STUDY ON THE INTENSITY AND ADOPTION OF IMPROVED WHEAT VARIETIES AND ASSOCIATED AGRONOMIC PRAC TICES IN KAFFA ZONE, THE CASE OF GESHA WOREDA

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Declaration

I hereby declare that the dissertation entitled STUDY ON INTENSITY AND ADOPTION OF IMPROVED WHEAT VARIETIES AND ASSOCIATED AGRONOMIC PRACTICES IN KAFFA ZONE, THE CASE OF GESHA WOREDA submitted by me for the partial fulfillment of the M.A. Rural Development to Indira Gandhi National Open University, (IGNOU) or to any other institution for the fulfillment of the requirement for any course of the study. I also declare that no chapter of this manuscript in whole or in part is lifted and incorporated in this report from any earlier work done by me or others.

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This is to certify that Mr. Tariku Bezabih Gebre student of MA. (RD) from Indira Gandhi National Open University, New Delhi was working under my supervision and guidance for his project work for the course MRDP-001 his project work entitled :

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BIOGRAPHY

Tariku Bezabih Gebre was born in Gesha woreda, Behato Kebele in Kaffa zone of the SNNPRS on June 20, 1978. He attended his elementary education in Behato primary school and junior education in Deka junior school and Yadota junior school of Gesha and Saylem woreda respectively. He also attended his high school education at Masha secondary school in Sheka zone of SNNPRS. After completion of his high school education, he joined Alemaya University of Agriculture (the present Haramaya University) to attend a four years Degree Program in plant Sciences and graduated on July 2000.

After graduation he was employed under Ministry of Agriculture in Gesha woreda and served the people in head positions of cooperative and agricultural offices and as chief administrator of the woreda. In third National election being candidate of Gesha electoral area, elected to member of House of people representative of Ethiopia and served his constituency or his birth place. After Serving for more than 10 years joined, he joined Indira Gandhi National Open University in July 2009 to pursue graduate studies for the M.sc. in Rural Development. Now he is working as Development plan preparation, monitoring, evaluation, and feedback officer of Pastoral Affairs Bureau of SNNPRS.

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ABBREVIATIONS AND ACRONYMS

ADLI	Agriculture- Development Led Industrialization
AI	Adoption Index
CIMMYT	International Maize and Improvement Center
CSA	Central Statistical Authority
df	Degree of freedom
EPID	Extension and Project Implementation Development
GDP	Gross Domestic Product
HHs	House Holds
LIMDEP	Limited Dependent Variable
masl	Meter above sea level
MOA	Ministry Of Agriculture
NGOs	Non Governmental Organizations
PAS	Peasant Association
SARI	Southern Agricultural Research Institute
SD	Standard deviation
SNNPRS	Southern Nation, Nationalities and Peoples Regional State
SPSS	Statistical Package for Social Science
TLU	Tropical Livestock Unit
VIF	Variance Inflation Factor
WAO	Woreda Agricultural office

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STUDY ON THE INTENSITY AND ADOPTION OF IMPROVED WHEAT VARIETIES AND ASSOCIATED AGRONOMIC PRACTICES IN KAFFA ZONE, THE CASE OF GESHA WOREDA

By Tariku Bezabih Gebre

ABSTRACT

Wheat (Triticum spp.) is one of the most important cereal crops in Ethiopia. It is largely grown in the highlands of the country and constitutes roughly 10% of the annual cereal production and plays a substantial role in supplying the population with carbohydrates, protein and minerals .Low production and productivity, which is mainly associated with poor adoption of improved technologies, is persistent in Gesha woreda. Adoption of improved technologies is one of the most promising ways to increase food security in Ethiopia. However, the adoption and dissemination of these technologies is inhibited by various factors. The objective of this study was to assess factors affecting adoption and intensity of adoption of improved wheat production and associated agronomic practices in Gesha Woreda, Kaffa zone of SNNPRS. A total of 120 sample households (109 male and 11 female) selected from 3 kebeles of the Woreda were interviewed using structured interview schedule. Qualitative data were collected using group discussion, and field observation.

Data analysis was done with the help SPSS 16; mainly Chi-square test, independent sample t-test. Tobit econometrics model was employed using STATA 10 to determine intensity and probability of adoption. The results of descriptive statistics and the econometric model indicated that the relative influence of different variables on probability and intensity of adoption of improved wheat production Thus, sex of house hold head, education of house hold, ,attending training on improved wheat production, attending field day programs, conducting demonstration, frequency of extension agent contact with house hold, mass media exposure, frequency of use of mass media, farm income farm size and ownership of livestock positively and significantly influenced adoption and intensity of adoption of improved wheat production

Results of measurement of farmers' adoption index revealed all respondents are in the category ranging from non adopters to medium adopters and no house hold has entered to high adopter category. Farmers' deviation from recommended package practices was found partly due to inadequate extension service, lack of adequate awareness creation. The overall findings of the study underlined the high importance of extension service provision to improve farmers' access to information and extension advices to address the recommended agronomic practices practically, educating farmers and avoiding gender biased extension services by participating women in development/extension programs. Attention has to be given to release of disease resistant varieties of wheat that suits agro ecology of the study area by researchers.

CHAPTER ONE

1. Introduction

1.1. Background of the Study

More than 85 percent of the Ethiopian population, which inhabits in the rural area, is engaged in agricultural production as a major means of livelihood (World Bank, 2006). The agricultural production system is mainly rain fed and traditional, which is characterized by low input of improved seeds, fertilizer, pesticides and other technologies (Legesse, 2004). Moreover, the ever increasing population pressure led to decline in land holding per household that eventually resulted in low level of production to meet even the consumption requirement of the households (Bezabih and Hadera, 2007).

In many developing countries, like Ethiopia, it has become obvious that generating new technology alone has not provided solution to help poor farmers to increase agricultural productivity and achieve higher standards of living. In spite of the efforts of National and International development organizations, the problem of technology adoption and hence low agricultural productivity is still a major concern (CIMMIYT, 1993).

New agricultural technologies are put to use on the basis of their potential to increase income. Often these technologies are not taken by farmers, either because they do not meet the intended objectives or simply unforeseen constraints prevent their adoption. The questions of technology adoption are vital concerns to researchers, extension specialists, planners and rural development policy makers. In developing countries such as Ethiopia, it is necessary to find out the reasons why new technologies have not been adopted widely by farmers as expected.

Cereals are by far the most dominant among field crops in Ethiopia, accounting for 68.3% and 73.4% of the total production and cultivated area, respectively, for the period 2004 to 2008. The share of pulses and oil seeds was 8.5 and 3% in the total production and 12.9 and 6.4% in the total area harvested. Expansion in area under cultivation was more important than increase in yield levels (CSA, 2008).

In Ethiopia, wheat is largely grown in the highlands of the country and constitutes roughly 10% of the annual cereal production and plays an appreciable role in supplying the population with carbohydrates, protein and minerals (Schulthess *et al*., 1997). The crop is grown at an altitude ranging from 1500 to 3000 meters above sea level (masl), between 6-16^0 N latitude and 35^0-42^0 E longitude. The most suitable agro- ecological zones, however, fall between 1900 and 2700 masl (Bekele *et al*., 2000).The major wheat producing areas in Ethiopia are located in Arsi, Bale, Shewa, Ilubabor, Western Hareghe, Sidamo, Tigray, Northern Gonder and Gojam zones (Bekele *et al*., 2000).

1.2. Statement of the Problem

Ethiopia presents one of the most important global challenges in agricultural development. It is among the poorest countries in the world, and its agricultural sector accounts for about 44 percent of national GDP, 85 percent of employment, and 90 percent of the poor. Rural poverty is further compounded by extreme land shortages in the highlands (where per capita land area has fallen from 0.5 ha in the 1960s to only 0.2 ha by 2008), low productivity of food production (with cereal yields averaging around 1.5 ton/ha), recurrent droughts and variable rainfall, and, as a consequence, high variability in agricultural production (World Bank, 2005).

To increase agricultural production and productivity, the Government launched the agriculture- development led industrialization strategy(ADLI) in 1991 (ICARDA *et al.*, 1999) where emphasis is put on linking research with development through well focused and targeted transfer of appropriate technology to farmers. The agricultural development strategy is aimed at promoting growth, reducing poverty and attaining food self-sufficiency while protecting the environment through safe use of improved technologies. The agricultural package programme is spearheaded through demonstration and provision of modern varieties and required inputs such as improved seeds, fertilizers and pesticides as well as better access to credit facilities. Since cereals, including wheat constitute greater share of agricultural out put of the country, new agricultural technologies are promoted and released by research centers. However, Technology generation alone without considering its acceptance by farmer can no longer be used for agricultural production and productivity.

Improved wheat production involves use and application of different agronomic practices such as improved variety, seed rate, spacing, fertilizer rate and pesticide at the recommended rate. However, sizeable improvement in production and productivity depends on the extent to which a household has applied the recommended package practices (Alemitu, 2011).

Like other parts of Ethiopia, in Gesha woreda, improved wheat production technologies are being promoted by woreda office of agriculture and development agents trained to perform agricultural extension activities in each kebeles. Farmers grow wheat as an alternative food source and for market sale. The Gesha woreda council 2008 annual report

shows that most of the farmers do not adopt the complete package of practices recommended by the research system and the average production in the study area is much below the average production for the region. Basically, the observed failure of farmers to recognize and fully put the recommended production package into practice could be ascribed to various factors, which appeared to have some bearing on the farmers' decision to adopt the improved Wheat production package. However, the adoption and intensity of use of improved wheat production technologies by farmers were not yet assessed in the study area. In order to alleviate the problem of wheat production technology adoption scientifically and statically analyzed findings are important rather than giving scattered and unreliable information.

Therefore, study on intensity and determinants to wheat production technology adoption have vital importance and needs investigation.

1.3. Objectives of the Study

1.3.1. General Objective of the Study

To assess factors influencing adoption of improved wheat varieties and associated agronomic practices.

1.3.2. Specific Objectives

1) To assess the level of adoption of wheat production technology package, and

2) To identify factors determining adoption and intensity of adoption of wheat Production technologies in the study area.

1.4. Research Questions

• What is the current level of adoption of the wheat production package?

• What are the determinants that may affect adoption of improved wheat production?

• What is the intensity of the use of improved wheat varieties and recommended agronomic practices?

1.5. Significance of the Study

The determination of factors that affect adoption of improved wheat varieties and associated agronomic practices is essential in taking measures to remove or at least alleviate the constraints affecting adoption. Identification of factors that accelerate the adoption of technology can enhance the formulation and implementation of technology dissemination programs.

Thus, the study assumed to produce very important information related to factors that affect adoption of improved wheat production technologies and recommended practices in the study area. Finally, the information produced from this study is expected to be of some value for technology generators, extension agents and policy makers. The paper is intended for the government, donor agencies, research institutes and other organizations concerned with development or governance, to contribute to increased focus on adoption of improved wheat varieties to enhance production and productivity by informing and stimulating debate, policy and action amongst key players in the development process.

1.6. The Scope and Limitations of the Study

Among many wheat growing districts in kaffa zone, the study was undertaken in Gesha woreda. Although a factor which is found to enhance adoption of a particular technology in one locality at one time might be found to hinder it or to be irrelevant for adoption of the same technology in another locality at the same or different time for the same or different technology or the other way round. From these inconsistent results it is difficult to identify universally defined factors either impeding or enhancing adoption of technology, this study is limited by time, financial constraints and human resources it is restricted to the above-mentioned woreda.

1.7. Organization of the Study

The thesis is organized into five main chapters. Chapter one has presented an introduction, the problem statement- the main thrust of the study, objectives of the study significance and scope and limitations of the study. Chapter two addresses introduce origin and economic importance of wheat, the general theory and description of technology adoption and conceptual frame work. Chapter three provides description of the study area, the methods of data collection and data sources; the sampling and analysis techniques used to analyze the empirical data, while Chapter four comprises the empirical results of the study and discussion. The final chapter gives summary, conclusions and recommendation of the study.

CHAPTER TWO

2. REVIEW OF LITERATURE

2.1. History & Evolutionary Processes of Bread Wheat

Wheat is believed to have originated in southwestern Asia. Some of the earliest remains of the crop have been found in Syria, Jordan, and Turkey. Primitive relatives of present day wheat have been discovered in some of the oldest excavations of the world in eastern Iraq, which date back 9,000 years. Other archeological findings show that bread wheat was grown in the Nile Valley about 5,000 B.C. as well as in India, China and even England at about the same time. Wheat was first grown in the United States in 1602 on an island off the Massachusetts coast. Man has depended upon the wheat plant for himself and his beasts for thousands of years. A global wheat failure would be a disaster that few nations could survive for even one year (Gibson and Benson, 2002).

The process, which began some ten thousand years ago, involved the following major steps. Wild einkorn *T. urartu* crossed spontaneously with *Aegilops speltoides* (Goat grass 1) to produce Wild Emmer *T. dicoccoides*; further hybridizations with another *Aegilops (A. taushi),* gave rise to Spelt (*T. spelta)* and early forms of Durum Wheat (cultivated emmer); Bread Wheat finally evolved through years of cultivation in the southern Caspian plains. This evolution was accelerated by an expanding geographical range of cultivation and by human selection, and had produced bread wheat as early as the sixth millennium BC. Modern varieties are selections caused by natural mutation starting with emmer wheat up to husk less modern wheat. Cytological and cytogenetic evidences showed that wheat consists of diploid, tetraploid and hexaploid (two, four and six

sets of chromosomes respectively) species with a basic chromosome set of x=7. Three genomes designated as A, B (G), and D was involved in the formation of the polyploidy series (Feldmann, 2001). *T. urartu* and *Aegilops squarossa* (syn. *Triticum tauschii*) are the diploid progenitors of the A and D genomes, respectively. It is believed that *T. monoccocum* naturally hybridized with the yet unknown B- genome donor to give rise to the tetraploid emmer group. Emmer wheat in turn hybridized with *Ae. Squarossa* and a spontaneous chromosome doubling of the triploid resulted in the formation of hexaploid wheat (Feldmann, 2001). Within the tetraploid group, cultivated emmer (*T. dicoccum*), which arose from the wild *T.dicoccoides*, was the first to be domesticated. The other forms, such as *T. durum*, *T. turgidum* and *T. polonicum* might have originated from cultivated emmer through mutation or accumulation of mutations that reduced the toughness of the glumes to a point at which free threshing was attained (Kimber and Sears, 1987). According to Mackey (1966) classification, at the tetraploid level, two main species have been recognized; *T. timopheevi* (AAGG) and *T. turgidum* (AABB). *T. durum* belongs to the latter group. There are many known wild and cultivated species in the genus *Triticum*. However, the principal wheat of commercial importance is *T. aestivum* and *T. durum* (Hanson *et al.*, 1982).

2.2. Economic Importance of wheat

Wheat (*Triticum spp*.), is the world's most widely cultivated crop. According to the FAO, 2005 report, about 620 million metric tons of wheat was produced from 217 million hectares in the year 2005/06 with an average yield of 2.85 metric tons per hectare. Wheat is grown on larger area than any other crop and its world trade is greater than for all other crops combined. Its world trade is greater than for all other crops combined. It is easily stored and transported (Slafer & Satorre, 1999).

Common bread wheat (*T. aestivum*, L.) and durum wheat (*T. durum* Desf.) make up 90% of the world's wheat crop. Wheat is further classified as winter or spring, hard or soft, red or white, and by protein content (Briggle and Curtis 2002). The majority of wheat produced is used for human consumption. Bread wheat is used in making bread, rolls, cakes, cookies, and pastries. Durum wheat is used for making pasta products (Wiese 1987). Wheat is also used on a limited basis for animal feed processing wheat produces by products which have proven especially useful in poultry rations (Briggle and Curtis 2002).

2.3. Agronomic practices of wheat production

Crop yield depends on a number of biotic and a biotic factor, all of which are dynamic in response to human interventions (Tanner, et al., 1999). Crop rotation, tillage practices, rate and method of fertilizer application, weed control and planting methods are among the most important management factors influencing wheat yield.

2.3.1. Seeding rate

The spatial distribution of plants in a crop community is an important determinant of yield (Egli, 1988) and many experiments have been conducted to determine the spacing between rows and between plants that maximizes yield. Two general concepts are frequently used to explain the relationship between row, spacing, plant density and yield. First, maximum yield could be obtained only if the plant community produced enough leaf area to provide maximum light interception during reproductive growth (Tessbo et al**.,** 2004). Secondly, equidistant spacing between plants affected interplant competition (Pendleton and Hartwing, 1973). Hence, it will be very important to adjust the spatial distribution of the recommended population in order to have maximum yield. Usually, wheat is broadcasted by hand and covered by oxen ploughing at a variable depth of 5-15 cm to facilitate crop establishment. The recommended seed rate is 150 kg ha^{-1} for hand broadcasting (125 kg ha^{-1} for drilling) both for bread and durum wheat (IAR, 1990). There is also location and varietal specific recommendations but these are not widely popularized or used by farmers (Zewide, 2004).

Lower seed rates than the normal recommended packages were also reported for the central highlands of Ethiopia (Beyene and Yirga, 1992a) and this could be attributed to the land preparation methods that require less seed. Some attribute low seed rate use to limited fertilizer application and less problems with weeds. Increased seed rate is used as a weed control strategy or may be associated with the farmers' lack of prior knowledge on germination potential of seed planted. Moreover, poor emergence due to short coleoptiles or poor tillering capacity of modern varieties and traditional hand broadcasting

which requires more seed rate (20-30%) than drilling may contribute to high seed rates (Tanner *et al*., 1991). Although farmers claim that certified seed is expensive some of them plant as much as 1.3-1.6 times the recommended rate of uncertified seed, a quantity which is almost equivalent to the price of the normal amount of certified seed.

2.3.2. Intercropping

The main objective of intercropping has been to maximize use of resources such as space, light, water and nutrients (Willey, 1990). In cereal\legume intercropping, cereal crops form relatively higher canopy structure than legume crops, and the roots of cereal crops grow to a greater depth than legume crops. This indicates that the component crops probably have different spatial and temporal use of environmental resources such as radiation, water and nutrients (Willey, 1990). Different seeding ratios or planting patterns for cereal-legume intercropping have been practiced by many researchers (Tsubo *et al*., 2003). A number of indices such as land equivalent ratio and economic advantage have been proposed to describe competition within and economic advantages of intercropping systems (Dhima *et al*., 2007).

Plant density and relative proportion of the component crops are important in determining yield and productivity efficiency of cereal\legume intercropping .The growth and yield of legume is reduced markedly when intercropped with high density of cereal component. To optimize plant density, the seeding rate of each crop in the mixture should be adjusted below its full rate (Sullivan, 2003).

Chemeda (1997) reported that in bean or maize intercropping, the relative yield advantage increased to a maximum of 18% and increased total productivity. Similarly, Tolera *et al*. (2005) showed that intercrops produced 32 to 98% more yield per unit area of land than the component sole crops. The results showed that LER is better when cereals are intercropped with legume than when they are sole cropped (Tolera *et al*., 2005).

2.3.3. Use of fertilizer and Application on wheat production

The use of manure (organic fertilizer) has decreased with the introduction of inorganic fertilizers and declining livestock population (Asamenew *et al*., 1993). Inorganic fertilizers are popular with farmers and shown to be profitable in wheat production both with modern and farmers varieties (Yalew, 1997b). Despite high adoption rates, there are major technical constraints such as conflicting recommendation rates arising from the national agricultural research system and the Ministry of Agriculture (Extension Project Implementation Department, National Fertilizer Input Unit). The two most commonly used inorganic fertilizers were DAP (18-48% N-P_2O_5) and Urea (46% N) as source of nitrogen and phosphorus throughout the country. The 'blanket' fertilizer recommendations of EPID is 100 kg ha^{-1} DAP and 50 kg ha^{-1} Urea, i.e., 41 kg N ha^{-1} and 46 kg P_2O_5 ha^{-1} all applied at planting time for all agro-ecological zones, soils and crops. The National Fertilizer Input Unit made region-based general recommendations without due consideration to differences in agro-climates and soil types. The IAR recommendations differentiate fertilizer rates between wheat and soil types, but based on colour rather than the nutrient status of the soil (IAR, 1990).

The percentage of sample farmers applying fertilizers below the recommended rate would increase substantially if the current blanket fertilizer recommendation from EARO is considered. Under such circumstances, it is difficult to ascertain if potential yield of modern variety reaches the desired level of production and productivity. The chronic shortage of fertilizer, higher prices due to removal of subsidies and falling output prices in reasonable harvest years are the main problems associated with low rates of application. Moreover, farmers may revert to use of local landraces in the absence of fertilizers or when they anticipate the problem of water logging due to high rainfall (Beyene and Yirga, 1992a).

Farmers realize that depleted soil fertility is a critical bottleneck in agricultural production. Similarly, researchers have indicated that nitrogen deficiency is among the major factors for low yield levels in wheat. Increased and split application of nitrogen was found to have a significant impact on yield and economic benefit of wheat production in waterlogged areas (Tilahun, et al., 1996). But optimum fertilizer application is constrained by high cost and unavailability of fertilizer as well as limited awareness about soil nutrients on the part of farmers. Planting time is often delayed due to late distribution of fertilizer.

2.3.4. Weed control practices

Weeds cause severe adverse effects on wheat including reduced grain yield and quality. Yield losses from weeds could reach up to 36% in bread wheat (Beyene *et al*., 1991). Applications of herbicides or hand weeding are the two most commonly recommended weed control measures. For wheat single hand weeding or use of 2, 4-D (U46), a selec-

tive herbicide against broadleaf weeds, is recommended at the rate of 1 l ha^{-1} about 30 to 35 days after emergence. Beyene *et al.* (1991) reported that 2, 4 D is the most widely used herbicide by farmers. Girma *et al.* (2000) found that from farmers who applied herbicide, about 71% applied less than the recommended rate (48% half or less than half). Ferede *et al*. (2000) also found that 63% of farmers adopted chemical weed control (2, 4-D), but on average applied a sub-optimal rate of 0.46 l ha^{-1} for wheat production. Sahile and Workiye (1997) found that mono cropping of wheat (or rotation with other cereals) coupled with continuous use of phenoxy type herbicides caused a shift in weed population from easy to control annual broadleaf weed species towards problematic annual grasses and resistant broadleaf weed species. Moreover, lack of adequate knowledge in proper application techniques and lack of equipment (sprayers) may result in inaccurate dosage, which is uneconomical, reduces the efficacy and may lead to herbicide tolerance of weeds (Tessema *et al*., 1999; Girma *et al*., 2000). In some parts of Ethiopia, farmers do not practice weeding and weed species such as *Phalaris* are left in the field until crop maturity where they can be used as livestock feed. Moreover, any late coming weeds are used for stubble grazing following the crop harvests. Both practices have substantial influence on the yield of wheat crops. Beyene and Yirga (1992a) made a similar observation in the central highlands of Ethiopia.

2.3.5. Disease and Pest control practices

Fungal and bacterial diseases are among the main production constraints in the major wheat growing areas of the country (Fininsa and Yuen, 2002). The effect of diseases may be restricted to certain production systems, locations and cropping seasons (Habtu

and Abiy, 1995). Among the listed disease of wheat in Ethiopia, rusts (stripe, leaf and stem), blotches (leaf legume), mildew (powdery mildew) and viruses (wheat streak mosaic) are economically important (Fininsa and Yuen, 2002). Using disease resistance varieties, clean seed, planting date and intercropping are some of the control measure for wheat diseases (SARI, 1997, SARI, 2002).

According to wheat production guide of 2008 aphids can directly damage wheat, but are of concern mostly because they transmit a viral disease called barley yellow dwarf. True army worm and other insects also occasional damage cereal grain crops.

2.4. Technology Evaluation by Farmers

In many countries, extension recommendations are being developed by researchers on experiment stations that aimed at maximizing the yields per unit of land area. Experimentation in the form of on-farm research is tried out in farmers' fields and evaluated based on agronomic performance and economic viability. This yield-oriented approach often brings forth recommendations that are irrelevant to farmers for two main reasons (Franzel and van Houten, 1992).

First, the recommendations are developed under physical conditions different from those of farmers, since they are generally formulated based on the results of experiments conducted on research station with modern farm management practice is to ensure a significant response from the experimental variables. Second by, the researchers' criteria for evaluation of new technologies are often to maximize yields or profit (Farrington and Martin, 1988; Franzel and van Houten, 1992), whereas farmers seek to maximize their

welfare in addition to yield for food supply to their family. Small farmers in Ethiopia generally seek to provide a reliable supply of food for their families and provide cash for what they regard as essential purchases (Franzel and van Houten, 1992). Farmers may have different priorities depending on their socio-economic position, or sex, or age, and their preferences may change over time, for example, due to change in household situation or in market conditions (van Veldhuizen *et al.*, 1997).

Often those farmer-initiated activities have been unanticipated by professionals working in technology development and transfer. Many researchers feel that there is an element missing in research procedure that they should use to develop technology for small farmers. Farmers are active participants in the diagnosis and in testing new technologies proposed to solve or alleviate their problems. Researchers and farmers evaluate new technologies according to their acceptability and feasibility. Farmers are economically rational and they adopt new technologies that are in their interests and reject those that are not. When farmers resist a new technology, it is probably because it is not compatible with their objective, resources or environment, not because of their backwardness, irrationality, or management mistakes (Franzel and van Houten, 1992). Farmers' assessment of the performance of trial technology is crucial and the most important part of technology evaluation. Farmers are rational in their decision-making Farmers will only decide to adopt technology if they are convinced of its benefits and if technology does not require unacceptable efforts on their part Therefore, involving farmers as active participants in the evaluation of recommended technological innovations can have several benefits for technology generation by agricultural research stations. This helps in get-

ting a full understanding of the criteria farmers use to decide whether to adopt or reject recommendations (Bunders *et al.*, 1996).

The choice of one technology/practice over others is greatly influenced by the balance between its positive and negative characteristics. Depending on the preferences, resources, and constraints that individual farmers face, a beneficial characteristic for one farmer may be a negative one for another, or the balance between positive and negative traits may be acceptable for one farmer but not for another. Any new technology presented to farmers will either improve or substitute for the technological options they currently have. It is fundamental to identify these options and understand perceptions about the advantages and disadvantages of each one.

2.5. Theoretical Perspective of Adoption

2.5.1. Definition of Concepts

Feder et al. (1985) defined adoption as the degree of use of a new technology in a long-run equilibrium when a farmer has all of the information about the new technology and its potential. Adoption at the farm level reflects the farmer's decision to incorporate a new technology into the production process. On the other hand, aggregate adoption is the process of spread or diffusion of a new technology within a region. Therefore, a distinction exists between adoption at the individual farm level and aggregate adoption within a targeted region. If an innovation is modified periodically, the adoption level may not reach equilibrium.

Colman and Young (1989) define adoption as it relates to the use or non-use of a particular innovation by individuals (Say farmers) at a point in time or during an extended period of time. Adoption, therefore, presupposes that the innovation (technological change) exists and studies of the adoption process analyze the reasons or determinants of whether and when adoption takes place in the words of Yapa and Mayfield (1978) the adoption of an entrepreneurial innovation by an individual requires the satisfaction of at least three conditions. These are (i) the availability of sufficient information (ii) the existence of a favorable attitude towards the innovation, and (iii) the physical availability of the innovation.

In the context of aggregate adoption as opposed to the final adoption at the individual farmer level, diffusion is defined as the process of spread of a new technology within a region (Rogers, 1983). In other words, diffusion is a cumulative process of adoption measured in successive time periods (Colman and Young, 1989). The introduction of agricultural innovation into a given geographical area in a given period of time may be through both private and public initiatives and the rate of diffusion depends on, among other things, extension communication, the extent to which farmers discuss agricultural issues among themselves on a day to day basis and consistency of performance with the message (Fliegel, 1984).

Following a lucid and extended description of an innovation Presser (1969) concluded that an innovation is something new and novel in human knowledge and experience. Van den Ban and Hawkins (1988) define innovation as an idea, method, or object which is regarded as new by an individual, but which is not necessarily the result of recent re-

search. An innovation has a point of origin in place and time. At its point of origin, it must be an innovation, but it is more commonly called an innovation, a research result or a new development of some older idea (s). In time, as knowledge and use of the innovation diffuse to other people in the surrounding area, the idea ceases to be an innovation in that area.

The rate of adoption is defined as the percentage of farmers who have adopted a given technology. The intensity of adoption is defined as the level of adoption of a given technology. The number of hectares planted with improved seed (also tested as the percentage of each farm planted to improved seed) or the amount of input applied per hectare will be referred to as the intensity of adoption of the respective technologies (Nkonya *et al*., 1997).

The importance of agricultural innovations in the transformation process of economies of developing countries has become, without doubt, the major concern of governments, citizens and development agencies alike. Agricultural economists in the development field have made a particular study of the adoption and diffusion of technical innovation because of the opportunities for increased output and higher levels of income which technological change can offer (Colman and Young, 1989).

2.6. Adoption pattern and factors affecting adoption of technologies

Leathers and Smale (1991) have identified the following adoption patterns from the large body of empirical evidence: for the most part, farmers choose to adopt inputs sequentially, adopting initially only one component of the package and subsequently add-

ing components overtime, one at a time; in some instances, farmers adopt a component and subsequently revert to traditional practices; adoption patterns vary by agro ecological zones, between farmers facing different markets and institutions. Adoption is not the final event of change but rather a decision-making process.

Giger *et al*. (1999) stated that if the technology promoted is not profitable from the farmers' point of view, it is highly doubtful that the use of direct incentives will lead to sustained adoption of a technology in the long term. The technology will almost be abandoned as soon as the project is phased out, and no replication beyond the boundaries and the lifetime of project can be expected. They further explained that rapid economic benefits are very important conditions for success and it is most probably much more important than the use of incentives in terms of achieving genuine, durable adoption.

2.6.1 Household's personal and demographic variables

Age is factor thought to affect adoption. Age is said to be a primary latent characteristic in adoption decisions. However there is contention on the direction of the effect of age on adoption. Age was found to positively influence adoption of sorghum in Burkina Faso (Adesiina and Baidu-Forson, 1995), IPM on peanuts in Georgia (McNamara, Wetzstein, and Douce, 1991), and chemical control of rice stink bug in Texas (Harper etal., 1990). The effect is thought to stem from accumulated knowledge and experience of farming systems obtained from years of observation and experimenting with various technologies. In addition, since adoption pay-offs occur over a long period of time, while costs occur in the earlier phases, age (time) of the farmer can have a profound effect on technology adoption.

The study conducted by Nkonya *et al.* (1997) on factors affecting adoption of improved maize seed and fertilizer in northern Tanzania, indicated that farmer's age did not significantly influence improved technology adoption. In contrary, the result of Million and Belay (2004) shows that age has significant by negative influence on the adoption of fertilizers.

Shiyani *et al*. (2000) also reported that more the experience of growing chickpea, the higher the adoption of new varieties. Such a pattern is expected because more experienced farmers may have better skills and access to information about improved technologies. However age has also been found to be either negatively correlated with adoption, or not significant in farmers' adoption decisions. In studies on adoption of land conservation practices in Niger (Baidu-Forson, 1999), rice in Guinea (Adesiina and Baidu-Forson,1995), Texas (Harper et al., 1990), age was either not significant or was negatively related to adoption.

Older farmers, perhaps because of investing several years in a particular practice, may not want to jeopardize it by trying out a completely new method. In addition, farmers' perception that technology development and the subsequent benefits, require a lot of time to realize, can reduce their interest in the new technology because of farmers' advanced age, and the possibility of not living long enough to enjoy it (Caswell et al., 2001; Khanna,2001).

Studies that have sought to establish the effect of education on adoption in most cases relate it to years of formal schooling (Tjornhom, 1995, Feder and Slade, 1984). General-

ly education is thought to create a favorable mental attitude for the acceptance of new practices especially of information-intensive and management-intensive practices (Walleret al. 1998; Caswell et al., 2001).

The findings of Habtemariam (2004), Million and Belay (2004), and Nkonya *et al*. (1997), indicated that farmer's education had positive and significant influence on adoption. Each additional year of education increases the probability of adoption of improved seed. Legesse (1992) and Degnet (1999) in their study stated that though education plays a significant role in the adoption decision, this variable was not found to be significant in affecting the decision to adopt improved technology.

There is a general agreement that education is associated with adoption because education is believed to increase farmers' ability to obtain, and analyze information that helps him to make appropriate decision. Studies conducted by Itana (1985); Chilot *et al*. (1996); Kansana *et al*. (1996); Asfaw *et al*. (1997); Mwanga *et al*. (1998) and Tesfaye *et al*. (2001) have reported that education had positive relationship with adoption. Similarly, Nkonya *et al.* (1997) reported positive relationship of education with adoption and intensity of adoption improved maize seed. On the other hand, study conducted by Tesfaye (2003), on soil and water conservation practices in Wello, Wolaita and Konso areas of Ethiopia revealed that there is no variation between literacy and illiteracy rates in terms of soil and water conservation practices. Therefore the effect of education can be negative or positive depending on the type of technology. Gender differentials are one of the important factors influencing adoption of improved agricultural technologies. Due to long lasted cultural and social grounds in many societies of developing countries,

women have less access to household resources and also have less access to institutional services. Regarding the relationship of household's sex with adoption of agricultural technologies, many previous studies reported that household's gender has positive effect on adoption in favor of males. For example, Techane (2002), in his study on determinants of fertilizer adoption in Ethiopia found that male headed households are more likely to adopt fertilizer than female headed households. Similarly, Mulugeta *et al* (2001) reported that gender differentials among the farm households positively influenced adoption and intensity of adoption of fertilizer use at 5% significance level. They also further mentioned that being a male headed household increases probability of adoption by 5.9 percent.

Gender issues in agricultural production and technology adoption have been investigated for a long time. Most show mixed evidence regarding the different roles men and women play in technology adoption. Doss and Morris (2001) in their study on factors influencing improved maize technology adoption in Ghana, and Over field and Fleming (2001) studying coffee production in Papua New Guinea show insignificant effects of gender on adoption. The latter study notes "effort in improving women's working skills does not appear warranted as their technical efficiency is estimated to be equivalent to that of males. Since adoption of a practice is guided by the utility expected from it, the effort put into adopting it is reflective of this anticipated utility. It might then be expected that the relative roles women and men play in both 'effort' and 'adoption' are similar, hence suggesting that males and females adopt practices equally.

Family size is one of the other important household demographic variables, which have influence on farmers' adoption behavior. Large family size usually implies availability of labor provided that majority or all of the family members are within the age range of active labor force (15-64 years). In most studies family size had positive relationship with adoption of improved agricultural technologies. For instance, Kidane (2001) on the study he conducted on factors influencing adoption of new wheat and maize varieties in Tigray reported positive and significant relationship of family size with adoption. Similarly, Haji (2003), reported positive effect of family size on adoption of cross-bred dairy cows. Others, for instance, Asante-Mensah and Seepersad (1992); Degnet *et al.* (2001) have also reported similar results. Contrary to this, Million and Belay (2004) reported that family size negatively affected adoption of physical soil conservation measures.

As to me the effect of family size would be magnificent if the contribution of family members in agricultural production is significant. If not the number of family members who were idle may not affect technology adoption.

2.6.2 Economic Variables

In rural context, livestock holding is an important indicator of household's wealth position. Livestock are also an important income sources which enables farmers to invest on the adoption of improved agricultural technologies. No doubt that in most cases, livestock holding has positive contribution to household's adoption of agricultural technologies. `This is evident from many of the past adoption studies which have reported positive effect of livestock holding on adoption. To mention some of them, for instance, Chilot (1994); Degnet *et al.* (2001); Kidane (2001); Birhanu (2002); Techane (2002) and

Endrias (2003) have found that livestock holding has positive influence on adoption of improved agricultural technologies.

Households' income position is one of the important factors determining adoption of improved technologies. In the context of rural households, annual farm income obtained from sale of crop and/or livestock, off-farm and non-farm income are important income sources. Regarding annual farm income, almost all empirical studies reviewed shows the effect of farm income on household's adoption decision is positive (Degnet *et al.*, 2001; Kidane, 2001; Getahun, 2004 and Gockowski and Ndoumbe, 2004).

Off-farm and non-farm activities are the other important activities through which rural households get additional income. The income obtained from such activities helps farmers to purchase farm outputs. Review of some of the past empirical studies shows that the findings regarding the influence of off-farm/ non-farm income on adoption vary from one study to the other. However, majority of the studies reported positive contribution of off-farm and nonfarm income to household's adoption of improved agricultural technologies. For instance, a study conducted by Kidane (2001); Mulugeta *et al*. (2001); Birhanu (2002) and Mesfin (2005) indicated positive relationship between off-farm /non-farm income and adoption of technologies. Contrary to this, Techane (2002) in his study on determinants of fertilizer adoption in Ethiopia reported the negative influence of participation in off-farm income on farmers' adoption of chemical fertilizer.

Availability of household labor is the other important variable which in most cases has an effect on household's decision to adopt new technologies. Several studies reported

the positive effect of household labor availability on adoption of improved agricultural Technologies. For instance, Million and Belay (2004) in their study on factors influencing adoption of soil conservation measures in southern Ethiopia found positive effect of household's labor availability on adoption of soil conservation measures.

2.6.3. Institutional Variables

The relationship between farmers' access to extension services and adoption has been repeatedly reported as positive by many authors. For example, study conducted by Kansana *et al.* (1996) indicated that participation in training, access to communication sources and number of information sources had positive association with level of knowledge and adoption of improved wheat varieties. Similarly, Nkonya *et al.* (1997) reported that visit by extension agents had positive influence on improved maize and fertilizer in Northern Tanzania.

Other sources of information such as mass media and neighboring farmers in the area are also important in diffusion of agricultural innovations. Particularly, interpersonal communication networks among farmers are important and reported in many studies to have positive influence on farmers' adoption decision. Mass media also plays the greatest role in provision of information in the shortest possible time over large area of coverage. Many studies reported positive relationship of mass media with adoption of agricultural technologies (Yishak, 2005). The other institutional support that farmers need to get to improve production and productivity is, credit service and other inputs. Capital and risk constraints are key factors that limit the adoption of high value crops by small scale farmers because these crops generally are much more costly to produce per hectare than

traditional crops and most growers require credit to finance their production. In line with this, study conducted by Gockowski and Ndoumbe (2004) on the adoption of intensive mono-crop horticulture in Southern Cameroon indicated that cash requirements for intensive horticulture production combined with the failure of formal rural credit institutions significantly affected adoption of especially resource poor households.

Similarly, other authors who conducted studies on adoption of cereals (wheat and maize) such as Legesse (1992); Mulugeta (1994); Chilot *et al*. (1996); Asfaw *et al*. (1997); Bekele *et al*. Mwannga *et al*. (1998); Wolday (1999) and Tesfaye *et al*. (2001) have also reported positive relationship of credit with adoption of improved technologies by farmers.

2.6.4. Psychological variables

Adoption (rejection) of technologies by farmers may reflect rational decision making based up on farmers' perceptions of the appropriateness (inappropriateness) of the characteristics of the technology under investigation (Adesina and Zinnah, 1993).

Behavioral change process involves decision-making, which implies cognitive engagement in deciding whether to adopt or reject a given innovation (Koch, 1986). According to Duvel (1991), psychological related factors that he distinguished as needs, perception and knowledge are the most important determinants of farmers' adoption behavior. Many of the studies which have considered these variables reported their significant relationship with adoption behavior. To mention some, a study conducted in Sera-Leone by Adesina and Zinnah (1993) showed that farmers' perception of specific characteris-

tics of technology significantly condition adoption decision. They further indicated that the omission of such variables in adoption model might bias the results of factors determining adoption decision of farmers by ignoring their possible and important influence on adoption behavior. Similarly, Chilot *et al*. (1996) found that perceived relative profitability of improved wheat variety over the traditional one has significantly affected adoption.

Different studies have been conducted in South Africa to see the effect of intervening variables particularly need and perception on adoption behavior. For example, studies conducted by Botha (1986); Louw & Duvel (1993) and Duvel & Botha (1999) confirm the positive and significant relationship of perception with adoption behavior. Similarly, Botha (1986) indicated that farmers' technical know-how of the innovation is important in adoption. Mulugeta (1994) in his analysis of smallholder wheat production and technology adoption in south eastern highlands of Ethiopia also indicated that farmers' knowledge of recommended fertilizer application rates was the critical variable influencing the decision to use higher rates of fertilizer per hectare. A study by Degnet (1999) also reported that adopters were found to have better knowledge on fertilizer application than non-adopters did.

Non adoption of new technologies can be traced back to unwillingness or incapability (related to aspects of perception and knowledge) to adopt (Duvel, 1994). Habtemariam studied the influence of intervening variables on adoption behaviors and production efficiency in Ethiopia. Adoption behaviors and production efficiency were hypothesized to

be a function of personal and environmental factors, which in turn are divided into independent and intervening variables identified by Duvel (Habtemariam, 2004).

Roling (1988) generalized that progressive farmers are more cosmopolites, eager for information; they are interested in extension advice; and have more homophiles with extension workers in that it is easy for them to communicate with each other. Farmers, who have awareness about the existence of the new technologies, continue in the search of further knowledge about the package to evaluate its importance so as to take further measures.

2.7. Conceptual frame work

Agricultural technology adoption and diffusion patterns often vary from location to location. The variations in adoption patterns were created due to the presence of disparity in agro ecology, institutional and social factors. Moreover farmers' adoption behavior, especially in low-income countries, is influenced by a complex set of socio- economic, demographic, technical, institutional and biophysical factors (Feder et al, 1985).

Adoption rates were also noted to vary between different groups of farmers due to differences in access to resources (land, labor and capital) credit, & information and differences in farmers' perceptions of risks and profits associated with new technology. The direction and degree of impact of adoption determinants are not uniform; the impact varies depending on type of technology and the conditions of areas where the technology is to be introduced (Legesse, 1998). Farmers' decision to adopt or reject new technologies can also be influenced by factors related to their objectives and constraints. These fac-

tors include farmers' resource endowments as measured by (1) size of family labors, farm size and oxen ownership, (2) farmers' socio–economic circumstance (age, and formal education) and (3) institutional support system available for inputs (CIMMIYT, 1993).

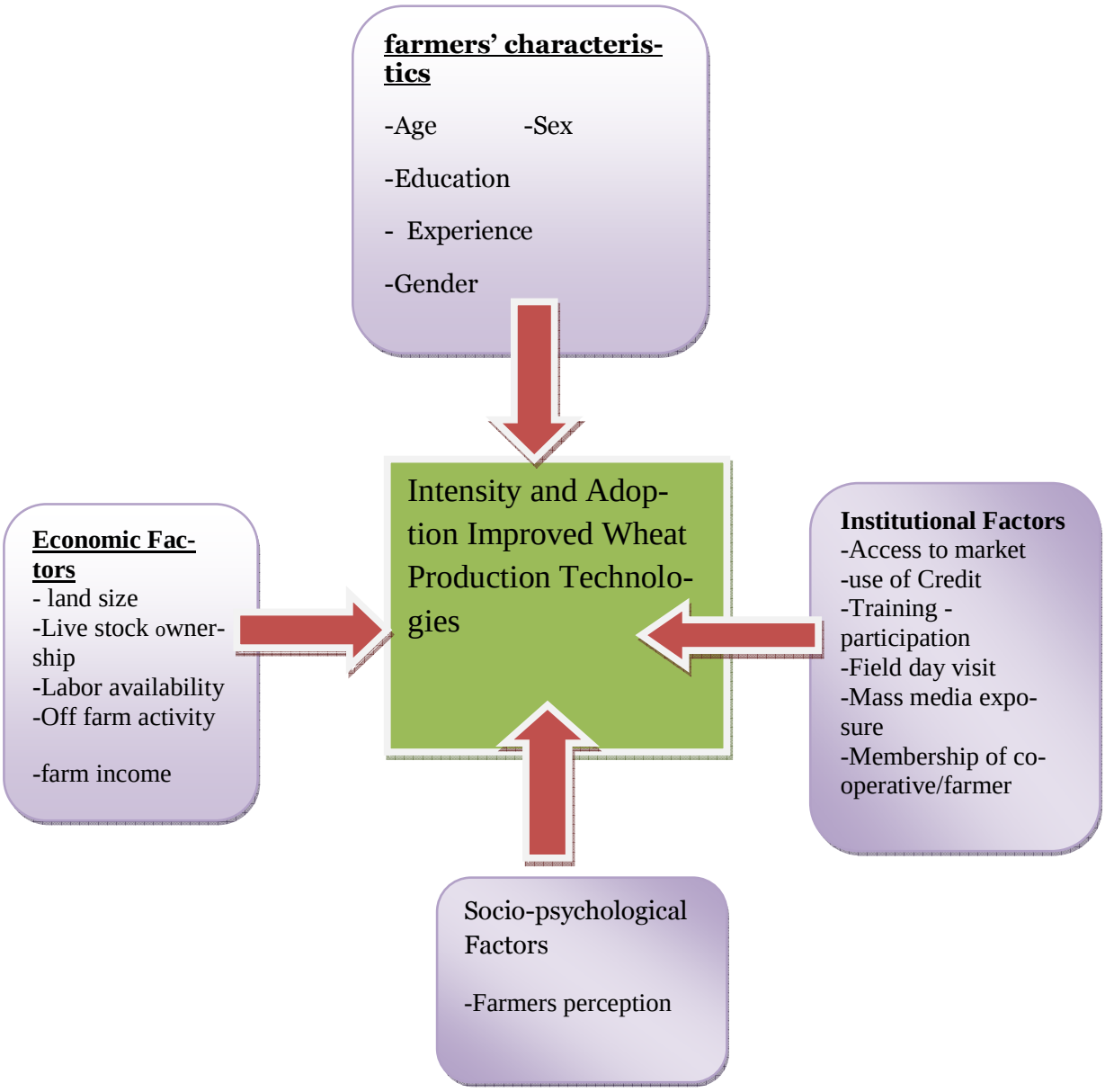

Figure 1. Conceptual framework of the study

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1. Description of the Study Area

The study area, Gesha woreda, is located in the Kaffa zone of the south Nations Nationalities and People Regional State (SNNPRS) of the Federal Democratic Republic of Ethiopia. The woreda capital, Deka town, is located at the distance of 560 kilo meters South West of Addis Ababa .Gesha Woreda is bounded from north by Saylem woreda, from south by Bita woreda, from east by Gewata Woreda and from west by Sheka zone.

The astronomical location of Gesha woreda reveals that the woreda is situated between 7.50^0-7.80^0 latitude north and 35.56^0-35.89^0 longitude east. Gesha woreda is grouped under the rain fall rings of the country in south west and categorized among the areas receiving highest rainfall in Ethiopia. The agro climatic zone of the woreda is subdivided in to 688.5 Km^2 *Woinedega* and 25.6Km^2 is *Dega* and it covers the total area of 714.1 Km^2. The average annual temperature ranges between $15.1c^0$ and 20^0c and the altitude of the woreda ranges from 1501-3000 metres above sea level. These favour for huge forest covers which greatly contribute for total country's forest coverage. The mean annual rainfall of the woreda ranges from2001- 2200mm. The major cereal crops grown in the woreda include wheat, barley, and maize and from pulses pea and beans can be mentioned. The major crop grown in the area is enset. Enset is the staple food for the area of study and more productive than other crops. Animal production is one of the economic activities practiced by the woreda and supplement as an additional income for farmers.

Gesha woreda is one of the few areas covered by dense broad leaved tropical forests in Ethiopia.

According to the information from 2007 census, the projected total population number of the Woreda is 95,305; and of which 46,422 males and 48,883 are females and sum up with a total of 18,080 house hold. The percentage of males and females are 49 percent and 51 percent respectively. The urban population comprises 4 percent of the total and the remaining 96 percent reside in rural area. Majority of Gesha woreda community is categorized under the Kaffecho Society and Kaffi nono language (Omotic language family) were their mother tongue.

Farming system

There are two cropping seasons in the area, *Belg* (short rainy season) from March to April and *Meher* (main rainy season) from June to September. *Belg* rains are mainly used for land preparation and planting long cycle crops such as maize and seedbed preparation for *Meher* crops. The *Meher* rains are used for planting of cereal crops like barley, teff and wheat. Crop production activity in the area is mainly undertaken during *Meher* season. *Meher* rains are also responsible for the growth and development of perennial crops such as enset and coffee. Livestock also play a major role in crop production in areas cereal production (draught power) in addition to meat and milk; it also represents prestige and asset to the households.

Livestock

The main livestock species in the Woreda are cattle, goats and sheep. The livestock resources are cattle 103,390 (57,285 local cows); sheep 46,942; Goats 9,427; Poultry 1,737,152; Horses 4,571; Mules 600; and Beehives 100,949. There is a large resource of production of skins and hides in the Woreda. However, only 45 percent of the marketable skins and hides were officially marketed in 2010. There is a plan to increase the proportion of marketable skins and hides to 85 percent in the 5 year growth and transformation plan. Production of fattened cattle and sheep has great potential and there is a plan to enhance meat production in the Woreda. Secondary data of the woreda agriculture office report reveal that the greater share of income of farmer is from animals and animal products. The woreda has ample potential for production of honey and significant income of farmer is from honey production. But use of improved bee hives were not advocated at expected level by the government except attempts of non governmental organizations to introduce improved method of honey production in two *kebeles*. Traditional way of bee production involves climbing on the canopy of tree and putting a hive on perpendicular position of canopy by tying with branch of trees. This is risky activity because a number of people die of falling from tree during climbing on tree or during harvesting time. But still Farmers entirely use traditional method of honey production. Although animal production is important source of income in the research area, there are no improved cattle breeds. The poultry production system is entirely traditional.

According to the data from WAO of Gesha woreda the representative sites of the study areas namely Batiogity, Batiganity and Meligawi are situated 15Km, 15Km and 17 km

east of the woreda capital, Daka town. They three kebeles are located above 2400 masl and grow cereal crops wheat and barley and as well pulses such as faba bean and pea. Besides crop production, fattening of cattle and sheep is the most important source of income for farmers of the research site.

Figure 2 Administrative Map of Gesha woreda.

3.2. Research Design and Data Collection Method

3.2.1. Data collection methods

Both primary and secondary data were used for this study. Primary data related to personal, socioeconomic, institutional variables and other relevant data were collected. Secondary information from published and unpublished documents and reports from relevant organizations were gathered to supplement primary data. Primary data were collected using quantitative approach by means of household survey. The household survey was carried out from December to February, 2012. The qualitative method of data collection was also employed. It consisted of in-depth open-ended interviews, direct observations and written documents. The interview method was mainly emphasized. Group discussion and individual interviews were held to have reactions of the farmers concerning their detail experiences and their perceptions of the technology and their priority problem. Discussions with woreda experts of the agricultural office and key informants were also conducted.

Before the administration of the structured and semi-structured interview schedules, exploratory farm surveys were conducted and the respondents were informed about the objectives of the survey. The interview schedules were pre-tested before actual data collection and amendments were made to modify some of the questions to make them fit to the context. Six enumerators and one supervisor were recruited. They were trained on the objective and contents of the interview schedule. The six enumerators conducted the interview in the local language, *Kaffi noono* with the supervisor and researcher follow-up.

3.2.2. Sampling Procedure

In this study a two stage sampling technique was employed. In the first stage purposive selection of wheat growing *Kebeles*, followed by selection of sample households were done. The *Kebele* identification was made through reviewing secondary data on production and area coverage of the wheat crop. Out of the total 25 *kebeles* in the woreda 1 is the woreda center and the rest 24 are Peasant Associations (PAS). Ten percent of 24 kebeles (3 *kebeles*) growing wheat were purposively selected as a sample. Preparing fresh list of the sampling frame households were determined based on probability proportional to size of total wheat growing farmers in each *Kebele.* Adopters and non adopters were selected randomly following simple random sampling technique. The total sample size for the study is 120 sample households. Focus group discussions were held in each sample kebeles with the participation of 9-12 people selected purposely. The participants of the focus discussion comprised elders, young farmers, and female heads of households.

Table 3.1. Distribution of sampled peasant association's households by adoption category and sex

Peasant association(kebeles)	Adoption category			Sex		
	Adopters	Non adopters	Total	Male	Female	Total
Batiogity	34	6	40	37	3	40
Batiganity	28	12	40	36	4	40
Meligawi	33	7	40	36	4	40
Total	95	25	120	109	11	120

(Source: Computed from own survey data. 2012)

3.2.3 Data Analysis

The data were analyzed using software SPSS version 16.0 and software STATA version 10. Appropriate techniques and procedures were used in the analysis to identify the influence of personal, socioeconomic, technical and institutional variables on the adoption decision process of the technology. Descriptive statistics were used to provide a summary statistics related to variables of interest. Chi-square test and an independent sample t-test were used to identify variables that vary significantly between adopters and non-adopter. The chi-square test was conducted to compare some qualitative characteristics of the adopters and non adopters. The t-test was run to see if there is any statistically significant difference between the mean of the respective adopter and non adopter categories with respect to continuous variables. The Tobit model was employed to identify the determinants of the technology package adoption and analyze farmers' probability of technology adoption and the intensity of adoption. VIF (Variance inflation factor) for association among the metric explanatory variables and contingency coefficients for categorical variables were used as tests of multi-collinearity.

3.3. Definition of Variables Used for Analysis

The explanatory variables in this study are those variables, which are thought to have influence on intensity of adoption of improved wheat production package. These include household's personal and demographic variables, economic variables, institutional variables and psychological variables (Table. 2). The explanatory variables are defined as follows:

1). Age of Farmer

The role of a framer's age in explaining technology adoption is somewhat controversial in the literature. Whatever the condition, it is important to include age as a factor that would help explain adoption decisions. It is measured in number of years from birth. It is assumed that as farmer age increases the probability of adoption is expected to decrease because as the farmer's age increases, it is expected that the farmer becomes conservative (Techane et al., 2006). Contrary to this Hailu (2008) reported positive relationship between age and adoption which enables easy adoption of new technologies.

2). Gender (Sex)

Gender difference is found to be one of the factors influencing adoption of new technologies. Due to many socio-cultural values and norms, males have freedom of mobility and participation in different extension programs and consequently have greater access to information. Therefore, it is hypothesized that male farmers are more likely to adopt new technology (Tesfaye *et al*., 2001; Mesfin, 2005). It is recorded as 1 if the farmer is male and as 0 (zero) if the farmer is female.

3). Farming experience:

With increased farming experience, farmers are generally better able to assess the relevance of new technologies. This often comes from their interactions with their neighbors and the outside world. It is measured in number of years of experience in wheat production. Farmers with higher experience appear to have often full information and better knowledge and are able to evaluate the advantage of the technology (Chilot. 1996).

4). Education level

It is often assumed that educated farmers are better able to process information and search for appropriate technologies to alleviate their production constraints. Nevertheless it is significant to examine the role education plays in technology adoption decisions. It is measured as: =0, if the farmer is Illiterate, 1 if the farmer can read and write, 2 if the farmer is from 1-4th grade, 3 if the farmer attend 5-8th grade if the farmer achieved 9-10th grade and 5 if the farmer attained above 10th grade. Adoption is expected to correlate positively with education (Getahun *et al*., 2000).

5. Total Land holding

Refers to the amount of land the household owned measured in timad (4 timad is one ha). But in the research area 8 timad is considered as one hectare which deviates from the national standard. But the researcher used the national standard instead of the local measurement. Land is perhaps the single most important resource as it is a base for any economic activity especially in agrarian society. Farm size influences households' decision to adopt or reject new technologies. It also influences scale of technology use. Hence, landholding was hypothesized to have positive relationship with adoption and intensity of adoption of improved wheat production technology.

6. Farm income

The farm income refers to the total annual earnings of the family from sale of agricultural produce such as sale of crop, livestock and livestock products after meeting family requirements. This is believed to be the main source of capital for purchasing agricultural inputs. Households with relatively higher farm income are expected to better adopt

technology and farm income is expected to positively influence adoption (Leggese, 1998). It is measured in Birr.

7. **Types of social participation**

Membership and leadership in community organization assumes that farmers who have some position in PA and different cooperatives are more likely to be aware of new practices as they are easily exposed to information (Chilot *et al,* 1996; Freeman *et al,* 1996; van Den Ban and Hawkins, 1996; Asfaw *et al,* 1997 and Habtemariam, 2004). It was, therefore, hypothesized that those farmers who participated in some social organizational as member or leader are more likely to adopt stumping technology and measured whether they participate or not and number of organization participated as well as types of participation (member or leader). The variable is measured by assigning a score of 0 if a farmer is not a member, 1 if a farmer is member of any farmers' social organization.

8. **Access to Credit**:

Improved technology adoption may require credit to procure complementary inputs to maximize their benefits. Farmers can invest in new technologies either from past accumulated capital or through borrowing from capital sources. It is measured as a binary variable: 1, if the farmer gets credit and 0, otherwise. Farmers without cash and no access to credit will find it very difficult to attain and adopt new technologies (Million *etal*, 2004).

9. Livestock ownership

In rural context, livestock holding is an important indicator of household's wealth position. Livestock serves as an important source of cash. In the study area, farmers in addition to other farming practices they rear livestock. Based on this assumption this variable was hypothesized to have positive relation with adoption and intensity of adoption of wheat production technology.

10. Participation in off farm activities

Additional income earned from activities outside the farm increases the farmers' financial capacity and increases the probability of investing on new technologies. Thus, it is expected that participation in off farm activities affects adoption positively. It was treated as a dummy variable taking 1 if a household head participated in off-farm income generating activities; 0 otherwise. Techane (2006) has found that participation in off farm activities positively influences farmers' adoption decision.

11. Access to extension services

The frequency of contact between the extension agent and the farmers is hypothesized to be the potential force, which accelerates the effective dissemination of adequate agricultural information to the farmers, thereby enhancing farmers' decision to adopt new crop technologies. The variable was treated as dummy, where a value of 1 was given if the household received extension service and zero, otherwise. Empirical results revealed that extension contact has an influence on farm households' adoption of new technology (Hailu, 2008).

12. Frequency of visit by extension agent

The number of times that the extension agents visit the farmer is determinant factor to technology adoption. Farmers more visited by extension agents are expected to positively influence adopt improved wheat variety than rarely visited**.**

13. Participation in field days

It is measured in terms of the number of times the farmer has participated in the field days for the last three years. Participation in field days is expected to positively influence farmers' adoption of improved wheat production (Habtemariam, 2004).

14. Participation in training

Training is one of the means by which farmers acquire new knowledge and skills and it is measured by the number of times the farmer has participated in training in the last three years. Hence, participation in training is expected to positively influence farmers' adoption behavior (Belay, 2003).

15. Hosting demonstration

It is measured in terms of the number of times the farmer has participated in demonstration. Participation demonstration is expected to positively influence farmers' adoption of improved technology (Hailu, 2008).

16. Labor availability:

Labor was measured in terms of Man Equivalent (Annex table 1) (Storck *et.al*, 1999). Availability of labor is likely to influence the gross margin of the innovation. A farm with larger number of workers per hectare (unit of land area) is more likely to be in a

position to try and continue using a potentially profitable innovation and it is expected to influence adoption positively. Household's labor availability has positive effect of on adoption (Million and Belay, 2004).

17. Distance from market center

Distance to the nearest market and the frequency of contact that the farmer maintains with it is likely to influence adoption of the innovation. The closer they are to the nearest market, the more likely it is that the farmers will receive valuable information. It is measured in Kilometers. As market distance increases adoption and intensity of adoption is expected to decrease (Hailu, 2008).

18. Mass media exposure

The adoption process of agricultural technologies depends primarily on access to information and on the willing ness and ability of farmers to use information channels available to them. The role of information in decision-making process is to reduce risks and uncertainties to enable farm households to make right decision on adoption of improved agricultural technologies. Mass media plays the greatest role in provision of information in shortest possible time over large area of coverage. However, as compared to other communication channels, its effect on behavioral change is weak as it is limited to awareness creation than skill development. But, as far as awareness is pre-requisite for behavioral change, still its role cannot be underestimated. Hence, mass media exposure was expected to positively influence adoption and intensity of improved wheat variety technology and measured on having of radio or not and ranking of different media on its' access and frequency.

19. Frequency of use mass media

In relation to this frequency of use of media is an important variable considered in this paper because only having radio or television cannot necessarily assure access of farmer to agricultural information unless used properly.

20. Farmers' perception on production of improved wheat variety technologies and agronomic practices

(Duvel, 1991) associates perceptions with the way the attributes of innovations are perceived and he distinguish between awareness of relative advantages, awareness or concern of disadvantages , the overall status or relative advantage of innovation and the compatibility with situational circumstances. In this study, it is measured by the knowledge of the farmers for the yield increase as compared to the yield without use of improved wheat variety technology practice. In this paper level of agreement on improved wheat variety technology was measured by asignining 1 for strongly agree up to 4 strongly disagree for positive statements and the reverse for negative statements. Therefore, perception of improved wheat variety technology was expected to be positively associated with adoption decision.

Table 3. 2. Summary of definition of variables, unit of measurement and expected effect of hypothesized variables

Variables code	Unit of measurement	Definition of variables	Rationale
AGEHH	Years	Age of house hold	The role of a framer's age in explaining technology adoption is Some what controversial in the literature. As farmer age increases probability of adoption is expected

Variables code	Unit of measurement	Definition of variables	Rationale
			to decrease (Techane, 2006).Younger farmers were more likely to adopt and the effect of age on the probability of adoption was elastic (Hailu, 2008).
SEXHH	Dummy	Sex of house hold	Due to many socio-cultural values and norms, male have freedom of mobility and participation in different extension programs and consequently have greater access to information (Taha 2007; Mesfin 2005).
FAREXP	Years	Farming experience of the house hold	Farmers with higher experience appear to have often full information and better knowledge and are able to evaluate the advantage of the technology (Chilot 1994).
EDULEV	Years	Education level of the house hold	It is often assumed that educated farmers are better able to process information and search for appropriate technologies to alleviate their production constraints. Adoption is expected to correlate positively as education increases (Getahun2000).
TOTLANDHOLD	Hectares	Total land holding of HH	Farmers with larger farms are more likely to adopt an improved technology (especially modern varieties) compared with those with small farms (Belay 2003 ;). Contrary to this Legesse (1992) and Degnet *et al.* (2001) reported negative relationship between farm size and adoption.
FARMINC	Birr	Total farm income of the house hold	The effect of farm income on household's adoption decision is positive (Degnet *et al.*, 2001) and Legesse (1998)
TYPSOCPART	Score	Membership of Farmers' Association	A farmer who is membership of farmer's association in rural kebeles and different positions like leaders are more likely to be aware of new practices as they are easily exposed to information (Habtemariam, 2004).
ACCESSCRED	Dummy	Access to	Farmers without cash and no access to credit will find it very difficult to

Variables code	Unit of measurement	Definition of variables	Rationale
		Credit	attain and adopt new technologies (Million and Bellay, 2004).
NUMLIVSTOCK	TLU	Number of Livestock	As livestock ownership increases adoption/intensity of adoption is expected to increase and correlate positively (Habtemariam, 2004).
PARTOFFARM	Dummy	Participation in off farm activities	Additional income earned from non agricultural activities outside the farm increases the farmers' financial capacity and increases the probability of investing on new technologies (Techane, 2006).
CONTEXT	Dummy	Contact to extension agent.	Hailu (2008) reported that visit by extension agents had positive influence on adoption of improved technologies.
FREQCONTEXT	Number	Frequency of contact with extension agent	Hailu (2008) reported that visit by extension agents had positive influence on adoption of improved technologies.
PARTIFIDA	Number	Attendance in field days	According Tesfaye *et al.* (2001), attendance of agricultural training is positively and significantly related to adoption.
PARTDEMONST	Number	Participation in on farm demonstration	Participation in on-farm demonstration is expected to positively influence farmers' haricot bean package adoption (Techane 2006).
PARTIRAIN	Number	Participation in training	Participation in training expected to positively influence farmers' wheat package adoption (Belay, 2003).
DISTMKT	Kilometer	Distance to output and Input Markets	As market distance increases adoption and intensity of adoption was expected to decrease (Dereje, 2006)`
AVALAB	Man equivalent	Labor availability of HH	Household's labor availability has positive effect of on adoption (Million and Belay, 2004).
MASSMEDEXP	Owner ship of radio	Mass media exposure of house hold	Positive relationship of mass media with adoption of agricultural technologies (Yishak, 2005).
PERCETECH	Likert scale	Perception of HH on im-	Chilot *et al.* (1996) found that perceived relative profitability of im-

Variables code	Unit of measurement	Definition of variables	Rationale
		proved wheat production technology	proved wheat variety over the traditional one has significantly affected adoption.

3.4. Estimation of the Adoption index:

Before analyzing the determinants of adoption, it is important to assess the level of the adoption for each farm household. Accordingly, farmers who were not growing improved variety of wheat were considered as non adopters, while farmers who were growing improved variety with some of the recommended agronomic practices of wheat production were considered as adopters. Among improved agronomic practices only three practices (improved variety, seed rate, and fertilizer application rate), are currently practiced by wheat producer in the study area. The remaining two practices (spacing in cm and chemical application rate) were excluded because of absence and difficulty in getting reliable information on it respectively. Adoption index score was calculated by adding up the adoption quotient of each practice and dividing it by number of adopted practices of each respondent. The adoption quotient of each practice was also calculated by taking the ratio of actual rate applied to the recommended rate.

In this study, adoption index was used to measures the extent of adoption at the time of the survey for multiple practices (package), which shows to what extent the respondent farmer has adopted the most set of package. The index for each respondent farmer was estimated as:

$$AI_i = \Sigma \left[\frac{AHi}{ATi} + sRAi/sRRi + (FAi)/FR \right] / NP$$

Where: AIi = Adoption index

AH_i = area under improved variety of wheat of the ith farmer.

AT_i = Total area allocated for wheat production (improved variety+ local, if any) of the ith farmer.

SRA_i = Seeding rate applied per unit of area in the production of improved wheat of ith farmer,.

SRR_i = Seeding rate recommended for application per unit of area,

FA_i = amount of fertilizer applied per unit of area in the cultivation of improved Variety of wheat by ith farmer,

FR = Amount of fertilizer recommended for application per unit of area in the Cultivation of improved variety of wheat,

NP = Number of practices

Thus, the adoption index is a continuous dependent variable calculated by the formula displayed above with a value ranging from zero to one. Zero indicates no adoption and 1 indicates full adoption. Once the adoption index was calculated, respondent farmers were classified into three categories, viz., low, medium and high adopter.

Improved wheat Production technology involves use of different package practices. These include use of improved variety, seeding rate, fertilizer rate, spacing and so on. Significant improvement in production and productivity depends on the extent to which a household has practiced the recommended improved agronomic practices. The level

of adoption of improved haricot bean production practices by farmers may vary depending on demographic and socioeconomic variables, although institutional and environmental factors in which the house hold operates also influence level of adoption.

The actual adoption index score ranges from 0 to 1. The sample households' index scores were categorized into four adopter groups' namely non adopter, low, medium and high adopter. Adoption index score of zero point implies non-adoption of the overall improved wheat production and greater than zero (>0 and ≤ 1) implies adopters with three category; namely low adopters, medium adopters and high adopters.

3.5. Econometric analysis; The Tobit model.

Tobit model was used to determine the relative influence of various explanatory variables on the dependent variable. Adoption studies based upon dichotomous regression models have attempted to explain only the probability of adoption versus non-adoption rather than the extent and intensity of adoption. Knowledge that a farmer is using high yielding variety may not provide much information about farmer behavior because he/she may be using 1 percent or 100 percent of his/her farm for the new technology. Similarly, with respect to adoption of fertilizers, a farmer may be using a small amount or a large amount per unit area. Hence, a strictly dichotomous variable often is not sufficient for examining the extent and intensity of adoption for some problems such as fertilizers (Feder *et al.*, 1985). There is also a broad class of models that have both discrete and continuous parts. One important model in this category is the Tobit. It is an extension of the Probit model and it is really one approach to dealing with the problem of censored data (Johnston and Dinardo, 1997). Some authors call such models limited depen-

dent variable models, because of the restriction put on the values taken by the regressed (Gujarati, 1995).

Examining the empirical studies in the literature, many researchers have employed the Tobit Model to identify factors influencing the adoption and intensity of technology use. For example, Nkonya *et al*. (1997); Lelissa (1998); Bezabih (2000) and Croppenstedt *et al*. (1999) used the Tobit model to estimate the probability and the intensity of fertilizer use.

According to Adesina and Zinnah (1993), as cited by Shiyani *et al.* (2000), the advantage of the Tobit model is that, it does not only measure the probability of adoption of technology but also takes care of the intensity of its adoption.

Specification of the Tobit Model

The Tobit model applied for analyzing factors influencing adoption and intensity of wheat production technology is the Tobit model shown in equation (1).

$Y_i^* = \beta X_i + ui$ i = 1, 2 ….n

$Y_i = Y_i^*$ if $Yi^* > 0$ ----------(1)

$= 0$ if $Y_i^* \leq 0$

Where,

Y_i = the observed dependent variable, in our case index of adoption of improved wheat production Technology

Y_i^* = the latent variable which is not observable.

X_i = vector of factors affecting adoption and intensity of old coffee stumping technology

β_t =vector of unknown parameters

U_i = residuals that are independently and normally distributed with mean zero and a common variance (σ^2).

Note that the threshold value in the above model is zero. This is not a very restrictive assumption, because the threshold value can be set to zero or assumed to be any known or unknown value (Amemiya, 1985). The Tobit model shown above is also called a censored regression model because it is possible to view the problem as one where observations of Y^* at or below zero are censored (Johnston and Dinardo, 1997). The model parameters are estimated by maximizing the Tobit likelihood function of the following form (Maddala, 1997; Amemiya, 1985).

$$L = \prod_{Y^*\leq 0} 1/\sigma f\left(Y - \beta_i X_i/\sigma\right) \prod_{y\,i\,*>0} F\left(-\beta_i X_i/\sigma\right) \text{----------(2)}$$

Where f and F are respectively, the density function and cumulative distribution function of Y_i*

$\prod_{Y^*\leq 0}$ means the product over those i for which $Y^*\leq 0$. $\prod$. Means the product $Y_{i^*}> 0$ Over those i for which Y*>0.

An econometric software known as "STATA" was employed to run the Tobit model. It may not be sensible to interpret the coefficients of a Tobit in the same way as one interprets coefficients in an uncensored linear model (Johnston and Dinardo, 1997). Hence, one has to compute the derivatives of the estimated Tobit model to predict the effects of changes in the exogenous variables.

As cited in Maddala (1997), Johnston and Dinardo (1997) and Nkonya *et al.*, (1997), McDonald and Moffit proposed the following techniques to decompose the effects of

explanatory variables into adoption and intensity effects. Thus, a change in X_i (explanatory variables) has two effects. It affects the conditional mean of Y_{i*} in the positive part of the distribution, and it affects the probability that the observation will fall in that part of the distribution. Similar approach is used in this study. The marginal effect of an explanatory variable on the expected value of the dependent variable is:

$$\partial E(Y_i)/\partial_i X_i) = F(z)\beta_i \quad \text{----------(3)}$$

Where, $\beta_i X_i/\sigma$ is denoted by z, following Maddala, (1997)

The Change in the probability of adopting a technology as independent variable Xi changes is:

$$\partial F(Z)/X_i = f(z)\,\beta_i/\sigma \quad \text{————————————————————(4)}$$

The change in intensity of adoption with respect to a change in an explanatory variable among adopters is:

$$\partial E(Y_i/Y_{i*} > 0)/\partial X_i = \beta_i[1\text{-}Z\, f(z)/F(z) - f(z)/F(z)^2] \quad \text{----------(5)}$$

Where, F(z) is the cumulative normal distribution of Z, $f(z)$ is the value of the derivative of the normal curve at a given point (i.e., unit normal density), Z is the z-score for the area under normal curve, β is a vector of Tobit maximum likelihood estimates and σ is the standard error of the error term.

CHAPTER FOUR

4. RESULT AND DISCUSSION

4.1. Wheat production technology package adoption by components

4.1.1. Overall adoption of wheat production technology package

In this study, farmers who did not grow improved variety of wheat were considered as non adopters and while the farmers who grow an improved variety with some of the recommended agronomic practices of wheat production (improved variety, seed rate, and fertilizer application rate) were taken as adopters.

The adoption index of sample households indicated that 25 of the sample respondents (20.8%) had adoption index score of 0 which shows they are non adopters, 32 respondents (26.7%) had adoption index ranging from 0.1 to 0.33 which indicates low adopters, while 63 respondents (52.3%) had adoption index score ranging from 0.34 to 0.66 indicating medium adopters, and no respondent was included in the category of adoption index score ranging from 0.67 to 1.00. which shows high level of adoption. This implies that the level of production of improved wheat variety i.e. area for improved wheat compared to the land holding, seeding rate, and amount of fertilizer application is low because no respondent is in the category of high adopters (Table 4.1).

4.1.2. Improved wheat varieties

The intensity of variety adoption is measured in the proportion of area covered by improved variety of wheat to total area. The area coverage was varied among wheat growing sample households. As indicated in (Table 4.1) the total sample households' average area proportion coverage was 0.11 hectare. The minimum and maximum area coverage by adopter sample households ranges from 0.002 to 0.7 hectare. The area coverage for improved wheat variety is token amount compared to the mean land holding of the respondents.

4.1.3. Seeding rate

Farmers in the study area were found to use varying seeding rates of improved wheat variety. On average low and medium adopters used 47.9, 62.5 kg/ha respectively (Table 4.1). There was a significant variation among the sample households in the amount of seed rate per unit area used where the minimum was 31 kg, while the maximum was 75 kg per ha. The independent t test analysis revealed the existence of significant mean difference in seeding rate applied among the two adopter categories, low and medium ($t=12.29$, $P=.000$) at 1% Significance level(Table 4.1).

4.1.4. Fertilizer application rate

As far as fertilizer use is concerned, farmers in the area use varying fertilizer rate, which is below the recommendation. The average rate of fertilizer applied for wheat production by sample grower households during the 2010/11 production year was 40.1 kg/ha and mean fertilizer rates of non-adopters, low, medium and high adopters were 0 kg, 32.8 kg, 44 kg and 0 kg per hectare (Table 4.1).Fertilizer application rate of sample res-

pondents vary across adoption Categories. Analysis of variance indicated that there was significant mean difference between adoption categories (T= 17.16, P= 0.000) in relation to fertilizer application rate at 1 % of significance (Table 4.1).

Table 4.1. Overall adoptions of wheat production packages by adoption category

Adoption category	Adoption index score range	Percentage of farmers	Mean of adoption index	Av. proportion of land improved wheat land / total land)	Average seed rate in Kg/ha	Average Dap fertilizer application rate in Kg/ha
Non adopters	0	20.8	-	-	-	-
Low adopters	0.1-0.33	26.7	0.28	0.04	47.9	32.8
Medium adopters	.34- .67	52.5	0.41	0.15	62.5	44
High adopters	>.67	0	-	-	-	-
Total		100.0	0.37	0.11	57.6	40.1
T value			45.8**	5.8*	12.29**	17.16**

Note: STD in parenthesis** indicates at < 1% significance level *5% significance level
(Source: Computed from own survey data.2012)

4.2. **Production practices by adoption levels**

4.2.1. Method of sowing

100 percent of respondents did not use row planting or drilling method in wheat production. The respondents entirely used broad casting method. Respondent farmers mentioned that reasons for not using the recommended spacing are lack of information and experience. 80% of farmers reasoned out that nobody demonstrated or trained them

about spacing while 20 % of respondents said it is difficult for them to practice recommended spacing (Annex 8).

4.2.2. Intercropping

Intercropping has an enormous importance for small-scale resource poor farmers' who experience food shortage (Tolera *et al.*, 2005). The cereal/legume intercropping could benefit Smallholders through generating sustainable income, minimizing risk of crop failure, and providing a source of protein diet (Chemeda, 1997).

In the study area 100% respondents used mono-cropping method and no respondent practiced either intercropping or both methods (Table 4.2). So the farmers in the study area are vulnerable to risks of shocks in crop production that may arise from disease, weather conditions and natural hazards because no substitute crop if failure of production happens.

Table 4.2. Cropping techniques used in wheat production

Type of cropping	No of household in Adoption category					
	Non adopters	Low adopters	Medium adopters	High adopters	Total	%
Mono cropping	25	32	63	-	120	100
Intercropping	0	0	0	-	0	0
Both	0	0	0	-	0	0
Total	25	32	63	-	120	100

(Source: Computed from own survey data.2012)

4.2.3. Weed control practices

In the study area, 23.3 % of the respondents do not weed their wheat farm while, 37.5% practice improved method of weed control by applying herbicides and 22.5% used local or indigenous method of weeding(Table 4.3). 16.7 % respondents utilized both improved and local method of weed control in wheat farm. So a lot of efforts have to be made by providing extension services regarding weed control practices. Failing to do so results not only in yield reduction but also it affects on grain quality for marketing.

4.2.4. Disease control practices

In area of the study 86.7 % of respondents reported occurrence of disease in their wheat farm in 2010/2011 cropping season and 13% replied no disease outbreak in their farm land (Annex 6). In connection to this the method utilized to control disease outbreak 12.5%, 34.2% and 2.5% of respondents utilized local, improved and both local and improved method of disease control respectively while 37.5% applied no disease control method and 13.3% had no problem of disease on their farm(Annex 7).

Table 4.3. Method used by respondent for weed control in wheat production

Method of weeding	**No. of house hold in adoption category**					
	Non adopter	**Low adopter**	**Medium adopter**	**High adopter**	**Total**	**%**
Improved	0	10	35	-	45	37.5
Local	5	12	10	-	27	22.5
Both	0	5	15	-	20	16.7
Nothing	20	5	3	-	28	23.3
Total	25	32	63	-	120	100

(Source: Computed from own survey data. 2012)

4.3. Farmers' selection criteria for improved wheat varieties

Farmers have their own preference criteria for adoption among the released varieties, which in most cases are not considered by research and extension. Significant numbers of technologies disseminated to farmers are simply rejected by farmers due to difference with preference criteria between technology disseminator and farmers.

The result of ranking made during the survey and focus group discussion in the study area showed that high yielding, disease resistance, market demand, price advantage, length of maturity, grain color, grain size and storability are the most preferred attributes of improved wheat varieties in order as ranked by sample households (Table 4.4). Although many varieties of wheat have been released by national seed certification agency only three varieties were released to the study area since 1994. Of the three varieties K6494A is obsolete and only HAR 604 and HAR 2536 varieties are under production. Of the three varieties, unfortunately K6494A was preferred by respondents although it is not under production. This implies that in the last three years the only two varieties were released to farmers of the research area. Because K6494A was released in 1995 and it is now obsolete and out of production.

Concerning improved wheat varieties on group discussion the respondents pointed out that during 2010/11 growing season improved wheat variety of HAR 604 was highly attacked by leaf rust and resulted up to 100 % yield loss. So yield loss for two successive years may result to restrain them from using improved wheat variety because there was no compensation mechanism made by responsible government institution as they report crop failure. The outcome of crop loss was associated with abandonment of HAR

604. Farmers' selection of obsolete variety was associated with dissatisfactions with the traits of current improved wheat variety. Therefore, attention should be given to participatory research and release of disease resistant varieties by researchers.

Table 4.4. Farmers' Evaluation Criteria of Improved wheat Varieties in the Study area

Selection criteria	frequency	Percent	rank
High yielding	35	29.16	1st
Disease resistance	30	25.00	2nd
Market demand	28	23.33	3rd
Time of maturity	11	9.17	4th
Price advantage	8	6.70	5th
Grain size	5	4.17	6th
Grain color	2	1.66	7th
storability	1	0.81	8th

(Source: Computed from own survey data. 2012)

4.4. Descriptive analysis of categorical variables

4.4.1. Sex

Out of 120 respondents, 90.83% were male and the rest 9.17% were female (Table 4.5). The majority of female household adopters were found in low adoption category which indicates that they are less capable in adopting wheat production packages as compared to their male household counterparts. This clearly shows the existing gap among male headed and female headed households in terms of participation in wheat production technology. The low participation of female-headed households in wheat production technology may be related to their access to information and other resources. Therefore, development interventions should address women's constraints to achieve wider adop-

tion in wheat production technology by female farmers. The result of chi-square analysis ($\chi 2$=8.34, P=0.001) revealed that there is significant relationship between sex and the adoption of wheat production package at 1 % significant level. The result of this study is in agreement with results of previous researchers who have reported the significant relationship between sex and adoption of agricultural technologies Degnet and Belay, (2001) and Mulugeta, *et.al*, (2001).

4.4.2. Educational status of Sample household heads

Among the sample households 45.83 % were illiterates, 26.67% can read and write, 12.5% were Primary first cycle (1-4th grade), 16% were primary second cycle (5-8th grade) and 1.7% were 9th -10th grade (Table 4.5).The result of chi-square- test (χ_2=19.15, P=0.00) revealed that there is significant relationship between education and the adoption of improved wheat production at 1% significance level. Educated farmers are better able to process information and search for appropriate technologies to alleviate their production constraints. The result of this study is in agreement with the studies conducted by Getahun *et al*., (2000) and Hailu (2008) who reported significant relationship between education and the adoption of improved maize production package.

4.4.3. Off-farm activities

Many farmers can earn additional income by engaging in various off-farm activities. This is believed to raise their financial position to acquire new inputs. Out of the total households interviewed only 7.5 % had participated in off-farm activities, while 92.5% had not participated (Table 4.5). Unlike priori expectation, participation in off-farm activities (χ_2=0.613, df= 1), had non significant relationship with adoption of improved

wheat production also the results of Cramer's V= 0.179 indicated that there is no association between off farm activity and adoption of improved wheat production package. The result of this study confirms the findings of Habtemariam (2004) and Teshale (2006).

4.4. 4 .Social participation

In the realm of rural and agricultural development, the importance of social capital is perceived as a willingness and ability to work together. The very likely assumption on which the relationship between social capital and adoption is anchored is that neighboring agricultural households are, de facto, members of a social structure who exchange information about improved agricultural practices. Rogers (1995) concludes that: "The heart of the diffusion process consists of interpersonal network exchanges ... between those individuals who have already adopted an innovation and those who are then influenced to do so."

In this study the analysis of field data showed that adoption and number of organization participated had positive relationship at 5% significant level. (χ_2=21.22 p = 0.035) Table 4.5.

4.4.5. Access to improved wheat seed credit

Access to credit is one way of improving farmers' access to new production technology. It increases the farmers' economy to purchase improved seed, fertilizer and other inputs (Tesfaye *et.al*, 2001). Thus, it is expected that access to credit can increase the probability of adopting improved wheat production technologies but in the study area there is no access to credit in cash but there is access to credit of improved wheat varieties seed in

kind. The result of this study shows statistically no significant difference between adoption categories by access to seed credit at less than 1% percent probability level ($\chi 2$=1.08, p=0.056) (Table 4.5). The result is statically insignificant because the extension policy of the government equally treats all respondents by providing 50 percent credit. Access to credit encourages farmers to adopt improved agricultural inputs which in turn raise agricultural productivity.

4.4.6. Contact with extension agent

The result indicated that 80, 84.4 and 90.5 percent of non adopters, low adopters, and medium adopters had contact with extension agent, respectively (Table 4.5). On other hand 20, 15.6 and 9.5 percent of non adopters, low, and medium adopters respectively had no contact with development agent. This implies that in general a larger proportion (86.7%) have contacts with a development agent while a smaller proportion (13.3%) had no contact with development agent. The chi square result (χ_2=1.44) and P=0.061) shows statistically non significant difference between adoption categories with respect to farmers contact with extension agent.

4.4.7. Frequency of Contact with extension agent

Concerning contact with extension agent in order to critically analyze, frequency of farmer contact with extension agent is considered in this analysis because the above parameter cannot be used the number of times that the extension agent contact with respondents. In this regard adopters were found to be visited by extension agents frequently than non adopters. Here the rationale behind is that person visited once by extension agent is not expected to adopt improved wheat variety production technology equally

with that has frequent contact with development agent. The chi square result (χ_2=16.96) and P=0.00) shows statistically significant difference between adoption categories with respect to farmers frequency of contact with extension agent (Table 4.5).

4.4.8. Participation in training

Training is one of the extension events where by farmers get practical skill and technical information for new technology. Out of total 120 farmers interviewed 74.3% of them had attended training while 25.7 % did not attend training program related to improved wheat production (Table 4.5). The chi square result (χ_2=22.57 and P=0.000) shows statistically significant difference between non adopter and adopter categories with respect to participation in training which help them to Perform new practice properly. This may be explained by the fact that farmers who have training gain better knowledge on production practices and technologies than non trainees which helps to increase production and productivity of improved wheat variety. The result of this study is in agreement with the findings of Tesfaye *et al*., (2001) and Teshale *et al*. (2006) who studied determinants of adoption of improved maize technology in Yelma Dansa woreda in Ethiopia. Training is an important input that improves farmers' performance and equips farmers with new knowledge and skills.

4.4.9. Participation in field day

In this study, participation of farmers in field day program was considered as one variable. From the total sample households 32.3 % of farmers have attended field days once while the majority of the farmers (66.7 %) did not attended field day programs (Table 4.5). The participation of respondents in field day with varying level of frequency of

low and medium adopters can be observed. To determine the relationship between field days participation and adoption status the chi-square analysis (χ_2=12.23, p=0.01) shows that there is significant difference between non adopter and adopter categories. The results of indicated that there is association between field day and adoption of improved wheat production package. The result of this study is in agreement with the findings of Tesfaye *et al*., (2001). In field days, neighboring farmers will get an opportunity to observe how the new technology is practiced in the field.

4.4.10. Conducting demonstration

Demonstration is an important method of extension to create concrete awareness among the farm community. It is also a means of diffusing information to neighboring farmers practically. Demonstration in this study means accepting new practices and put it to practice in the field in the form of trial with close supervision of extension agents and then inviting others to visit how she/he perform it. This situation may facilitate the adoption process and it is hypothesized that there is a positive correlation with adoption.

The study indicated that only 21.3 % of total sampled households have participated in field demonstration on improved wheat production and associated agronomic practices and the rest 78.7 % did not participated (Table 4.5). Chi-square test indicated that, there is Significant (χ_2 =8.73, P=0.001) relationship between participation in demonstration and adoption at 5% probability level. Participation in demonstration significantly and positively influences the adoption of wheat production technologies. Similar results were reported by Kidane (2001) and Belay (2003**).**

4.4.11. Mass media exposure

In this study, respondent farmers' exposure to mass media was measured on having of Radio and television or either of the two and by analyzing frequency of use of media. As the result indicated from the total 95 adopter respondents 76(80%) and from the total 25 non-adopter respondents 8(32%) had radio and statistically significant ($\chi 2 = 21.74$; df = 1; phi value= 0.00) (Table 4.5).

4.4.12. Frequency of use of mass media

From the total respondents 30.8 % never used or listened radio in relation to agricultural programme while the majority of respondents (69.2%) used radio at different level of frequency. Frequency of use of radio by low and medium category of adopters was indicated in Table 4.5. Similarly frequency of use of media materials was compared between adopters and non adopters. The result indicated that ($\chi 2=25.88$, p=00) was significant at 1 percent significance level (Table 4.5).

4.4.13. Farmers' perception on wheat production technology

Farmers' perception of certain technology is the interwoven result of technical and socioeconomic factors. Farmers' knowledge and beliefs about the technology can originate from different sources of information and experiences. They consider the consequence of using the technology from different angles. Technical, economic and social factors influence and/or determine the possibility and /or the extent of use of the new ideas and practices. Similarly, in this study, there is a need to consider the perceived nature of the old coffee stumping technology. Therefore, farmers' perception towards improved wheat production technology was assessed in terms of their evaluative perceptions on

technology, using a scale developed for the purpose of this study. The value of the scale for the positive statements of evaluative perception on improved wheat production technology were assigned 5,4,3,2,1 for strongly agree, agree, neutral/undecided, disagree, and strongly disagree; respectively, where as the negative statements were assigned to the reverse value. Finally the result showed that there was statistically non significant mean difference on each statement developed to measure perception about improved wheat production technology adopter's category (Table 4.6). Mean of total perception statements rate of adopters was 3.32, where as non-adopters was 2.91 which were non significant at 1% and 5% significant level. In contrary to the hypothesis, total mean of wheat production technology perception has non significantly related with wheat production technology adoption t-value=3.75, p=.0624(Table 4.7).

Table 4.5. Characteristics of wheat growing farmers by adoption levels: (Categorical variables percentage of farmers)

		Adoption category						
Indicator	**Category**	**Non adopter**	**Low adopter**	**Medium adopter**	**High adopter**	**Total**	$\chi 2$	P-value
Education	Illiterate	21(84.0)	11(34.4)	23(36.5)	-	55(45.83)	19.15**	0.00
	Can read and write	3(12.0)	12(37.5)	17(27.0)	-	32(26.67)		
	1-4 Grade	1(4.0)	3(9.4)	11(17.5)	-	15(12.5)		
	5-8 Grade	_	5(15.6)	11(17.5)	-	16(13.33)		
	9-10 Grade	-	1(3.1)	1(1.6)	-	2(1.7)		
	>10 Grade	0	0	0	-			
Sex	Male	19(76)	30(93.7)	60(95.2)		109(90.83)	8.34*	0.001
	Female	6(24)	2(6.3)	3(4.8)		11(9.17)		
Off farm Activity	NO	24(96)	29(90.6)	58(92.1)	-	111(92.5)	0.558	0.179
	Yes	1(4)	3(9.4)	5(7.9)	-	9(7.5)		
Access to wheat seed	No	25(100)	31(96.9)	60(95.2)	-	116(96.7)	1.08	0.056

Indicator	Adoption category					Total	$\chi 2$	P-value
	Category	Non adopter	Low adopter	Medium adopter	High adopter			
credit	Yes	0(0)	1(3.1)	3(4.8)	-	4(3.3)		
Contact with extension agent	No	5(20)	5(15.6)	6(9.5)	-	16(13.3)		
	Yes	20(80)	27(84.4)	57(90.5)	-	104(86.7)	1.44(NS)	0.061
Frequency of contact with extension agent	Never	7(28)	3(9.4)	6(9.5)	-	16(13.3)		
	Once in week	5(20)	13(40.6)	35(55.5)	-	53(44.16)		
	Twice in week	0(52)	8(25.0)	15(23.8)	-	23(19.2)		
	monthly	0	8(25.0)	18(28.6)	-	26(21.7)		
	Yearly	0	0	1(1.6)	-	1(.83)	16.96**	0.00
Participation in training	Never	16(64)	5(15.6)	11(17.4)		32(25.7)		
	once	9(36)	27(84.4)	51(81)	-	87(72.5)		
	5 and more	0	0	1(1.6)	-	1(.83)	22.57**	0.00
Participation in field day	Never	24(96)	17(53.1)	39(61.9)	-	80(66.7)		
	once	1(4)	15(46.9)	24(38.1)		40(32.3)	12.23**	0.01
Participation in demonstration	Never	25(100)	23(71.9)	46(73)	-	94(78.3)		
	once	0	9(28.1)	17(27)	-	26(21.7)	8.73**	0.01
Social participation	yes	1(4)	15(46.9)	24(38.1)	-	94(78.3)	21.22*	0.035
Mass media exposure	Have radio	8(32)	25(78.1)	51(80.9)	-	84(70)		
	Have TV	0	0	0	-	0		
	Not have radio and TV	17(68)	7(21.9)	12(19.1)	-	36(30)	21.74**	0.00
Frequency of use of mass media	never	18(72)	10(31.25)	9(14.3)	-	37(30.8)		
	rarely	7(28)	5(15.6)	30(47.6)	-	42(35)		
	occasionally	0	5(15.6)	13(36.1)	-	18(15)		
	often	0	3(9.3)	17(27)	-	20(16.7)		
	Very often	0	0	3(4.8)	-	3(2.5)	25.88**	0.00

*Significant at 1% significant level,** significant at 5% level.
(Source: Computed from own survey data.2012)

Table 4.6. Farmers mean perception on wheat production by adoption category

Statement	Adoption category	N	Mean	Standard deviation	t-value	P-value
1/productivity of wheat is decreasing year to year.	adopters	95	4.35	.402	2.723	0.03
	Non adopters	25	4.21	2.55		
2/Use of improved wheat variety increase yield as compared to local variety.	adopters	95	4.26	.441	2.53	0.061
	Non adopters	25	3.91	.325		
3/Fertilizer application to improved seed increase production than sowing with out fertilizer.	adopters	95	3.25	.665	1.82	0.056
	Non adopters	25	3.01	.395		
4/Even though fertilizer application to wheat increases productivity, its disadvantage outweighs advantage.	adopters	95	2.70	.862	-5.27	0.039
	Non adopters	25	2.79	.601		
5/recommended seeding and fertilizer application rate to wheat production are nothing to do with yield increment.	adopters	95	2.82	.821	-6.25	.043
	Non adopters	25	2.68	.595		
6/since weed problem do not significantly affect productivity weed control on wheat should not be considered in agronomic practice.	adopters	95	2.42	.893		
	Non adopters	25	2.21	.623	-8.25	0.125
7/There are other technologies rather than wheat production which can be easily adopted and give more return.	adopters	95	4.56	.391	3.35	0.008
	Non adopters	25	4.48	.352		
8/Improved wheat varieties are more disease and weed resistant than the local.	adopters	95	3.11	.692	2.21	0.143
	Non adopters	25	2.04	5.35		
9/Intercropping of wheat with other crop is possible and increase effective utilization of land.	adopters	95	3.01	.775	2.53	0.057
	Non adopters	25	2.83	5.62		
Total			**3.25**	**0.671**	**3.75**	**.0624**

(Source: Computed from own survey data. 2012)

4.5. Descriptive analysis of continuous variables

4.5.1. Age of the household head

Age is one of the demographic factors that is useful to describe households and provide clue about the age structure of the sample and the population. Age is usually considered in adoption studies with the assumption that older people have more farming experience which enables them to easily adopt new technologies. However, on the other side, age is related to the risk management nature of an individual farmer. As indicated in Table 4.7, the mean age of respondents was 45.33. The average age for non adopters, low and medium adopters was found to be 48.20, 50.28 and 41.68 respectively. An independent-sample t-test was conducted to see if there was significant difference in the mean age of adopters and non- adopters. The t-value (t=-1.209, p=0.229) showed statistically non significant in the mean age of adopters and non-adopters. This result indicated that there was no relation- ship between adoption of improved wheat variety technology and age of the household.

4.5.2. Family size

Family size in the study is considered as the number of individuals who resides in the respondent's household. Large family size is assumed as an indicator of labor availability in the family. Based on this fact this variable was hypothesized to have positive and significant relationship with adoption of wheat production technologies because availability of labor is likely to influence the gross margin of the innovation. The mean family size of adopters was 4.81 and While that of non adopters was 4.16. The average family size of the respondents was 4.68 members. The minimum family size of the sample

households was 1 while the maximum was 11 persons (Table 4.7). The results showed that there is no significant difference among the adoption categories in family size. Independent t-sample test (t=1.46. P= .146) shows that there is statistically non significant mean difference between adoption categories. The result is not in favor of the study conducted by Kidane (2001) on factors influencing adoption of new wheat and maize varieties in Tigray reported positive and significant relationship of family size with adoption and Getahun et.al (2000).

4.5.3. Total land holding

Land is perhaps the single most important resource, as it is a base for any economic activity especially in rural and agricultural sector. Farm size influences households' decision to adopt or to reject new technologies. Hence, land holding was hypothesized to have positive and significant relationship with adoption and intensity of adoption. The average total land holding of the sample households were 1.875 hectare. The minimum and maximum total land holding of the respondents ranges from 0.375 to 8.25 hectares (Table 4.7). The average total land holding of the non adopters group was 0.775 hectares where as the low and medium adopters categories was 2.035 and 1.875 ha respectively. Independent sample t-test (t=10.11, P=0.008) shows that there was statistically significant mean difference among adoption categories.

Table 4.7. Characteristics of wheat growing farmers by adoption levels: (Continuous variables percentage of farmers)

Indicators	description	Adoption category								T-value
		Non adopter		Low adopter		Medium adopter		Total		
		Mean	STD	Mean	STD	Mean	STD	Mean	STD	

Indicators	description	Adoption category								T-value
		Non adopter		Low adopter		Medium adopter		Total		
		Mean	STD	Mean	STD	Mean	STD	Mean	STD	
AGE	Age of HH	48.20	14.29	50.28	13.64	41.68	11.85	45.33	13.35	1.209
WHEATFMEXP	Wheat farming exprience	14.00	8.20	18.72	9.06	13.16	7.17	14.82	8.21	0.557
DISTMKT	Distance of HH from main general market	3.80	1.31	2.88	1.96	2.87	1.75	3.07	1.76	2.391
TOTLANDHOLD	Total land holding of HH	0.775	1.35	2.460	12.60	2.035	9.14	1.875	10.40	10.11**
TLUHH	Total livestock of HH in TLU	2.97	1.17	13.54	11.49	10.44	6.13	10.18	8.00	3.63**
TFARMINC	Total farm income of HH	1466.2	1729	14461.72	41875.36	7253.40	7827.30	7969.95	22579.20	3.16**
ACTFAMLAB	Actual labor availability in man equivalent	2.5	1.43	2.87	1.69	2.73	1.73	2.72	1.65	0.832
TOTFAMNUMBER	Total family number of HH	4.16	2.05	5.06	1.88	4.68	1.99	4.68	1.98	1.46
OFFINCOME	Income earned from off farm by HH	20	100	78.16	313.9	142.9	618.5	100.0	478.97	0.938 (NS)

(Source: Computed from own survey data. 2012)

4.5.4. Livestock holding

Livestock holding is an important indicator of household's wealth position in rural context. The number of livestock owned by a farmer was hypothesized to affect positively the adoption of improved wheat production technology. Livestock is the farmers' important source of income, food and draught power for crop cultivation in Ethiopian agriculture. Hence, a household with large livestock holding can have good access for more

draught and it is one of the main cash sources to purchase inputs. As indicated in Table 4.7, the average livestock ownership of sample households in TLU was 10.18. The minimum livestock number of the total respondents' in TLU was 0 whereas the maximum number of livestock was 66. To knows whether there is a variation in average livestock ownership between adopters and non- adopter's independent sample t test was conducted. The result of t (t=3.63, P=0.00) revealed that there is significant variation in average livestock ownership within the adopter categories. The result of this study is in conformity with earlier adoption studies of Degnet (2001), and Habtemariam (2004), in their studies reported that livestock holding has a positive significant influence on adoption of agricultural technologies.

4.5.5. Labor availability

Large working labor force in a family means, the household may not need to hire more additional labor and the money saved due to use of own labor force could be used for purchasing other crop production inputs. This will increase household's possibility to adopt improved wheat production package. Therefore, it was hypothesized to have positive relationship with adoption and intensity of adoption of wheat production package. The total average labor availability in terms of man equivalent for sample household was 2.72 with standard deviation of 1.65 (The average number of available labor force in terms of man equivalent for non-adopters, low, and medium adopters were 2.5,2.87 and 2.73 respectively (Table 4.7) The analysis of variance (t= 0.83 and P =0.51) shows insignificant mean difference between adoption categories, the result of this study did not confirm the findings of Bekele *et.al***,** (2000) and Million (2004).

4.5.6. Farm income

It was indicated in Table 4.7 that, the average annual farm income of the sample households was 7969.95 Birr. The maximum annual farm income was 39,960 Birr while the minimum was 802.5. On average, adopters had higher annual farm income of 8608.66 Birr as compared, to non-adopters who on average had only 4490.48 Birr. The major cash income for sample households in the study area is from sale livestock and livestock products.

Analysis of mean variance of annual farm income using an independent sample t-test (t=3.16, p=00) had indicated that there was significant mean difference among the adopter categories at 1% significance level. This study confirms with the findings of Degnet *et al.,* (2001) and Kidane, (2001).

4.5.7. Access to market

Access to road in general and distance from a near market and input suppliers in particular influence farmers' adoption of new technologies. Markets are communication centers both for producers, consumers and traders (Hailu, 2008). In this study, it is hypothesized that the distance between the respondent's residence and the nearest market place (measured in kilo meters) is negatively correlated with the decision to adopt newly introduced crop varieties with its associated agronomic practices.

In this study the sample farmers on average travel about 3.07 kms to sell their wheat production. When comparing average travel distance of non-adopters, low and medium adopters traveled average distance of about 3.80 kms, 2.80 and 2.87 kms respectively.

But the independent sample t-test (t=-2.391, p=.058) revealed that it was not statistically significant (Table 4.7).

4.5.8. Experience of the household

Farmers with higher experience in wheat production appear to have often full information and better knowledge and supposed to evaluate the advantage of the technology. Hence it was hypothesized to affect adoption positively. With respect to the respondents' farming experience, the most experienced farmers in the sample had mean experience of 14.8 years whereas the least experienced farmers had 2 year of experience in wheat farming (Table 4.7). On average, the sampled respondents had 14.82 years of experience in wheat cultivation. The average years of wheat cultivation experience of house hold heads for non adopters, low adopters; and medium adopters were 14, 18.72, and 13.16 respectively. One way analysis independent sample t test (t=.0.557 P=0.578) shows that there is no statistically significant mean difference among adoption categories. The result of this study is in complete agreement with the findings of Chilot *et.al* (1996).

4.6. Results of the Econometric Model

Identification of factors affecting adoption of improved wheat varieties and agronomic practices alone is however not enough to stimulate policy actions unless the relative influence of each factor is known for priority based intervention. In this section, the results of the Tobit model is presented and discussed to see the relative influence of different personal, demographic, socio-economic, institutional and psychological variables on adoption and intensity of adoption of improved wheat varieties technology.

Several variables that had shown significant relationship with the dependent variable were included into the model. But, regardless of their importance and their significant relationship, some of them were excluded due to the instability they created in the model. Finally a batch of ten variables that fit to the model was used for running the model. Table 10 below presents list of these variables with their operationalization.

Table 4.8. List of variables to be included in the econometric model

Variables code	Variable type	Description of variables	value
SEXHH	Dummy	Sex of house hold	0=female 1=male
EDULEV	Dummy	Education level of the house hold	0=illtrate,1=can read and write,2=primary 1st cycle,2=primary 2nd cycle,3=secondary school =preparatory &above
FARMINC	continuous	Total farm income of the house hold	Measured in birr.
TLUHH	continuous	Number of Livestock	Measured in tropical livestock units
PARTIFIDAY	Dummy	No of Participation in field days	0=no, 1=yes
PARTDEMONST	Dummy	No of Participation in on farm demonstration	0=no, 1=yes
PARTIRAIN	Dummy	No of Participation in training	0=no, 1=yes
MASSMEDEXP	Dummy	Mass media exposure of HH	0=has no radio, 1=has radio
FREQCONTEXT	continuous	Frequency of HH contact with ext. agent	Measured in numbers
FREQMASSMED	continuous	Frequency of use of mass media(radio)	Measured in numbers

Prior of running the Tobit model all the hypothesized explanatory variables were checked for the existence of multi-collinearity problem. There are two measures that are often suggested to test the existence of multi-collinearity. These are: Variance Inflation Factor (VIF) for association among the continuous explanatory variables and contingency coefficients for dummy variables. The VIF values displayed in Table 4.9 have shown that all the continuous explanatory variables have no serious multi-collinearity problem.

Table 4.9. Variance inflation factor (VIF) for continuous variables.

	Colinearity statics	
Variable	Adjusted R^2	VIF($1/1-R^2$)
FARMINC	0.3602	1.563
TLUHH	0.4502	1.819
MASSMEDEXP	0.4565	1.840
FREQCONTEXT	0.4632	0.1863
FREQMASSMED	0.2424	1.320

(Source: Computed from own survey data. 2012**)**

The VIF values displayed in Table 4.9 have shown that all the continuous explanatory variables have no serious multi-collinearity problem. Similarly, contingency coefficients were computed for dummy variables. The values of the contingency coefficients were also low (Table 4.8). Based on these test, both the hypothesized continuous and dummy variables were included into the model.

Table 4.10. Contingency coefficients for discrete variables

Var.	1	2	3	4	5
1	1				
2	0.045	1			
3	0.624	0.112	1		
4	0.337	0.048	0.256	1	
5	0.048	0.256	0.152	0.422	1

(Source: Computed from own survey data. 2012**)**

Key

1=Sex of HH (SEXHH)

2=Educational level of HH (EDULEV)

3= Participation in field day (PARTIFIDA)

4= Participation in demonstration (PARTDEMONST)

5= Participation in training (PARTIRAIN)

Table 4.11. Maximum Likelihood Estimates of Tobit Model

Variable	Coeff	STD. error	t-ratio	P-value
CONSTANT	-4.52667	26.308	-0.165664	0.768343
SEXHH	0.5675765	0.0533227	1.80*	0.0000
EDULEV	0.0782856	0.0288318	2.51313**	0.00757332
AGE	-1.48857	27.287	-0.0434282	0.856506
ACTFAMLAB	0.0433544	0.0356117	1.21341	0.223441
TOTLANDHOLD	0.38087	0.107017	3.44887**	0.000360772
CONTEXT	0.081008	0.223211	1.15	0.0033
TLUHH	0.088732	0.0530616	1.29	0.0216
ACESSCRED	0.0212017	0.0180839	0.755443	0.443237

OFFFAMINC	0.8500115	0.000925683	0.00494625	0.17786
WHEATFAMEXP	-0.0043389	0.0420569	-0.105437	0.804831
T0TFAMNUMB	-1.0117e-005	1.23535e-005	-0.818957	0.401701
MASSMEDEXP	0.00170013	0.0014374	2.8268**	0.236894
PARTIFIDA	0.348547	0.139061	2.50643**	0.0121956
DISTMKT	-0.0412422	0.115361	-0.357506	0.720713
SOCIAPART	0.154249	0 .0830112	2.85817**	0.0631452
PARTDEMONST	0.273417	0.0806258	3.39119**	0.000695906

Variable	Coeff	STD. error	t-ratio	P-value
FREQCONTEXT	0.348547	0.139061	2.50643**	0.0121956
FREQMASSMED	0.117505	0.0575994	2.04005**	0.0413455
PARTRAIN	0.149042	6.69934e-006	67.114**	4.50302
Sigma	0.272927	0.0331476	8.23368	2.88658e-015

** and * represents 1% and 5% significance level respectively.
Source: Model output

4.6.1. Determinants of adoption and intensity of adoption of improved wheat production technology

Estimates of the parameters of the variables expected to determine the adoption and intensity of adoption of improved wheat production technology are given in Table 4.11. A total of 20 explanatory variables were considered to be included in the econometric model, of which 11 variables were found to significantly influence adoption and intensity of adoption of improved wheat production technology. These include, sex, education of household head, total land holding, total livestock ownership of house hold, farm income, mass media exposure, frequency of use of mass media , participation in field day

and frequency (number) of participation in field day, types of social participation, hosting demonstration, and participation in training. The effect of changes in the explanatory variables on the probability of adoption and intensity of adoption of improved wheat production technology was computed and the results were summarized in Table 4.12.

Education of households (EDUHH)

Education has a positive and significant relationship with the adoption and intensity of adoption of improved wheat production technology (Table 4.11). In this regard, the adoption and intensity of improved wheat production technology by farmers who were literate is likely to be greater than farmers who were illiterate. This suggests that being literate would improve access to information, capable to interpret the information, easily understand and analyze the situation better than illiterate farmers. So, farmer who are literate were likely to produce improved wheat and use wheat production package properly than those illiterate farmers. This result has supported by other previous studies such as Lelissa (1998), Techane (2002), Lelissa and Mulate (2002), Yitayal (2004).

Sex of house hold

Sex of a house hold head is one of the determinants of technology adoption. As the Tobit model indicates sex of house hold head had positive and significant influence on the adoption of improved wheat production technology at 1% significance level (Table 4.11). This shows that being male headed households have better access to information on improved wheat production technologies and are more likely to adopt new technolo-

gies than female headed households and also increase their wheat production. Female headed households have not better access to information on improved technologies and are not more likely to adopt new technologies than male headed. This result agrees with Tesfaye et al., (2001) and Mesfin, (2005)

Participation in training (PARTRAIN).

Training is one of the extension events where by farmers get practical skill and technical information for new technology. Results of the study indicated that participation in training was positively and significantly affected by acquiring training at 1% significant level (Table 4.11). This may be explained by the fact that farmers who have training gain better knowledge on wheat production practices and technologies than non trainer which helps to increase production and productivity of improved wheat.

Participation in field day (PARTIFDA)

Participation in extension events is the other means through which farmers get information about improved technologies. Such events include extension arrangements such as training, demonstration, and field days or visits. In this study, participation of farmers in field day program was considered as one variable. Result of the finding indicated participation in field day program was positively and significantly related to adoption and intensity of improved wheat production technology at 5% significance level (Table 4.11). The implication is that emphasis has to be given to farmers' training, participation in

demonstration, and field days to enhance adoption of improved wheat production technology.

Frequency of contact with extension agent (FREQCONEXT)

In visiting of farmers a mere contact of extension agent cannot result attitudinal change of house hold since adoption is a gradual process and difference speed of adoption among farmers. Therefore frequency of visit by extension agent should be considered. In this case as the Econometric Tobit model result showed the number or frequency of visit of house hold by development agents has positive and significant relation to adoption and intensity of adoption improved wheat production technology (4.11). As the extension agents number of visit of the farmer increases the probability of adoption of improved wheat production increases. The implication is that frequent visit of farmers by extension agents should be given emphasis in order to enhance adoption of improved wheat production technology.

Conducting demonstration (PARTDEMONST)

Farmers can acquire new knowledge through demonstration to improve production and productivity of agriculture. The Tobit result indicates that the probability of wheat production package adoption was positively and significantly affected by demonstration at 1% significant level (Table 4.11). This implies that demonstration approach is important to transfer agricultural production technologies to farmers practically .When farmers conducting a new practice they can weigh the advantage and disadvantages of the new technology and this can facilitate adoption and helps them to implement the new technology properly. This result shows that farmer who conducts demonstration is more likely to

adopt new improved technology than others. This suggests that wider demonstration coverage would speed up the adoption of the package and hence calls for development of the existing limited demonstration practices. Similar results were identified by Legesse (1998) and Belay (2003).

Social participation (SOCIAPART)

Membership and leadership in community organization assumes that farmers who have some position in peasant associations and other different social organization are more likely to be aware of new practices as they are easily exposed to information and cosmopolite. Therefore, as the Econometric Tobit model analysis result showed the types of social participation has significant and positive relationship with the adoption of improved wheat production technology (Table 4.11). This implies that, compared to non membership from less and only member ship participation in organization, being leader and committee were more likely to adopt improved wheat production technology. Therefore, strengthening the types of participation in organization facilitates adoption of improved wheat production technology.

Mass media exposure (MASSMEDEXP) and frequency of use of mass media (FREQMASSMED)

Media is an important tool for providing information of technologies and used to link innovations from the source to end users . Radio and television are media materials used to disseminate information about new technologies. It is expected that ownership of radio and frequency of use of radio would make difference in technology adoption by informing farmers about wheat production technology and creating attitudinal changes.

As was expected, the Econometric Tobit model analysis result revealed that wheat production package adoption was positively and significantly affected by both exposure to mass media and frequency of use of mass media Table (4.11). Therefore, advocacy work by using local media that is accessible to farmers would have positive impact on intensity and adoption of improved wheat production package.

Table 4.12. The effect of change in significant explanatory variables on adoption and Intensity of adoption of improved wheat production technology

Variable	change in probability of adoption	change in intensity of adoption	Total change
CONSTANT	-0.0534	-3.7674	0.3587
SEX	0.0008	0.0657	0.0066
EDUHH	0.0044	0.3446	0.0320
TLUHH	0.0030	0.2850	0.0292
MASSMEDEXP	0.0018	0.1314	0.0129
FREQCONTEXT	0.0032	0.2330	0.0229
PARTDEMONST	0.0102	0.7584	0.0737
PARTIFIDA	0.0014	0.1001	0.0099
FREQMASSMEDEXP	0.0018	0.1406	0.0129
PARTTRAIN	0.0078	0.5719	0.0563
SOCIAPART	0.0068193	0.083761	0.083762
FARMINC	0 .031650	0 .073650	073650

* Computed using mean values
Source: Model output

4.6.2. Effects of changes in the significant explanatory variables on probability of Adoption and intensity of adoption of improved wheat production technology

Using a decomposition procedure suggested by McDonald and Mofffitt (1980), the results of Tobit model can be used to assess the effects of changes in the explanatory variables in to adoption and intensity of use of improved technologies (Adensina and Zinnah, 1993; Bezabih, 2000 as cited in Endarias, 2003). Based on this fact, in this study too, the effect of changes in the explanatory variables on the probability of adoption and intensity of adoption of improved technology was computed and the results were summarized in Table 4.12.

The results computed indicate that a unit increase in education of the household head would increase the probability of adoption and intensity of adoption of wheat production technology by 0.04% and 34.6% respectively. This indicates that improvement in educational level would improve access to information so that the farmer can easily understand the benefit of improved wheat production technology and increases the probability of adoption and intensity of adoption.

Sex of household was one of the variables found in this study to positively influence adoption wheat production technology. Analysis of its marginal effect indicated that being male headed house hold increase in the probability and intensity of adoption of adoption of wheat production technology 0.08% and 6.8 % respectively (Table 4.12).

This indicated that participating women wheat production technology should be area of intervention by government and non governmental organizations.

A higher marginal effect was accounted to in conducting demonstration and participation in field day. Conducting demonstration increases probability of adoption and intensity of use of improved wheat production technology by 1% and 75.8% respectively. Similarly, participation in field day in wheat production farm by one level of measurement increases the probability of adoption and intensity by 0.75% and 58% respectively (Table 4.12).

A marginal change in ownership of livestock increases the probability of adoption and intensity of adoption of wheat production technology by 0.3% and 28.5% respectively. A marginal effect of farm income increases the probability of adoption and intensity of adoption by 0.18% and 13% respectively (Table 4.12).

A marginal change of participation in field day visit increases probability of adoption and intensity of adoption of wheat production technology by 0.15 % and 11 % respectively. Similarly, a change in participation of social organization from less participation to committee and leader type participation increases probability of adoption and intensity of adoption by 0.07% and 8% respectively (Table 4.12). This implies the need to give emphasis to increase number of field day participation or visiting and strengthening types of social participation to enhance adoption of wheat production technology. When we said increasing types of social participation, increase their involvement in any activity of social organization by encouraging members with different means of incentives

like moral and material incentives, also by strengthening the organization itself to fulfill its' establishment objectives.

CHAPTER FIVE

5. SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1. Summary

This study was conducted in Gesha woreda, which is located in the southern part of Ethiopia, in Kaffa zone about 560Km away from Addis Ababa. In this area, wheat is being promoted by government to be adopted and farmers use both local and improved varieties currently. This study was conducted in order to assess factors influencing adoption and intensity of adoption of improved wheat production technology by farmers in the area. The study attempted to investigate the status of adoption and factors influencing farmers' adoption behavior. The main subject of this study was to assess the current level of adoption and identify factors affecting adoption of improved wheat varieties with its associated agronomic practices. A total of 120 sample households (109 male and 11 female) selected from 3 *kebeles* of the Woreda were interviewed using structured interview schedule. Qualitative data were collected using group discussion among selected wheat growers and extension development agents who were working in the respective *kebeles*.

Improved wheat production technology adoption considered in this study includes use of improved wheat variety, seeding rate, application of fertilizer, method of planting, weeding, disease and pest control. After all adoption of these package practices is very important for farmers to achieve the intended production and productivity, but most of the time is not considered in adoption studies. Almost all the component practices considered in this study were found to be practiced by adopters of improved wheat production technology, but there was variation among the adopter households in the level of adoption or use of these practices. On the other hand, for various reasons farmers' practices were found to deviate from the rate and practices recommended by the research recommendations. As mentioned by sample respondents the reasons for deviation ranges from knowledge to other household, personal, technological and institutional related factors.

Variation in adoption among the sample households was assessed in view of various factors theoretically known to influence farmers' adoption behavior of new technologies and practically assessed factors. These variables were categorized as household personal and demographic, socio-economic, institutional and psychological factors. Result of descriptive statistics using independent sample t-test and chi-square tests indicated that most of the variables hypothesized to influence farmers' adoption behavior were significantly related with adoption of improved wheat production technology.

From household's personal and demographic factors, sex of the household head, and education were positively and significantly related to adoption of improved wheat production technology. Households' farm characteristics are also other important factors which influence adoption of improved wheat production technology. In this study, total

land holding was found to have positive and significant relationship with wheat production technology adoption.

Concerning economic and wealth related variables which were hypothesized to influences adoption of improved wheat production technology and have related positively and significantly with adoption are total farm income and livestock holding.

From institutional variables, frequency of contact with extension agents, mass media exposure, frequency of use of mass media information sources, participation in extension events (training, field day participation and hosting demonstration) and social participation, were found to have positive and significant relationship with adoption of improved wheat production technology.

On the other hand, results of the econometric model indicated the relative influence of the different variables have on adoption and intensity of adoption of improved wheat production technology. A total of twenty explanatory variables were included into the model of which eleven variables had shown significant relationship with adoption of improved wheat production technology. Accordingly, education level of house hold, sex, livestock owner ship, total land holding, farm income participation of field day, participation in training ,conducting in demonstration, types of social participation, mass media exposure and frequency of use of mass media were found to have positive and significant influence on adoption and intensity of adoption of improved wheat production technology. The highest contribution in facilitating probability of adoption intensity of use of improved wheat production technology was obtained by conducting demonstration

followed by field day visit. The relative contribution of each factor on adoption of improved wheat production technology was different.

5.2. Conclusion and Recommendations

Wheat is the most important cereal crop in production and area coverage in Ethiopia. Its contribution to households' income and food security is very high. Although the emphasis given nationally to improved wheat production is high, the adoption level in Gesha woreda is low. All adopters in the study area were found to be in the adoption index low and medium category.

The study shows importance of extension services specially training, field visits and demonstration in adoption of improved wheat production technology. Besides, the role of media on adoption of improved wheat production technology is high. Therefore, lack of institutional support, together with several household personal, demographic and socio-economic factors greatly affected the adoption of improved wheat production technologies and consequently production and productivity of the sector.

Based on the research findings of this study, the following points are recommended to improve farmers' adoption of improved wheat production technology so as to enhance production and productivity. Non-adoption and variation in level of adoption among households was found to be influenced among other things by education, sex and farm income, participation in extension events (training, field visiting and conducting demonstration), media exposure and frequency of use of media material, and generally resource ownership and income position. As a result of this, female headed households and re-

source poor farmers could not adopted improved wheat production technology. Therefore, strengthening of financial position of female households and resource poor male households has to be considered as a central and core component of any development intervention in the sector. In order to mitigate gender differences in adoption of improved wheat production technology exclusive schemes to participate women in extension service should be focused.

Improved wheat production technology involves the use of different practices, which require knowledge, and skill of application and management. Education was found to have a strong relation with adoption of improved wheat production technology as it enhances ability to acquire and use information required for wheat production. Therefore, due emphasis has to be given towards strengthening rural education at different levels for youth and adults using farmers training centers.

Farmers' deviation from recommended package was found partly due to poor extension service. In addition to this extension agents should visit farmers and their farm frequently to give technical support pertinent to use of agricultural technology. Increasing of the farmers' knowledge of relative advantage of improved wheat production is important to improve the recent token amount of wheat cultivation area. To this end promotion of participatory research and participatory assessment of improved wheat variety appropriate for the area should be considered. Similarly, extension service provision especially with farmers' field school method has to be strengthened so as to improve farmers' access to information and extension advices. Since technology adoption involves crea-

tion of attitudinal change, frequent visit of farmer by developmental agents should be day to day activity.

As discussed in focus group discussion one of the major bottle necks to the development of adoption of improved wheat production technology is susceptibility of improved wheat variety to wheat rust disease, which is very common in the Ethiopian high lands in general and in study area in particular. Therefore, development and dissemination of wheat varieties that are resistant to disease and high yielding should be focused by research center because almost all adopters abandoned one of the improved wheat varieties (HAR604) disseminated by the government due to failure by wheat rust.

The other point that was discussed in focus group discussion was most of the farmers in the study area pointed out cost of fertilizer and improved wheat seed was too expensive to afford by themselves. Therefore provision of credit and mechanisms to minimize input cost by reducing management costs like transportation etc. can improve use of agricultural inputs by farmers.

Local media plays an important role in creating awareness and changing attitude of farmers on adoption of improved wheat production technology. Therefore, dissemination of agricultural information using local language has to be considered to improve technology adoption.

Finally, for future study extension approaches followed by experts and officials to introduce agricultural technology can be one area of study for researchers since it is not included in this paper.

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7. APPENDICES

Appendix 1**.** Conversion factor used to compute man equivalent (Labour Force)

Age groups(in years)	Male	Female
Less than 10	0.0	0.0
10-13	0.2	0.2
14-16	0.5	0.4
17-50	1	0.8
Greater than 50	0.7	0.5

Source: Stork, *et al.,* 1991.

Appendix 2**.** Conversion factors used to estimate tropical livestock unit

Animal Category	TLU	Animal Category	TLU
Calf	0.25	Donkey (young)	0.35
Weaned Calf	0.34	Heifer	0.75
Camel	1.25	Sheep & Goats (adult)	0.13
Cow and ox	1.00	Horse	1.10
Sheep & Goats (young)	0.06	Chicken	0.13
Donkey (adult)	0.70		

Source: Stork, *et al.,* 1991.

Appendix 3 Distribution of Sample households in their age category

Age category	Adoption category		Total
	Non Adop-ters	Adopters	
20-30	4	17	21
31-40	5	25	30
41-50	6	29	35
51-60	4	14	18
>60	6	10	16
	25	95	120
Mean	48.2	44.58	

Appendix 4 Educational level of sample house hold

Level of adoption	**Educational level of house hold**											
	illite-rate	**%**	**can read and write**	%	**Prima-ry first cycle**	%	**pri-mary secon d cycle**	**%**	**second-ary first cycle**	**%**	**Total**	**%**
non adopter	21	84	3	12	1	4	0	0	0	0	25	100
Low adop-	11	34.4	12	37.5	3	9.4	5	15.6	1	3.1	32	100
Medium adopter	23	36.5	17	27	11	17.5	11	17.5	1	1.6	63	100
Total	55	45.8	32	26.6	15	12.5	16	13.3	2	1.6	120	100

Source: Own survey, 2012

Appendix 5 Distribution of sample adopter by growing year and varieties

NO	Type of variety	Years cultivation started	Number of adopters
1	HAR 604	2009	76
2	HAR 2536	2011	85
3	K6295	1997	102

Source: Own survey, 2012

Appendix 6 Disease occurrence report by the respondents.

Disease occur-rence	Frequency	Percent

Yes	104	86.7
No	16	13.3
Total	120	100

Source: Own survey, 2012

Appendix 7 Distribution of respondents by measure used when disease occurs

NO	Measures utilized to control disease out break	Frequency	Percent
1	No disease occurrence	16	13.3
2	Local method	15	12.5
3	Improved method	41	34.2
4	Both	3	2.5
5	Nothing	45	37.5
	Total	120	100

Source: Own survey, 2012

Appendix 8 Distribution of respondents by methods of planting improved wheat

Method of sowing	No of household in Adoption category					
	Non adopters	Low adopters	Medium adopters	High adopters	Total	%
Broad casting	25	32	63	-	120	100
Row planting/drilling	0	0	0	-	0	0
Both	0	0	0	-	0	0
Total	25	32	63	-	120	100

Source: Own survey, 2012

Appendix 9 Frequency of contact of extension agent with respondents

Frequency of contact with extension agent	Non adopters		Adopters		Total	%
	No	%	No	%	No	
Never	13	52	9	9.47	22	18.3
Once in a year	5	20	26	27.37	31	25.8
Once in a month	0	0	23	24.2	23	19.1
weekly	7	28	36	37.89	43	35.73
daily	0	0	1	1.07	1	1.07
Total	25	100	95	100	120	100

Source: Own survey, 2012

Appendix 10 Distribution of respondents in relation to area under local and improved Variety

	Local wheat variety grown in hectare	Improved wheat variety grown in hectare
Mean	0.211	0.122
minimum	0	0
maximum	1	0.75

Source: Own survey, 2012

Appendix 11. Problems on improved wheat seed purchased from market for wheat Production

Problem on improved wheat variety	Frequency	Percent	Cumulative Percent
not available	19	15.8	15.8
not timely available	73	60.8	76.7
quality problem	22	18.3	95.0
expensive	6	5.0	100.0
Total	120	100.0	

Source: Own survey, 2012

Appendix 12. Problems of fertilizer purchased from market for wheat production

Problem on fertilizer	Frequency	Percent	Valid Percent	Cumulative Percent
not timely available	3	2.5	2.5	2.5
quality problem	3	2.5	2.5	5.0
expensive	114	95.0	95.0	100.0
Total	120	100.0	100.0	

Source: Own survey, 2012

Appendix 13 Problems of chemicals purchased from market for wheat production

Problem on chemicals		Frequency	Percent	Valid Percent	Cumulative Percent
	not timely available	9	7.5	7.5	7.5
	quality problem	20	16.7	16.7	24.2
	expensive	77	64.2	64.2	88.3
	Quality problem & expensive	14	11.7	11.7	100.0
	Total	120	100.0	100.0	

Source: Own survey, 2012

Appendix 14 Distribution of respondents in relation to frequency of contact with different Agricultural information sources

Source of information	Frequency of contact in percentage					
	Never	Once in a year	Monthly	Weekly	Daily	Total %
Researcher	120	0	0	0	0	100
Contact farmer	30.8	3.3	35	22.5	8.3	100
Fellow farmer	28.3	2.5	36.7	30	2.5	100
PA leader	48.3	0	6.7	44.2	0.8	100
NGO	95	0.8	4.2	0	0	100
Cooperative	85	5.8	6.7	2.5	0	100
Neighbor/Friends/	30	0.8	8.3	20	40.8	100
Input dealer	90.8	4.2	0.8	2.5	1.7	100
Agricultural professionals	15	27.5	34.2	20	3.3	100

Source: Own survey, 2012

Appendix 15. Distribution of respondents by access to market price information

	Level of adoption of the house hold		Total
	non adopter	adopter	
Do you get mar-	4	6	10

ket price information?	no			
	yes	21	89	110
Total		25	95	120

Source: Own survey, 2012

Appendix 16. Total area of production, yield ha^{-1} and total grain yield of the major Cereal crops in Ethiopia (2009)

Crop	Area ('000000 ha)	% Area	Yield (Q ha^{-1})	Total yield ('000000 Q)
Tef	2.58(1st)	22.5(1st)	12.28	31.79
Maize	1.77(2nd)	15.4(2nd)	21.99	38.97
Wheat	1.68(3rd)	14.64(3rd)	18.27	30.76
Sorghum	1.62(4th)	14.07(4th)	18.36	29.71
Barley	1.13(5th)		15.5	17.5

Source; CIMMYT, 2010

.Appendix 17. The interview Schedule

Study on Intensity and Adoption of Improved wheat varieties and associated agronomic practices in Kaffa Zone, The case of Gesha woreda.

General information

Date of interview……

Name of the respondent: ----------

Adopters _____ Non adopters _____

PA: ----------

Village: ----------

Name of the Interviewer: ----------Sign. ----------

1 1. House hold characteristics

1.1. Name of the respondent: ----------.

1.2. Age of the respondent ----------.

1.3. Sex 1/ male □ 2/ Female □

1.4. Education level ----1) Illiterate □ 2) can read & write □ 3) years of formal education. --------

1.5. Religion _____ 1) protestant □ 2) orthodox □ 3) Muslim □ 4) catholic 5/other

1.6. . Marital status. 1. Married 2. Unmarried. 3. Divorce 4. Widowed 5. separated

1.7. Total Farming experience of the household head in years ----------.

1.8. Wheat Farming experience of the household head in years----------.

1.9. . Distance from woreda in Kilo meter _____

1.10. Distance from main general market center in kilo meter _____

km2. Economic variables

2.1. Land ownership in 2002/ 2003E.C

Land allocation	**Land size(in hectare)**
Wheat	
Enset	
Coffee	
Maize	
Teff	
pea	
Barley	
fruits	
Grazing land	
forest land	
Others(specify)	
Total	

2.1. **Livestock ownership by the end of 2002/2003 E.C and Income from the sale of livestock.**

Category	Total	TLU	No. sold	Unit price	Total price	Purpose sold

Category	Total	TLU	No. sold	Unit price	Total price	Purpose sold
Local cows						
Cross bred cows						
oxen						
Local Heifers						
Crossbred heifers						
Calves						
Bulls						
Goats						
Sheep						
Poultry						
mule						
Horse						
Others						
Grand total						

2.3/ Household members and labor availability in 2002/2003 EC

Se.no	**List of Family members**	**Sex**	**Age**	**Education level**	**Family members working behavior**				**Activities participated**
					Not working on farm	**Permanently work on**	**work on farm(but not perma-**	**Reasons for not**	
1									
2									
3									
* Wheat production activities includes: - 1) Land preparation 2) sowing 3) Weeding 4) Harvesting 5) Threshing 6) Transportation 7) Storage 8) Marketing 9) others (specify									

2.4. Crop production and annual income by the household in 2002/2003 E.C production season.

Types of Crops grown	**Land size (in ha.)**	**Average yield/ha**	**Total annual harvest**	**consumed**	**sold**	**Unit price**	**Total price**	**Purpose sold**	*Typ produ
Local wheat									
Improved									

wheat									
Barley									
Enset									
Coffee									
Faba bean									
Pea									
Fruits									
Maize									
Vegetables									
Others(specify)									
Total									
Purpose sold1) For purchasing farm inputs 2) For settling debts 3) For buying clothes for family 4) To buy food grains 5) Others (Specify) ----------									
*Type of production 1) Sole/mono/ cropping 2) intercropping 3/ both									

2.5. Income from sale of livestock products/2003E.C/

Product type	**Amount collected per year**	**Consumed**	**Sold**	**Unit price**	**Total revenue**	***Purpose sold**
Milk						
Cheese						
Butter						
Egg						
others						
*Purpose includes 1) For purchasing farm inputs 2) For settling debts 3) For buying clothes for family 4) To buy food grains 5) Others (Specify) ----------						

2. 6.Income from participation in off-farm activities.

2.6.1. Do you have off-farm activities? 1/ Yes □ 0/ No □

2.6.2. If yes, type of work:

Types of off-farm income activities	**Income earned(in birr)**	***Purpose used**
Petty trading		
Daily laborer		
Support from Relative (son, daughter)		

Civil servant		
Others, specify		
Purpose used include 1) To purchase household items □2) to purchase farm inputs □4) to settle debts □ 5) to buy food □ 6/other(specify)		

3. Institutional Factors

3.1/ Market centers accessible to you

Name of Market	**Distance(km)**	**Mode of Transport**	**Transport cost**	**Type of com-modity sold in market**
Mode of transport; 1=feet 2= bus 3/Pack animals **Commodity; 1 = pulses 2= wheat 3=coffee 4 = fruits & vegetables**				

3.2/ Credit accessible to you

3.2.1/ Have you obtained credit for wheat production in the last three years?

1) Yes □ 2) No □

3.2.2/ If yes, from where you get and how much did you get?

Source ----------

Amount (in Birr) ----------

3.2.3/ For what purpose did you use the credit?

1) For purchasing fertilizer □ 2) For purchasing improved seeds □ 3) For purchasing

Chemicals □ 4) other purpose (Specify) ----------

3.2.4/ Have you obtained credit of improved wheat in kind?

1) Yes □ 2) No □

3.2.5/ If yes, from where you get and how much did you get?

Source ----------

Amount (in k/gram) ----------

3.3. Extension services

3.3.1/ Do you get advisory services from extension agents? 1) Yes □ 2) No □

3.3.2/ How frequently do the extension agents visit you?

0) never □1) Once in a week □2) twice in a week □3) monthly □4) yearly□

3.3. 3/ when does extension agent visit you? a) during land preparation □b) during

Sowing d) when disease/ pest occur □ d) during harvesting □ e) others (Specify)

3.3**.** 4/ Do you visit extension agent? 1) Yes □ 2) No □

3.3. 5/ If yes, when do you visit? 1) During sowing for technical advice □ 2) During input provision to obtain inputs□ 3) It depends (any time when there is technical problem) □

3.3.6/ What are your other sources of information and how often you use/ have contact with them?

Sources of Information	How Often you contact them?					*Means of information exchange
	Never	Once in a Year	Monthly	Weekly	Daily	
Researcher						
Contact farmer						
Fellow farmer						
PA leader						

Sources of Information	How Often you contact them?					*Means of information exchange
	Never	Once in a Year	Monthly	Weekly	Daily	
NGO						
Cooperative						
Neighbors/ friends						
Input dealers						
Agricultural professionals						
*Means of information exchange: 1) Demonstration 2) Field day/visit 3) Training 4) Written materials (leaflets, manuals, and so on) 5) Others (Specify) ----------						

3.3.7. When have you first heard of improved variety of wheat? _____

3.3. 8. Indicate your access to and frequency of use of the following media materials on agricultural extension programs related wheat production.

Mass media	Do you have?		How often you use them for attending agricultural programs/obtaining messages				
	YES	NO	NEVER	RARELY	OCCASIONALLY	OFTEN	VERY OFTEN
Radio							
Television							
Others(specify)							

3.3. 9. Rank your sources of information based on Accessibility, timeliness, reliability of their Information

Sources of information	**Rank accessibility**	**Rank timeliness**	**Rank reliability**	**Remark**
Extension agent				
Researcher				
NGO				
Contact farmers				
Mass media				

Neighbors/friends				

3.3. 10. Which improved variety of wheat have you first grown?

1) HAR 604 2) HAR 2536 3) 1685 4) others (specify) ----------

3.3. 11. Why did you choose this particular variety first? ---------- 1/good yield 2/the only available 3/disease resistance 4/other (specify)

3.3. 12. Which improved varieties of wheat you have grown so far? When you have grown them?

No	**Variety**	**Year first grown**	**Being used/stopped**	**When stopped using the variety**	***Reasons for stopping**
1	HAR 604				
2	HAR 2536				
3	HAR 1685				
* 1) Availability of better variety 2) Unavailability of seeds 3) High seed purchase price 4) Low yield in my field 5) disease and pest problem 6) Others (Specify) ------					

3.3. 13. Please, indicate your participation in the following extension events related to wheat production in the last 5 years

NO	Extension events	Participated/not participated	Number of times participated in the last 5 years	*Who arranged for You?
1	Field Day			
2	Training			
3	Demonstration			
Who arranged for you? 1) MoA 2) Research 3) NGO 4) Others (Specify *)----------				

3.4/ Membership of farmer's association

3.4.1/ In which of the following organization are you member and leader? Please tick

	Membership 1=member 0= non member	Committee member(2) 1= yes, 0= No	Leader(3) 1 = yes, 0 = No
Seed multiplication group			
PA Leader			
Saving and credit group			
Marketing cooperative			
Idir			
Youth association			
Other/specify			

3.5 Market related variables

3.5.1/ what was the average market price of the seed of wheat last year?

Variety of wheat	Price at		*To whom you Sell the product
	Farm gate	market	
Improved Varieties			
HAR 604			
HAR 2536			
HAR 1685			
Local			
*To whom 1) to whole seller 2) to retailer 3) to direct consumers 4)cooperative 5/farmers			

3.5.2. / Have you changed to whom you sell the seed of wheat in the last 2-3 years?

1=yes □ 0=No □

3.5.3/ If yes, is there change? 1=yes □ 0=No

3.5.4/. What was the change? _____

3.5.5/. What is the trend in price in the last 3-4 years?

1) Decreasing □ 2) stable □ 3) increasing □

3.5.6/ .In that light, how does it compare with alternative crops that you can grow? -------

--? 1) It is better _____ 2) It is not better _____ 3) No difference _____

3.5.7/. In your view how do you see the selling price of the seed of wheat? ----------

Type of wheat	Price condition				
	Very poor(1)	Poor(2)	Moderate(3)	Good(4)	Very Good(5)
Improved seed					
Local seed					

3.5.8/ In your view how do you see the prices of inputs used for wheat production in relation to the income generated by wheat produced/sale?

Inputs	Price condition (√)				
	Very expensive	Expensive	Medium	Less expensive	Not expensive
Improved wheat seed					
Fertilizer					
Chemicals					
Labor					
Others (Specify)					

3.5.9. Do you get market price information on wheat? 1) Yes □ 2) No □

3.5.10. If yes, what are your sources of information and how often do you get access to it?

No	Sources of Information	How often you get access to it?					
		Never(0)	Once in a year(1)	Monthly(2)	Weekly(3)	Daily(4)	Which source You prefer
1	DA						
2	Traders						
3	Neighbor farmers						
4	Cooperative society						
5	Middle men						
6	0ther(specify)						

3.5.11. Do you expect low price in wheat? 1/ yes 0/ No?

3.5.12. When you expect low prices?

3.5.13. What do you do when you expect low prices? ----------

4. Access and utilization of farm inputs for wheat production (2002/03 production season)

4.1. Which type of agricultural inputs do you use for wheat production & what are the sources?

Type of input	Specific name	Source (√)					Do not use
		Market	MoA	Research centers	NGO	Other source (Specify)	
Fertilizers	DAP						
	Urea						
Chemicals	Fungicide						
	herbicides						
	Insecticide						
Compost							
Others(specify)							

4.2. Quantity of inputs purchased /used for wheat production and their price in 2002/2003 E.C

No	Type of in-puts	Specific name	Amount purchased/used (kg/Lit)(kg	Unit price(Birr)	Total cost
1	Wheat variety	HAR 604			
		HAR 2536			
		HAR 1685			
2	fertilizer	DAP			
		Urea			
3	Chemicals	Fungicide			
		Herbicides			
		Insecticide			
	Grand total				

4.3. Can you purchase the required amount of inputs as you need (Availability?)

1) Yes□ 2) No □

4.4. Which of the following problems do you think are there with inputs purchased from market?

Input	Problems				Remarks
	Not Avail-able	Not Timely Available	Quality problem	Expensive	
Wheat variety					
fertilizer					
Chemical					
Other(specify)					

4.5. How much does the timeliness of availability of inputs affect your level of input? adoption? Tick

No Effect(1)	Less effect(2)	Moderately affected(3)	High Effect(4)	Very high(effect)

5. Intensity of adoption of improved wheat varieties and its agronomic practices

5.1. In the last three years production season what kind of wheat varieties did you use? 1) Local □ 2) improved □ 3) both □

5.2 Which type of cropping do you used for wheat production?

1) mono/sole /cropping □ 2) intercropping with other crops □ 3) both □

5.3. If you are intercropping, with which crop do you intercrop?

1) Haricot bean □ 2) sorghum □ 3) chat □ 4) cabbage □ 5) other crop/specify

5.4. Which method of sowing you used in cultivation?

1) Row planting □ 2) Broadcasting □ 3) Both □

5.5. If your answer is row planting, to which variety you used this method?

1) Local □ 2) improved □ 3) Both □

5.6. Did you apply fertilizer in wheat production? 1) Yes □ 0) No □

5.7. If your answer is yes, to which variety you applied fertilizer?

1) Local □ 2) improved □ 3) both □坷

5.8. If your answer is yes, which kind of fertilizer you used? 1) DAP □ 2) Urea □ 3) both□

5.9. If you apply DAP fertilizer in wheat production, what amount of /kg/ fertilizer used amount per hectare? 1) 100kg □ 2) 50-80kg □ 3, less than 50 kg □

5.10/ If you did not apply fertilizer in wheat production, what is your reason for not applying?

1/high price 2/not timely available 3/Farm land fertile 4/other (specify)

5 .11/Did you encounter disease problem in cultivation in 2002/2003 E.C Production season? 1) Yes □ 0) No □

5.12/ If yes, what kind of measure did you take? 1) Local method □ 2) improved method □ 3) Nothing □

5.13/ If you did not apply improved method of disease control what is your reason? -----

1/high price 2/ not timely available 3/effect on animals& human being 4/ lack of credit 5/lack of information 6/ 0ther (specify)

5.14/ did you come across weed problem in 2002/2003 E.C wheat cultivation?

1) Yes □ 0) No □

5.15/ If yes, how did you solve this problem? 1) Using chemical □ 2) hand weeding□

5.16/If no, what is the reason?

5.17/How many times do you cultivate your land before sowing improved wheat?

1/once 2/twice 3/ 3 times 4/ 4 times 5/ >4 times

6. Intensity of adoption of improved wheat varieties & its agronomic practices in 2002/2003 E.C

Subject	**Name of wheat variety grown**	**Area coverage in ha.**	**Seed rate(kg)**	**Fertilizer rate(kg)**		**Yield per ha**
				DAP	**Urea**	
Total area	HAR 604					

Subject	Name of wheat variety grown	Area coverage in ha.	Seed rate(kg)	Fertilizer rate(kg)		Yield per ha
				DAP	Urea	
allocated for improved wheat	HAR 2536					
	HAR 1685					
Total area allocated for local	local					

7/ **Perception about wheat production technology**

statements	Degree of agreement					
	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	I don't know
1/productivity of wheat is decreasing year to year.						
2/Use of improved wheat variety increase yield as compared to local variety.						
3/Fertilizer application to improved seed increase production than sowing with out fertilizer.						
4/Even though fertilizer application to wheat increases productivity, its disadvantage outweighs advantage.						
5/recommended seeding and fertilizer application rate to Wheat production is nothing to do with yield increment.						
6/since weed problem do not significantly affect productivity weed control on wheat should not be considered in						

statements	Degree of agreement					
	Strongly agree	**Agree**	**Unde-cided**	**Disag-ree**	**Strong-ly dis-agree**	**I don't know**
agronomic practice.						
7/There are other technologies rather than wheat production which can be easily adopted and give more return.						
8/Improved wheat varieties are more disease and weed resistant than the local.						
9/Intercropping of wheat with other crop is possible and in-crease effective utilization of land.						

8. What parameters do you consider important to select among different improved varie-ties of wheat? Put them in order of importance.

Parameters	1	2	3	4	5	6	7	8	**score**
1) High yielding									
2) Grain size									
3) Grain color									
4) Time of maturity									
5) Market demand									
6) Price advantage									
7) Stora-bility									
8) Disease resistance									