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Determinants of smallholder maize þÿFarmers row planting technol adoption in Alefa woreda, central Gondar, Ethiopia

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Determinants of smallholder maize Farmers' row planting technology adoption in Alefa woreda, central Gondar, Ethiopia

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Statement of Certification

This is to certify that SimegnewSetegneYilma has carried out his research proposal on the topic entitled "**Determinants of smallholder maize farmer's row planting technology adoption in Alefa woreda, central Gondar, Ethiopia**. The work is original in nature and is suitable for the submission for the reward of MSc Degree in Economics.

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Abbreviations' and Acronyms

ATA	Agricultural Transformation Agency
ADB	African Development Bank
ADLI	Agricultural Development Led Industrialization
BoARD	Bureau of Agriculture and Rural Development
CADDP	Comprehensive African Agriculture Development Program
CSA	Central Statistical Agency
EPRDF	Ethiopian Peoples' Revolutionary Democratic Front
GDP	Gross Domestic Product
GoE	Government of Ethiopia
GTP	Growth and Transformation Plan
ICARDA	International Center for Agricultural Research
LDCs	Least Developed Countries
MoFED	Ministry of Finance and Economic Development
NGOs	Non-governmental Organizations

Abstract

Ethiopian agriculture is characterized by small-scale farming and experiencing erratic rainfall as well as drought. The low produce can possibly grow through developing technology adoption and improved practices on the marginal land farms. This study, therefore, examines the determinant of row-planting technology adoption on smallholder farmer's maize production in Alefa woreda, Amara region using primary data source from a survey of a random sample of 386 smallholder farmers each. To deal with this, the researcher used both descriptive and econometric analyses as a tool.

In the econometric analysis part, the marginal effect revealed that variables like sex of the household head, education, active labour availability, size of cultivated land, access to credit, off-farm participation, were found to be significant and affects positively to smallholder farmer's adoption of both row-planting technologies. Access to Medias variables was also strongly affects row-planting technology positively.

The policies which expand the accessibility of credit service, dissemination of productive agricultural technology information, and creating opportunity of education for farm house hold has potential to increase the chance of row planting technology adoption decision and strengthen the level of adoption among smallholder farmers.

***Key words**: determinant, adoption, technology, row planting, maize, Alefa.*

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CHAPTER ONE: INTRODUCTION

1.1Background of the study

Maize provides food, feed and nutritional security in some of the world's poorest regions in Africa, Asia, and Latin America. Globally, 765 million metric tons (m t) of maize were harvested in 2010 from just under 153 million hectares (m ha). About 73 per cent of this area was located in the developing world, with again a predominant proportion of this area in the low and lower middle-income countries. The crop provides over 20% of total calories in human diets in 21 countries, and over 30% in 12 countries that are home to a total of more than 310 million people (Shiferaw et al. 2011). For 900 million farmers and consumers in low- and middle-income countries, maize is a preferred crop or food.

The growth in demand for human consumption of maize in the developing world is predicted to be 1.3% per annum until 2020. Moreover, rising incomes are expected to result in a doubling of consumption of meat across the developing world (Naylor et al. 2005), leading to a predicted growth in demand for feed maize of 2.9% per annum. However, the average maize yields in several of the developing countries, especially in sub-Saharan Africa, where maize is a highly important staple food crop, are still below 1 t/ha, while many countries have only 1-2 t/ha, due mainly to poor soil fertility, frequent occurrence of droughts, high incidence of insect-pests, diseases and weeds, farmers' limited access to fertilizer, and lack of access to improved maize seed (Shiferaw et al. 2011). The importance of improving maize production and productivity in the developing world could be gauged from the fact that one-third of all malnourished children are found in systems where maize is among the top three crops (Hyman et al. 2008). Asia's contribution to the worldwide harvested maize area as well as production has been significantly increasing.

The major maize producers in Asia are China and D.P.R. Korea in East Asia; Indonesia, Philippines, Vietnam and Thailand in Southeast Asia; India, Pakistan and Nepal in South Asia; and Turkey and Iran in West Asia. It is notable that eight major maize-producing countries in Asia – China, India, Indonesia, Nepal, Pakistan, Philippines, Thailand, and Vietnam – taken together, now produce 98% of Asia's maize and 26% of global maize (Erenstein, 2010); in all these countries, maize is predominantly grown under rainfed conditions by the smallholder, resource-poor farmers.

The maize scenario in Asia is unique compared to the rest of the world. Firstly, 70% of the total maize produced in Asia is used for feed purposes, 23% as food, and 7% for other uses. By contrast, in sub-Saharan Africa, maize is mainly a food crop accounting for 73% and 64% of the total demand in Eastern and Southern Africa (ESA) and Western and Central Africa (WCA), respectively (Shiferaw et al., 2011).

Although the maize feed, market is rapidly growing, especially in countries such as China, India and Indonesia, maize is still an important staple food in many countries/areas in Asia, especially in the hills and tribal regions of Nepal, Bhutan, and India. Secondly, in terms of grain preference, unlike sub-Saharan Africa where white maize plays a highly dominant role as food, in almost all the Asian maize-growing countries, the demand is mostly for yellow maize. Despite these differences, the resource-poor maize farmers in Asia face many challenges that are shared by smallholders in sub- Saharan Africa and Latin America; among many, these include poor purchasing capacity, an array of a biotic and biotic stresses, poor soil fertility, and limited access to quality seed (particularly in the non-commercial maize belts.

The Growing Demand

During 2003-08, maize production increased annually by 6.0% in Asia, as compared to 5.0% in Latin America, and 2.3% in sub-Saharan Africa (FAOSTAT, 2010). However, between now and 2050, the demand for maize in the developing world will double, and by 2025 maize will have to become the crop with the highest production in the developing world (Rosegrant et al., 2009). This has particular implications to Asia, where an array of factors is contributing to a sharply increasing demand for maize, including the growth rate of per capita GDP (gross domestic product), changing diets, and a significant rise in feed use that is driven largely by the strongly growing poultry sector. Maize used for feed in the seven major Asian countries. has more than tripled from 29 m t in 1980 to 109 m t in 2000 (Wada et al. 2008).China's rapid economic growth, coupled with the booming maize feed and processing demand, has the potential to transform the global maize scenario. In 2010, China's maize area in 2010 (31.5 m ha) was quite comparable to that of USA (32.89 m ha). During the past four decades, China registered an impressive 3.4% annual average growth rate in maize yields, and by 2002 had become the world's second leading exporter of maize, after the USA (Dixon et al. 2008; Wada et al. 2008). However, China recently started to import maize, and to date has imported about 1 million metric tons of maize. Indonesia, the third biggest maize growing country in Asia, imported 1.1 million metric tons of maize in 2010.

Although predictions vary considerably in magnitude, there seems to be little doubt that the rate of increased demand will soon out-pace the rate of increased maize production in Asia, and that China, Japan, South Korea, Malaysia, Philippines and Thailand may import substantial amounts by 2025 (Gerpacio and Pingali 2007; Falcon 2008).Both the area and production of maize in India have grown significantly in the past few decades. Maize grain production has increased from about 7 million tons in 1980/81 to about 21 million tons in 2010/11.

The impressive growth of maize in India has been largely driven by the increasing demand for maize grain as feed for the rapidly expanding poultry industry (Hellin and Erenstein 2009).

The adoption of maize in non-traditional areas, the strong role of the private sector in the maize seed industry, and the development and delivery of higher-yielding, single cross hybrids, are some of the major factors behind this.

Annual growth rates for production have been recorded as 1.9%, 3.3% and 5.3% for the decades 1980–1990, 1990– 2000, 2000–2010, respectively. While growth in the first two decades (1980-2000) was driven mainly by the yield increases due to improved adoption of high-yielding cultivars, area expansion had constituted more than half the growth over the past decade (DAC 2010).

Simultaneous with these trends, maize prices have more than doubled over the past ten years, along with prices of other commodities, with consequent implications to maize dependent countries and consumers in the developing world. What happens in the rest of the world, especially in the USA, which is the largest producer and exporter of maize, affects the maize prices worldwide. Since prices are largely influenced by supply-and-demand, world maize prices are largely dependent not only on the weather in the US Corn Belt, but also the pattern of maize use (40 percent of maize produced in US is used for producing ethanol).

Challenges to Maize Production

Despite the impressive growth in the last decade, the average maize yields in many of the Asian countries still remain low vis-à-vis the world average of 5.02 t/ha in 2010.Countries with sizable maize area but with less than 3 t/ha yields include India, Indonesia, Philippines, Pakistan and Nepal, while Vietnam and Thailand have registered maize yields in the range of 4-5 t/ha in 2010. China recorded an average yield of 5.33 t/ha in 2010. Although maize is grown in almost every province in China, approximately two-thirds of the maize in China is grown in temperate, high-potential production environments in the north, and the rest is grown in the subtropical and tropical environments of the south.

Drought is recognized as the most important constraint across the rainfed lowland and upland environments, covering about 70% of the maize production area in Asia. This situation is likely to exacerbate in the coming decades due to climate change, often leading to inadequate and/or uneven incidence of rainfall in the crop season alongside temperature changes (IPCC 2007). Alleviating the effects of drought alone could increase average maize yields by 35% across Asia-7 (excluding China), and by 28% in Southwest China (Gerpacio and Pingali 2007). At the same time, over 18% of the total maize production area in South and Southeast Asia is frequently affected by floods and water logging problems, causing production losses of 25– 30 % annually (Zaidi et al. 2010).

By the end of this century, growing season temperatures will exceed the extreme seasonal temperatures recorded in the past century (Battisti and Naylor 2009). Recent analysis of more than 20,000 historical in humidity also potentially affects the diversity and responsiveness of pathogens and insect-pests, and could lead to new and perhaps unpredictable epidemiologist

(Gregory et al. 2009). For example, GLS is now becoming an important disease globally, with high incidences reported in Nepal, China, Bhutan, Colombia, Mexico, Brazil and several countries in Africa.

Poor soil fertility (including micronutrient deficiencies) and low nutrient use efficiency also rank among the most important factors limiting crop productivity and yield stability in both high potential–low risk environments as well as low potential–high risk environments. A common concern is imbalanced fertilizer use (i.e., very high use of N, less use of P, and negligible use of

K, S, and micronutrients), which is particularly prevalent in the rice maize systems that are distributed all over South Asia, but more so in Bangladesh, India, Nepal, and Pakistan (Timsina et al. 2010). Obviously, genetics and breeding alone cannot solve the complex challenge of enhancing productivity in smallholder farms.

There is a distinct need for effective complementation of improved maize cultivars by suitable conservation agriculture practices. Availability of equipment for direct seeding or minimal tillage operations is a constraint that needs to be addressed in developing locally relevant options for conservation agriculture. In addition, agronomists and geneticists/breeders have to work in tandem to identify cultivars that respond best to such practices, and for generating better understanding of the complex interactions between genotype x environment x management practices.

Much has to be achieved also in terms of institutional and policy innovations that support maize growth and development in Asia. Also, an integrated approach that links the biophysical and the socioeconomic work is essential for success in improving productivity of maize and in enhancing adaptation to changing climate (Shiferaw et al. 2011). This includes understanding the smallholder farmers' affordability and access to quality seed, constraints in adoption of high-yielding, stress resilient and nutritionally enriched maize varieties, and partnerships and policies to significantly enhance seed production and distribution. Maize trial yields in Africa over an eight-year period, combined with weather data, showed that for every degree day above 30°C, maize grain yield was reduced by 1% and 1.7 % under optimal rainfed and drought conditions, respectively (Lobell et al. 2011). High temperature stress and drought are likely to aggravate in northern China (Piao et al. 2010) as well as in many tropical maize growing areas, especially in South and Southeast Asia. Spring maize is an important option for intensifying and diversifying cropping systems in South Asia, but is prone to severe heat stress during flowering/early grain filling stages, particularly in the upper and middle Indo-Gang tic plains. This highlights the importance of developing maize germplasm with tolerance to both drought and high temperature stress. Biotic stresses that that have widespread effects in Asia include the downy mildews, post-flowering stalk rots (PFSR), grey leaf spot (GLS), banded leaf and sheath blight (BLSB), turcicum leaf blight (TLB), ear rots, mycotoxins, stem borers and weevils.

Agriculture is the mainstay of the Ethiopian economy, contributing 41.4% of the country's Gross Domestic productGDP), provides 70% of the country's raw material 83.9% of the total exports and 80% of all employment in the country (Matousa,Todoc and Mojoc2016).Put in perspective, Ethiopia's key agricultural sector has grown at annual rate of about 10% over the past decade much faster than population growth(Matousa,Todoc and Mojoc2016).

Most of the Ethiopian population, residing in the rural area is engaged in agriculture as a major means of livelihood. However the agricultural productivity is low due to use of low level of agricultural technologies, risks associated with weather conditions. Moreover due to the ever increasing population pressure, the landholding per household is declining leading to low level of production to meet the consumption requirement of the households (Bezabih and Hadera, 2015).

There are different pathways that help to escape out of poverty such as intensification of smallholderagriculture, commercialization, diversification, migration and urbanization and technology adoption. The pathway to escape outof poverty trap in Ethiopia depends on the growth of the agricultural sector since agriculture isthe mainstay of the country's economy and drive the livelihood of the majority of the poor. Yield enhancing technical options should be there to achieve agricultural growth anddevelopment because withoutimproved agricultural technologies it is no longer possible tomeet the needs of increasing numbers of people by expanding areas under cultivation (Menaleet al., 2015).
Agricultural production can be increased through extensification (i.e. through expansion of farmlands) or intensification (i.e. by using more inputs and technologies per unit of land). However,extensification is not a viable strategy to increase agricultural production in most of the foodinsecure countries where high population pressure is a critical bottleneck.Where there is scarcity of land, intensification, which is mainly investments in modern inputs and technologies, is a better option toincrease agricultural production and reduce food insecurity. This option was implemented by several Asian countries in 1970s and was dubbed the "green revolution" (Menaleet al., 2014).

New agricultural technologies and improved practices play a vital role in increasing agriculturalproduction (and hence improving national food security) in developing countries, Wheresuccessful adoption of improved agricultural technologies could stimulate overall economic growth through intersectoral linkages while conserving natural resources (Abdulai, 2016, Sanchez, et al 2015). Given the close link between food insecurity, farming and environmentaldegradation the impact of cultivation practices has received significant attention in the last twodecades. New cultivation techniques have been introduced in many countries to enhanceproductivity in the agriculture sector.

Although agriculture is one of Ethiopia`s most promising resource, the sector has been slowed down by periodic drought, high level of taxation and poor infrastructure that often make it hard and expensive to get goods to market. Also overgrazing, deforestation and high population density has led to massive soil degradation leading to low productivity (SIDA, 2015).

The agricultural production system in Ethiopia is highly dominated by traditional farming and the application of modern inputs has been extremely limited.

Agriculture in Ethiopia had not been open to outside information due to many factors and consequently, its technological progress has been restrained for a long time. It is a fact beyond dispute that technology can play an important role in increasing production, income and efficient use of resources for the economic development of the country (Tsegaye, 2003). As Habtemariam, (2004) stated a thriving agricultural economy is critical for reducing poverty, ensuring food security and managing natural resources, and to this effect, agricultural extension is expected to play an accelerator role.

In view of this the government of Ethiopia in an attempt to increase agricultural productivity and improved food security at both national and household level, efforts has been underway to generate and disseminate improved agricultural technologies among the small holder farmers. Over the past two decades, on-farm trials, demonstration and popularization of improved maize production technologies and enhance their adoption (Legesseet al.2005; Million and Asnake, 2011).So far many improved maize technologies have been released to increase maize production and productivity. However, due to various reasons the adoption of improved technologies is low. Some of the previous studies indicated that demographic, socioeconomic, institutional and infrastructure access factors, attitude towards the technology and communication condition of the household were significantly related to adoption and intensity of adoption of improved agricultural technologies (Almaw, 2008; Hassen2013 Akinobode and Bamore; 2015).

After the Ethiopian peoples' revolutionary democratic front /E.P.R.D.F./led-government come to power in 1991 the economic management of the country was transformed from a command economic system into market-led systems and the subsequent structural adjustment programs have had brought the effect of reversing the collapse and healing of the overall economic status of the country (Freduet al,2011).To alleviate that severe poverty government of Ethiopia (GoE) designed, introduced, and implemented the famous Agricultural Development Led Industrialization (ADLI) strategy since 1991 (Lulitet al., 2012). As part of that GoE has introduced different new agricultural technologies for adoption in its policy and strategies to boost the sector such as integrated seed sector development Ethiopia (ISSD) to supply improved maize seed to move up agricultural production and productivity of smallholder farmer's.

Although the use of new agricultural technologies on the agricultural sector plays a vital role in reducing poverty,achievement of the intended plan in enhancing produce using new technologies is not yet met.

Having all these in to consideration, the researcher aims mainly to examine Determinants of smallholder maize farmer's row planting technology adoption in alefa woreda, central Gondar, Ethiopia. Even though many efforts have been conducted to popularize and disseminate improved maize technologies among farmers of Alefaworeda, the adoption of improved technologies are not impressive. Why farmers are resisting to adoptimproved maize technologies is a big question so far not answered with substantial evidence for the study area. This study is proposed with the objective of analyzing Determinants of smallholder maize farmer's row planting technology adoption in alefa woreda, central Gondar, Ethiopia.

1.2. Statement of the Problem

Maize is the most staple and strategic crop in Ethiopia followed by teff and sorghum (Zerihun, 2014).Maize is Ethiopia's leading cereal in terms of production, with 6 million tons produced in 2012 by 9 million farmers across 2 million hectares of land (CSA 2011/2012).Over half of all Ethiopian farmers grow maize, mostly for subsistence, with 75 % of all maize produced being consumed by the farming household.

Currently, maize is the cheapest source of calorie intake in Ethiopia, providing 20.6 % of per capita calorie intake nationally (IFPRI, 2010). Maize is thus an important crop for overall food security. Maize is also used for making local beverages. Currently, 24-quintal per hectare is the national average yield of maize 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, 2018).Whereasin China average yield of maize is about 40 to 60 quintal per hectare (Lester, 2016). Likewise, in Western Europe maize yield ranges from 60 to 80 quintal per hectare (Ibid). Likewise, maize is given due emphasis to increase its production among other cereals in Amhara Region. Its area coverage isaround 0.1million hectares and produce 1.93 million quintals of maize per annum from the totalcultivated land of 1.04 million hectares in the region (Ibrahim and Fetien, 2014). Around 45% of the regional total maize production and 46.3% of maize area coverage has found from the northpart of Amhara (as cited in Bekeleet al., 2012). The current average maize yield in Amarais estimated 35 to 40 quintal per hectare in 2016 production year. Some Amarasmallholderfarmers are obtained and have registered more than 60 quintal per hectare maize yield when therainy season is longer or from July into mid-September (ibid).Shahidu(2015) noted that more than 60 percent of the total calorie diet is covered fromfour staple cereals (maize, "Teff", maize, and sorghum) produced by the small scale farmhouseholds in Ethiopia.

To stimulate the overall economic growththrough inter sector linkages while conserving natural resources is possible through successfuladoption of improved agricultural technologies done over developing countries (Abdulai, 2015).However, agricultural production in Ethiopia still is under traditional farming methods. Enhancing the productivity of agriculture in general and crops in particular is indispensable at the country level and Amara region as well. To improve thetraditional agricultural practice, the Ethiopian government has been made utmost efforts via dissemination of improved agricultural technologies like row-planting and improved seed to farmers (Tsegaye and Bekele, 2012).

The result of recent studies prove that modern planting method give better output than most commonly practiced traditional methods, such as conventional and broadcasting. Consequently, in order to get higher grain of maize yield row planting method is advised (Attaullahet al., 2017). Mishra et al.(2011) explained that maximum crop yield is obtained from row planting method as compared to broadcasting. Appropriate supplies and adoption of improved seeds andplanting methods are also positively associated to high crop yields (CAADP, 2012). Row plantingmethod had significant maize output increment than broadcasting (Mohammad et al., 2016).Lower technology adoption on agriculture is the main reason behind the poorperformance of the sector in Ethiopia (Lulitet al., 2015).

During the year 2019/2020 croppingseason Alefa woreda has planned to familarize8244 farmers inrow planting to produce maize.but only 6805 farmers were adopted row planting technology. Inaddition,the woreda had planned to introduce200 quintal of improved seed but only 112 quintal of improved seed was adopted by local farmers (Alefaworeda agricultural office,2019).

Given the aboveempirical and theoretical explanations of high yielding agricultural technologies, the determinants of row-planting technology adoption on maize production using advanced econometric model has scarcely examined in the maizebelt study area.Therefore, this study was designed to identify demographic, institutional and socio-economic factors that determine households decision to adopt raw planting technology on their maize production in Alefa woreda.

1.3Research questions

The following research questions have been designed to analyze the stated problem.

- What are the determinant factors that affect row-planting technology adoption of small holder maize producers in Alefa woreda?
- What are the current farming practices and major potential and constraints in farmer`s maize production practices?

1.4 Objectives of the study

The general objective of this study is to access the Determinant factors as well as to access farming practice of agricultural technology adoption of smallholderfarmer's on maize production. Based on the general objective, the following specific objectives have been designed.

- To investigate the determinantsof adoption of new technology of maizeproducers of smallholderfarms' in Alefaworeda.
- To assess current farming practices and
- To synthesize major potential and constraints in farmer`s maize production practices.

1.5 Scope of the study

Even if there are many agricultural technologies available, the study is limited only to evaluate the determinant of row-planting technology adoption on maize production in Alefa woreda, Central Gondar, Ethiopia in the production year 2019/20. The study covers the farmers who are organized by clusters in a five ketenas.other kebeles under the woreda administration are not part of this study due to differences in their cereal production type and lack of time and resources to collect data.

1.6 Limitations of the study

Since the information is gathered through structured survey questionnaire, the quality of the information depends on the knowledge and recalling capacity of respondents. Furthermore, some respondents may also be reluctant to give the correct response for some sensitive variables.in addition to the above problem theoccuance of CORONA virus as well as current social and political conditions of the area may be the problem to gather information since the area is located in a conflict areas .However, maximum efforts is made to gather reliable information by convincing farm households about the objectives of the study.

1.7 Significance of the Study

This study contributes and fills the literature gap on the determinants of row-planting technology adoption on maize yield over small-scale households since the study area is a maize belt area, it may have a policy lesson on similar areas fostering economic growth by doubling production and productivity using those agricultural technologies in Amhara and in Ethiopia. Lastly, the paper may serve as a source of additional evidence to scale up the intervention of those technologies to policy makers in the study area.

1.8 Organization of the thesis

This paper is organized in five sections. Chapter one shows the Background of the study. Chapter two shows literature reviews that provides the theoretical literatures and empirical literatures from journals, papers and related materials related to the Determinants and adoption of agricultural technologies of farmers. Chapter three provides information about data set and the methodology. Chapter four focuses on the descriptive and econometric results of the study. Finally, chapter five summarizes the conclusion and recomendations.

CHAPTER TWO: REVIEW OF LITRATURE

2.1 Defination of basic terms and concepts

2.1.1 Concepts of technology

According to Loevinsohnet al. (2013), technology is the means and methods of producing goods and services. It is new to a particular place or group of farmers, but the technology may in use within a particular place or farmers.

2.1.1.1 Basic concepts of technology adoption

Technology adoption is important because it is the vehicle that allows most people to participate in a rapidly changing world where technology has become central to our lives. Individuals who can't adopt will increasingly limit their ability to participate fully in the financial and convenience benefits associated with technology. Understanding the factors influencing technology adoption helps us predict and manage who adopt, when and at what conditions. Unfortunately there is no clear definition of technology adoption, in large part due to the tremendous variability in types of technology and circumstances under which people adopt them.

Technology adoption and diffusion are highly interrelated but distinct concepts. Technology adoption is measured at one point in time while technology diffusion is the spread of a new technology across population over time (Thirtle and Ruttan, 2014). While explaining the distinction between these concepts, Rogers (2012) argued that, technology (synonymously used with the term innovation) is often accompanied by two processes, namely the processes of adoption and diffusion. Technology is described as an idea, practice, or object that is perceived as new by an individual or groups of a society. Technology adoption is the use or non-use of a new or improved technology by an individual or farmer at a given period of time. On the other hand, technology diffusion is defined as "the process by which a technology is communicated through certain channels over time among the members of social systems". It signifies a group of phenomena, which suggests how technology spreads among users. It takes place at the individual level and is the mental process that starts when an individual first hears about the technology and ends to its final adoption or rejection. Rogers (2012) summarized the above definition of technology diffusion using the following four core 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 suppliers (extension, technology suppliers) to final users or farmer, (3) the time period over which a social system adopts a technology and (4) the social system. Overall, the technology diffusion process essentially encompasses the adoption process of several individuals or farmers over time.

According to Federet al. (1985), adoption can be categorized into individual or aggregate adoption. They defined individual adoption as the degree of use of a new technology in long- run equilibrium when the farmer has full information about the new technology and its potential, whereas aggregate adoption is defined as the process of spread of a technology within a region. Further, their studies distinguished technologies that are divisible and non-divisible. Divisible technology in terms of resource allocation requires the decision process to involve area allocations as well as levels of use of the rate of application (for instance, improved seed, chemical fertilizer, and bio-inoculant fertilizer). Therefore, adoption of improved agricultural technologies such as improved chickpea variety, bio-inoculant and/or chemical fertilizer can therefore be categorized as divisible technology, defined as farmers who planted at least one improved chickpea variety and/or use chemical fertilizer for chickpea, and non-adopters are those who did not grow any of the improved chickpea variety and/or used chemical fertilizer in chickpea production.

Different intellects has been defined the word “technology” in different ways. For example, Rogers (1995; P.12) often use “innovation” and “technology” synonymously. Added also “technology is a design for instrumental action that reduces the uncertainty in the cause effect relationships involved in achieving a desired outcome”. Enos and Park (1988) defined technology as “the general knowledge or information that permits some tasks to be accomplished, some service rendered, or some products manufactured”. Rogers (1995; P.5) conceptualized that “diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system” provided that decisions are not authoritative or collective, each member of the social system faces his or her own innovation decision following a five stage process.

The innovation decision process is the process through which an individual (other decision making unit) passes from first knowledge of an innovation forming an attitude toward the innovation, to a decision of adopt or reject, to implementation of the new idea, and to confirmation of this decision"(Rogers [2015;P.20-21]). New technology adoption takes place within the mind of an individual or other decision making unit, however; diffusion occurs among the units in a social system. Finally, there are five main stages in new technology adoption

Process stated as follows: Thus,

1. **Knowledge**: A decision making individual becomes aware of an innovation and has some idea of how it works is the main idea of this stage. As decision making persons first exposed to an innovation, however; lack information about the innovation and even have no desire to find extra information about the innovation.

2. **Persuasion**: This stage takes place when an individual decision unit creates a favorable or unfavorable attitude toward the innovation. Individual decision unit become interested in innovation and actively seeks information regarding to the new technology.

3. **Decision**: In this stage an individual typically is attracted to seek innovation-evaluation information, which is the reduction in uncertainty about an innovation's expected out comes. Questions like innovation's consequences, advantages and disadvantages be in my situation are usually answered by most individuals from their peers whose subjective opinion of the innovation is most convincing. Though this stage is most difficult to endorse by empirical evidence, individuals focus in activities that lead to a choice either to adopt or reject the innovation in weighing the advantages and disadvantages of adopting the innovation.

4. **Implementation**: Takes place when persons put an innovation in to use. Injunction to that an individual determines the usefulness of innovation as well. When that adopted new technologies give utility to him/her will continue to use the innovation and otherwise.

5. **Confirmation**: A person evaluates the results of an innovation-decision already made. As a result, individual decision unit decided to use the innovation even up to the fullest capacity.

2.1.3 Types of adopters in new technology adoption process

Rogers (1995; P.246-250) conducted a research on 'innovation adoption' stated that in the new Technology adoption processes there are five adopter categories. These are:

1. **Innovators**: This category of adopters is very eager to try new ideas and leads them out of a local circle of peer networks and into more modern social relationships. Generally, the adopters of the innovation category are risk takers, under youngest age brackets, have highersocial status, nearest to scientific sources, and interact with other technology innovators.

2. **Early adopters**: Characterized by greatest degree of opinion leadership in mostsocial systems, younger in age, have more financial variability, have higher social status, advanced education, greater social relationships, and greater exposure to different mass- mediachannels.

3. **Early majority**: Adopt new ideas before the average number of a social system.

Similarly, they interact repeatedly with their peers and sometimes hold leadership positions. Theinnovation–decision period of early majority adopter is relatively longer as compared toinnovator and the early adopter.

4. **Late majority**: Individual decision unit in late majority category characterized byadopting an innovation after the average member of the society adopts the innovation becausethese are with high degree of skepticism.

5. **Laggards**: Laggards or individual decision unit who falls behind peers are the lastcategory to adopt an innovation. Furthermore, laggards behave as they do have more isolated insocial networks, lowest social status, and lowest financial changeability up to the extent littleopinion leadership over the average number of a social system (Rogers, 1995; P.247).

2.1.1 Modern technology adoption

For years, in the industrialized world scientist and technological advancements have benefited farmers by driving agriculture production. However in the developing countries of the world smallholder farmers who are responsible for 80% of the food have yet to see similar gains. The majority of these farmers containing women, lack of access of many modern tools needed to be successful, such as crop management products, modern irrigation practices, fertilizers, postharvest loss solutions, improved seeds, mobile technology, as well as access to information and extension services.

According to Foster and Rosen Zweig and Carlettoet al., there are two major drivers of successful agricultural technology in developing countries: first one is the availability and affordability of technologies; and second one is farmer expectations that adoption will remain profitable both which determine the extent to which farmers are risk averse. There are number of factors which drive the above expectations, ranging from availability and size of land, family labor, prices and profitability of agricultural enterprises.

The conceptual framework presented here highlights the various pathways through which different factors influence household decisions to adopt agricultural technologies. One of the most highlighted constraints to agricultural technology adoption is the availability of cultivable land. DE Janvry and Sadoulet argued that the availability of land helps to reduce the liquidity constraints faced by households and also reduces risk aversion. On the other hand, ownership of large tracts of land can facilitate experimentation with new agricultural technologies and also determine the pace of adoption as large land owners are more likely to be the early adopters.

On the other hand, the limited availability of land may spur the use of organic fertilizers in a poor resource setting.

Furthermore according to Carlettoet al. the quality of land may be a major factor in deciding the use of key inputs such as chemical fertilizers, or adopting improved crop varieties due to expected higher returns. In the case of a country such as Uganda, with entrenched overlapping and relatively unsecure property land rights availability of land alone may not spur agricultural technology adoption.

The literature on agricultural technology adoption is vast and somewhat difficult to summarize compactly. Traditionally, economic analysis of agricultural technology adoption (or lack thereof) has focused on imperfect information, risk, uncertainty, institutional constraints, human capital, input availability, and infrastructure as potential explanations for adoption decisions (Feder et al. 1985; Foster and Rosenzweig 1996; and Kohli and Singh 1997).

A more recent strand of literature focuses on social networks and learning. In the following, prominent analyses of agricultural adoption, from both traditional and social network perspectives, are presented. The literature is then synthesized into three paradigms of technology adoption.

In studying agricultural technology adoption, analysis of the adoption of high yielding varieties (HYV) in India has been particularly influential. Kohli and Singh

(1997) found that inputs played a large role in the rapid adoption of HYVs in the Punjab. They claimed that the effort made by the Punjab government to make the technological innovations and their complementary inputs more easily and cheaply available allowed the technology to diffuse faster than in the rest of India.

Butzer et al (2002) used a choice of technique framework to characterize the decision to adopt HYVs in India. They found that since HYVs require higher levels of fertilizer and irrigation to realize their yield potential, their introduction corresponded with a large jump in the demand for fertilizer and irrigated land. McGuire and Mundlak (1991) also use a choice of technique framework in a study of the transformation of Punjab agriculture during the Green Revolution and find that the short period of transition from the use of traditional varieties to the adoption of HYVs was largely determined by the availability of irrigation facilities and fertilizer. This result partially stems from the fact that, as mentioned before, to fully utilize the yield potential of HYVs, it is necessary to apply considerably larger doses of fertilizer and water per unit of land.

More recently, an influential body of literature on technology adoption has 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. Once a year's harvest is realized, the farmer then updates his priors concerning the technology which may increase his probability of adopting the new technology in the subsequent year.

2.2 Theoretical litrature review

2.2.1 Agricultural Technologies

2.2.1.1RowPlanting Method

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 (Ram and Prashanta, 2011). In general speaking, there are two main systems of maize intensification (SWI) principles of crop production. Namely; principles of root development and principles of 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 maize yield it needs intensive care in each stage plant development including management of weed, insect, disease, irrigation, and organic manure (Ram and Prashanta, 2011).

The Ethiopian agricultural transformation agency (ATA, 2012) investigated that crop planting with space starts with growing seedlings in a garden center and planting these in the field with sufficient and equal spacing between each seedling. On the other hand, seed crop can be sown in rows with enough spacing between the seeds and rows simultaneously. It's antonyms to the traditional broadcasting sowing method that contributes positively to the low agricultural produce.

The process of adoption is the change that takes place within individual in relation to as in innovation starting from adopters initially aware of the innovation to the last decision of either to adopt or not that new technology. Despite, Ray (2015) has been defined that adoption does not necessarily follow the stages starts from awareness creation to adoption of that new technology.

Small scale farm households may adopt the new technology by passing loosely the trial stage in practice. Sometimes it can be seen as a fact with regard to environmental innovations. Though small scale farm households may have both awareness and knowledge together, adoption of new technology may not occur due to other endogenous and exogenous factors affecting the adoption decision (Ibid).

2.2.1.2 Agricultural Input Use

It's a general fact that agricultural input use is a fundamental determinant factor of the level ofoutput though it's not a sufficient condition in its own. Smallholder farmers adopt differentagricultural input types for farming practices. However, the level and intensity of input use varygreatly among and even between themselves. In this study the most reviewed agriculturaltechnology inputs were row-planting and improved seed as compared to local seed andbroadcasting planting method for maize production. So as to boost agricultural productivity; modern inputs like row planting methods, improved seed, soil and water conservation, andfertilizer usage are important.

Feder and zilberman (1985) made a comprehensive study tosummarize factors that affect farm technologies and agricultural innovations. Among otherfactors whether to adopt or not a technology depends on the profitability of the technology (ibid).Among the smallholder farmer's manure application could also be a substitute to fertilizer isagain important at smallholder farmer's level. In nutshell, in sub-Saharan Africa (SSA) countriesagricultural new technology adoption levels remain low.

Attaullalhet al., (2007) conducted a research on evaluation of planting methods for grain yield and yield components of maize found a result row planting methods give higher out puts relative to the commonly used conventional and broadcast planting methods. Therefore, adopting row planting agricultural technology over maize crop increases more yield of maize as compared to the aforementioned commonly applied methods by smallholder farmers even in Ethiopia.

Usually, the main potential determinants of agricultural technology adoption decisions has focused on imperfect information, risk, uncertainty, institutional restraints, human capital, input accessibility, and infrastructure (as cited in Uaieneet al.,2009). However, the recent agricultural technology adoption decisions literature emphasized on both social networks and education. New agricultural input access played enormous role in the fast adoption of improved seed varieties in Indian province Punjab as an example (Ibid).

2.3 Adoption and impact of improved agricultural technologies

The adoption of an innovation within a social system takes place through its adoption byindividuals or groups. According to Federet al. (1985), adoption may be defined as theintegration of an innovation into farmers' normal farming activities over an extended period oftime. It is also noted that adoption, however, is not a permanent behavior. This implies that anindividual may decide to discontinue the use of an innovation for a variety of personal, institutional, and social reasons one of which might be the availability of another practice that isbetter in satisfying farmers' needs.

Adoption is a mental process through which an individual passes from hearing about aninnovation to its adoption that follows awareness, interest, evaluation, trial, and adoption stages(Bahadur and Siegfried, 2004).It can be considered a variable representing behavioral changesthat farmers undergo in accepting new ideas and innovations in agriculture anticipating somepositive impacts of those ideas and innovations.

2.4Empirical literature review

2.4.1 Empirical Studies for African Agriculture

Several studies in Africa show that adoptions of improved agricultural technologies, thoughvariably and incompletely, had positive impacts on income, food security and poverty reduction(e.g. Wanyama, et al 2010; Solomon et al 2010**,** Adekambi, et al 2009, Kassie, et al 2010). Usingthe number of months that grains stay in store as a proxy to food security, Wanyama et al (2005)showed that soil management technologies had a positive impact on the food security of thefarming community within the soil management project area and its neighborhood in Kenya.

Setotaw et al (2003) found that adoption of improved agricultural technologies (improvedvarieties and agronomic practices) have positively and significantly affected household’s foodsecurity in Ethiopia. Solomon et al (2010) examined the impacts adoption of chickpea varietieson the level of commercialization of smallholder farmers in Ethiopia. They found that adoptionof improved chickpea varieties has a positive and robust effect on marketed surplus whichreduces food insecurity in adopter households.

A study by Adekambi et al, (2009) on the impactof agricultural technology adoption on poverty in Benin indicates the increase in productivity ofrice farmers, following the adoption of NERICA varieties. These results suggest that thepromotion of NERICA cultivation can contribute to improving expenditure/income of farmersand consequently to poverty reduction. Similarly, Kassie, et al (2010) found that improvedground technologies had a significant positive impact on crop income and poverty reduction inUganda.

Studies conducted in Asia also reveal similar results. Using a propensity score matching method,Mendola (2007) examined the impacts of agricultural technology adoption on poverty reductionin rural Bangladesh. Findings show a robust and positive impact of agricultural technologyadoption on farm households’ well-being. Similarly, Wu et al (2010) conducted an impact study rural China and found that adoption of agricultural technologies had a positive impact onfarmers' well-being thereby improving household income.

The production of maize in SSA is lower and accounts 10 to 15 percent of its potential (ICARDA, 2013). About 75% of Africa's poor population lives in rural areas where their economies rely on the agriculture sector IFAD (2011). However, the agriculture economic sector has not been yet able to ensure food self-sufficiency in many SSA countries both at the national and household level. Although production has risen over the last years, productivity has not increased proportional to the total area cultivated in the region. This low productivity is partly because of low agricultural technology adoption (Ibid).

A study conducted by the authors Bola et al., (2012) stated that the decision of small farm households to adopt improved rice varieties in Nigeria was determined by the different socioeconomic and demographic variables such as number of years of residence in the village, access to media, mobile phone, vocational training, livestock ownership, access to improved seed, and income from other crop production significantly increased the probability of adoption. Although a small farm household is aware of technology, access to improved seed is a necessary condition for the adoption of a technology (Ibid.) Low agricultural productivity amongst small farm holders in Ghana that has been identified were mainly because of low adoption of new agricultural production technologies (Mamuduet al. 2012). Based on these authors studyconcluded that plot size, expected returns from technology adoption, access to credit, andextension services are the factors that significantly affect technology adoption decisions of smallfarm households in the west district area of that country.

Yaronet al., 2012) and Harper et al., (2008) found that small farm households have a negative correlation between adoption of new technology and land size of small farm households. Federetal., (2015) pointed out that only large plot size owners will adopt these types of technology. Rogers (2003); Ehler and Bottrell (2010) technology complexity has a negative impact on adoption of technologies and this bottleneck could only be solved through education. Access to credit that affects technology adoption decision positively. Most small farm households in Ghana were unable to afford the basic production technologies such as fertilizers and other agrochemicals resulting in low crop out puts mainly due to poverty and limited access to credit (Ministry of Food and Agriculture of Ghana in 2010). Bola et al., (2012) conducted a study on the ‘impact of improved agricultural technology adoption on sustainable rice productivity and rural farmers’ welfare in Nigeria result showed that among other findings access to improved seed was important in determining technology adoption. Its impact was also higher among the female headed households as compared to households who are male headed. Similarly, the adoption of improved rice varieties was also against the poor in nature as it had a higher positive impact on the poor householders than the non-poor in all the outcomes (ibid). Improved agricultural technology adoption can lead to the desired increase in productivity, ensure national and small scale households food self -sufficiency and can also be a way out of poverty in Nigeria as well.

Kijima et al., (2008) made a study on ‘the impact of new rice for Africa (NERICA) in Uganda’ found that NERICA adoption of improved rice seed reduces poverty. Applied the propensity score matching econometric model to examine the impact of agricultural technology adoption in Bangladesh stated that adoption of improved seed varieties has a positive impact on small farm householders wellbeing as compared to local seed in that country (Mariapia , 2006). However, a study conducted in Bangladesh by Hussainet al., (2003) reveals that the adoption of improved seed varieties of maize crop leads to a moderate increase in income of the technology adopters.

In the mid of 1990s in Upper Egypt maize yield was around 33 quintal per hectare and this was below potential. The main causes for the lower maize yield were use of local seed varieties, poor seed multiplication services coupled with high winter temperature that affect negatively (A.Aw-Hassan et al., 1995). After the international center for agricultural research in the dry areas (ICARDA) launched on farm trials and a demonstration program in the five year plan (1988 – 1992) results of demonstration fields showed that small farm households who adopt that new technology on average register yields 63 quintal per hectare increase as compared to those who did not adopt received 43 quintal per hectare. Small farm households’ adoption levels of improved maize varieties, irrigation, and dates of sowing where high unlike to the adoption levels of planting method, seed rate, and chemical fertilizer rates where low. Ibrahim Kasirye (2011) stated that small farm heads with low educational level and small farms size holdings are less likely to adopt agricultural technologies. Besides, peer effects play a great role in influencing small farm household either to adopt improved seed or fertilizer technologies.

2.4.2 Empirical Researches in Ethiopia

"In Ethiopia, increase crop production is one of the pre requisite conditions to attain food security. Most of the required increases in crop productions now and in the future are likely to come from yield growth rather than area expansion. Therefore, among others further deployment of improved variety is critical. Seed production and multiplication in Ethiopia is largely left to a state run seed enterprise. Very few NGOs and private traders are engaged in seed production and multiplication. However, agencies such as the state run Ethiopian seed enterprise (ESE) have been unable to satisfy the seed demand of the vast majority of the nation's farmers who are small-holders and subsistence farmers"(Mesayet al.,2010).

This low improved seed supply coupled with the low adoption of new agricultural technologies leads to low crop production. Adoption of improved maize varieties on small farm households increases food security and small farm households that did not adopt that technology would also have benefited sufficiently had they adopted improved seed (Bekele et al.,2013). Tsegaye and Bekele (2012) conducted a study on the 'impacts of adoption of improved maize technologies on households' food consumption in South eastern Ethiopia' stated that improved maize seed varieties grown based on a recommended planting space had a robust and positive impact on small farms' food consumption levels. A research conducted on the productivity and efficiency of agricultural extension package in Ethiopia by the authors Gezahegn et al.,(2006) stated that low percentage of small farm households adopt selected seed on maize crop as compared to that of maize crop. About 87% of the maize extensions small farm households are using local seed relative to 100 percent in maize non–adopters. Maize technology is therefore the most widely adopted and intensive improved seed applied in the extension package system. Important variables such as age of small farm household heads, distance from market, frequency of cultivation per hectare of land, plot size, labor and agrological differences are significantly affect it. Consistently, gender variable of household heads, access to extension level, and religion seems to have positive effect as well (Ibid).

According to Debela (2011), agricultural growth can be achieved through better small farm management practices and increased adoption of improved agricultural technologies such as chemical fertilizers, improved seed varieties, pesticides, and organic minerals.

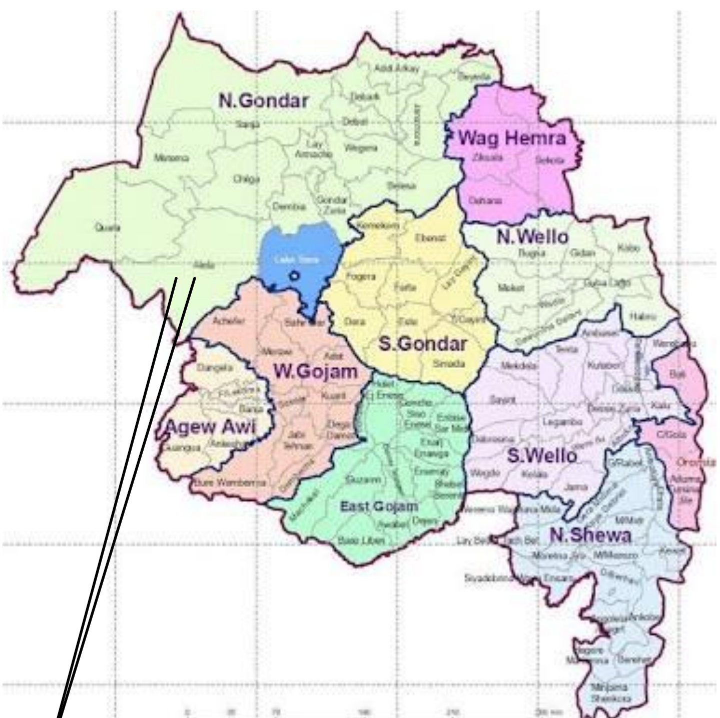
The impact of adopting improved seed varieties are the major one as compared to other agricultural productivity. Among other important variables age of the household head, family size, number of oxen, access to credit, and off-farm activities are positively affect the probability of participation in an agricultural extension program. Of which age, education level, and access to credit affect significantly. Solomon et al. (2011) conducted a study on 'agricultural technology adoption, seed access constraints and commercialization in Ethiopia' stated that knowledge of small farm households about existing varieties, perception about the characteristics of improved varieties, wealth (livestock and land) and availability of labor force are main determinant factors for adoption of improved technologies.

At national level the total production of cereals accounts 136 million quintal in the production year 2007/08. This shows an increase by around 48 million quintal compared to production year of 2003/04. Similarly, the total cultivated area to cereals also rises by 27 percent on the production year 2017/18 (Bingxin et al. 2016). Average cereal output reached 16 quintal per hectare at national level in 2007/08, this meaningful cereal yield raise witnessed that a 22 percent growth within these past five years. The low production of maize yield was partly due to low row planting and improved maize seed technology adoption over smallholder farms.

CHAPTER THREE:METHODOLOGY OF THE RESEARCH

3.1 Description of the study area

Alefa is one of the woredas in Amara region of Ethiopia part of north Gondar zone. It's located between 11 57' North Latitude and 36 52' East Longitude and bordered on the south west by Agew AwiZone, on the west by quara, on the north by takussa,on the East Lake Tana and on the southeast by mirabgojjam zone.it far from addis ababa by 829km and also it is far from bahirdar by 88 km. The administrative center of alefa is shawra;other towns include dengelber, eseydebir, atsedemaryam and gomenge.rivers include dinder where jawi and takussa woredas were separated from alefa.Alefa is named after the historic region to the southwest of lake tana,which was the target of a punitive expedition led by emperor suseniyos in 1608(Wikipedia).based on the 2007 national census conducted by the central statistical agency, this woreda has a total population of 170,291 of whom 86,350 are men and 841,141 are women.Only 6.8% of its population is urban inhabitants.like other most areas of Ethiopia the economy of alefa is mainly depend on agriculture like producing crop production. For the land under cultivation in Alefa, 75.38% was planted in cereals like teff,sorghum and maize (CSA, 2017).



Map of the study area

3.2 Research design

The study employees quantitative and qualitative research approaches, it employees descriptive,correlational and causall aspects.In this study demographic, socio- economic, institutional variables was analyzed using quantitative research methods. In the qualitative aspect some qulitative results are derived from qualitative variables by using key informants.

3.2.1 Type and sources of data

The study considers primary source.Primary data was collected from 386 sample households drawn out of total 11,225 household residing in Shahuratara, Atsede mariam,Ghazge,Dengelber and Finjit ketenas.The data included information of households'demographic and socio economic characterstics such as age, sex, education,household size, household income, land size, and other variables.

The primary data was collected by using structured questionary schedule that is administered by the researcher and the trained enumerators. Three enumerators who can capable of speaking English and the local language Amharic as well as to explain the prepared questionnaire in the local language are hired to collect the data. One day training is given to enumerators on the content of the interview schedule and procedures to follow in the process of conducting the interview. The field/farm specific questions are collected based on the conditions that prevailed during 2019/2020 cropping year.

3.2.2 Sample size and sampling techniques

A two-stage sampling technique was applied to select sample households for this study. In the first stage, before selecting household heads to be included in the sample, the sampling frame was stratified into technology user and nonuser households. Alefaworeda is selected purposively.It is because of the extensive production of maize production andit is the place where various agricultural crops are produced.Furthermore, fivekebelesare selected using purposive sampling technique based on their availability, utilization and experience of agricultural technologies from the total of 37 kebeles and five study kebeles are Shahuratara, Atsedemariam,Ghazge,Dengelber and finjit.Total population from the selected kebeles are 11225 households (3025users and 8200 non users) From these, the total households used agricultural technologies found Shahuratara, Atsedemariam,Ghazge,Dengelber and Finjit Are 800,700, 550 and 400 and 575, respectively. Additionally, the total non-technology adopter households found in those kebeles include 2150, 1000, 2175, and 1032 and 1843 respectively.

In the second stage, 104 technology user and 282 non-technology user households were selected by using simple random sampling technique in order to give an equal chance of the households' participation to be selected and to minimize the sampling error. In order to select the sampling households the researcher used the kebeles household list as a source.104 technology user households and 282 non technology users are not random numbers rather they are counted from the collected household data. The household's selection would be based on probability proportional sampling.

The total sample size was determined based on Yamane (1967) formula, at 95% confidence level:

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

n - The sample size

N - Population size

e - The level of precision

Where n is sample size, N = 11225 is the population size, and e (0.05) the level of precision.

Table 3.1: Sample size determination

Kebele	population/ household/	User	sample size	non user	sample size
Tara shahura	2950	800	28	2150	75
Atsedemariam	1700	700	24	1000	34
Gazgie	2725	550	18	2175	75
Dengelber	1430	400	14	1030	35
Finjit	2420	575	20	1845	63
Total	11225	3025	104	8200	282

Source: own summary, 2020

3.3Method of data analysis

3.3.1 Descriptive analysis

To explain the situation of demographic and socioeconomic variables of the households descriptive analysis are made. The analysis was used to analyze the overall livelihood of thepopulation in the study areas. The specific method of data analysis involved include frequency, percentages of descriptive statistics. To support the analysis, different tables were used.

3.3.2 Model Selection and Econometric analysis

To measure the determinants of agricultural technologies, empirical model was utilized. The model that was used for the study is indicated below.

Logit model

Logistic regression is a special, simpler case of multinomial regression. The logit function is useful because it can take as an input any value from negative infinity to positive infinity, whereas the output is confined to values between 0 and 1(Green, 2007).

Following Gujarati (2004),Furthermore, let $P_i$denotes the conditional probability that the i^{th} household is used agricultural technologies or not. Thus, the model for which the outcome variable is binary, can be written as:

$$Pi = E(Y = 1/x')$$
$$= X'\beta \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where:

With $X'\beta = \beta 0 + \beta_1 X_1 + \beta_2 X_2 +$ ------- $\beta_{ni} X_{ni}$, Here **y**is n×1 vector of response having y_i= 0 if the household is not technology user and yi = 1 if the household is technology user, Xis an n× (p+1) design matrix of explanatory variables, β is a (p+1) ×1 vector of parameters. The quantity P_i is the probability for the i^{th}covariatesatisfying the important requirement $0 \leq P_i \leq 1$.

But ,consider the following representaion of being non adopter:

$$Pi = E(Y = 1/x')$$
$$= \frac{1}{1 + e^{-(X'\beta)}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

For ease of exposition ,we can write (2):

$$Pi = \frac{1}{1+e^{-(X'\beta)}}$$
$$= \frac{e^{(X'\beta}}{1+e^{(X'\beta)}} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots . \ldots \ldots \ldots \ldots \ldots \ldots \ldots (3)$$

Where: $X'\beta = \beta 0 + \beta_1 X_1 + \beta_2 X_2 +$ ------- $\beta_{ni} X_{ni}$,Equation (3) represents logistic distribution function. It is easy to verfy that as $X'\beta$ ranges from $-\infty$ to $+\infty$, P_i ranges between 0 and 1 and P_i is nonlinear related to$X'\beta$ (i.e x'). If P_i , the probablity of being non technology adopter is given by (eq.3), then(1- P_i)probablity of being technology adopter, is :

$$1 - Pi = \frac{1}{1+e^{(X'\beta)}} \text{ ,Therefor ,we can write } = \frac{Pi}{1-Pi} = \frac{1+e^{(X'\beta}}{1+e^{-(X'\beta)}} = e^{(X'\beta)} \ldots \ldots \ldots (4)$$

Now (Pi/1- Pi) is simply the odds ratio in favor of being non technology adopter,the ratio of the probablity that a household will being non technology adopter to the probablity that the household is technology adopter. Now if we take natural log of (eq.4),we have obtain a very intersting linear equation.

$$Li = \ln\left(\frac{Pi}{1-Pi}\right) = X'\beta$$
$$= \beta 0 + \beta 1X1 + \beta 2X2 + -\,-\,-\,-\,- \beta niXni \ldots \ldots \ldots \ldots . \ldots \ldots \ldots \ldots (5)$$

Liis known as logist model. The most commonly used method of estimating the parameters of a logistic regression model is the method of Maximum Likelihood (ML) .

The variable $X'\beta$ is usually defined as:

$X'\beta = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 \ldots \beta_p X_{pi} + \varepsilon$ ----------------------------------(6)

Where, β_0 is called the "intercept" and β_1, β_2, β_3, and so on, are called the regression coefficient and X_1, X_2, X_3,X_4, X_5, X_6, X_7, X_8, X_9,X_{10},X_{11}, are idependant variables.Now it is possible to formulate the model. Thus, the cross-sectional estimation for the determinants of technology adoption were conducted through the empirical model is specified as follows:

Technology adoption=f(age of hh, sex of hh, education level of hhh, HH Size, active Family labor, land size, access to credit, extension service, off farm activity and access to media)

In short expression,

(Technology Adoption) = $\beta_0 + \beta_1$ AGE +$\beta_2$sex + $\beta_3$educlevel + $\beta_4$hhsize + $\beta_5$actfamlbr+ $\beta_6$landsize+$\beta_7$acctcrdt+$\beta_8$extser+$\beta_9$offfarm+β_{10}acctomedia+Ui$_{i)}$============**is the general equation**

Table 3.4.2. 1: Description & assumption of variables in the logistic model

Sr.No	Variable Description	Variable representation in the model	Variable type	Values if the variable is dummy	Expected sign
	Technology adoption	Tecadp	Dummy	0= if $y_i>z$ 1= if $y_i<z$	N/A
1	Age of the hh head	Age	Continuous		Negative/positive
2	Marital status of the hh head	Dmart	Dummy	1=single, 0= Otherwise	Positive
3	Sex of the household head	Dsex	Dummy	0= male, 1= female	Positive
4	Number of family size	Famsize	Continuous		Positive
5	Active family labor	Actfamlbr	Continuous		Positive
6	Off farm activity	Offact	Dummy	0= if there is no activity, 1=otherwise	Negative/positive
7	Educational level of HH head	Educlevel	continious		Negative
8	Access to credit	Acctcrdt	Dummy	0= if,no, 1= yes	Negative
9	HH access to media	Acc tomedia	Dummy	0= if,no1=otherwise	Negative
10	Extension service	Extservice	Dummy	1=yes, 0=otherwise	Negative

3.4 Choice and definition of variables

Different literatures has been reviewed, expertise ideas used, and knowledge and experience of the researcher even were employed so as to differentiate the determinant factors of the assigned outcome variables used in the study.

The assigned dependent variable used in this research to be analyzed is the following:

Row-planting technology adopter households' maize yield in (2019/20 G.C) Production year.This dependent outcome variable is explained by 11 important variables, and The dependent variable of this study is binary variable i.e. it takes value 1 for technology user and 0 for non-user.

The independent (explanatory) variables which are expected to affect the dependent variables are, therefore, described as follows:

1. Smallholder farm's demographic characteristics

Age of the household head: - is a continuous variable measured in terms of years. It is expected to affect the dependent variables. Abebaw (2013) researched that age has significant effect on household's crop production. The older the households head, the more experience he/she has in farming plus weather forecasting. On the other hand, it's assumed that younger farmers are more innovative and hence more willing to adopt new agricultural technologies than older farmers. The study did not hypothesize explicit relationship between age of the household head and participation in agricultural new technology adoption hence its mixed nature.

Sex of the household head: - It is dummy variable with the values of either 1 if the household head is male and 0 female. Male headed households often have better control to thehouseholds resources and decisions concerning to adoption of agricultural inputs and 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. It is the hypothesis of this paper too.

Education level of the household head: - is a continuous variable measuring the formal school years completed by the household head. In many adoption researches for example;

Ramjiet al., 2002 identified that more educated farmers show higher tendencies to adopt new agricultural technologies as compared to less educated. As a result, it is expected to affect positively to the explained variable in this study too.

Number of active family labor in the household head: - This is a continuous variable measured in number of active labor household members. Hence, composition of the family matters. It is the summation of both sex adult members in the household. Households with large number of active labor members are supposed to have higher maize yield through adopting new agricultural inputs demands active labor unlike to the non-adopter households. Hence, it is expected to have a positive effect on the households' probability of agricultural technology adoption and on the maize yield outcome variables.

2. Socio-institutional and economic factors of farm households

Land size (plot-size):- It's a continuous variable measured in hectare and is refers to the total cultivated land of the household. Since most of the households in the study area of this paper are small holders almost with less than one hectare of land, one of the possible ways to increase theiroutput is by intensive farming. Therefore, this important variable is hypothesized to have a positive impact on the adoption of new agricultural inputs that enhance agricultural produce.

Access to credit: - 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 creates a clear capability for a household to purchase new agricultural inputs at a time which might be impossible or take long time if it was thought to be purchased by timely saving from ones income and expected to have positive effect.

Access to extension service: - This is a dummy variable. It's with the values 1 if the household head has access to extension services and 0 otherwise. Due to the large role ofextension services in increasing agricultural productivity and production, the coefficient for this independent variable is hypothesized to be positive.

Off-farm participation:-This is a measure of a household member participated in non–farming activities and generated an income in ETB. It is a dummy variable that takes value 1 if the household participates in off-farm activity and 0, otherwise. Participation in off farm promotes the capacity to invest in new agricultural technologies. Rahimeto (2007) contend that participation in off-farm activity affects farmers' agricultural technology adoption decisionpositively.

Access to media: - This is a dummy variable. Access to media (radio, TV, papers print, and mobile phones) play a vital role in disseminating awareness regarding to different activities including adoption decision of new agricultural technologies by households.

3.5. Diagnosis Testing

3.5.1 Model Specification:

From the very assumptions oflogistic regression, the model is assumed to be correctly specified. But, when the assumptions of logistic regression analysis are not met, we may have problems, such as biased coefficient estimates or very large standard errors for the logistic regression coefficients and these problems may lead to invalid statistical inferences. Therefore, it is important to check the model before using it for any statistical inference. It is also important to check that the model fits sufficiently well and to check for influential observations that have significant impact on the estimates of the coefficients. (www.ats.ucla.edu).

3.5.2 Goodness of Fit Test

The p-value associated the chi-square with "n" degrees of freedom and Hosmer and Lemeshow's are used to test goodness-off-fit test.The most commonly used test of model fit is the Hosmer and Lemeshow's goodness-of-fit test. The Hosmer-Lemeshow goodness-of-fit statistic is computed as the Pearson chi-square from the contingency table of observed frequencies and expected frequencies. Similar to a test of association of a two-way table, a goodness of fit as measured by Hosmer and Lemeshow's test will yield a large p-value (Green,2006).

3.5.3 Multicollinearity

Multi colinearityis the presence of linear relationship among some or all of the independent variables. The existence shows that the regression cannot interpret the influence of independent variable towards dependent variable precisely (Gujarati & Porter, 2009, p. 321).

In order to get unbiased estimators, the main concern is no co linearity between independent variables. This can be done by including other independent variables that is uncorrelated with existing independent variables. When correlation coefficient is 80% or above means, there is existence of multi co linearity problem (York, 2012).

CHAPTER FOUR:RESULTS AND DISCUSSIONS

This chapter deals with presentations, discussions and interpretations of the data collected through questionnaire and interview. The main objective of the study is to analyze determinants of agricultural technology on maize production. Questionnaires and interviews were the tools selected for the collection of data and Stata as the main software in the analysis of the data. To collect the data 386 questionnaires were distributed to rural household and all 386 questionnaires were returned back with completely filled and significant responses.

The discussion and data analysis parts are divided into two sections, descriptive and econometric analysis. In the first section of descriptive analysis, the socio economics characterists of the woredawill be explained using the summary statistics. Then, determinants of agricultural technologies are analyzed based on the regression result obtained from the Stata in comparison with different economic models and researches. Data were collected from five kebeles.

4.1. Descriptive Analysis

As explained before the data were analyzed using both descriptive and econometrics methods. On the descriptive side the demographic characteristics like sex, age, socio economic characteristics like education, characteristics of households were analyzed using frequency, percentage, standard deviation minimum and maximum value of the variables.

4.1.1 Demographic and Socio-economic features of respondents

In this particular research the demographic and socio economic attributes including sex,age, family size, marital status , and education of the randomly selected respondentswere analyze.

Table 4.2Sex and technology adaptability

Sex	**Non user**		**User**		**Total**	
	#[1] Frequency	Percentage	#[2]Frequency	Percentage	#[2] Frequency	Percentage
Male	208	72.47%	79	23.53%	287	74.35%
Female	74	77.08%	25	21.08%	99	25.65%
Total	282	100%	104	100%	386	100%

Source: (Computing from own survey, 2020)

[1] # represents number of households

In this study, from the total of 386 sample households interviewed, 25.65% are femalehousehold heads, and 74.35% are male household heads. Of the total female headed households, 77.08% of them are found to be non user; and 21.08% are users. Of the total male headed households, only 72.47% of them are non users, and the rest are users.

4.1.2 Family size and technology adoption

The maximum and minimum household size of the study area is 9 and 2, respectively. The average household size is 5 people per household .

Table 4.1.3 Family sizeand technology adopter of respondent.

Family size	**Non user**		**User**		**Both**	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Below five	93	48.19%	182	87.92%	275	68.75%
five to eight	98	50.77%	25	12.08%	123	30.75%
Above eight	2	1.04%	0%	0%	2	0.5%
Total	193	100%	207	100%	386	100%

Source: (Computing from own survey, 2020)

As shown in Table 4.3.1 above, the share of non user households who have a family size below average are 48.19%; while non technology user households that have household sizes of five to eight are 50.77%, while eight and above were only 1.04% of the total non technology user households. When we compute the share of users of agricultural technologies within theirrespective household size ranges, it appears to be 87.92%,of households family size four and below were technology user ,12.08 % were technology user for family size five to eight while none of the family size eight and above were technology user.

Table 4.1. 4 Education and technology adoption

Educational level	Technology user status					
	Non user households		**user households**		**Both**	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Illiterate groups	46	23.83%	12	5.8%	58	14.5%
Primary education	82	42.49%	28	13.53%	110	27.5%
Sec.edu level	26	13.47%	42	20.28%	68	17%
Diploma level	21	10.88%	39	18.84%	60	15%
Degree and Above	18	9.33%	86	41.55%	104	26%
Total	179	100%	207	100%	386	100%

Source: (Computing from own survey, 2020)

Education plays a significant role in expanding technology.households who have an access to higher education are highly active to accept technologies than non educated ones.

As shown in Table 4.4 above, of the total illiterate sample respondents, 79.31% of them are non technology users and the largest share of non user come from such household base. From the total sample households, the percentage share of the non user for each primary, secondary to certificate, diploma, first degree and above educational levels are: 20.5%, 6.5%, 5.25% and 4.5%, respectively.

Thus, with an increasing educational level of households, the numbers of households who are voulenerable to accept technologies tends to increase. With regard to this, human capital theory links between education and technology,education as a means of technology expansion and increases GNP at macro level. Thus, the same theory states that investment on education is one of the main policy intervention areas of a country that enables to expand technology (World Bank,2012).

Table 4.1. 5 technology adoption status

Ketenas	Raw planting technology user status			
	Technology user		**Non user**	
	Frequency	Percentage	Frequency	Percentage
Tara shahura	28	26.92%	75	26.59%
Atsedemariam	24	23.07%	34	12.05%
Dengelber	18	17.30%	70	24.82%
Gazgie	14	13.46%	35	12.41%
Finjit	20	19.25%	68	24.13%
Total	104	100%	282	100%

Source: (Computing from own survey, 2020)

As shown in Table 4 .1 above, from the total sample households drawn in the selected woreda, theshare of household who can use agricultural technologies is 104 (26.95); while 282 (73.05%) cannot use agricultural technologies in their agricultural activity.this figure shows most of the households living in the woreda are not agricultural technology users.

As shown in Table 4.1 above, kebeles nearer to the town(woreda administrative town) are better adopters of agricltural technologies while those which are far from the woreda town are less agricultural technology users.The reason could be distant from the woreda town and frequent education from the woreda agricultural officials and access to transportation may be the reason for the difference for the selected kebeles.

4.2 Qualitative Results

As indicated in the methodological section thematic analysis was used for the qualitative data. In this regard, two themes were created to summarize the qualitative data. The themes were grouped in to market and institutional factors for crop production in the study area.

4.2.1 Market Problems

Participants in the study area complain the unsatisfactory opportunities to sell their crops in the local markets. Key informant participants from technology users mentioned that market is a challenging problem for them. All groups mentioned that lack of adequate storage and marketing facilities for their products was another constraint. Lack of access to market integration for outputs creates problems for production on a market-oriented basis.

4.2.2 Lack of Institutional Services

Informants mentioned that unfair distribution of resources among households is the one of the factor for technology non-adaptability. Institutional services from development agents are not enough to aware about the use of raw planting technologies. Lack of institutional service implies that different resources like development agents,agricultural technologies are not evenly distributed.

4.3Econometric Result

4.3.1 Test of Logistics Regression

4.3.1.1 Specification error test

Model Specification: From the very assumptions of logistic regression, the model is assumed to be correctly specified. It is also important to check that the model fits sufficiently well and to check for influential observations that have significant impact on the estimates of the coefficients. (from a diagnostic test from logit model).

4.3.2 Goodness of Fit Test

The p-value associated the chi-square with “n” degrees of freedom and Hosmer and Lemeshow’s are used to test goodness-of-fit test. In this study, p-value associated the chi-square with 5 degrees of freedom. The p- value of .0000 indicates that the model as a whole is statistically significant i.e. the model fitted the data properly (Green,2006).

A test of association of a two-way table, a goodness of fit as measured by Hosmer and Lemeshow's test will yield a large p-value. Hence, in this study the test result revealed that p= .9121 this suggests that the model is correctly fitted with the data.

4.3.3Multicollinerarity Test

High pair wise correlation between two variables means there is a serious multicollinearity problem in the regression model. The level of high multicollinearity exist when the correlation between two variables exceed 80% (Gujarati & Porter, 2009, p. 338).The result reavels that correlation for all variable is less than 80%,no multicollinearity problem.Initially, the logistic regression econometric model is used to estimate the potential factors that affect households not to participate on both row-planting technologies. To do all these different econometric estimates the researcher used STATA version fifteen (STATA 15). The marginal effect results are provided below in (Table 4.5.).

The pseudo Rsquared is found about 0.8339 meaning all the explanatory (independent) important variables included in the model do exactly explain 83-percent of the probability of households' row planting technology adoption. The overall model is proven, as it is statistically significant at a pvalue of 0.000.

Table 4. 6: Odd ratio estimates of hhs technology adoption determinants.

Variables dependent ; technology adoption	**Coefficients**	**Robust Std. Err.**	**P>t**
Age of the household head /continues/	0.5620913**	0.268334	0.036
Age-sq.	0.0060598**	0.0026381	0.022
Sex of the household head /dummy/	2.13787**	1.031614	0.138
Number of family size /continuous/	2.6884414**	.0059067	0.005
Active family labor/continuous/	1.315334**	0.6834236	0.046
Access to credit /dummy/	0.575504**	.07461425	0.041
Household's head educational level /continuous/	1.825654***	.0487905 3	0.000
Extension service/dummy/	0.6684239**	1.106263	0.046
Household's access to social media/dummy/	6.89966*	1.632008* **	0.560
Household's land size /continuous/	18.99428***	4.55955	0.000
Off farm participation	2.911847**	1.209673	

Source: (Computing own survey data of, 2020).

Number of obs = 386 Logistic Regression

Wald chi2 (11) = 317.32 Log likelihood=-31.609719

Prob> chi2 = 0.0000

Pseudo R2 = 0.8339

***, ** and* Statistically Significant at 1%, 5% and10% respectively

The result for the logit estimates of households' probability of adopting row-planting technology is presented in the above (Table 4.5). At the bottom of the table, we see 386 observations in the data set that were used in the analysis. The Pseudo R2 is the measure of goodness of fit, which is0.8339. This implies that 83.39 % of the variation in the households' probability of adopting the technology is explained by the independent variables included in the model. The Wald chi2 (11) 317.32 with a p-value (Prob>chi2) 0.0000 also tells us the logit model as a whole is statistically Significant, as compared to the model with no predictors. As reported in the same table, the Coefficients for the row-planting technology adoption such as age, education level, labor availability, off-farm participation, access to credit, extension service, access to information, and field visit days are significant at 1%, 5%, and 10% probability level of significance. In addition, those explanatory variables have the expected positive sign.

Table 4.7: marginal effects of row planting adoption

Variables dependent ; technology adoption	Coefficients	Robust Std. Err.	P>t
Age of the household head /continues/	.0449601	.02906	0.122
Age-sq.	-.0104847*	.00029	0.098
Sex of the household head /dummy/	2.13787	1.031614	0.138
Number of family size /continuous/	-2.6884414	.0059067	0.005
Active family labor/continuous/	0.0854541***	0.5745	0.011
Access to credit /dummy/	0.575504**	.06089	0.041
Household's head educational level /continuous/	0.1460288**	0-81270	0.000
Extension service/dummy/	0.545716*	0.9288	0.057
Household's access to social media/dummy/	0.8463562***	0.9676	0.000
Household's land size /continuous/	1.519298***	0.51776	0.003
Off farm participation(dummy)	0.1641475**	o.7949	0.027
Constants	-31.25919	9.177716	0.001

Source: (Computing own survey data of, 2020)

Number of obs = 386 Logistic Regression

Wald chi2 (11) = 317.32 Log likelihood=-31.609719

Prob> chi2 = 0.0000

Pseudo R2 = 0.8339

***, ** and* Statistically Significant at 1%, 5% and10% respectively

(Technology Adoption) = β_0 –0.01AGE +2.14sex +0.15educlevel-2.69hhsize +0.1actfamlbr+ 1.52landsize+0.56acctcrdt+0.55extser+0.16offfarm+0.84acctomedia+Ui$_{i)}$

4.3.3.1. Interpretations of the marginal effects of row planting adoption

As the marginal effect estimates of (Table 4.5) shows that keeping other factors constant, a 1 year increase in the age square of the household head, decreases households' probability of adopting row planting technology on maize by 1.1 percent. Again, it is statistically significant at 10% probability level of significance. This result is consistent with Abebaw (2003) who researched that age has significant effect on household's crop production. The older the households head, the more experience he/she has in farming plus weather forecasting. On the other hand, it's assumed that younger farmers are more innovative and hence more willing to adopt new agricultural technologies than older farmers.

Education level of the household head is statistically significant with the expected positive sign. The positive sign of the coefficient of this variable assures that households that are more educated may have more knowledge and awareness about the advantages of row planting participation on farm.

Thus, as education (year of schooling) of the household head increases by one year, the probability of adoption of row-planting use would increases by 15% percentage point, holding other variables constant. Therefore, educated households trust more that new technology better than non-educated smallholder farms and is consistent to the previous works of Ramie etal., (2012).

Availability of working labour is significant and it is positively associated with the probability of adoption of row-planting use. Households composed of with more active labour participant are more likely to adopt row-planting technology since this new technology adoption requires high labour and energy during sowing. As labour availability of the household increases by one unit, the probability of adoption of row-planting technology raises by 8.6% of marginal effect, keeping other things constant. This is consistent with Rogerset al, (2012) which states that households with large number of active labor members are supposed to have higher maize yield through adopting new agricultural inputs demands active labor unlike to the non-adopter households. Hence, it is expected to have a positive effect on the households' probability of agricultural technology adoption and on the maize yield outcome variables.

In similar way, plot size is significant and positively correlated with the probability of adoption of row-planting use. Farm households with more plot size are more likely to adopt row-planting use. As plot size of a household increases by one hectare, the probability of adoption of row planting use would increase by 1.52 hectare, ceteris paribus.

Off-farm participation is significant and it positively affects the probability of adoption ofrow-planting use. Farm households engaging in off-farm participation encourages them to engage in adoption of new technologies for better yield. Farm households participating in off farm participation are 16.4% higher to adopt row planting than non-participants, other things remaining constant. Participation in off farm promotes the capacity to invest in new agricultural technologies.this result is consistent with Rahimeto (2007) contend that participation in off-farm activity affects farmers' agricultural technology adoption decisionpositively.

Access to credit is statistically significant and it affects the probability of adoption of row planting positively. In addition, it raises participation by 4.5% higher to adopt row planting on maize. This result is consistent with Rogers et al. (2012) which states that Credit creates a clear capability for a household to purchase new agricultural inputs at a time which might be impossible or take long time if it was thought to be purchased by timely saving from ones income and expected to have positive effect.

Access to information (media) is statistically significant and economically meaning full to affect the probability of adoption of row-planting use. This serves the small-scale farm households as basic information and it enables them to have awareness with the merits of the new technology. Farm households with access to media are 84.47% higher to participate in adoption of row-planting technology compared to their counter parts.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusion

A remarkable improvement in agricultural Productivity in majority of developing countries in late 1960s resulted from agricultural Transformation agenda including of agricultural research, extension services and rural infrastructural development that underline the role technology adoption among smallholder's farmer in increasing production was vital. Technological change in agriculture comprises of introduction of row planting, high yielding variety of seeds, fertilizers, plant protection measures and irrigation. These changes in agricultural sector augment the productivity per unit of land and bring about rapid increase in production to tackle the severe problem of poverty.

In Ethiopia, even though some progress has been recorded over time, the use of agricultural technologies especially row planting is found at its low level.

To this end, this study was conducted with the aim of investigating the institutional, demographic and socio-economic factors that influence the adoption decision of row planting among smallholder maize farmers.

A cross-sectional primary data was collected from a total of 386 sample rural small-scale farm households used for the analysis of the research in Alefa woreda, central Gondar.

The adoption decision of row planting use was driven by factors such as size of farm land, size of family, availability of family labor force, education status of household head, accessibility of credit service; access to media and sex of head.

It was observed that on aggregate levels there are farm and farmer specific attributes that explain the technology adoption behaviour of farmers. For instance, older farmers have lower probability of adopting a new technology as compared with younger farmers. Thus, it would appear that younger farmers were more likely to bear the risk associated with the new technologies.

Farmers with larger land size are more likely to be technology adopters when compared to those with smaller land holdings. Similarly, proximity to extension service centres may be an important factor in improving the adoption of new technology. Information is a crucial determinant of the adoption of a technology.

Hence, extension has been found to be an important variable in explaining the adoption behaviour of farmers, the result implies that benefits from extension would be maximized by focusing extension activities on those factors that are important in subsistence producers' adoption behaviour of row planting technologies.

5.2. Recommendatios

This study has shown that adopting row-planting technologies enabled smallholder farmers increase maize yield. Scaling up that program is therefore very important. Based on those facts the researcher recommends the following.

- Strengthening and Scaling up the already started provision of basic adult education enormously andPrepare short training in the farmer's technology demonstration sites to adaptor and non-adopter households in their locality.
- Soil conservation and environmental protection program has to be expanded.This will bring sustain soil fertility and increase production and productivity crops by reversing the existing situation.
- Encourage the already started cluster based seed multiplication business of smallholder farms by solving the technical challenges and working at the attitudinal change intensively.
- Complementary agricultural technologies adoption yield best results when they are taken up as a complete package rather than in the individual elements indeed. Though there is access to credit, farmers need to have lower loan interest rate to improve their maize yield. Create market for the households in their locality hence they were forced to sell their produce at the cheapest autumn season to cooperatives.
- In light of these findings, Membership to a farmer group or cooperative being a crucial factor in enhancing the farmer technology adoption, it is suggested that policy makers should promote collective action among smallholders because it eases access to production, technology diffusion and marketing information as well as cheaper inputs.

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Appendices

Bahir dar University

Survey questionnaire

<u>Questionnaires</u>

Dear Respondent, My name is **Simegnew Setegn**. I am a student at Bahir Dar University undertaking the thesis in partial fulfillment of the requirements for the degree in Masters of Science in Developmental Economics entitled: **The determinants of Agricultural Technology Adoption of Small Holder Farmers on Maize production: Alefaworeda, Ethiopia.** You have been selected to participate in this study to obtain your perceptions and views regarding various aspects of the agricultural technologies. Your honest participation in answering the questions will assist to analyze determinants of agricultural technology determinants. The information provided will be treated confidentially and your personal information will keep in secret.

Mobile: 0923418780

Thank you for your cooperation!!!

Questionnaire respondent number --------

I. Household information

1. Information on Household Head.

1.1 Age ………….

1.2 Sex Male □Female □

1.3 Marital status? a) Married b) Single c) Divorced d) Widowed

1.4 Level of Education of the household head …………………..

1.5 Level of Education the household head partner ……………….

1.6 Household size ……………

Age category

A) < 14 …………………

B) 14 < x < 65 ……….

C) > 65 ………………..

Categories- II. Household Asset: land and livestock

2.1.1 Own and rented land

2.2 Total area of own cultivated land that the household have_________ (timad) of which

_________ (timad) for maize cultivation.

2.3 Total area of rent in cultivated land that the household have_________ (timad) of which

_________ (timad)for maize cultivation.

2.5 Total area of rented out cultivated land that the household have_________ (timad) of which

_________ (timad) for maize cultivation

2.6 How many times you plow your plot a year. 1. Ones 2. Two times 3. Three times

4. four times 5 Other, Specify————

II. Institutional Services

3.1 Credit services

3.1.1 Amount of credit receiving……………….

3.1.2 Amount of saving ………………………..

3.2 Extension Service

3.2.1 The distance from development agent office to your home (hours)………

3.2.2. The number of times (frequency) the household members have contact with DA's? 0=No 1=per week 2= per month 3=per year

3.2.3 Has any member of the household have taken training regarding to the advantages of line sowing method in crop productivity? 1=Yes 0= No

3.2.4 Has any member of the household have taken training regarding to the advantages of Improved seed crops in production increment? 1= Yes 0=No

3.2.5 Did you meet DA's for technical assistance? 1= Yes 0= No

3.2.6. If yes, what were the major factors to communicate with your DA's? 1. Help how to use line-sowing 2. Help how to use improved Seed crops 3.Help how to use fertilizer 4.Help how to use anti-weeds and pesticides 5.Environmental Protection like Forty-day-Campaign mobilization 6. Other, Specify—————————

3.2.7 Is there any increment after the technology participation in your agricultural wheat yields /productivity?

In 2010E.C. harvest time _______ in 1=quintal 1=sack 3= not increased

3.3 Market Information and infrastructure

3.3.1 Do you get market information a) yes) No □

3.3.2 Who is the major buyer of your products/outputs?

a) Rural Traders b) cooperatives c) urban consumers d) others

3.3.3 What is the distance from your farmland to the market you sell in km …………?

3.3.4 Do you have transport access to the nearest market a) yes □b) No□

3.3.5 How do you transport your products to the market

a) On back/ foot b) by vehicles/ cars c) by back animals d) others(specify it)

III. Household income

4.1 Off-farm income (non-farming income from wage, trade(in birr))……………….

Categories-III. Agricultural Inputs and Out put

3.1 Agricultural Inputs used from 2010 to 2011E.C.(multiple

Answers is possible below)

1. Did you use Chemical Fertilizers in your farm in 2010E.C? 1= Yes 0= NO

2. If no, state your reasons in the order of their importance. 1. Not necessary for cultivated crops 2. Expensive 3. Not available 4. Lack of income 5.Lack of access to credit 6. Lack of rainfall burns crops 7. Other, Specify—————

3. Did you use Chemical Fertilizers in your farm in 2011 E.C? 1= Yes 0= NO

4. If no, state your reasons in the order of their importance. 1. Not necessary for cultivated crops 2. Too expensive 3. Not available 4. Lack of income 5. Lack of access to credit 6.lack of rainfall burns crops 7. Other, Specify——————

5. Did you use improved wheat/barley/maize/sorghum seed in your farm in 2010 E.C? 1= Yes

0= NO

8. If no, state your reasons in the order of their importance. 1. No yield difference from local seed 2. Too expensive 3. Not available on time 4. Lack of income 5.Lack of access to credit 6.Risky (no crop insurance) 7. No suppliers of improved seed in the area 8. Other,

Specify——————

9. Did you use improved wheat/barley/maize/sorghum seed in your farm in 2011 E.C? 1= Yes 0= NO

10. If no, state your reasons in the order of their importance. 1=No market opportunity 2= Not available on time 3=No crop insurance if production fails 4= No yield difference from local seed 5.Other, Specify————

Access to media of household

1. Do you have access to———— 1= Radio 2=Mobile phone 3=TV other,

Specify———— 1= Yes 0=No

2. If yes in one of the above items, did you follow Agricultural Programs specifically; line sowing and improved Seed crops use? 1=Yes 0= No

3. Have you been participated in the celebration of Experience sharing/ training of demonstration day Programs? 1= Yes 0=No

4. If yes what did you learn from? 1= Best Experience Shared 2= Some Experience Shared and Changed in to Own 3= Not new Experience already I know it 4= Other, Specify———————