Rogers, 1969). The solution to the problem of low agricultural productivity was, therefore, conceptualized within a trickle-down transfer of technology framework. the low level of agricultural development is introverted policies followed by the governments of these countries over the years.

The conventional wisdom in the 1950s and early 1960s was to lay the blame for the non-adoption of improved technologies on the perceived rigid adherence of peasant producers to tradition, their ignorance and their lack of education (Rogers, 1969). The solution to the problem of low agricultural productivity was, therefore, conceptualized within a trickle-down transfer of technology framework.

Development strategies of the 1950s and early 1960s also gave priority to promote the industrial sector for which agriculture was neglected. The rapid population growth, on the one hand, and the widening gap between the demand for and the supply of food production, on the other, has brought an impetus for agriculture to receive increased attention in the late 1960s. Therefore, in order to reap the benefits that agriculture can provide to the mass of the rural poor in particular and to the national development at large, it was necessary to transform the traditional agriculture into a productive sector (Shultze, 1964) termed as "getting agriculture moving." Agricultural transformation, therefore, requires appropriate public policy intervention (Yotopoulos, 1967) so as to generate the surplus produce. One of the basic factors in the transformation of agriculture is technological change. Mosher and Barret (2006) emphasized that new technology adoption and diffusion alone is not enough to get agriculture moving and thus changes in the institutional, infrastructural, and cultural factors must occur in the process of transformation.

Most of the agricultural development assistance in the 1960s was predicated on the assumption that the wide agricultural productivity gap between the developed and the less developed countries could be attributed to the low level of technology application, by what were then perceived, as irrational tradition bound peasant farmers in the latter (Hayami and Ruttan, 1971). Agricultural development assistance in the 1960s and 1970s was therefore, conceptualized within a dualistic theory of development which perceived the solution to the problem of low agricultural productivity as depending on the direct transfer of modern agricultural technologies from the developed countries to the list developed countries. This approach, as encapsulated in the Green Revolution of the late 1960s and early 1970s, brought tremendous yield increases among many resource-rich farmers in Asia and Latin America (Chambers and Ghildyal, 1985).However, in most of Sub- Saharan Africa and some parts of Asia and Latin America, where millions of resource-poor farmers face harsh agro-ecological and institutional constraints different from those that characterize the research stations in which the innovations were developed, Green Revolution technologies were not only poorly adopted, but led to serious distributional and social consequences (Chambers and Ghildyal,1985).

The need for technology adoption in agriculture, besides increasing factors' efficiency, is to cope with natural hazards faced by the sector. Experiences of many countries showed that sizable proportion of agricultural technology is commodity specific (improved seeds and animal breeds) that are suited only for limited and usually most favorable ecological environments (Anderson, 2002). Therefore, areas with poor environments may not have a chance of adopting due to their poor response to the technologies in question. It can be deduced that technological change in agriculture, its diffusion and adoption can substantially induce growth to agricultural production. Agricultural research and extension are the basis for such a process to advance further.

2.4. Paradigms on Agricultural Technology Adoption

The literature on agricultural technology adoption is vast and somewhat difficult to summarize
compactly. A recent strand of literature focuses on social networks and learning .For instance,
Bandiera and Rasul (2006) looked at social networks and technology adoption in Northern Mozambique and found that the probability of adoption is higher amongst farmers who reported discussing about new technologies with others.

More recently, literature on agricultural technology adoption has also focused on the effect of social learning on adoption decisions. The basic motivation behind this literature is the idea that a farmer in a village observes the behavior of neighboring farmers, including their experimentation with new technology and then farmer updates his priors concerning the technology which may increase his probability of adopting the new technology in the subsequent year. Moreover, there are two important assumptions about the nature of social learning in this story. First, each farmer receives information on the outcomes of experiments from every other farmer in the village. Second, each farmer observes other farmers experiments with no loss of information. Applying this model to high yielding varieties (HYV) adoption in India, Foster and Rosenzweig (1995) found that initially farmers may not adopt a new technology because of imperfect knowledge about management of the new technology; however, adoption eventually occurs due to own experience and neighbors' experience. Overall evidence suggests that network effects are important for individual decisions, and that, in the particular context of agricultural innovations, farmers share information and learn from each other.

The introduction of a new technology consists of two phases. In the first phase, the new technology is introduced to farmers through for instance, demonstrations plots or other means and the new technology will be adopted when found beneficial. The second phase is characterized by declining use of the new technology over time until abandonment (Dinar and Yaron, 1992). Abandonment (discontinue use) of a new technology is a reflection of either a loss of profitability due to increasing costs of inputs, falling yields or the results of a switch to another more profitable technology. In the case of new improved seeds, abandonment is stopping the use of new variety any more. On the other hand, replacement of the existing improved variety with recently released new one is considered a continuation of use of the improved seed, because the new varieties are substitutes for each other. With this background, technology diffusion is presented next.

The concept of early and late adopters provided the basic hypothesis for explaining the S-shape nature of the adoption path. Studies by Mosher (1979), Rogers (1983), Mahajan and Peterson (1985), and Bera and Kelley (1990) provided explanations related to the process of acquiring information and the time lags that creates in terms of the speed of adoption among various members of the community in question to become adopters. In other words, the S-shaped curve results from the fact that only a few members of the social systems (farmers) adopt a new technology in the early stage of the diffusion process. At the early stages of introduction of a new technology, only few farmers obtain full information about the potential economic benefits of the technology and hence the adoption speed is slow.

Moreover, even if they get full information about the potential economic benefits of the technology at the early stage, most farmers fear the possible risks associated with the new technology and hence do not adopt. However, in subsequent time periods potential adopters acquire more information about the benefits of the technology and the degree of riskiness associated with it. Then adoption accelerates until it reaches an inflection point after which it increases gradually at a decreasing rate and begins to level off, ultimately reaching an upper ceiling. Studies by Griliches (1957) and Mansfield (1961) attributed the S-shaped diffusion curve to the spread of information as well as economic factors. Their studies showed that the rate of adoption of a technology is a function of the extent of economic merits (profitability) of the technology, the amount of investment required to adopt the technology and the degree of uncertainty associated with it and availability of the technology. Another study by Gutkind and Zilberman (1985) also revealed that the S-shaped diffusion curve can be explained by the profit maximization behavior, learning by doing and subjective evaluations of decision makers. The Gutkind and Zilberman's (1985).study also indicated that the tendency of large firms to be early adopters of new technologies explains the S-shape curve, based on the assumption that large farmers have advantages over smaller farmers in most of the determining factors listed above, e.g., better access to information, education, capital and credit. Theoretical and empirical adoption studies also investigated factors determining the long-run ceilings of the S-shaped diffusion curve. The long-run upper limit or ceiling of the S-shaped curve is determined by the economic characteristics of the new technology in the aggregate adoption. A study by Griliches (1980) showed that aggregate adoption ceiling is a function of economic variables (e.g. profitability) that determine the rate of acceptance of a technology. Differences in profitability of a technology in different regions result in different adoption ceilings.

2.5. Empirical Studies on Factors Affecting Technology Adoption

Agricultural technology adoption has long been of interest to social scientist because of its importance in increasing production and productivity of crops. In developing countries, adoption studies started about four decades ago following the Green Revolution in Asian countries. Since then, several studies have been undertaken in Asia and Latin America to assess the rate, intensity and determinants of adoption. Most of these studies focused on the Asian countries where the Green Revolution took place and was successful.

Doss et al. (2003) on their examination of the existing literature on technology adoption in Eastern Africa had reported that depending on the location of the study and the objective, it is difficult to indicate one factor as a key determinant of the adoption of improved agricultural technologies. However, a wide range of economic, institutional and demographic aspects may influence farmers' decision to adopt new technologies (Johannes et al.,2010).Economic analysis of technology adoption has also sought to explain Technology adoption behavior in relation to household specific characteristics, household resource endowments, asymmetric information, risk and uncertainty, institutional related factors, availability of agricultural input, and poor infrastructure (Uaiene et al., 2009).

A more recent strand of literature has included social learning and networks in the categories of factors influencing agricultural technology adoption (Uaiene et al.,2009). Some other studies classify these factors into different categories. For instance, Akudugu et al. (2012) grouped the determinant of agricultural technology adoption into three categories namely; economic, social and institutional factors. Empirical literature indicates many categories for grouping determinants of agricultural technology adoption. However, there is no clear distinguishing feature between variables in each category. Categorization is done to suit the current technology being investigated, the location were the technology is used, and the researcher's preference, or even to suit client needs (Bonabana-Wabbi,2002). This study was reviewing the resent studies on factors determining adoption of agricultural technology by categorizing them into household specific factors, economic related factors, and institutional factors. Based on this classification a critical review was done on each factor (variables) how it affects agricultural technology adoption among farming households.

2.5.1. Household Specific Factors

Farmer age is plays an important role in the adoption of new Agricultural technologies. However, the effect of age on the adoption of new technology is somewhat ambiguous. On the one hand, some studies suggest that as farmers get older they become more conservative and less open to new ideas. On the other hand, it is also argued that they gain more experience and they are more able to evaluate the benefits of new technologies (Johannes et al., 2010).The effect is thought to stem from accumulated knowledge and experience of farming systems obtained from years of observation and experimenting with various technologies.

Contrary to this, age has also been found to be negatively correlated with adoption decisions. Berihun et al. (2014) have reported that age was negatively affecting adoption of new technologies. Older farmers, perhaps because of investing several years in a particular practice, may not want to jeopardize it by trying out a completely new method. Similarly, farmers' perception that technology development and the subsequent benefits, require a lot of time to realize, can reduce their interest in the new technology because of farmers' advanced age, and the possibility of not living long enough to enjoy it (Caswell et al., 2001).Moreover, Tolosa (2014) on his study on factors limiting adoption of wheat row planting technology in Ethiopia and Hailu (2008) reported that as age increases, farm households would become reluctant and conservative in adopting new technologies and do prefer their indigenous one.

Another factor that affects agricultural technology adoption in developing country is sex of household head. It has been investigated for a long time in agricultural production and technology adoption. Most study show mixed evidence regarding the different roles men and women play in technology adoption. For instance, Solomon et al. (2014) on their study found that Sex has positive effect on the adoption of fertilizer and improved seed variety in Ethiopia. Another study by Gilbert et al. (2002) had shown a positive significant effect of sex on fertilizer use in Malawi. They explained that in their study district, letting females to be a household head is not yet well developed and recognized. Consequently, female headed households mostly are those who are widowed and divorced. In such instances, beside the cultural factors, their probability of adopting new agricultural technology becomes negligible.

The observed patterns of technology adoption are also typically influenced by Education level of household heads. Education is thought to create a favorable mental attitude for the acceptance of new practices especially of information-intensive and management-intensive practices and reduce the amount of complexity perceived in a technology adoption and increase. Technology adoption (Caswell et al.,2001). For instance, Wangare (2007) and Yonas (2014) studded on impact of row planting of wheat crop on rural household income in Ethiopia and Alene et al. (2000)on adoption and intensity of use of improved maize varieties in the central highlands of Ethiopia reported the positive effect of education on adoption. They explained that more educated farmers are able to access information on a given technology and understand and asses the attributes of that technology compared to non educated farmers. Similarly, Mohammed and Lakew (2013), Leake and Adam (2015), Abrhaley (2016) and Tolosa et al. (2014) reported the positive influence of farmer's education on technology adoption. They explained that farmers with higher education level can easily process information and search for appropriate technologies to alleviate their production constraints. Contrary to this, Hailu (2008) found that education had negative impact on the adoption of amount of fertilizer applied on wheat production. He explained that farmer may be attributed to the fact that while educated farmers are more willing to adopt new innovation they have less access to cash and assets as ownership of livestock. This limits their ability to purchase inputs and hence apply lower rates than the less willing to adopt but wealthier farmers. Similarly, Uematsu and Mishra (2010) reported a negative influence of formal education on adoption of improved crop varieties.

Another important factor which affects agricultural technology adoption is labor. The effect of labor availability on technology adoption differs depending on whether the area targeted with the technology has a net labor shortage or net labor surplus or whether the proposed technology is labor-saving or labor-intensive. Higher labor supply is associated with higher rates of adoption of labor-intensive technologies.

On the other hand, the dual nature of off-farm labor possibilities but can also reduce the availability of labor and thereby decrease the likelihood of adopting high-labor technologies (Lee et al.,2001). Labor bottlenecks, resulting from higher labor requirements that new technologies often introduce, and seasonal peaks that may overlap with other agricultural activities, are also another important constraints to technology adoption (Meinzen-Dick et al., 2002). Tadele (2016), Abrhaley (2016) and Yonas (2014) were reported that, probability of farmers to adopt and the level of adoption of row planting technology are positively affected by family labor. They explained that, row planting technology is labor intensive and hence the household with relatively high labor availability uses the technologies on their farm plots better than others. Similarly, Hailu (2008), Motuma et al.(2010) and Leake and Adam (2015) on their study in Ethiopia found that adoption of improved wheat technology positively influenced by the family labor. They argued that farmers who have more family labor can supply the required labor for different operations and undertake the agricultural activity in time and effectively manage the wheat fields.

Farmers' perception towards technology characteristics were also very important explanatory variables that are usually omitted in most of agricultural technology adoption studies. Few studies have revealed the importance of such variables in explaining technologies adoption. For example, Ermias (2013) in his study on adoption of improved sorghum varieties and farmers' varietal trait preference in Ethiopia found positive and significant effect of perception on adoption and intensity of use of improved sorghum varieties. He explained that farmers are more responsive in adopting new technologies if they perceive those new technologies as compared to the existing one gives better results. Similarly, Kwame and Bhavani (2014) reported that the intensity of use of soil and water conservation practices and perception of soil fertility are positively and significantly correlated. Moreover, Timu et al. (2012) confirmed that improved sorghum varieties in Kenya had desirable production and marketing attributes while the local varieties were perceived to have the best consumption attributes.2.5.2. Institutional Factors

The major option for increased adoption of technology is to overcome the income/ capital constraint through increased credit provision (Mkandawire, 1993).Access to credit takes cognizance of farmers' access to sources of credit to finance the expenses relating to the adoption of new innovations.

Similarly, Namwata et al. (2010), Leake and Adam (2015), Akinola et al.(2010), Frank et al.(2016) and Beyan (2016) where reported the positive influence of credit availability on technology adoption. The explanation they put for this could be that the availability of credit enables households to pay for external hired labor and other expenses incurred in the process of technology adoption. In addition, Hailu (2008) studded on adoption and intensity of use of improved technology in Ethiopia and Simtowe et al. (2016) studded on determinants of agricultural technology adoption under partial population awareness, the case of pigeon pea in Malawi were also reported positive influence of access to credit on technology adoption. They explained that with the availability of credit a household can purchase improved seed and hire extra labor and increase the propensity of adopting improved technologies. In contrast to this, Tolosa (2014) found a negatively influence of access to credit on technology adoption.

Extension service is very crucial institutional factor that differentiates adoption status among farmers. Studies suggest the likelihood that a farmer will continue using a new agricultural technology is related to the frequency of contact with trained extension workers, especially for technically complex technologies, contact with neighboring farmers who possess knowledge of the proposed technology also increases the likelihood of adoption (Andrei, 2011).Information reduces the uncertainty about a technology's performance hence may change individual's assessment from purely subjective to objective over time (Caswell et al.,2001). Exposure to information about new technologies as such significantly affects farmers' choices about it. Kapalasa (2014), Kwame and Bhavani (2014) and Ghimire et al. (2015) were reported that frequency of extension contact has positive influence on agricultural technology adoption. They explains that farmers with access to information through contacts with extension workers are the ones who are more likely to adopt improved practice than who are not got access to extension service.

Similarly, Chirwa (2005), Yonas (2014), Frank et al.(2016) and Kaliba et al. (2000) were reported a positive influence of extension contact on technology adoption. Tolosa et al.(2014) were also reported farmer access to improved seed through extension service significantly affect adoption of wheat row planting technology. The extension contact variable incorporates the information that the farmers obtain on their production activities on the importance and application of innovations through counseling and demonstrations by extension agents on a regular basis. Contrary to this, Mohammed and Lakew (2013) reported that access to extension service did not significantly correlate with the decision to adopt improved technologies. He argued that farmers have good knowledge about agricultural technologies through media and information from neighbors. Similarly, Solomon et al. (2015) on their study on measuring the effectiveness of extension innovations for out-scaling agricultural technologies found that frequency of extension contact has no significant effect on new technology adoption.

Availability of improved seed is also another important explanatory variable in influencing the adoption of new agricultural technologies. Some new agricultural technologies are not used alone to increase the production and productivity of crops. Improved seed is so important input which is used with many new agricultural technologies to increase the production and productivity of farmers. For instance, Ume and Ochiaka (2016) reported that input seed availability was positively affecting technology adoption. They explained that high cost, untimely and unavailability of inputs has profound effect on rejection of adoption of technologies by farmers.

Similarly, Tolesa (2014) and Tolesa et al. (2014) reported that availability and access to improved wheat seed have a positive effect on adoption of wheat row planting technology. They argued that availability of improved wheat seed had increased the probability of adoption and intensity of use of wheat row planting technology. This is because improved seed increase production at harvesting period when used with row planting technology than local seed. Ghimire et al. (2015), Laduber (2016) and Bayissa (2010) also reported the positive influence of availability of improved seed on technology adoption.

Belonging to an association or social group as member can influence farmer's decision to an improved technology. In most farming communities farmers form or join social group/associations of various kinds for all sorts of reasons. For instance, Franket al. (2016) and Mignouna et al.(2011) found that belonging to a social association/group enhances social capital allowing trust, idea and information exchange. Farmers within a social group learn from each other the benefits and usage of a new technology. Uaiene et al. (2009) suggests that social network effects are important for individual decisions and that in the particular context of agricultural innovations; farmers share information and learn from each other.

Martey et al. (2013) study on fertilizer adoption and use intensity among smallholder farmers in northern Ghana found positive influence of farmer membership to association on fertilizer adoption. They argued that farmer membership to an association let them to access inputs easily with an affordable price that is pertinent to increase agricultural production and thereby increase technology adoption. Similarly, Ghimire et al. (2015) and Abreham and Tewodros (2014) have reported that farmer's membership to social group/association has positive effect on adoption intensity of agricultural technology. They explained that farmers', who exposure to various information sources is able to analyze the risks, benefits and take advantage of new innovations.

2.5.2. Economic Related Factors

The use of new agricultural technology is directly or indirectly related with the level of income of the farm households. The direct relation is most of the time due to the better purchasing power of the higher income households and induces an improved access to technologies available.

Rich farmers are usually observed as the first movers to try new technologies and better risk taking behavior in technology uptake. In contrary, poor farmers are usually characterized by their slow movement towards trying new technologies. This is mainly due to fear to fail to harvest lower yield than basic required amount for their subsistence. Therefore, participation in off-farm activate is one of the mechanism by which farmer alleviate their income constraint because it is important in financing purchased farm inputs and hiring labor (Mwania et al., 1989).

Tadele (2016), Akinola et al. (2010) and Frank et al.(2016) were reported positive influence of off-farm activities on technology adoption decision of farm households. They argued that income from off-farm activity support farmers to easily afford agricultural input costs; and these farmers are mostly exposed to new and updated information since they move from one town to another and contacted with different people with different background. Contrary to this, Tolosa et al. (2014) reported that income from off-farm activity is negatively affected wheat row planting technology adoption. He explains that, farmer are not willing to use time and labor consuming technology.

Land size is perhaps the single most important resource, as it is a base for any economic activity especially in rural and agricultural sector. Farm size influences farmers' decision to use or generate new technologies and plays a critical role in adoption process of a new agricultural technology. Many researchers have analyzed farm size as one of important determinant of agricultural technology adoption. Some technologies are termed as scale-dependant because of the great importance of farm size in their adoption (Bonabana-Wabbi, 2002). Farmers with large farm size are likely to adopt a new technology as they can afford to devote part of their land to try new technology unlike those with less farm size (Uaiene et al., 2009).On the other hand, small farm size may provide an incentive to adopt some technologies or practices, especially in the case of an input-intensive innovation such as a labor-intensive or land-saving technologies. The impact of farm size on adoption and intensity of use of agricultural technologies on the other hand, is not consistently similar in various adoption studies. Some of the studies reported a positive influence of farm size on adoption decision. For instance, Tadele (2015) found positive effect of farm size on adoption of row planting technology in Walaita Sodo, Ethiopia. Similarly, Abreham and Tewodros (2014) reported a positive effect of cultivated farm size on adoption and intensity of use of new agricultural technology.

Moreover, Awotide et al. (2012) were also reported positive effect of farm size on technology adoption. Contrary to this, Hassen (2014), Ermias (2013) and Etwire et al.(2016) reported a negative influence of farm size on intensity of use of improved agricultural technology. They explained that farmers with small farm size use improved technologies more than large farm households and small farms are efficient as they intensify farm technologies and relatively better ratio of labor to land compared to large farms that may acquire labor at higher transaction costs. From the above in-depth review of previous adoption studies, it is evident that there is no consistency in the findings of the cited literature. However, the above-cited studies are indicative of which factors influence the agricultural technology adoption process.

2.6. Overview of agricultural technology adoption

Adoption process is the change that takes place within individual with regards to an innovation from the moment that they first become aware of the innovation to the final decision to use it or not (Ray, 2001).

Adoption is a mental process through which an individual passes from first knowledge of an innovation to the decision to adopt or reject and to confirmation of this decision (van den Ban and Hawkins, 1998). According to Feder et al. (1985) adoption refers to the decision to use a new technology, method, practice, etc by a farmer or consumer.

Dasgupta (1989) indicate that the decision to adopt an innovation is not normally a single instantaneous act, it involves a process. The adoption is a decision-making process, in which an individual goes through a number of mental stages before making a final decision to adopt an innovation. Decision-making process is the process through which an individual passes from first knowledge of an innovation, to forming an attitude toward an innovation, to a decision to adopt or reject, to implementation of new idea, and to confirmation of the decision (Ray, 2001).However, as emphasized by Ray (2001), adoption does not necessarily follow the suggested stages from awareness to adoption; trial may not always be practiced by farmers to adopt new technology. Farmers may adopt the new technology by passing the trial stage. In some cases, particularly with environmental innovations, farmers may hold awareness and knowledge but because of other factors affecting the decision making process, adoption does not occur (Ray, 2001).As indicated by Dasgupta (1989), adoption is not a permanent behavior. Consequently, an individual may decide to discontinue the use of an innovation for a variety of personal, institutional or social reasons one of which could be the availability of an idea or practices that is better in satisfying his or her needs (Ray, 2001).On the other hand, although farmers often reject an innovation instead of adopting it, non adoption of an innovation does not necessarily mean rejection. Farmers are sometimes unable to adopt an innovation, even though they have mentally accepted it, because of economic and situational constraints (Dasgupta, 1989).The rate of adoption is defined as the percentage of farmers who have adopted a given technology. Put it in a different way, the number of hectares planted with improved seed also tested as (the percentage of each farm planted to improved seed) or the amount of input applied per hectare represent the intensity of adoption of the respective technologies (Nkonya et al.,1997).According to Augustine and Mulugeta, (2005), the importance of adoption study is to quantify the number of technology users over time and to assess impacts or determine extension requirements that would help us in monitoring and feedback in technology generation. It also provides further insights into the effectiveness of technology transfer.

2.7. Conceptual Framework of Agricultural Technology Adoption

Adoption of new and improved agricultural technologies can only be effective when the right conditions for their successful implementation are in place. Farmers face many complex challenges in adoption and scaling out of agricultural and natural resource management technologies and practices (Shiferaw et al., 2009). Context specific empirical understanding of factors affecting household decision is important for promotion and scaling up of adoption of productivity enhancing technologies (Bewket, 2007).Researchers have argued that numerous factors can affect the farmer's decision to adopt agricultural technologies(Yu et al., 2010). Based on theoretical and empirical reviews of the literature on technology adoption various factors that influence technology adoption and intensity of use can be identified and grouped into the following four broad categories. (1) Factors related to farmers characteristics; (2) factors related to technological attributes; (3) factor related to institution and markets; and (4) economic related factors.

The factors related to the characteristics of farmers include sex, age, labor availability and literacy. Better endowment of human capital and active labor force in the family increases farmers' probability of adoption of new agricultural technologies because of investment capacity and the ability to take risks when experimenting with new technologies. Improved technologies have different labour requirements, hence labor endowment matters. For instance, higher labor supply is associated with adoption of labor-intensive technologies.

Literacy is also another important human capital that encourages farmers to experiment in new agricultural technologies, hence increase adoption of the technologies. The factors related to the attributes the technology include the individual's perception towards the new technology with respect to its relative advantage, compatibility, complexity, trainability and observability. Generally, technologies perceived positively by farmers are more likely to be adopted.
The institutional factors include credit uses, distance to the nearest market, and availability of improved seed, membership in social association, agricultural training and extension contact. The likelihood that a farmer will adopt and continue use an agricultural technology is related to the credit use, frequency of extension contact and participation in agricultural training, especially for technically complex technologies .Credit improves farmer's financial constraints for purchasing different agricultural inputs. In addition, Extension contact and training provides update information, technical skill and enhances farmers' awareness towards the new technologies, hence motivates them to adopt the technologies. New technologies often require repeated and consistent use of new inputs

such as improved seed that increase adoption of agricultural technologies. Moreover, Farmers who participated more in social association have better information about new technologies; hence raise their likelihood of adoption of the technologies.

Economic related factors include cultivated farm size, livestock ownership and off-farm income which their better endowment increase farmers' probability of adoption of new agricultural technologies because of investment capacity. Livestock ownership and off-farm activity improve farmer's financial capital for purchasing productivity enhancing inputs and allows farmers to invest in new technologies. On the other hand, farmers with large cultivated farm land are good candidates for investing in scale dependent technologies and also increase farmer's adoption and experimenting with risky or new technologies. However, practical experiences and observations of the reality have shown that one factor may enhance adoption of one technology in one specific area for certain period of time and may create hindrance for other locations. The direction and degree of impact of the factors are not uniform and the impact varies depending on the type of technology and conditions of areas where the technology is to be introduced. Because of this reason, it is difficult to develop a one and unified adoption model in technology adoption process for all specific locations.

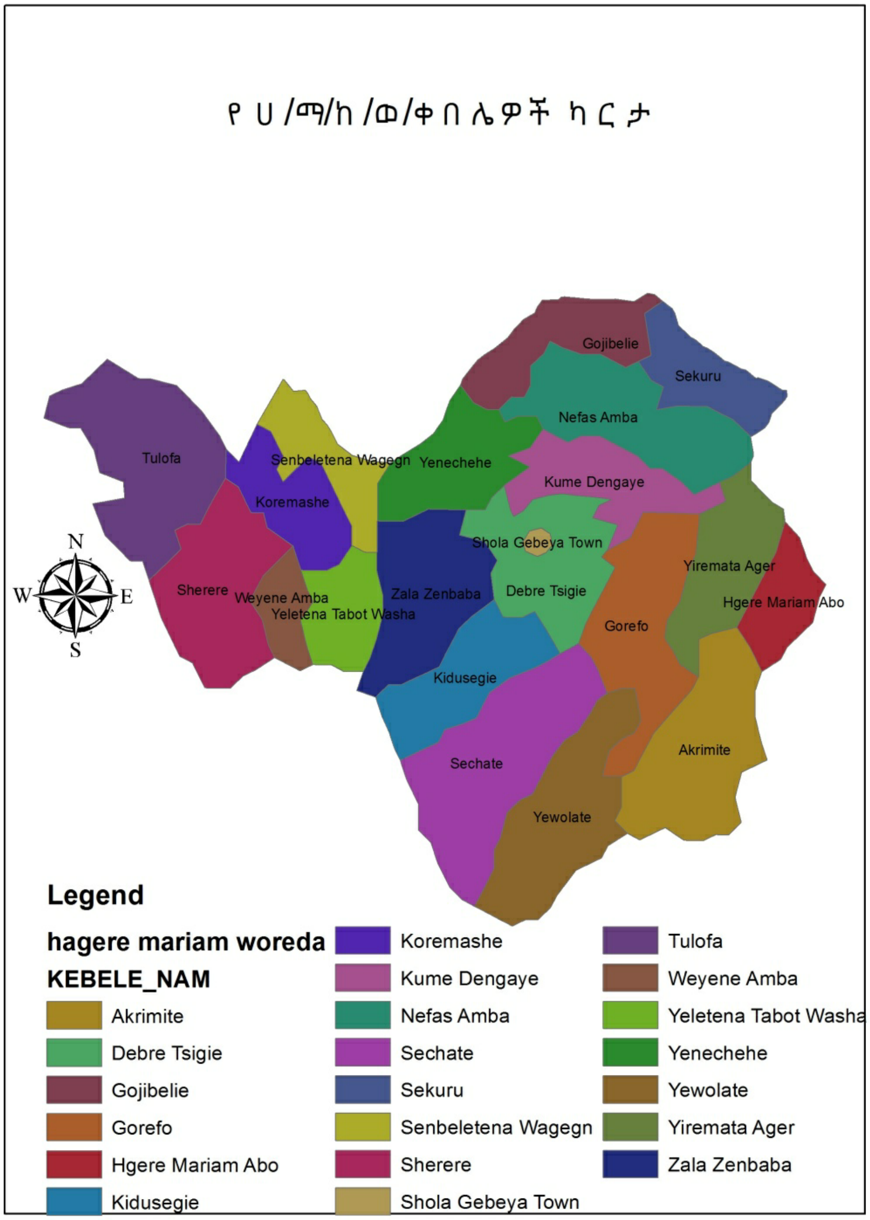
CHAPTER THREE

RESEARCH METHODOLOGY

This chapter starts with a brief description of the study area, Hagere Mariamna kesem district followed by sources and methods of data collected for the study.

3.1. Description of the Study Area

The research area, Hagere Mariamna kesem district, is one of the 24 districts of North Shewa Zone in Northern Ethiopia. The district is sub divided into 20 kebeles (small administrative units). Agriculture is the main stay of people in the district. Agro ecologically the Woreda (district) categorized into middle altitude (Woinadega) 38.87%, high altitude (Dega) 32.05%, lowland (kola) 14.18%, and frosty weather (wurech) 14.9%, it is suitable for diverse agricultural production. Crop and livestock production are the major sources of income in the district. The total area of the district is 67772.9 hectare and out of which the total 22780 hectare land is used for annual crop production, 2050.5 hectare is covered by permanent crops, 1828.36 hectare is covered by forest, and 4976.5 hectare is used for other purposes such as grazing. Out of 12871 total population, 9788 (76.05%) are male and remaining 3083 (23.95%) are females.



3.2. Sources and Methods of Data collection

The data for this study was collected from both primary and secondary sources. The primary data sources were the sample respondent households' heads, who have the dominant share in the decision of the selection and application of wheat row planting technology. On the other hand, the secondary data was collected from various secondary sources like Keble and Woreda Agricultural coordination offices. Primary data was collected with the help of survey by means of structured interview schedule for the quantitative data. Pre-test of interview schedule was made among the non respondent households. The qualitative data was obtained through organizing the focus group discussion session with the group members who are supposed to have clear insight about the row planting wheat technology and its local implementation.. Moreover, personal interview was conducted with the Woreda agricultural extension communication experts.

3.3. Sampling Technique and Sample Size Determination

The study employed three stages probability sampling procedures were used for sample selection. In the first case, select the study district which is the major wheat producing district within North shewa Zone is purposively select. There are strong research and extension intervention programs embracing wheat producers in the area. For this study newly release improved wheat technology and improved farming practices were relatively more disseminate and practice in this area. In the second stage, lists of major three wheat producing Keble within the district were obtained. In the 3rd stage, three wheat producing Keble were selected from the list of wheat producing Keble through simple random sampling technique. Then the adopters and non adopter households' list was prepared on a format before selected the sample households. Finally, systematic sampling technique was applied to select sample households from the select three rural Keble. The collected data were arranged into coding sheet and inserted into computer statistical software SPSS/PC and analyzed using appropriate statistical techniques. Accordingly, the number of respondents in each selected rural kebele was as shown in the Table1.The sample size was determined by following a formula developed by Yemane (1967). The formula is:

$$n = \frac{N}{1 + N(e^2)} = \frac{1325}{1 + 1325(0.08^2)} = 140$$

Where

n is the sample size for the study,

N is the population of interest which is 1325,

e is the precision level which is 0.08 in this study. The sample size from each kebles was determined based on their proportion to total share of households residing in each kebles and, adding 5% for a possibility of un-returned questionnaires, the sample size would be 147 (140+140x 0.05 = 147). Finally out of the total sample size (147), 80 respondents would be randomly selected from the total cultivators who are Adopter and the remaining sample respondents 67,would be randomly selected from those who non-adopter.

Table 1 Number of respondents from each selected Keble

Name of Kebeles	Number of wheat producer household heads		Selected number of respondents
	Male	Female	Number
Nefaseameba	390	105	52
Kumidenegaye	378	37	44
Debiretsege	339	76	44
Total	1107	218	140

Source: Keble offices of agriculture

3.4. Method of Data Analysis

Descriptive statistics such as frequency, percentages, mean, standard deviation, and inferential statistics such as chi-square test for dummy variables and F-test comparison for continuous/discrete variables were employed to assess the relationship of socio-economic, demographic and institutional variables, and technology characteristic related variables with farmer's adoption levels of wheat row planting.

3.4.1. Model Specification

One of the purposes of this study is to assess the factors that affect the adoption of row planting technology of wheat. The dependent variable in this case takes a dichotomous variable, which take a value of zero for non adopters' households and one for the adopters ones.

When one or more of the independent variables in a regression model are binary, we can represent them as dummy variables and proceed to analyze. Binary models assume that households belong to either of two alternatives and that depends on their characteristics. Thus, one purpose of a qualitative choice model is to determine the probability that a household who fall in one of either alternatives (in this study the alternatives were adoption and non adoption).

The Probit and Logit models are commonly used models in adoption studies. However, the probit probability model is associated with the cumulative normal probability function. Whereas, the Logit model assumes cumulative logistic probability distribution. The advantage of these models over the linear probability model is that the probabilities are bound between 0 and 1. Moreover, they best fit to the non-linear relationship between the probabilities and the independent variables; that is one which approaches zero at slower and slower rates as an independent variable (Xi) gets smaller and approaches one at slower and slower rates as Xi gets large (Train, 1986).

Usually a choice has to be made between Logit and Probit models, but the statistical similarities between the two models make such a choice difficult. Gujarati (1988) illustrated that the logistic and Probit formulation are quite comparable. It does not matter much which function is used except in the cases of where the data are concentrated in the tails following points. For this study the Logit model is selected, though both Logit and Probit models may give the same result. The logistic function is used because it represents a close approximation to the cumulative normal distribution and is simpler to work with. 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).

3.5. Definition of Variables and Hypothesis

Dependant variable: In the estimation of factors that affect farmer's decision on adoption of use of wheat row planting, the dependant variable used in the Logit model is the proportion of farm area covered by wheat row planting technology from the total cultivated wheat area which is a value ranges from 0 to 1 or from 0 %-100%.

Independent variables and hypothesized relationship: The variables that tend to explain a given dependent variable are said to be explanatory or independent variables. The independent variables were identified from previous similar empirical studies and the nature of the study area. These variables are expected to affect farmer's adoption of use of wheat row planting and are defined as follows:

1. Age of a household head (HHAGE): Age is a continuous variable and measured in years. It's one of the factors that determine decision making of a person on the adoption of new agricultural technology. Older farmers may have more experience, resource, or authority that would allow them more possibilities for trying new technologies. On the other hand, it may be that young farmers are more likely to adopt new technologies, because they may have more schooling than older farmers and have been exposed to new ideas and hence more risk takers. It's also that, advanced aged household heads are more reluctant to accept new technology and agricultural production styles than younger household heads (Assefa and Gezahegn, 2010).Thus, in this study, age of household head was hypothesized to have negative relationship with adoption and intensity of use of row planting on wheat production.

2. Sex of household head (HHSEX): This variable was entered the model as dummy variable and expected to have a positive relationship with adoption and intensity of use of row planting technology on wheat production.sex is a biological nature of human being of maleness or femaleness of the head of the household and found to be one of the factors influencing adoption of new technologies. Due to many socio-cultural values and norms, males have freedom of mobility and participation in different extension programs and consequently have greater access to information. Therefore, it was hypothesized that male farmers' household head are more likely to adopt new technology than their counter parts(Mesfin, 2005).

3. Literacy (HHLITERACY): In this study, literacy were measured as dummy variable and expected to influence adoption and intensity of use of row planting technology on wheat production positively. It is often assumed that literate farmers are better able to process information and search for appropriate technologies to alleviate their production constraints. Nevertheless, it is significant to examine the role literacy plays in technology adoption decisions (row planting technology). Adoption correlates positively with literacy (Getahun *et al.*, 2000).

4. Credit use: This variable is treated as dummy variable. In this study, it was hypothesized to have positive relationship with adoption and intensity of use of row planting technology on wheat production. 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. Hence, the amount of credit received has direct relationship with the adoption of new agricultural technology.

6. Distance to the nearest market: It was continuous variable and measured by kilometers taken to arrive nearest market center from the respondent residency. As the farmers are closer to the market, the higher will be the chance of adopting agricultural technology because they do not have to travel long distance with their produce to sell hence incur no costs on transport unlike those that are far and have bulky and a lot of harvest. On the other hand, the furthest residence of farmers from nearest market is the higher cost of transportation, the limited access to inputs and the lower the output price and less access to information about the new agricultural technology than their counterparts. Therefore, distance from the nearest market center is hypothesized to influence negatively the farmers' decision to adopt improved agricultural technology

(Kabuli, 2005; and Namwata *et al.*, 2010). In this study, it was also expected to influence adoption and intensity of use of row planting technology on wheat production negatively.

7. Cultivated farm size: In this study, it's the amount of cultivated farm land operated in the survey year measured in hectare and is continuous variable. Farm land is a key factor of production in farming community. The large farm area implies more resource and greater capacity to invest in new technologies, purchase agricultural inputs and an increased readiness to take risk that may affect adoption of new agricultural technologies (Ellis, 1992). Some of the studies showed a positive influence of the farm size on adoption decision of farm households. For instance, Alene *et al.* (2000) studied determinants of adoption and intensity of use of improved maize varieties in the central highlands of Ethiopia found a significant positive effect of farm size on technology adoption. Therefore, the farmer who owns relatively more cultivated farm land was hypothesized to be more likely to adopt new technologies and expected to influence adoption and intensity of use of row planting on wheat production positively.

8. Participation in training: Training is one of the means by which farmers acquire new knowledge and skill on new agricultural technology provided for them and then increases the probability of adoption of new technology (wheat row planting). It was measured by the number of times the farmer has participated in training of wheat row planting in last three years. Participation in agricultural training influence farmers' adoption behavior of new agricultural technology and intensity of its usage positively (Belay, 2003). In this study, it was expected to affect adoption and intensity of use of row planting technology on wheat production positively.

Table 2: Summary of hypothesized independent variables and their expected signs

Independent variable	Variable description	Measurement	Expected Sign
Age of HH head	Age of the household head, measured in years.	Continuous	–

Sex of HH head	Sex of the household head, 0 for male and 1 for female.	Dummy	+
HH size	Number of household/family members who live under the same household	Continuous	+
Education level	Education level of the head of the household	Continuous	+
Farmland size	Size of crop land, measured in hectares	Continuous	-
Oxen ownership	Number of oxen the household owned, measured in number	Continuous	+
Extension Contact	Number of DA visit in a year	Continuous	+
Agricultural training	Attending the modular skill training at FTC,0= participants, 1=non participants	Dummy	+
Credit use	use of the credit 1=Yes 2= No	Dummy	+
Fertilizer Application	Application of fertilizer 1= yes 2= no	Dummy	+
Cultivated farm size	Cultivated farm land size in number	Continuous	_

Distance to the market	Distance to the nearest market in Kilometer	Continuous	_
Soil type	Soil type 0=no 1=yes	Dummy	+

CHAPTER FOUR

4. RESULT AND DISCUSSION

4.1. Descriptive Results

4.1.1. Household characteristics on technology adoption

From this study out of the total sample, male headed households' comprise79.6% while female headed households make the balance 20.4%. The data further revealed that 54.42% sampled households cultivated wheat row planting during the study year, reflecting a high degree of adoption of wheat row planting technology in the study area (Table 3).

Table **3**. Sex characteristics of respondents in technology adoption

Sex	Adopters		Non-adopters		Total	
	No	%	No	%	No	%

Male	63	42.86	54	36.73	117	79.6
Female	13	11.56	13	8.84	30	20.4
Total	80	54.42	67	45.58	147	100

Sources: own survey 2018, result

4.1.2. Descriptive statistics

According to descriptive analysis, some variations were observed between adopters and non-adopter of wheat row planting in terms of household demographic characteristics, socio-economic and institutional factors (Table 4 and 5). The two groups differ to some extent in their farm experience, level of education, farm size, access to credit, extension contact, sex, Market distance, Soil type and participation in training. The study revealed that adopters have better educational background than non adopters. In terms of farm experience, average farm experience of adopter was about 23.47 years while non-adopters comprise 20.3 years of farm experience. Average farm size of adopters' was more than non-adopters. The levels of significance for those significant variables include age is at 10% probability level whereas farm land size is at 5% significance level. The number of oxen, soil type and Family size available are significant at 1% level of significance. Family size in the study area is large with 8.3 persons per household having minimum value of 1 and maximum of 10 (Table 4).

Table 4. Descriptive statistics for continuous explanatory variables

Variables	Adopters (80)		Non-adopters(67)		Total sample(147)		t-value
	Mean	Stdvn	Mean	Stdvn.	Mean	Stdvn.	
Age	41.5	12.8	47.1	12.6	42.1	12.87	1.82*

Family size	4.97	2.0	3.65	1.63	4.389	1.96	2.837***
Experience	23.47	9.89	20.3	6.89	23.5	9.05	1.606 NS
Education	0.80	0.624	0.680	0.4	0.74	0.51	-0.384 NS
Oxen	3.3	2.2	2.7	1.6	3.1	2	2.54***
Farm size	6.14	3.82	3.62	3.664	5.02	3.944	2.308**
Market distance	8.32	17.7	8.9	17.9	8.3	17	-0.13NS
Extension contact	5.5	4.8	5.1	6.3	5.42	4.93	1.2NS

***, ** and * significance at 1%, 5% and 10% level source own survey result, 2018

The respondent farmers were recorded as adopters and non-adopters with the relationship of the explanatory dummy variables. There was no significant difference between adopters and non-adopters of wheat row planting technologies on the explanatory variables of sex, credit use and participation in training (Table 5).

Table 5. Descriptive analytical results for discrete explanatory variables

Variables	Adopters			Non-adopters		Total	Pearson	
	Category	No	%	No	%	No	%	χ^2
Sex	Male	63	42	54	36.73	117	79.6	0.002NS
	Female	17	11.56	13	8.84	30	20.4	
Credit	Yes	70	47.6	54	36.73	124	84.4	0.002NS
	No	10	6.8	13	8.84	23	15.6	

Participation in training	Yes	61	34.1	5	2.7	66	44.9	1.02NS
	No	19	54.8	62	8.4	81	55.1	

Source: Own survey, 2018. *** represents significant at 1% significance levels.

4.1.3. Sub plot level factors

Operated sub plots. sub plot characteristics which are non-significance on wheat row planting technology adoption are soil fertility, slope, depth and significance on wheat row planting technology adoption is soil type at 1% level. From the total observed subplots 84.4% is fertile and the balance is unfertile. Regarding soil fertility about 47.6% from the fertile and 8.84% from the unfertile soil was adopters. Similarly in relation to soil type about 68.02% of subplots were red and the balance was other type. About 54.4% of red soil and 0% of other soil types was adopters (Table 6).

Table 6.Sub plot level explanatory variables

Plot characteristics		Adopters %	Non adopters %	Total	Pearson χ^2
Soil fertility	Fertile	47.6	36.73	84.4	0.002NS
	Unfertile	6.8	8.84	15.6	
Soil type	Red	54.4	13.60	68.02	23.325***
	Others	0	47	31.98	
Soil depth	Deep	32.62	44.51	70.13	0.01NS
	Shallow	3.9	18.97	29.87	
Soil slope	Flat	19.43	10.10	16.60	0.57NS
	Sloppy	17.12	51.30	83.40	

*** Level of significant at 1%

Source: own survey, 2018

4.2. The model result on determinants of adoption of wheat row planting technology

Before entering the variables in to the model, the multicollinearity problems were checked in terms of Variance Inflation Factor (VIF) for continuous and contingency coefficients for dummy and discrete variables respectively.

As a rule of the thumb, when the variables having VIF values less than the cut off value (10) are believed to have no multicollinearity problems and those with VIF of above 10 are assumed to have a multicollinearity problem. Therefore, since, in this study, the computational results of the VIF for continuous variables confirmed the non-existence of association between the variables and were included in the model.

Out of 13 independent variables which had been expected to be significantly related with the adoption status of wheat row planting technology, five variables were found statistically significant (Table 7).

Table 7: Logistic estimates of factors affecting the adoption of wheat row planting technology

Variables	Coefficients	S.E	Wald statistics	Odds ratio	Significance Level
Age HH	.277	.127	4.757	1.330	.057*
Sex HH	-2.113	1.832	1.330	.137	.24
Household size	5.243	2.536	4.274	.015	.039**
Farming experience	-.139	.131	1.126	.886	.290
Education level HHH	.262	1.323	.0392	1.138	.843
Cultivated Farm size	3.270	1.218	7.203	26.304	.007***
Oxen ownership	1.596	.556	8.227	.203	.004***
Extension contact	-2.201	1.825	1.851	.080	.160

Participation in Training	-.034	.52	.421	.967	.516
Fertilizer Application	-.162	.152	1.135	.879	.287
Credit Use	.705	.592	1.418	2.023	0.234
Soil type	2.353	.842	7.811	.0108	.005***
Distance to the market	.511	.596	.735	.596	.391

***, ** and * significance at 1%, 5% and 10% level source own survey result, 2018

Number of observation=147,

Probability > chi^2 = 0.000,

Log likelihood = -10.89 and

Pseudo R^2=0.8925.Source: own survey, 2018 analysis result.

4.3. **Discussion of the significant explanatory variables**

The logit model results used to study factors influencing adoption of wheat row planting technology in Table 7. Among the 13 variables used in the model, 5 variables were significant with respect to adoption of wheat row planting technology with less than 10% of the probability level. These variables include Age, family size, Cultivated Farm size, oxen ownership and Soil type whereas the rest 8 explanatory variables were found to have no significant influence on the adoption. The effect of the significant explanatory variables on adoption of wheat row planting technology in the study area is discussed below:

Soil type: Most of the respondents with red soil on their field plant wheat seeds through the application of row planting method for this Table 7, Soil type positively and significantly influenced the probability of adoption of wheat row planting technology at less than 1% significant level. The result of logit model in relation to this variable shows that farmers who have red Soil farm land wheat row planting technology are more likely to be adopter than those farmers who have other type of soil farm land. Other soils mostly have a great tendency sticking its particles which made it very difficult for human movement at time of work and it is very impossible to dig row lines in order to open furrows for the application of row planting. the odds ratio in favor of being adopter increase by a factor of .0108 when other factors remain constant.

Oxen Ownership: Oxen ownership positively influenced the probability of adoption of wheat row planting technology at less than 1% significance level. This result suggests that, those farmers who owned more oxen have better chance to adopt the technology than those who have owned small number of oxen. Wheat row planting technology requires a well-prepared soil and readymade ridges that fulfills the recommended row to row size. Therefore, farmers need to own at least more than one pair of oxen to prepare land. According to Worku (2016), the odds ratio for the number of oxen owned indicates that, the odds ratio in favor of adopting the wheat row planting technology increases by a factor of odds ratio the number of oxen increases by one unit.

Cultivated Farm size: The total farm size owned by the farm household affects adoption of wheat row planting technology positively at a significance level of 1%. Farmers having large farm size are more likely to adopt those improved technologies. This is due to the reason that farmers having large size of farm could manage their farm properly and could produce more product and quality standard wheat gain to the market. Other thing held constant, the odds ratio in favor of adopting wheat row planting technology increases by a factor of 26.304.

Household Size in AE was significant at less than 5% probability level and positive in explaining the household adoption status. This reveals that when household size increases, the probability of the household being adopter of the technology will increases. Other studies also indicated that if other factors are constant, an increase of a single adult equivalent increases households' likelihood of being adopter by a factor of .015. This indicates that the technology being labor intensive there by demanding more household labor(Worku *et al.*, 2016).

Age of household head: The age of the household head affects adoption of wheat row planting technology positively at a significance level of 10%. The role of age in explaining technology adoption is somewhat controversial. It is usually said that older farmers are assumed to have gained knowledge and experience over time and are better able to evaluate technology information than younger farmers (Mignouna *et al.,* 2011).

Contrary to this, as farmers grow older, there is an increase in risk aversion and a decreased interest in long term investment on new technology than the youngest one (Mauceri *et al.*, 2005). On the other hand, younger farmers are typically less risk-averse and are more willing to try new technologies

CHAPTER FIVE

5. SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1. Summary

This study assessed the current status of adoption of wheat row planting and identifies factors that determine farmers' decision on adoption of use of wheat row planting. A multi-stage sampling and proportional allocation techniques were used to obtain sample respondents. Thus, the study used a primary data collected through pretested structured interview schedule from randomly selected 147 sample respondents from purposive selected three *Kebeles* in Hagermariamna kesem district of North Shewa zone. Furthermore, secondary data from selected district, keble, published and unpublished sources were reviewed for this study purpose. The studies were used descriptive statistics, inferential statistics and econometric model (Logit model) for the data analyses. Inferential statistics were used to test the significant relationship between independent and dependent variable.VIF were also used to assess the existence of multi co-linearity problem among the independent variables. The result of descriptive analysis has shown that 54.42 % of sample respondents are adopters and 45.58% are non-adopters of wheat row planting during the survey year in study area. From 13 explanatory variables included in the logit model, five variables had shown significant relationship with adoption of use of wheat row planting. Accordingly, Age of household head, household size, Cultivated farm size, Oxen ownership and Soil type were found to have positive and significant influence on adoption of use of wheat row planting technology.

5.2. Conclusions

Wheat has assumed its importance as a major staple food crop in Ethiopian agriculture. Expansion in the production of wheat crop stimulated through technological change is expected to support higher calorie intake and improve households and national food security. It is understood that there is enormous potential for further productivity growth in wheat crop through the adoption of use of row planting technology which is important to meet the growing demand and food deficit particularly in Ethiopia specifically in the study area, hence reduce poverty and countries dependence on wheat import and then stimulates economic growth of the country. Regardless of its contribution, however, the emphasis given nationally to the sector is still relatively low compared to other food crops. As a result of this, institutional support service, several household personal, demographic and economic related factors affected the adoption of use of wheat row planting technologies and consequently production and productivity of the sector.

5.3. Recommendations

Based on the research findings, the following significant variables are recommended to improve farmers' adoption and of use of wheat row planting technology. The study find out that Oxen ownership affected significantly and related positively with the adoption of wheat row planting technology. The possession of more oxen assists the households in combating the shortfall of labor requirements from land preparation up to planting and sowing. On the other hand, family size and age of household head of the wheat row planting technology was strongly and positively related. Decisions and measures need to be implemented in order to make the technology labor extensive since the study area is known by its dense population; it is difficult to increase household size as a response against the new technology. Thus, this could be done through designing appropriate agricultural tools that assist. During sowing season in order to facilitate the adoption of wheat row planting technology. At last, the study had found Soil type as a key factor in determining the adoption of wheat row planting technology. Wheat row planting technology requires a well-prepared soil and readymade ridges that fulfills the recommended row to row size.

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