

FACTORS AFFECTING ADOPTION OF IMPROVED HARICOT BEAN  
VARIETIES AND ASSOCIATED AGRONOMIC PRACTICES  
IN DALE WOREDA, SNNPRS

M.Sc. THESIS

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A THESIS SUBMITTED TO THE  
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## **STATEMENT OF THE AUTHOR**

I declare that this thesis is my bonafide work and that all source of the materials used for the thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirement for an advanced M.Sc. degree at Hawassa University and is deposited at the University library to be made available to borrowers under rules of library. I solemnly declare that this thesis is not submitted to any other institution any where for the award of any academic degree, diploma or certificate. Brief quotations from this thesis are allowable without special permission provided that accurate acknowledgment of source is made. Request for permission for extended quotation from or reproduction of this manuscript in whole or part may be granted by the head of the major department or the Dean of the school of graduate studies when in his or her judgment the proposed use of the materials is in the interest of scholarship. In all other instances, however, permission must be obtained from the author.

Alemitu Mulugeta

Signature -----

## **DEDICATION**

I dedicate this thesis manuscript to my father Mulugeta Ayalew who passed away without seeing my achievements and to my mother Tegitu Zewdie for nursing me with affection, love and dedicated parent ship in the success of my life.

## **ABBREVIATIONS AND ACRONYMS**

ANOVA	Analysis of Variance
CIMMYT	International Maize and Wheat Improvement Center
<sup>0</sup> C	Degree Celsius
CSA	Central Statistical Authority
DWARDO	Dale Woreda Agriculture and Rural Development Office.
EIAR	Ethiopian Agricultural Research Institute
FDRE	Federal Democratic Republic of Ethiopia
Ha	Hectare
IPMS	Improving Productivity and Market Success of Ethiopian farmers.
Kg	Kilogram
Km	Kilometer
masl	Meter above Sea Level
MEDaC	Ministry of Economic Development and Cooperation
MoARD	Ministry of Agriculture and Rural Development.
NGOs	Non Governmental Organizations
SARI	Southern Agricultural Research Institute.
SD	Standard deviation
SNNPRS	Southern Nation's Nationalities and People's Regional State
SPSS	Statistical Package for Social Science
TLU	Total Livestock Unit

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Factors affecting adoption of improved haricot bean varieties and associated agronomic practices in Dale Woreda, SNNPRS

By Alemitu Mulugeta Ayalew

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ABSTRACT

*Haricot bean (Phaseolus vulgaris L.) is one of the most important food legumes of Ethiopia and it is considered as the main cash crop and the least expensive source of protein for the farmers in many lowlands and mid altitude of the country. Low production and productivity, which are mainly associated with poor adoption of improved technologies and poor marketing system, were among the major problems. Adoption of improved technologies is one of the most promising ways to reduce food insecurity in Ethiopia. However, the adoption and dissemination of these technologies is constrained by various factors. The aim of this study was to examine factors affecting adoption and intensity of adoption of improved haricot bean varieties and associated agronomic practices in Dale Woreda, Sidama zone of SNNPR. In the area, haricot bean is an important crop, which serves as a source of food and cash. A total of 150 sample households (131 male and 19 female) selected from 5 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 17; mainly Chi-square test, F-test Cramer's V, and Pearson Correlation. Tobit econometrics model was employed using STATA11. The results of the econometric model indicated that the relative influence of different variables on probability and intensity of adoption of improved haricot bean production. Thus, sex of house hold head, attending training on improved haricot bean production, attending field day programs, conducting demonstration, access to improved seed credit and membership of seed multiplication group were positively and significantly influenced where as market distance negatively influenced adoption and intensity of adoption of improved haricot bean varieties and associated agronomic practices. Farmers' evaluation and selection criteria of improved haricot bean varieties in the study area in order of importance were high yielding, market demand, price advantage, time of maturity, grain color, grain size, disease resistance and storability. Based on these criteria Nasir variety ranks first and dimtu variety ranks second. In addition, majority of farmers in the study area used seed and fertilizer rates below research and extension recommendations. Farmers' deviation from recommended package practices was found partly due to inadequate extension service, high cost of fertilizer and also lack of finance. 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, facilitating access to credit and improving market condition, Attention has to be given to women household headed to participate in improved haricot bean production, Therefore development interventions should give emphasis to improvement of such institutional support systems to increase adoption and productivity of the crop.*

Key words Adoption, Agronomic practice, Haricot bean, Varieties

# **1. INTRODUCTION**

## **1.1. Background**

More than 85% of the Ethiopian population, which resides 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).

Increasing agricultural production at the household level is vital to achieve food security (Degnet and Belay, 2001). On the other hand, any marketable surplus could be sold to the non-farming and even to the farming communities (Hailu, 2008). Therefore, increasing the production and productivity in a sustainable manner could address the problem of food shortage (Habtemariam, 2004). As one of the approaches to ensure households food security, the Ethiopian rural development policy and strategy document has given weight to follow diversification and specializations in production systems along with improved access and use of agricultural technologies (Hailu, 2008). In general, raising agricultural output and productivity on a sustainable basis necessitates large scale adoption and diffusion of new technologies (Mehumud *et al.*, 2009).

Although cereal crops are most important in Ethiopian agriculture in providing staple diet to the population, pulses are also important components of crop production (Ali *et al.*, 2003).

Accordingly, pulse crops provide an economic advantage to small farm holdings as an alternative source of protein, cash income, and food security (Ferris and Kaganzi, 2008). Among legumes, haricot bean constitute a significant part of human diet in Ethiopia (Ali *et al.*, 2003). Apart from this, haricot bean has been cultivated as a field crop for a very long time and hence, it is the important food legume produced in the country (Ali *et al.*, 2003). Haricot bean is a principal food crop particularly in Southern and Eastern part of Ethiopia, where it is widely intercropped with maize and sorghum, respectively, to supplement farmers income (EPPA, 2004). The two major haricot bean producing regions are Oromiya and Southern Nations, Nationalities and People's Region (SNNPR), which produce 70 and 60 thousand tones per year, respectively, and these two regions make up 85% of the total production (CSA, 2005).

Average national production is approximately 150 thousand tones per annum. The level of production in 2005 was approximately 175 thousand tones with a domestic market value of USD 30 million (Ferris and Kaganzi, 2008).

Although haricot bean is largely grown in Ethiopia, the national average yield of haricot beans is low ranging from 0.5 to 0.8 tone ha<sup>-1</sup>, which is far below the corresponding yield recorded at research sites (2.5 – 3 tones ha<sup>-1</sup>) using improved varieties (EPPA, 2004). The low national mean yield observed for haricot bean could be attributed to various constraints related to low adoption of improved agricultural technologies, drought, and lack of improved varieties, poor cultural practices, disease, and environmental degradation (Legese *et al.*, 2006). In essence of things, the generation and transfer of technologies is not an end in itself. Therefore, increasing productivity and production of haricot bean will be realized if and only if the farmers adopt the technologies that are developed by research.

Some efforts have been made by both research and extension systems for promotion of technology. Different research centers under Ethiopian Agricultural Research Organization (now Ethiopian Agricultural Research Institute) have released different improved haricot bean varieties with their agronomic practices and disseminated them among farmers with full package of information as a new innovation through MoARD.

Nowadays, increasing production on a sustained basis by means of extensive farming is becoming more and more daunting agricultural undertaking owing to limited opportunities for area expansion (Legese,2004). Hence, the solution to food problem would depend on measures that could allow the farmers increase yield through intensification which involves different improved agricultural practices (Million and Belay, 2004). Despite the significant contribution of adoption of agricultural innovations for increasing production and income, Legese,(2004) and Kebede,*et al.*,(1990) indicated that adoption rate of modern agricultural technologies in the country is very low. In order to raise the agricultural output and productivity on a sustainable basis in the developing countries, large-scale adoption and diffusion of new technologies is very essential (Ravula *et al.*, 2006).

In the study area, Dale Woreda, some improved varieties of haricot bean have been disseminated among the farmers through different extension organizations such as BoARD and NGOs. Farmers produce haricot bean in intercropping (with maize, coffee, enset, and chat) and monocropping primarily as an alternative food source and for market sale. 103 farmers from 11 PA produce seed of improved haricot bean varieties for developing informal seed sector in the study area (IPMS, 2009).

Improved haricot bean technologies are being promoted by the BOARD and NGO including IPMS (Improving Productivity and Market Success of Ethiopian farmers). However, the adoption and intensity of use of improved agricultural technologies are not yet assessed in the study area.

## **1.2. Statement of the Problem**

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

In the study area, it was found out that farmers did not adopt the complete package of practices recommended by the research system. Essentially, 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 haricot bean production package.

However, there is no empirical information in the study area about the determinants of the adoption and intensity of use of the improved haricot bean varieties along with the recommended agronomic practices. Therefore, this study was undertaken with the following objectives.

### **1.3. Objectives of the Study**

The overall objective of this study was to assess factors influencing adoption of improved haricot bean varieties and associated agronomic practices with the following specific objectives.

- To assess the level of adoption of the haricot bean production technology package; and
- To identify major factors influencing the level of adoption and intensity of adoption of haricot bean production package in the study area

### **1.4. Research Questions**

- What is the current level of adoption of the haricot bean production package?
- What are the determinants that may affect adoption of improved haricot bean production?
- What is the intensity of the use of improved haricot bean varieties and recommended agronomic practices (seed rate, spacing, fertilizer use, etc)?

### **1.5. Significance of the Study**

Adoption studies can provide research and extension staff, rural development institutions, and policymakers with valuable information that improve the efficiency of communication among them in promoting available technologies. Apart from this, acquired information from such studies could enhance the efficiency of agricultural research, technology transfer, input provision, and agricultural policy formulation. All development partners including extension educators, technical assistants, NGOs and other development agents involved in agricultural development must be aware and understand the factors affecting the level of adoption of recommended agronomic practices for haricot bean in order to target and proirate appropriate technologies to farmers. The present study attempted to reveal those underlying factors which may account for the observed variations in the adoption level of improved haricot bean

production package among the farmers in Dale Woreda. To this end, the findings of this study are expected to render very valuable information for further promotion of this important crop in the study area. Furthermore, farmers' technology evaluation criteria would help researchers to develop technologies appropriate to local situation and in line with the farmers' criteria. The key findings from this study could help to fine tune extension in such a way that the technical and socioeconomic constraints on haricot bean production can be addressed. Such information would suggest interventions that may help to improve the efficiency of agricultural research and extension.

#### **1.6. The Scope and Limitations of the Study**

This study was undertaken in Dale Woreda, which is found in the SNNPR. The adoption of new technology is influenced by many factors. 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 crops. Therefore, it is difficult to identify universally defined factors either impeding or enhancing adoption of technology. This study was restricted to assessing factor affecting adoption of improved haricot bean varieties and associated agronomic practices in Dale Woreda.

## 2. LITERATURE REVIEW

### 2.1. The Haricot Bean Crop

Haricot bean (*Phaseolus vulgaris* L.) belongs to order Rosales, family Leguminosae subfamily Papilionideae, tribe Phaseolinae (CIAT, 1986). The common bean was originated in Tropical America (Mexico, Guatemala, and Peru), but there are also evidences for its multiple domestication within Central America (Kay, 1979). The crop is now widely distributed throughout the world and consequently, it is grown in all continents except Antarctica (Singh, 1999). In Ethiopia, it is most likely to be introduced by the Portuguese in the 16th century (Wortman, 1997). It is well adapted to areas that receive an annual average rainfall ranging from 500–1500 mm with optimum temperature range of 16°C–24 °C, and a frost free period of 105 to 120 days. Moreover, it performs best on deep, friable and well aerated soil types with optimum pH range of 6.0 to 6.8 (Kay, 1979). Major haricot bean producing regions are Central, Eastern, and Southern parts of the country and in central Ethiopia; farmers grow early maturing white pea bean crop for export as their cash crop (CSA, 2005).

The common bean is cultivated primarily for its dry seeds, green pods (as snap beans), and green-shelled seed. Young tender leaves and flowers are also used as fresh vegetables in some Central and Eastern African, and in Latin America countries (Kay, 1979; Singh, 1999). The world demand for common bean is ever increasing because of its significance in human nutrition as a source of proteins, complex carbohydrates, vitamins, and minerals (Bennink, 2005). Their role in reducing blood cholesterol level and combating chronic heart diseases, cancers and diabetics is also gaining recognition from human health point of view (Singh, 1999) It is an

important source of protein and energy in human diets in the tropical and sub-tropical developing countries, particularly in the Americas and Eastern and Southern Africa (Walelign, 2002).

Currently, haricot beans cover the dominant part of the Ethiopia's pulses export. However, the share of pulses in general in the export market has been limited by external demand for quality (Gezaheng and Dawit, 2006). In addition to other production constraints that limit the volume of production, lack of high yielding varieties with improved resistance to diseases and other biotic and abiotic constraints has been the major production constraint of common bean in Ethiopia in general (Teshale *et al.*, 2006).

## **2.2. Haricot Bean Production and its Economic Importance in Ethiopia**

There is a wide range of haricot bean types grown in Ethiopia including mottled, red, white and black varieties (Ali *et al.*, 2003). The most commercial varieties are pure red and pure white coloured beans and these are becoming the most commonly grown types with increasing market demand (Ferris and Kaganzi, 2008).

To support both the growth in domestic and export bean markets, the Ethiopian Institute of Agricultural Research (EIAR) has developed a range of high yielding, multi-disease resistant bean varieties (Ali *et.al*,2003). The focus of this genetic improvement program has been on the pure red and white beans to support the commercial sector (Ali *et.al*, 2003). Within the red bean types, the most favored and most commercially accepted varieties include Red Melka, a mottled medium sized red; Red Wolaita, a medium sized pure light red; and Nasser, a small pure dark red variety ( Ferris and Kaganzi, 2008).

With regard to economic importance of haricot bean, it is used as source of foreign currency, food crop, means of employment, source of cash, and plays great role in the farming system (CSA, 2005). According to EPPA (2004) in the year 2000, 2001 and 2002 Ethiopia exported 23994.4, 32932.7 and 42127.0 tones and earning 8.2, 9.98 and 13.2 million USD respectively. The main destination markets were Pakistan, Germany, Yemen, UK, South Africa, India and Mexico having 12.5, 7.8, 6.9, 5.79, 4, 4, 4 % share respectively (EPPA 2004) The country's exports of haricot beans have increased over the last few years, from 58,126 MTs in 2005 to 78,271 MTs in 2007 and Ethiopia gets 63 million dollar from haricot bean market in 2005 (Legese *et.al*, 2006).

White beans from the northern Rift Valley were sold into export markets to supply European canning factories and red beans were exported from the southern Rift Valley areas to supply drought affected areas in northern Kenya (Ferris and Robbins, 2004). The major storage and trading sites in the southern Rift Valley area are concentrated in the towns of Sodo, Awassa and Shashemene while the major collection centers for white beans being in Nazareth, prior to exportation through Djibouti (Ferris and Kaganzi, 2008). There are good prospects that this market will grow as consumers in industrialized countries seek evermore competitive suppliers (Ferris and Kaganzi, 2008). For the major processing companies, Ethiopia is a relatively new source of supply and recent investments by a number of international companies from Italy, UK and Turkey indicate that market prospects are good (CIAT, 2008).

### **2.3. Agronomic Practices on Haricot Bean Production**

Improved agronomic practices are used to increase crop yield and are recommended by researchers after testing on the research field and also on farmer field.

### **2.3.1. Seeding rate**

Ethiopian farmers, in general, use lower seed rate than research recommendations which result in lower grain yields (Ali *et al.*, 2003). The seed yield of bean is the result of many plant growth processes which ultimately influence the yield components such as pods/plant, seeds/pod, and unit weight of seed. The highest seed yields were obtained when all the above got maximized (Tessbo *et al.*, 2004).

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.

To avoid nutrient competition sufficient spacing between plants and rows is vital to get maximum yield in a given plot of land. Appropriate spacing enables the farmer to keep appropriate plant population in his field. Hence, a farmer can avoid over and less population in a given plot of land which has negative effect on yield. Research recommendation of seeding rate based on sowing method and seed size for the available haricot bean varieties is presented in Table 1.

**Table 1. Recommended seed rate based on sowing method and seed size**

Variety name	Seed Size	Seed rate in kg/h	
		Row	Broad cast
Awash-1	Small	90-100	100-120
Awash Melka	Small	90-100	100-120
Argene	Small	90-100	100-120
Chore	Small	90- 100	100-120
Chercher	Small	90-100	110-120
Roba	Small	90-100	100-120
Gofta	Medium	80-90	90-110
Ayeneu	Medium	80-100	100-120
Melke	Large	110-120	120-130
Beshbesh	Small	70-80	90-100
Omo 95	Small	60-70	90-100
Goberasha	Large	110-120	120-130
Tabore	Medium	80-90	100-120
Hawasa dume	Medium	60-70	90-100
Nasir	Small	90-100	110-120
Dimtu	small	90-100	110-120
Melka dima	Medium	110-120	120-130
Anger	Medium	110-120	120-130
Ibado	Large	110-120	120-130
Omo nech	Small	90-100	100-120
Haremaya	Medium	110-115	115-125
Denknesh	Medium	90-100	100-120
Batu	Large	110-120	120-130
Deme	Large	110-120	120-130

Source: Setegne & Legese, 2010.

### 2.3.2. Intercropping

Intercropping of legumes with cereals has been popular in the tropics (Tsubo *et al.*, 2004) and rain-fed areas of the world (Dhima *et al.*, 2007). Intercropping is advantageous for soil conservation; weed control, lodging resistance and yield increment and legume root parasite infection control (Fenandez-Aparicio *et al.*, 2007).

Intercropping is also an ecological method to manage insect pest, disease and weeds via natural competitive principle that allow for more efficient resource utilization (Tsubo *et al.*, 2004).

Chemeda and Yuen (2002) reported that in maize\bean intercropping disease incidence in bean was reduced by 36% and severity by 20% in intercropped than sole cropped bean.

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\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 on haricot bean production**

Application of fertilizer in a recommended amount is essential for high yield and quality of grains (Morgado, 2003). The use of fertilizer is considered to be one of the most important factors to increase crop yield per unit area basis, how ever the response to the type of fertilizer and rate of application vary widely with location, climate and soil type (Marshner, 2002). Nitrogen deficiency occurs almost every where unless Nitrogen is applied as a fertilizer or manure (Desta, 1988). It has been reported that there was increased yield responses of pulse for nitrogen fertilizer (Morgado, 2003).

Phosphorus is the second limiting element after nitrogen for plant growth (Tolera *et al.*, 2005). Phosphorus deficiency is also the major constraints to the growth of legumes in many soils (Desta Beyene, 1988). Beans respond to the application of phosphorus and production increase proportionally with increase of phosphorus fertilizer (Tolera *et al.*, 2005). Many research on legume indicated that phosphorus availability in the soil is a great limitation for bean production in tropics ((Morgado, 2003).

Application of fertilizer on haricot bean production is vary depend on area of production and soil fertility. According to the regional Agricultural bureau extension program manual (2006), Setegne and leggese (2003).The recommended fertilizer rate, is 100 kg DAPha<sup>-1</sup> and 50 kg ha<sup>-1</sup> UREA.

#### **2.3.4. Weed control practices.**

Weeds are major constraints in pulse production in Ethiopia, particularly in the low lands, where competition between crops and weeds is high due to the prevalent problem of moisture stress (Ali et.al, 2003). Proper weed controls crucial to ensure optimum crop performance but in pulse either the operation is not done at all or employed too late to provide any benefit to the crop. (Tenaw et.al.,1997).Crop loss assessment trials shows that uncontrolled weeds growth could result in over 36% yield reduction in haricot bean and more than 50% in soybean (Beyenesh,1988).in haricot bean production 2-3 times weeding is necessary for getting good yield. The first weeding is done after two weeks of the plant emergence and the second is 21-25 days after emergence (Setegne and leggese (2003).

#### **2.3.5. Pest control practices.**

Insect pest constitute a major constraints to sustainable production of haricot bean .The key pests in food legume crops in Ethiopia are aphids and bean stem maggot (Walle, 2002). The bean stem maggot and bean bruchids are the most important pest of haricot bean in the field and in storage respectively (Ferede .N, 1994). According to haricot bean production manual 2003, control measure for pests are, intercropping and dressing the seed with 25gm prenilol methyl for 10kg seed of haricot bean.

#### **2.3.6. Disease control practice.**

Fungal and bacterial diseases are among the main production constraints in the major bean 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 beans in Ethiopia, common bacterial blight, rust, anthracnose and angular

leaf spot are economically important (Fininsa and Yuen, 2002). Using disease resistance varieties, clean seed and intercropping are some of the control measure for haricot bean diseases (SARI, 1997, SARI, 2002).

### **2.3.7. Harvesting**

Timely harvest is important to reduce mold, bird and insect damage and also to decrease losses due to shattering and wet weather (Ali *et.al*, 2003). Crops may be harvested when they are physiologically mature. Haricot bean is harvested when the foliage of the crop is turned to yellow and before starting shattering (Setegne and Leggese, 2003).

## **2.4. Overview of Technology Adoption**

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

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

Dasgupta (1989) indicate that the decision to adopt an innovation is not normally a single instantaneous act, it involves a process. The adoption is a decision-making process, in which an individual goes through a number of mental stages before making a final decision to adopt an innovation. Decision-making process is the process through which an individual passes from first

knowledge of an innovation, to forming an attitude toward an innovation, to a decision to adopt or reject, to implementation of new idea, and to confirmation of the decision (Ray, 2001).

However, as emphasized by Ray (2001), adoption does not necessarily follow the suggested stages from awareness to adoption; trial may not always be practiced by farmers to adopt new technology. Farmers may adopt the new technology by passing the trial stage. In some cases, particularly with environmental innovations, farmers may hold awareness and knowledge but because of other factors affecting the decision making process, adoption does not occur (Ray, 2001).

As indicated by Dasgupta (1989), adoption is not a permanent behavior. Consequently, an individual may decide to discontinue the use of an innovation for a variety of personal, institutional or social reasons one of which could be the availability of an idea or practices that is better in satisfying his or her needs (Ray, 2001).

On the other hand, although farmers often reject an innovation instead of adopting it, non adoption of an innovation does not necessarily mean rejection. Farmers are sometimes unable to adopt an innovation, even though they have mentally accepted it, because of economic and situational constraints (Dasgupta, 1989).

The rate of adoption is defined as the percentage of farmers who have adopted a given technology. On the other hand, the intensity of adoption is defined as the level of adoption of a given technological package. Put it in a different way, the number of hectares planted with

improved seed also tested as (the percentage of each farm planted to improved seed) or the amount of input applied per hectare represent the intensity of adoption of the respective technologies (Nkonya *et al.*, 1997).

According to Augustine and Mulugeta, (2005), the importance of adoption study is to quantify the number of technology users over time and to assess impacts or determine extension requirements that would help us in monitoring and feedback in technology generation. It also provides further insights into the effectiveness of technology transfer.

### **2.5. Evaluation of Improved Crop Varieties by Farmers**

Farmers' criteria vary greatly between households, depending on the productive resources controlled by the household. However, the criteria also vary within a household (van Veldhuizen *et al.*, 1997). The division of responsibilities and tasks is socially defined according to gender and age. This means that different household members evaluate a technology according to different criteria, which are related to their role and functions in the household (Bundlers *et al.*, 1996).

Farmers identify and select the type of crops most likely to do well in their areas and selection is normally preceded by extensive discussions both within the farm family and with neighbors (van Veldhuizen *et al.*, 1997). Any family member may make observations of crop performance, looking at the crop on field and other criteria after harvest and good crop stand is noticed by neighbors and becomes a subject of conversation within the community (Bundlers *et al.*, 1996).

Characteristics of the varieties play a vital role in adoption of improved crop varieties. Accordingly, if the characteristics of the varieties satisfy the need and interest of the farmers they

eventually adopt the improved crop varieties (Van Veldhuizen *et al.*, 1997). Farmers' technology evaluation criteria include growth habit, yield, color of grain, ease of threshing main uses in the diet, storage, qualities, marketability (Farrington and Martin, 1988), cost, ease of sale, desirability for home consumption, compatibility with existing practices, taste, nutritional value, cooking quality and resistance to pest (Van Veldhuizen *et al.*, 1997).

The choice of one technology/practice over others is greatly influenced by the balance between its positive and negative characteristics (Farrington and Martin, 1988). 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 (Bunders *et al.*, 1996). 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 then will researchers be able to assess the appropriateness of potential new technologies or practices, evaluate the likelihood that they will be adopted, and if necessary modify them to suit farmers' needs better (Van Veldhuizen *et al.*, 1997).

## **2.6. Empirical Studies on Adoption**

People and institutions both outside and inside Ethiopia have conducted empirical studies on the adoption and diffusion of agricultural innovations. But the studies were mainly Different concerned with major cereals and thus, studies conducted in pulse crops particularly haricot bean are very limited. In general, the variables so far identified as having relationship with adoption are categorized as household, personal and demographic variables, socio-economic, economic and institutional.

In the study conducted to understand the major factors contributing to the use of improved seeds in Ethiopia, Wolday (1999) reported that, price of inputs, access to credits, fertilizer use, economic status of the household, size of land owned, visits of extension agents and infrastructure development were the principal determinants of the adoption of improved seed. Likewise, similar studies on factors influencing the adoption of high yielding maize varieties revealed that factors such as age of the farmers, frequency of contact with extension workers, annual on-farm income level and farmers' knowledge of fertilizer use and its application rate (Degnet and Belay, 2001), the number of oxen, availability of off-farm income opportunity and wealth status of the head of household affected adoption of maize technology significantly (Degnet *et al.*, 2001).

On the other hand, Techane *et al.* (2006) in their study on factors affecting the adoption of fertilizer in Ethiopia, found that extension service, number of oxen owned, access to credit and hired labor were among the important determinants of the decision to adopt fertilizer. The rate of adoption was attributed to farm size, family size, access to credit, hired labor and off farm income (Degnet and Belay, 2001),

## **2.7. Conceptual Framework of the Study**

Agricultural technology adoption and diffusion patterns often vary from location to location. In general, the variations in adoption patterns proceed from the presence of disparity in agro ecology, institutional and social factors (CIMMIYT, 1993). Moreover, farmers' adoption behavior, especially in low-income countries, is influenced by a complex set of socio-economic, demographic, technical, institutional and biophysical factors (Legesse, 1998).

Adoption rates were also noted to vary between different group of farmers due to differences in access to resources (land, labor, and capital), credit, and information as well as differences in farmers' perceptions of risks and profits associated with new technology (Tesfaye *et al.* 2001).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, 2001).

Practical experiences and observations of the reality have shown that, one factor may enhance adoption of one technology in one specific area for certain period of time while it may create hindrance for other locations Tesfaye *et al.* (2001). Because of these reasons, it is difficult to develop a one and unified adoption model in technology adoption process for all specific locations. Hence, the conceptual framework presented in Figure-1 shows the most important variables expected to influence the adoption of improved haricot bean varieties in the study area.

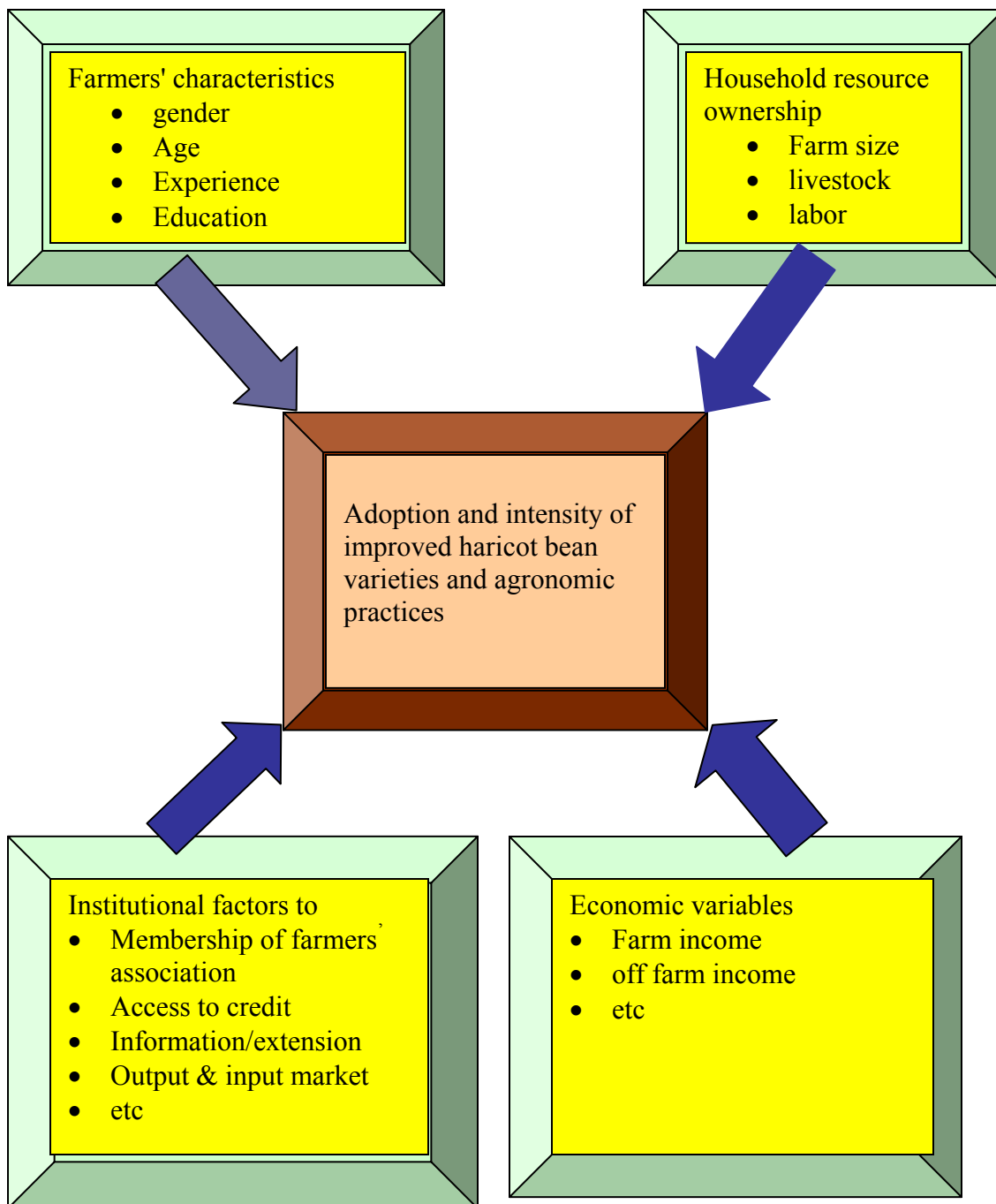


Figure1. The conceptual frame work for the study of factors affecting adoption of improved haricot bean varieties and associated agronomic practices

### **3. RESEARCH METHODOLOGY**

#### **3.1. Description of the Study Area: Dale Woreda**

This research was carried out in Dale wereda which is one of the nineteen Woredas of Sidama administrative Zone of the Southern Nations Nationalities & Peoples Region (SNNPR). It is located at 60 39' 20.47" to 60 50' 28.83" North and 380 18' 12.73" to 380 31' 30.60.78" East (Fig. 1). It is also the selected pilot learning wereda by IPMS (Improving Productivity and Market Success of Ethiopian Farmers) and is located 320 km south of Addis Ababa and 50 km from Hawassa.

The wereda has 36 kebele administrations. According to CSA (2008), the population of the wereda is estimated to be 244,692 of which women account for 49.7% and men account for 50.3% of the population. The altitude of the wereda ranges from 1626 to 2423 masl. The annual average rainfall at Awada is 1316 mm & the mean temperature ranges between 18 and 20<sup>0</sup>c (IPMS,2005).

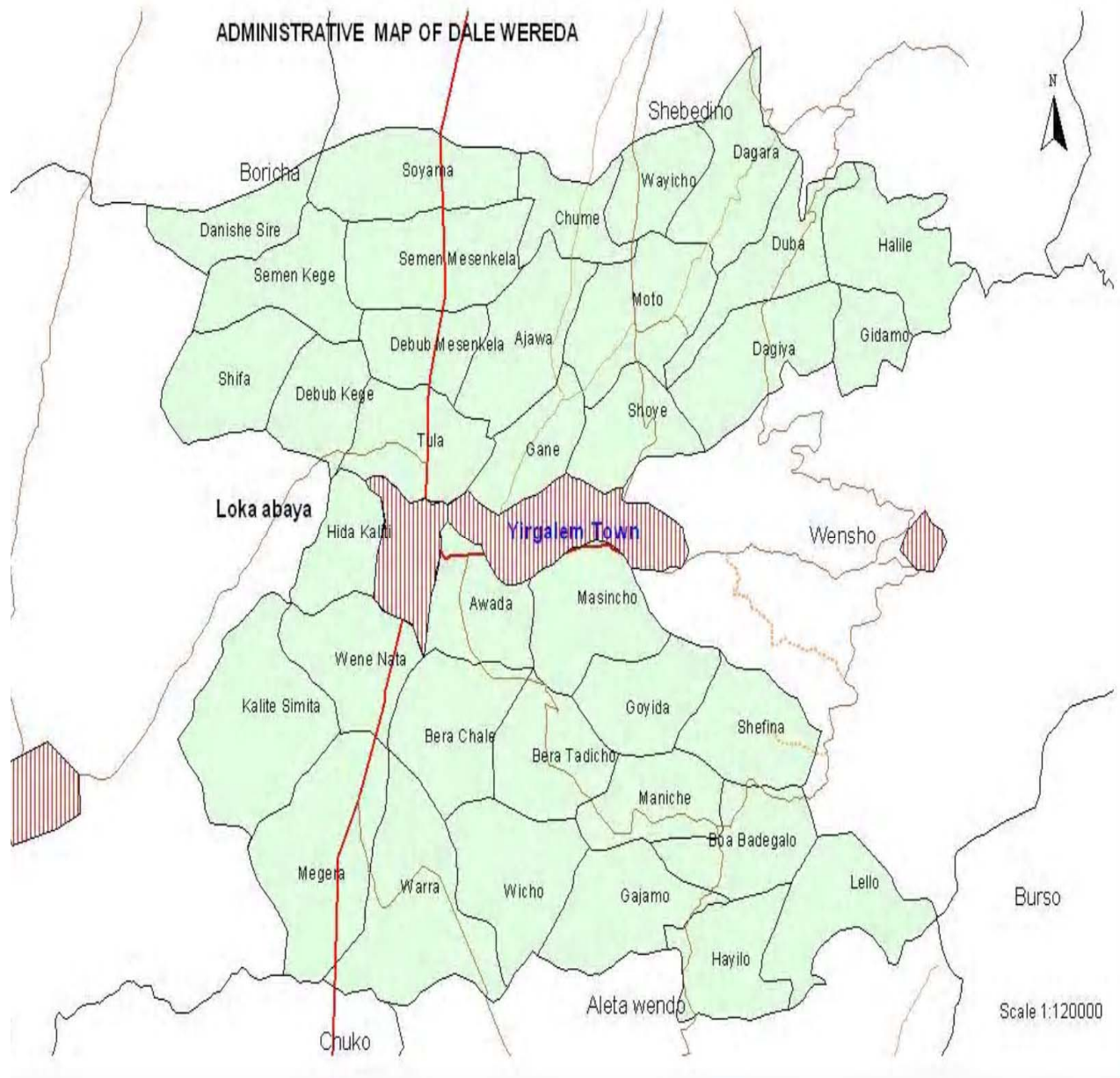
There are two cropping seasons in the area, Belg (short rainy season) from March to April and Meher (main rainy season) from June to September. Belg rains are mainly used for land preparation and planting long cycle crops such as maize. The Meher rains are used for planting of cereal crops like barley, teff, wheat and vegetable crops. Meher rains are also the major source of moisture for the growth and development of perennial crops such as enset, coffee and chat. Haricot bean is grown in both of the cropping seasons.

Livestock also play a major role in crop production in the study area; they serve as draught power, in addition to providing meat and milk. Livestock also denote prestige and asset to the household.

### **Farming systems**

According to IPMS (2005), two main farming systems are found in Dale woreda. They are the garden coffee, *enset*, and livestock system (referred as coffee/livestock system), which is found east of the main road transecting Dale from north to south; here the terrain is hilly and soils are red (Nitosols). Rainfall is higher and more reliable than under the haricot bean/livestock system explained below. The farming system is composed of garden coffee, *enset*, and cattle, which are tethered and kept for manure and production of dairy products. Other crops in the system are haricot beans (as an intercrop), yam, cereals, fruits, mainly avocado and bananas. Because of the perennial nature of the crop and the small holding size (between 0.25-0.5 ha per family), hand hoeing is the predominant method of cultivation.

The second farming system is the Cereals, *enset*, haricot beans, garden coffee, and livestock system (referred to as haricot bean/livestock system). This system is found west of the road transecting Dale from North to South. The terrain varies from relatively flat to hilly. Black soils (Pellic Vertisols) are commonly found on the flat areas and red soils on the slopes. Rainfall is lower and more erratic than in the coffee/livestock system. This system is dominated by cereals (maize, *teff*) rotated with haricot beans. *Enset* is cultivated near the homesteads. Average farm size is estimated at 1.5 ha. The farmers use oxen for their cultivation (IPMS, 2005).



**Figure: 2 Map of the study Woreda**  
**Source SNNPRS, Bureau of Agriculture**

### 3.2. Sampling Procedure

In this study a two stage sampling technique was employed. The first stage was purposive selection of haricot bean growing Kebeles of the woreda, followed by selection of sample households. The Kebele identification was made through reviewing secondary data on production and area coverage of the haricot bean crop. Five haricot bean growing Kebeles were purposively selected as a sample out of 36 kebeles of the Woreda. Before selecting household heads to be included in the sample, haricot bean grower household heads of each rural kebele were identified in collaboration with kebele leaders, key informants and development agents of the respective rural kebele.

In the second stage, 150 farm household heads were selected from identified haricot bean growers using systematic random sampling technique taking into account proportional to size (number) of haricot bean growers in each of five selected rural kebeles. As a result, the survey was administered and data were collected and analyzed on 150 respondents. Accordingly, the number of respondents in each rural kebele is shown in table 2.

**Table 2. Number of haricot bean producers selected from each identified *kebele***

No	Name of the kebele	Total Number of haricot bean growing households	Sample household selected
1	Debub kege	265	38
2	Debub mesenkela	195	27
3	Tula	182	26
4	Soyama	162	23
5	Semen kege	253	36
	Total	1057	150

### **3.3. Method of Data Collection**

Primary and secondary data were collected to answer the research questions and achieve the objectives of this study. Enumerators were given training and briefings on the objective, contents of the interview schedule and were also acquainted with the basic techniques of data gathering and interviewing techniques and on how to approach farmers.

The interview schedule was tested at the farm level on 10 randomly selected farm households. Pre-test enabled to know whether farmers had clearly understood the interview schedule. As a result, some unnecessary questions were deleted but those found important were incorporated in the final version of the interview schedule (Annex 17).

Primary data were collected through personal and face-to-face interview using structured and pre-tested interview schedule (Annex 17) that were filled up by recruited and trained enumerators under the close supervision of the researcher. Totally, 150 randomly selected sample household heads were covered under the survey. At last, to fill gaps observed during personal interviews, focus group discussions were conducted with group of farmers in each selected rural kebele.

Secondary data were obtained from various sources such as reports of bureau of agriculture at different levels, IPMS, NGOs, CSA, Woreda Administrative office, previous research findings, Internet and other published and unpublished materials, which were found to be relevant to the study.

### **3.4. 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 haricot bean production package. These include household's personal and demographic variables, economic variables, and institutional variables (Table 3).

The explanatory variables are defined as follows:

**1). Age of Farmer:** The role of a farmer'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 haricot bean 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 : =1,if the farmer is Iliterate, = 2 if the farmer can read and write, = 3 if the farmer attend formal education. Adoption is expected to correlate positively with education (Getahun *et al.*, 2000).

**5). Farm Size:** The size of the family farm is a factor that is often argued as important in affecting adoption decisions. It is frequently argued that farmers with larger farms are more likely to adopt an improved technology (especially modern varieties) compared with those with small farms. Hailu (2008) reported that farm size exerts a positive influence on adoption of improved technologies. It measured in hectares.

**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) Membership of Farmers' Association:** Belonging to an association or cooperative as member can influence farmer's decision to adopt an improved technology. In most farming communities farmers form or join associations or cooperatives of various kinds for all sorts of reasons. The variable is measured by allocating a score of 0 if a farmer is not a member, 1 if a farmer is member of any farmers social organization. Therefore it is assumed that such experience and exposure would increase adoption positively (Getahun *et al.*, 2000).

**8). Position of the farmer in farmer's association:** Farmers who have some position in rural kebeles and different cooperatives are more likely to be aware of new practices as they are easily exposed to information (Habtemariam, 2004). The variable was coded as 1 if the farmer has leadership position and, 0 other wise.

**9). Access to Credit:** Improved 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 *et al.*, 2004).

**10). Number of Livestock:** Livestock is the farmers' important source of income, food and draft power for crop cultivation in Ethiopian agriculture. It was measured in terms of Tropical Livestock Units TLU (annex table 2) (Storck *et al.*, 1999). It was hypothesized that as livestock ownership increases adoption/intensity of adoption is expected to increase because it serves as proxy for wealth status (Freeman *et al.*, 1996; Chilot *et al.*, 1996; Habtemariam, 2004).

**11). 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.

**12). 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).

**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 days. Participation in field days is expected to positively influence farmers' adoption of improved haricot bean 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). Participation in demonstration:** It is measured in terms of the number of times the farmer has participated in demonstration. Participation demonstrations 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). Output and Input Markets:** 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).

**Table 3 Definition, unit of measurement and expected effect of hypothesized variables**

<b>Variables code</b>	<b>Unit of measurement</b>	<b>Definition of variable</b>	<b>Expected sign</b>	<b>Rationale</b>
AGEHH	years	Age of house hold	±	The role of a farmer's age in explaining technology adoption is somewhat controversial in the literature. As farmer age increases probability of adoption is expected 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).
FAREXEP	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).
EDULEVEL	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.

Variables code	Unit of measurement	Definition of variable	Expected sign	Rationale
				(Getahun, 2000).
FARMSIZ	Hectares	Total farm size of the household	+	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 <i>et al.</i> (2001) reported negative relationship between farm size and adoption.
FARMINC	Birr	Total farm income of the household	+	The effect of farm income on household's adoption decision is positive (Degnet <i>et al.</i> , 2001) and Leggese (1998).
MEMSHIP	Score	Membership of Farmers' Association	+	A farmer who is membership of farmer's association in rural kebeles and different cooperatives are more likely to be aware of new practices as they are easily exposed to information (Habtemariam, 2004).
ACCESCRE	Dummy	Access to Credit	+	Farmers without cash and no access to credit will find it very difficult to attain and adopt new technologies (Million and Bellay, 2004).
NUMLISTO	TLU	Number of Livestock	+	As livestock ownership increases adoption/intensity of adoption is expected to increase and correlate positively (Habtemariam, 2004).

<b>Variables code</b>	<b>Unit of measurement</b>	<b>Definition of variable</b>	<b>Expected sign</b>	<b>Rationale</b>
PARTOFAR	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).
CONEXE	Dummy	Contact to 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 <i>et al.</i> (2001), attendance of agricultural training is positively and significantly related to adoption.
PARTDEMO	Number	Participation in on farm demonstration	+	Participation in on-farm demonstration is expected to positively influence farmers' haricot bean package adoption (Techane 2006).
PARTRAI	Number	Participation in training	+	Participation in training expected to positively influence farmers' haricot bean package adoption (Belay, 2003).
MARKACE	Kilometer	Distance to output and Input Markets	-	As market distance increases adoption and intensity of adoption was expected to decrease (Dereje, 2006)
Labor	Man equivalent	Labor availability	+	Household's labor availability has positive effect of on adoption (Million and Belay, 2004).

### **3.5. Analytical Techniques**

The data were analyzed using software SPSS version 17.0 and STATA 11 software. Chi-square and F-tests were used to evaluate the significance of the relationship between adoption groups.

For the categorical variables chi-square test was used while for the continuous variables F test was used by classifying the respondents into different classes of adoption groups.

#### **3.5.1. 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 haricot bean were considered as non adopters, while farmers who were growing improved variety with some of the recommended agronomic practices of haricot bean production were considered as adopters. Among improved agronomic practices only three practices (improved variety, seed rate, and fertilizer application rate), are currently practiced by haricot bean producer in the study area. The rest two practices (spacing in cm and chemical application) were excluded because of absence and difficulty in getting reliable information on them. 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 measure 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:

$$AI_i = \sum \left[ \frac{\frac{AH_i}{AT_i} + \frac{SRA_i}{SRR} + \frac{FA_i}{FR}}{NP} \right]$$

Where:  $AI_i$  = Adoption index

$AH_i$  = area under improved variety of haricot bean of the  $i$ th farmer.

$AT_i$  = Total area allocated for haricot bean production (improved variety+ local, if any) of the  $i$ th farmer.

$SRA_i$  = Seeding rate applied per unit of area in the production of improved haricot bean of  $i$ th 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 Haricot bean by  $i$ th farmer,

$FR$  = Amount of fertilizer recommended for application per unit of area in the cultivation of improved variety of Haricot bean,

$NP$  = Number of practices

Thus, the adoption index is a continuous dependent variable calculated using the formula presented 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 haricot bean production 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 household 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 haricot bean production and greater than zero ( $>0$  and  $\leq 1$ ) implies adopters with three category; namely low adopters, medium adopters and high adopters. The mean adoption index scores of non adopters, low, medium and high adopters groups were 0.00, 0.30, 0.58 and 0.84, respectively (Table 5).

### **3.5.2. Econometric analysis: Tobit model.**

Tobit model was used to determine the relative influence of various explanatory variables on the dependent variable.

The econometric model applied for analyzing factors influencing adoption and intensity of adoption of an improved haricot bean variety and its agronomic practices was the Tobit model. This model was chosen because; it has an advantage over other analytical models in that, it reveals both the probability of adoption and intensity of use of the technology (Maddala, 1992; Johnston and Dandiro 1997). Production and productivity of farm households depend not only on adoption but also on the intensity of use of the technology. Tobit model, which has both discrete and continuous part, is appropriate because it handles

both the probability and intensity of adoption at the same time (Augustine and Mulugeta, 2005).

The farmer may adopt only some part of the recommended package and may also do this on 1% or 100% of his/her farm. So, Tobit model is more appropriate to give reliable output of both discrete and continuous variable combination. 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), and Getahun *et al.*, (2000) used the Tobit model to estimate the probability of adoption and the intensity of fertilizer use. According to Adesina and Zinnah (1993, cited in Shivani *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.

**Tobit model specification:** The Tobit model (McDonald and Moffitt, 1980; Maddala 1983), which tests factors affecting the incidence and intensity of determinants of adoption, can be specified as follows:

$$\begin{aligned}
 A_{i}^{*} &= B_0 + B_i X_i + U_i \\
 A_i &= A_i^{*} \text{ if } B_0 + B_i X_i + U_i > 0 \dots\dots\dots (1) \\
 &= 0, \quad \text{if } B_0 + B_i X_i + U_i \leq 0
 \end{aligned}$$

Where:

$A_i^{*}$  = is the latent variable and the solution to utility maximization problem of intensity of adoption subjected to a set of constraints per household and conditional on being above certain limit,

$A_i$  = is adoption index for  $i$ th farmer

$X_i$  = Vector of factors affecting adoption and intensity of adoption,

$B_i$  = Vector of unknown parameters, and

$U_i$  is the error term which is normally distributed with mean 0 and variance  $\sigma^2$ .

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).

Before 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. In this study, variance inflation factor (VIF) and contingency coefficients were used to test multicollinearity problem for continuous and dummy variables respectively. The larger the value of VIF, the more troublesome. As a rule of thumb, if the VIF of a variable exceeds 10 (this will happen if  $R_i$  exceeds 0.95), that variable is said to be highly Collinear (Gujarati, 1995).

Similarly, contingency coefficients were computed for dummy variables. If the value of contingency coefficient is greater than 0.75, the variable is said to be collinear (Healy, 1984 as cited in Mesfin, 2005).

### **3.6. Description of Improved Production Practices**

Production practices are related with the selection of planting material, land preparation, planting, weeding, cultivation, plant protection, harvesting, and threshing along with cleaning and grading. The stated practices can be improved /recommended by research. This study was documenting the practices undertaken by the farmers. The discussion below gives the production practices for which there are improved and/or recommended packages.

### **3.61. Improved varieties**

For improvement in production and productivity of haricot bean a lot of efforts have been made by the researchers in developing different types of improved varieties with appropriate agronomic practices. Among the released haricot bean varieties Ibado, Dimtu, Nasir, Awasa dume and Omo 95 varieties were introduced to the farmers of the study area through a Non-governmental organization (IPMS or Improving productivity and market success of Ethiopian farmers) and by DWOoA (Dale Woreda Office of Agriculture) starting from 2004.

For adoption index (AI) calculation, area under improved variety of haricot bean to total land was used.

One way analysis of variance were used to see the existence of significant mean difference of land covered with improved haricot bean rate applied among the three adopter categories.

**Table 4 List of improved Haricot bean varieties and their characteristics**

Variety name	Released year	Maturity period Days	Type			Recommended agro ecology
			Export	Domestic	Both	
Awash-1	1990	95-100	✓			Middle rift valley
Awash Melka	1998	95-100	✓			In all haricot bean production area
Argene	2005	85-90	✓			Middle rift valley
Chore	2006	87-109	✓			In all haricot bean production area
Chercher	2006	98	✓			Harer & dega areas
Roba	1990	75		✓	✓	In all haricot bean production area
Gofta	1997	95			✓	East & west Hararge
Ayeneu	1997	90-95			✓	East & west Hararge
Melke	1998	82		✓		Southern rift valley
Beshbesh	1999	82		✓		Southern rift valley
Omo 95	2003	104		✓		Southern rift valley
Goberasha	1998	90-95			✓	Western Ethiopia
Tabore	1998	80-90			✓	Southern Ethiopia
Hawasa dume	2001	85-90		✓		Southern Ethiopia
Nasir	2003	88			✓	In all haricot bean production area
Dimtu	2003	86			✓	In all haricot bean production area
Melka dima	2006	91			✓	Middle rift valley
Anger	2005	91			✓	Bako & west Ethiopia
Ibado	2003	90-120			✓	Southern Ethiopia
Omo nech	2003	90-120			✓	Southern Ethiopia
Haremaya	2006	100			✓	In cold area of Harer
Denklesh	2006	92			✓	Middle rift valley
Batu	2008	75-85			✓	In all haricot bean production area
Deme	2008	90-115			✓	In all haricot bean production area

Source Awassa research centre, 2006.

### 3.6.2. Seeding rate

Use of proper seeding rate is one of the most important practices in improved haricot bean production. Excessive or under utilization of seed will result in poor production performance.

Usually research recommends specified level of seeding rate for a given variety or crop with a given range of seed viability and spacing. Appropriate plant spacing is important because overcrowded sowing would result in slow and stunted growth and eventually poor yield. According to the regional Agricultural Bureau extension program manual 2006, the recommended seed rate of haricot bean for row planting is 70- 100 kg and for broadcasting is 90- 120 kg seed per hectare based on seed size (table 1). Also spacing for row planting is 10 cm between plants and 40 cm between rows. For adoption index (AI) calculation, 100kg<sup>-1</sup> improved haricot bean seed was used. One way analysis of variance were used to see the existence of significant mean difference in seeding rate applied among the three adopter categories

### 3.6.3. Fertilizer

Haricot bean production, like any other crop, requires use of different inputs. Fertilizer application is one of the most important practices. Both phosphoric and nitrogenous fertilizers are essential to realize good yields. According to the regional Agricultural bureau extension program manual 2006, the recommended fertilizer rate, is 100 kg ha<sup>-1</sup> DAP at planting and 50 kg ha<sup>-1</sup> urea before flowering. The farmers in the study area were used only DAP fertilizer for haricot bean production. For adoption index (AI) calculation, 100kg<sup>-1</sup> DAP fertilizer was used. One way analysis of variance were used to see the existence of significant mean difference in fertilizer rate applied among the three adopter categories

#### **3.6.4. Weeding practice**

Crop loss assessment trials show that uncontrolled weed growth could result in over 36% yield reduction in haricot bean and more than 50% in soybean (Beyenesh,1988). In haricot bean production 2-3 times weeding is necessary for getting good yield. The first weeding is done after two weeks of the plant emergence and the second is 21-25 days after emergence (Setegne and leggese, 2003). Production practices such as spacing, intercropping, weeding etc, are not used for computing Adoption index (AIi) and not used in the econometric analysis, but are generally reported in the thesis.

## **4. RESULT AND DISCUSSION**

### **4.1. Haricot bean technology package adoption by components**

#### **4.1.1 Overall adoption of haricot bean technology package**

In this study, farmers who did not grow improved variety of haricot bean were considered as non adopters and while the farmers who grow an improved variety with some of the recommended agronomic practices of haricot bean 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 (17%) had adoption index score of 0 which shows they are non adopters, 6 respondents 4% had adoption index ranging from 0.1 to 0.33 which indicates low adopters, while 81 respondents (54%) had adoption index score stretching from 0.34 to 0.66 indicating medium adopters, and 38 respondents (25 %) had adoption index score ranging from 0.67 to 1.00. which show high level of adoption. (Table 5).

#### **4.1.2. Improved haricot bean varieties**

The intensity of variety adoption is measured in the proportion of area covered by improved variety of haricot bean to total area. The area coverage was varied among haricot bean growing sample households. As indicated in (Table 5) the total sample households' average area proportion coverage was 0.22 hectare. The minimum and maximum area coverage by adopter sample households ranges from 0.06 to 0.50 hectare. The difference in area coverage under improved haricot bean variety may be attributed to varying land holding and stage of an individual in the adoption process.

### **4.1.3. Seeding rate**

Farmers in the study area were found to use varying seeding rates of improved haricot bean variety. On average low, medium, and high adopters used 55.3, 61.31, 67.38 kg/ha respectively (Table 5). All adopter groups used below the recommendation rate.

There was a significant variation among the sample households in the amount of seed rate per unit area used where the minimum was 43.5 kg, while the maximum was 75.4 kg per ha. One way analysis of variance revealed the existence of significant mean difference in seeding rate applied among the three adopter categories, low, medium and high ( $F=39.304$ ,  $P=.000$ ) at 1% significance level.

### **1.1.4. 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 haricot bean production by sample grower households during the 2009/10 production year was 57.28 kg/ha<sup>-1</sup> and mean fertilizer rates of non-adopters, low, medium and high adopters were 0 kg, 50 kg, 67.38 kg and 71.06 kg per hectare (Table 5). Fertilizer application rate of sample respondents vary across adoption categories. Analysis of variance indicated that there was significant mean difference between adoption categories ( $F= 26.418$ ,  $P= 0.000$ ) in relation to fertilizer application rate at 1 % of significance (Table 5).

**Table 5 Adoption of haricot bean packages by adoption category**

Adoption category	Adoption index score range	Mean of adoption index	% of farmers	Average proportion of land (improved HB land / total land)	Average seed rate in Kg/ha	Average Dap fertilizer application rate in Kg/ha
Non adopters	0	-	17	-	-	-
Low	0.10-0.33	0.30 (0.02)	4	0.14 (0.08)	55.33 (38.40)	50.00 (30.00)
Medium	0.34-0.66	0.58 (0.08)	54	0.20 (0.07)	61.31 (21.66)	67.38 (32.22)
High	0.66-1.00	0.84 (0.21)	25	0.30 (0.13)	67.68 (20.30)	71.06 (23.48)
Total or Mean	0.00-1.00	0.54 (0.30)	100	0.22 (0.10)	54.27 (29.54)	57.28 (36.13)
F-value		244.891***		16.012***	39.304***	26.418***

Note: STD in parenthesis, \*\*\* indicates at < 1% significance level

## **4.2. Haricot bean production practices by adoption levels**

### **4.2.1. Spacing**

From total respondent 23% of them used row planting in which only 11% of them used recommended (20 cm between plants and 40 cm between rows) The rest used as they prefer.

Respondent farmers have mentioned different reasons for not using the recommended spacing. According to the majority of respondents they mainly used intercropping haricot bean with different crops, broadcasting; they also said that it requires additional labor and skill, because of these reason they said that, it is difficult for them to practice recommended spacing.

### **4.2.2. Intercropping**

Intercropping has an immense 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 (Chemed, 1997).

In the study area from total of 150 respondents, 28 (19%) used mono-cropping method of production, 75 (50%) employ intercropping and while (31%) used mono-cropping as well as intercropping in one production season in the same or different plots of land (Table 6). During group discussion the respondent mentioned that due to farm land shortage and to minimize the risk of crop failure most of them employ intercropping.

**Table 6. Type of cropping techniques in haricot bean production**

Type of cropping	No of household in Adoption category					
	Non adopter	Low adopter	Medium adopter	High adopter	Total	%
Mono cropping	0	3	23	2	28	19
Intercropping	16	2	35	22	75	50
Both	9	1	23	14	47	31
Total	25	6	81	38	150	100

The result indicated that,21% of respondents were intercropping haricot bean with maize and coffee , 21% with maize and chat, 20% with only maize, 13% with maize and enset, 5% with enset, 2% with enset and 2% with chat. (Table 7).

**Table 7. Type of crops used for intercropping**

Type of crop used for inter cropping	No of house hold in Adoption category					
	Non adopter	Low adopter	Medium adopter	High adopter	Total	%
Maize	4	1	19	6	30	20
Enset	2	0	4	2	8	5
Chat	0	1	2	0	3	2
Coffee	0	0	1	1	2	2
maize and coffee	9	0	14	8	31	21
maize and enset	5	1	10	4	20	13
maize and chat	5	0	11	16	32	21
Mono cropping	0	3	20	1	24	16
Total	25	6	81	38	150	100

#### 4.2.3. Weed control practices

In the study area, 42 % of the household do not weed their haricot bean farm while, 55 % practice one time weeding and only 3% of the households practiced two times weeding (Table ). So a lot of efforts have to be made by extension services regarding weed control

practices not as failing to do so results in yield reduction but also it affects on grain quality for marketing.

**Table 8 Frequency of weeding in Haricot bean production**

Frequency of weeding	No of house hold in Adoption category					
	Non adopter	Low adopter	Medium adopter	High adopter	Total	%
One time	14	2	47	19	82	55
Two times	0	0	4	1	5	3
No weeding	11	4	30	18	63	42
Total	25	6	81	38	150	100

#### **4.3. Farmers' selection criteria for improved haricot bean 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 mismatch with preference criteria between technology disseminator and farmers.

The result of ranking made during the survey and focus group discussion in the study area. Accordingly, high yielding, market demand, price advantage, length of maturity, grain color, grain size, disease resistance and storability are the most preferred attributes of improved haricot bean varieties in order as ranked by sample households (Table 9). Survey result indicated that, among the total sample adopters the majority of the sample households produced Nasir variety starting from the year 2004. They prefer Nasir Variety due to its high productivity, market demand, price advantage, and color. Due to these cases the numbers of

sample households growing Nasir were increasing but there is seed shortage of this improved variety in the study area.

**Table 9 Farmers’ Evaluation Criteria of Improved haricot bean Varieties in the study area**

Parameters	Frequency	Percent	Rank
High yielding	49	39.2	1 <sup>st</sup>
market demand	23	18.4	2 <sup>nd</sup>
Price advantage	16	12.8	3 <sup>rd</sup>
Time of maturity	12	9.6	4 <sup>th</sup>
Grain colour	9	7.2	5 <sup>th</sup>
Grain size	7	5.6	6 <sup>th</sup>
disease resistance	5	4	7 <sup>th</sup>
Storability	4	3.2	8 <sup>th</sup>
Total	125	100	

#### **4.4. Socio-demographic Characterization of haricot bean farmers by adoption levels**

##### **4.4.1. Sex**

Out of 150 respondents, 87.3% were male and the rest 12.7% were female (Table 10). The majority of female household adopters were found in low adoption category which indicates that they are less capable in adopting haricot bean production packages as compared to their male household counterparts.

The result of chi-square analysis ( $\chi^2=73.274$ ,  $P=0.000$ ), Cramer’s  $V=0.501$  revealed that there is significant relationship between sex and the adoption of haricot bean 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 31.3 % were illiterates, 27.3% were literates and 41.4 were attending regular school education (Table 10).The result of chi-square- test ( $\chi^2=18.315$ ,  $P=0.005$ ) revealed that there is significant relationship between education and the adoption of improved haricot bean production. 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 24.7 % had participated in off-farm activities, while 75.3% had not participated (Table 10). Unlike priori expectation, participation in off-farm activities ( $\chi^2=0.613$ ,  $df= 3$ ), had insignificant relationship with adoption of improved haricot bean production also the results of Cramer's  $V= 0.179$  indicated that there is no association between off farm activity and adoption of improved haricot bean production package.The result of this study confirms the findings of Habtemariam (2004) and Teshale (2006).

In the study area, trading, daily laborer activities, and civil servant were found to be some of the off-farm activities in which sample households were participating.

#### **4.4.4. Membership to Seed multiplication group**

Participation in social organization is expected to have an indirect influence on the adoption behavior of farmers. This exposure exposes them towards innovative ideas and practices (Tesfaye and Shiferaw, 2001). As seed multiplication group is one of farmers association it is expected to have significance relationship on adoption. Table 9, indicates 54 (34.6 %) of the total sampled house hold participates in seed multiplication while 96 (65.3 %) did not participate in seed multiplication group (  $X^2 = 16.109$ ,  $P = .001$  ). The result revealed that there is significant relationship between membership and the adoption of haricot bean production practices at 1 % level.

#### **4.4.5. Access to improved haricot bean 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 haricot bean technologies but in the study area there is no access to credit in cash but there is access to credit of improved haricot bean varieties seed in kind. The result of this study shows statistically significant difference between adoption categories by access to seed credit at less than 1% percent probability level ( $\chi^2=10.395$ ,  $p=0.000$ ).

Different types of improved haricot bean varieties were available on credit basis to farmers from the office of agriculture and NGOs in the cropping season. Regarding improved haricot bean credit access, 35.7 % respondent farmers in the study reported having access to the seed credit while the remaining 64.3 percent reported lack of access to seed credit (Table 10). Seed credit from institutional sources was expected to influence the adoption decisions of the

farmers. Access to institutional seed credit would alleviate the lack of improved haricot bean seed varieties for the resource poor farmers and also motivate the farmers for adoption of improved haricot bean varieties. Farmers without cash and no access to credit will find it very difficult to adopt new technologies. Previous authors verified this preposition on access to credit (Hailu 2008; Teshale *et.al.*, 2006). It is expected that access to credit will increase the probability of adopting improved haricot bean production package. Access to credit encourages farmers to adopt improved agricultural inputs which in turn raise agricultural productivity.

**Table 10. Characteristics of haricot bean farmers by adoption levels: categorical variables (%age of farmers)**

Indicator	category	Adoption category					Chi square test
		Non adopter	Low adopter	Medium adopter	High adopter	Total	
Sex	Male	7.6	2.3	61.1	29	87.3	73.27***
	Female	78.9	15.8	5.3	0	12.7	
Education status	Illiterate	31.9	8.5	42.6	17	31.3	18.32***
	Literate	14.6	0	56.1	29.3	27.4	
	Formal education	6.5	3.2	61.3	29.0	41.3	
Off farm activity	Yes	10.8	2.7	59.5	27	24.7	0.67
Membership in seed multiplication	Yes	0	3.8	65.4	30.8	34.6	16.11***
Access to improved haricot bean seed credit	Yes	0	7.7	61.5	30.8	34.7	10.39***
Contact with extension agent	Yes	3.5	1.2	67.1	28.2	56.7	30.88***
Participation in training	Yes	0	3.2	66.1	30.6	41.3	21.83***
Participation in field day	Yes	1.7	3.4	67.8	27.1	39.3	16.72***
Conducting demonstration	Yes			53.1	46.9	21.3	15.86***

Note: \*\*\* indicates significance level <1%

#### **4.4.6. Contact with extension agent**

The result indicated that 28, 50, 72.8 and 92.1 percent of non adopters, low adopters, medium and high adopters had contact with extension agent, respectively (Table 10). Where as 72, 50, 27.2 and 7.9 percent of non adopters, low, medium and high adopters had no contact with development agent. This implies that in general a larger proportion (69.3%) have contact with a development agent while a smaller proportion (30.7) have no contact with development agent. This implies that as the study indicates most farmer had contact with the extension agent and most of farmers are adopters in different adoption category. The chi-square result ( $\chi^2=30.879$  and  $P=0.000$ ) shows statistically significant difference between adoption categories with respect to farmers contact with extension agent. Lelisa, (2002.), Mulugeta et al., (2001) also reported similar result.

#### **4.4.7. Participation in training**

Out of total 150 farmers interviewed 41.3% of them had attended training while 58.7 % did not attend training program related to improved haricot bean production (Table 10). The chi-square result ( $\chi^2=21.878$  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. 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.

#### **4.4.8. Participation in field day visit.**

From the total sample households 39.3 % of farmers have attended field days at different level of frequency while the majority of the farmers (60.7 %) did not attended field day programs (Table 10). The participation of respondents in field day with varying level of frequency of low, medium, and high adopters can be observed. To determine the relationship between field days participation and adoption status the chi-square analysis ( $\chi^2=16.721$ ,  $p=0.001$ ) shows that there is significant difference between non adopter and adopter categories. The results of Cramer's V= 0.255 also indicated that there is association between field day and adoption of improved haricot bean 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. This situation may facilitate the adoption process.

#### **4.4.9. 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 haricot bean production and associated agronomic practices and

the rest 79.7 % did not participated (Table 10). Chi-square test indicated that, there is significant ( $\chi^2 = 15.864$ ,  $P=0.001$ ) relationship between participation in demonstration and adoption at 5% probability level. Participation in demonstration significantly and positively influences the adoption of haricot bean production technologies. Similar results were reported by Kidane (2001) and Belay (2003).

#### **4.4.10. Age of household head**

The role of age in explaining technology adoption is some what controversial. It is usually considered in adoption studies with the assumption that older people have more farming experience that helps them to adopt new technologies. On other side, because of risk averting nature older age farmers are more conservative than the youngest one to adopt new technology.

The mean age of sample households was 41.16 years with standard deviation of 9.672. The maximum age for the sample farmers was 85 years while the minimum was 25 years (Table 10). Result of mean test using one-way ANOVA indicated that there was no significant mean difference ( $F=1.229$ ,  $P=0.301$ ) among adoption categories, implying the absence of significant relationship of age with adoption of improved haricot bean production package. This is evident from the non-significant mean difference in average age among adoption categories. The mean age of non adopters, low, medium and high adopters were found to be 43.40, 45.33, 40.00 and 41.50 years respectively. The studies of Tesfaye *et al.*,(2001) on Adoption of Seed and Fertilizer Packages also reported absence of statistically significant mean age difference between adopters and non adopter groups.

#### **4.4.11. Experience of the household head**

Farmers with higher experience in haricot bean 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 15 years whereas the least experienced farmers had 3 year of experience in haricot bean farming (Table 10). On average, the sampled respondents had 6.18 years of experience in haricot bean cultivation. The average years of haricot bean cultivation experience of house hold heads for non adopters, low adopters, medium and high adopters were 10.6, 7.33, 10.26 and 12.11 respectively. One way analysis of variance ANOVA ( $F=1.394$   $P= 0.247$ ) 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).

**Table 11 Characteristics of haricot bean farmers by adoption levels: continuous variables (average values).**

Indicator	description	Adoption category										F-value
		Non adopter		Low adopter		Medium adopter		High adopter		Total		
		Mean	STD	Mean	STD	Mean	STD	Mean	STD	Mean	STD	
Age of HH	Age of house hold	43.40	11.78	45.33	11.57	40.00	8.55	41.50	10.06	41.16	9.67	1.23
Expe.of HH	Experience of house hold	10.6	3.73	7.33	2.58	10.26	5.7	12.11	8.32	10.67	6.18	1.39
Family siz	Family size of HH	4.48	1.15	6.67	2.65	5.63	1.15	5.42	1.44	5.43	1.53	5.43***
Total lan.	Total land of HH	0.84	.33	1.74	.48	1.35	.67	1.60	2.17	1.34	1.23	2.24*
Livesto TLU	Total livestock in TLU	2.97	2.06	3.1	1.10	3.01	0.74	4.12	2.91	4.29	3.29	1.99
Labor MAE	Availability of labour	3.57	1.25	3.10	1.1	3.01	.74	3.00	.95	3.11	.93	4.39***
Farm inco.	Total farm income	3289.8	1803.2	5728.6	4694.6	6073.0	4834.2	6871.5	5196.1	5797.7	4680.42	5.29***
Marke.dist .	Out put/ input market	6.07	1.813	6.39	1.597	5.82	1.687	5.48	2.325	5.80	1.880	0.72

Note: \*\*\* indicates significance level at 1%, and \* significance at 10%

#### **4.4.12. 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 haricot bean production technologies. Because availability of labor is likely to influence the gross margin of the innovation.

The average family size of the respondents was 5.43 members. The minimum family size of the sample households was 1 while the maximum was 10 persons (Table 11). The results showed that there is significant difference among the adoption categories in family. One way analysis of variance ANOVA ( $F=5.424$ ,  $P= .001$ ) shows that there is statistically significant mean difference between adoption categories. 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, Getahun et.al (2000), reported the same result.

#### **4.4.13. 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 1.34 hectare. The minimum and maximum total land holding of the respondents ranges from 0.37 to 2.13

hectares (Table 11). The average total land holding of the non adopters group was 0.84 h<sup>1</sup> where as the low, medium and high adopter categories was 1.74, 1.35, and 1.60 ha respectively. One way analysis of variance (F=2.240, P=0.086) shows that there was statistically insignificant mean difference among adoption categories. The result of this study confirms with the findings of Million and Belay (2004).

#### **4.4.14. 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 haricot bean 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 11, the average livestock ownership of sample households in TLU was 3.29. The minimum livestock number of the total respondents' was 3 whereas the maximum number of livestock was 10. To know whether there is a variation in average livestock ownership between adopters and non- adopter's analysis of variance was conducted.

The result of ANOVA (F=1.986, P=0.119) revealed that there is no significant variation in average livestock ownership with in the adopter categories. The results of this study are not in conformity with earlier adoption studies. On the other hand, Degnet (2001),

and Habtemariam (2004), in their studies reported that livestock holding has a positive significant influence on adoption of agricultural technologies.

#### **4.4.15. 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 haricot bean production package. Therefore, it was hypothesized to have positive relationship with adoption and intensity of adoption of haricot bean production package.

The total average labor availability in terms of man equivalent for sample household was 3.10 with standard deviation of 0.93 (The average number of available labor force in terms of man equivalent for non-adopters, low, medium and high adopters were 3.57, 3.10, 3.01 and 3.00 respectively (Table 11) The analysis of variance ( $F= 4.393$  and  $P = 0.005$ ) shows significant mean difference between adoption categories, the result of this study confirms the findings of Bekele *et.al*, (2000) and Million (2004).

#### **4.4.16. Farm income**

Farm income is the main source of capital to purchase farm inputs and other household inputs. In this study the household farm income was estimated based on the sales of crop, livestock and livestock products. The major cash income for sample households in the study area is from sale of coffee (dry berry and red berry coffee).

The average annual farm income for the total sample households was birr 5797.70 where as the average farm income for non-adopters was Birr 3289.80 and that of low, medium and high adopters mean on-farm income was 5728.66, 6073.09 and 6871.51, respectively (Table 11). The minimum and maximum farm income of the total sample households ranges from 1545 Birr to 23410 Birr. Analysis of variance was conducted to test the relationship of farm income with adoption of haricot bean production package and the result ( $F=5.285$  and  $p=0.0.000$ ) showed that significant mean difference among adoption categories. This study confirms with the findings of Degnet *et al.*, (2001) and Kidane, (2001).

#### **4.4.17. Distance to Output/input market**

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.

Regarding the distance taken to travel from home to the nearest market place, sample farmers reported that they had to travel an average of 5.80 km with standard deviation of 1.89 km (Table 11). For sample respondents the minimum and the maximum distance that a farmer had to travel to access market center were, 0.2 km and 11 km, respectively. Mean distance traveled to the nearest market centers by non-adopters, low adopters, medium and high adopters was 6.07, 6.39 km, 5.82 and 5.48 km respectively Results of

one way analysis of variance (F=1.411 and P=0.242) reveals that there is no statistically significant mean difference among adoption categories. The study confirms with Tesfaye and Shiferaw, (2001).

**4.5. Determinants of the adoption of haricot bean technology package: the Tobit model estimates.**

This part presents the Tobit econometric model estimates of the determinants of the adoption of the haricot bean production technology package. Before running the model analyses the existence of a serious of multicollinearity among independent variables for all continuous and discrete variable were checked by Variance Inflation Factor (VIF) for continuous explanatory variables and contingency coefficients for dummy explanatory variables.

The factors considered are related with personal, demographic, economic, institutional variables relevant to the adoption and intensity of adoption of improved haricot bean production package. From the total of 16 explanatory variables hypothesized to influence adoption, eight variables were found to significantly influence probability of adoption and intensity of adoption of improved haricot bean production package (Table12

**Maximum Likelihood Estimates of Tobit Model**

Variables	Estimated Coefficient.	Std. Err.	t	P
SEXHH	0.5675765	0.0533227	4.90***	0.0000
PAOFA	-0.0199447	0.05165	-0.39	0.7005
SEECRED	0.0336503	0.0473561	2.13**	0.0325

PAFILD	0.081008	0.223211	3.16**	0.0033
FAREXP	-0.0013123	0.045314	-0.03	0.9770
MEMSEM	0.1072141	0.1532016	1.76 *	0.0804
PATRAIN	0.088732	0.0530616	1.29 **	0.0216
AGEHH	-0.4567856	0.375619	-0.33	0.7405
TLU	-0.000214	0.02985	-0.01	0.9941
MANEQ	-0.0242109	0.0817001	-0.30	0.7670
TOTLAN	0.0662677	0.040857	1.62	0.1072
TOTINCO	0.0317772	0.0308668	1.03	0.3050
CONDEM	0.093043	0.0592687	3.36*	0.0911
MARKDIS	-0.0600924	0.0161347	-3.23**	0.0020
Constant	0.0932834	0.3708259	0.25	0.8021
Sigma	0.238506	0.055337	12.35***	0.0000

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Log likelihood = -16.70931

Pseudo R2 = 0.7764

Prob = 0.0000

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Source: model output

\*\*\*, represents 1%, \*\*, 5% and \* 10% level of significance respectively

### 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 haricot bean production technology at 1% significance level (Table 12). This shows that being male headed households have better access to information on improved haricot bean production technologies and are more likely to adopt new technologies than female headed households and also increase their haricot bean 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).

### **Access to improved haricot bean seed credit**

Access to credit is one way of improving farmers' access to new production technology. the Tobit model indicates Access to credit had positive and significant influence on the adoption of improved haricot bean production technology at 5% significance level (Table 12).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 haricot bean technologies but in the study area there is no access to credit in cash but there is access to credit of improved haricot bean varieties seed in kind. Different types of improved haricot bean varieties were available on credit basis to farmers from the office of agriculture and NGOs in the cropping season.

### **Participation in field day**

Participation on field day is one of the means of teaching and learning process of improved technologies. The result of Tobit model in relation to this variable shows that participation in training was positively and significantly related to adoption of improved haricot bean production package at 5% significance (Table 12).

Farmers who have an opportunity to attend field day of improved haricot bean production are more likely to use improved haricot bean production technology than those farmers who have no similar opportunity. In another word, the result indicates that farmers who are exposed to formal extension information have a higher probability towards adoption than those with less exposure. This suggests that access to participation of field day improved production of haricot bean and farmers could be aware of the various aspects of

the production and productivity of the crop. This result agrees with the findings of Tesfaye *et al.*, (2001).

### **Membership of seed multiplication:**

Participation in seed multiplication had positive influence on adoption and intensity of adoption of improved haricot bean production package at 10 % level of significance (Table 12). Organizing of farmers to be a member of seed multiplication group would use to get access to seed credit (received basic seed from research for multiplication (20kg/farmer), access to extension information and also access to market. This implies strengthening and expansion of seed multiplication is of paramount importance to improve availability of sustainable seed supply system in the area and enhance adoption of improved haricot bean production.

### **Participation in training**

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 5% significant level (Table 12). This may be explained by the fact that farmers who have training gain better knowledge on production practices and technologies than non trainer which helps to increase production and productivity of improved haricot bean.

The implication is that emphasis has to be given to farmers' improved technology package through training to enhance adoption of improved haricot bean production package. The result is agree with findings Tesfaye *et al.*, (2001) and Asfaw *et al.* (1997)

### **Conducting demonstration**

Farmers can acquire new knowledge through demonstration to improve production and productivity of agriculture. The Tobit result indicates that the probability of haricot bean production package adoption was positively and significantly affected by demonstration at 10% significant level (Table 12). 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).

### **Out put input market distance**

Distance from farmers house to the input and output market was negatively related to the adoption of haricot bean production package. The probability of adoption of the package significantly affected by market distance at 10% significance level (Table 12). Market access result indicated that as market distance decrease, adoption by among the household increase. This indicates that farmers nearer to the input and output markets have more access to input, technology and out put market and also getting information about improved technology than those who are in distant areas and can make early

decision of adoption. Similar finding was identified by (Hailu, 2008), as market distance increases adoption and intensity of adoption decreased.

#### 4.6 Effects of changes in the significant explanatory variables on probability and intensity of adoption of improved haricot bean production

All variables that were found to influence the adoption and intensity of use of haricot bean production technologies might not have similar contribution in influencing the decision of farm household. The results of Tobit model (marginal effect) was used to assess the effects of changes in the explanatory variables into adoption and intensity of use and the result is presented in Table13

**Table 13: Effects of changes in explanatory variables**

Variables	Change in the probability of Adoption	Change in the intensity of adoption	Total change
SEXHH	0.478765	0.567527	0.567528
ASECRED	0 .031650	0 .073650	0 073650
PAFILED	0.054763	0.081068	0.081069
MEMSEM	0.107235	0.153214	0.157214
PATRAN	0.068193	0.083761	0.083762
CONDEM	0.052843	0.093068	0.093069
Constant	0 .093283	0.370825	0.370824

Source: model output

The marginal effect result shows that, being male headed house hold in the area increases probability of adoption and intensity of use of improved haricot bean production package

by 47 % and 56 % respectively. 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 improved agricultural technologies.

The results computed indicate that the estimated increase in the probability of adoption and intensity of use of improved haricot bean production technologies resulting from having access to improved seed credit was 3.1 % and 7.3 % respectively

The marginal effect result also shows that the estimated increase in the probability and intensity of use of improved haricot bean production package resulting from attending in field day visit programs of improved haricot bean production package is 5.4 % and 8.1 % respectively. Field day is also an important method of extension to pull farmers in accepting technology packages. In field day visit program, farmers can have an opportunity to see the implementation of the technology practically.

The marginal effect result also shows that the estimated increase in the probability and intensity of use of improved haricot bean production package resulting from participating in seed multiplication group towards improved haricot bean production package is 10.7% and 15.3 % respectively. This implies that strengthening and promoting of seed multiplication in farming community will enhance the adoption of new technology including improved haricot bean package.

An increase in improved haricot bean production training increases the probability of adoption and intensity of use of improved haricot bean production package by 3.1 % and 7.3 % and also increasing conducting demonstration was increases the probability of adoption and intensity of use of improved haricot bean production by 5.2% and 9.3% respectively. Therefore the extension service has to take in to consideration to conduct a variety of extension events as a major component of extension to promote technology adoption.

In this study the unit increase in an explanatory variables, will be certain percent increase on the probability of adoption and intensity of use of improved haricot bean production and associated agronomic practices. Therefore the current extension service has to give more emphasis on improving the influencing factors on adoption of improved haricot bean.

12). These are sex of house hold head, Extension frequency, attending training, attending field day programs, conducting demonstration, access to improved seed credit ,membership of seed multiplication group and market distance.

**Table12 Maximum Likelihood Estimates of Tobit Model**

Variables	Estimated Coefficient.	Std. Err.	t	P
SEXHH	0.5675765	0.0533227	4.90***	0.0000
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### 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 haricot bean production technology at 1% significance level (Table

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significantly affected by market distance at 10% significance level (Table 12). Market access result indicated that as market distance decrease, adoption by among the household increase. This indicates that farmers nearer to the input and output markets have more access to input, technology and out put market and also getting information about improved technology than those who are in distant areas and can make early decision of adoption. Similar finding was identified by (Hailu, 2008), as market distance increases adoption and intensity of adoption decreased.

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CONDEM	0.052843	0.093068	0.093069
Constant	0.093283	0.370825	0.370824

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Source: model output

The marginal effect result shows that, being male headed house hold in the area increases probability of adoption and intensity of use of improved haricot bean production package by 47 % and 56 % respectively. 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 improved agricultural technologies.

The results computed indicate that the estimated increase in the probability of adoption and intensity of use of improved haricot bean production technologies resulting from having access to improved seed credit was 3.1 % and 7.3 % respectively

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multiplication in farming community will enhance the adoption of new technology including improved haricot bean package.

An increase in improved haricot bean production training increases the probability of adoption and intensity of use of improved haricot bean production package by 3.1 % and 7.3 % and also increasing conducting demonstration was increases the probability of adoption and intensity of use of improved haricot bean production by 5.2% and 9.3% respectively. Therefore the extension service has to take in to consideration to conduct a variety of extension events as a major component of extension to promote technology adoption.

In this study the unit increase in an explanatory variables, will be certain percent increase on the probability of adoption and intensity of use of improved haricot bean production and associated agronomic practices. Therefore the current extension service has to give more emphasis on improving the influencing factors on adoption of improved haricot bean.

## **5. Summery and conclusion**

This study was conducted in Dale Woreda, which is located in Sidama zone Southern Ethiopia. In the area, haricot bean is an important crop, which serves as a source of food and cash. The main theme of this study was to assess the current level of adoption and identify factors affecting adoption of improved haricot bean varieties with its associated agronomic practices. A total of 150 sample households (131 male and 19 female) selected from 5 kebeles of the Woreda were interviewed using structured interview schedule. Qualitative data were collected using group discussion among selected haricot bean growers and extension development agents who were working in the respective kebeles.

The data analysis was done with the help of employing SPSS 17; mainly Chi-square test and F-test were used to test the variation of the sample group towards adoption of haricot bean production. The Tobit econometrics model was employed using STATA 11 software to estimate the effects of hypothesized independent variables on dependent variable.

The study tried to investigate the status of adoption and factors influencing farmers' adoption behavior. Improved haricot bean production package considered in this study includes use of improved variety, seeding and fertilizer rate. These were found to be practiced by haricot bean producer farmers who use improved varieties, but below the recommendation rate.

There is variation among the grower households in the level of adoption. Variation in adoption among the sample households was assessed in view of various factors categorized as household personal and demographic, economic and institutional.

Most of the variables assumed to influence the adoption behavior were significantly associated with the adoption and intensity of adoption of improved haricot bean production.

Among the personal and demographic factors educational status and sex of the household head were significantly related to the intensity of adoption of improved haricot bean production. From a total of 150 sample households 19 were female households. Among these women households 15 of them were categorized under the non adopter level of adoption category, three female were low adopters and the rest, one female was in medium adoption category. This implies that male farmers have better access to information on improved technologies and are more likely to adopt new technologies than female. On the other hand and family size of the household head was also having significant relationship with the intensity of the adoption of the haricot bean production package.

Concerning economic and wealth related variables which were hypothesized to influence adoption of improved haricot bean production technology, labor availability and farm income had positive and significant relationship with adoption.

In the case of institutional variables, getting advisory service from extension agents, attending training, field day, conducting demonstration, access to improved seed credit, and membership of seed multiplication group also had positive and significant relationship with intensity of adoption of improved haricot bean production

The farmers' selection and evaluation criteria of improved haricot bean varieties were also investigated through interviews and group discussions. In this respect, high yield, market demand, price advantage, time of maturity, grain color, grain size, disease resistance and storability were the most important characteristics selected by farmers. Based on these selection criteria most of haricot bean producers in the study area produce Nasir variety because it fulfills the above criteria and there is high seed demand of this improved variety.

The results of the econometric model also pointed out the relative influence of different variables on probability and intensity of adoption of improved haricot bean production. Thus, sex of house hold head, access to seed credit, attending extension training, attending field day programs, conducting demonstration, participation in seed multiplication and market distance were found to have significant influence on probability and intensity of adoption of improved haricot bean production package.

## **6. Recommendation**

Haricot bean contribution to households' nutrition, income and food security is very high. Regardless of its contribution, however, the emphasis given nationally to the sector is relatively low compared to other food crops. As a result of this, institutional support provided to this sector, such as credit service, research and extension was not to the expected level. These factors together with several household personal, demographic and socio-economic factors affected the adoption of improved haricot bean production technologies and consequently production and productivity of the sector. Based on the

findings of this study, the following points are recommended to improve farmers' adoption of improved haricot bean production package so as to enhance its production and productivity.

Improved haricot bean production involves the use of different practices which require knowledge and skill of application and management. Extension service on improved haricot bean production was found to have a strong relation with adoption of improved haricot bean production package as it enhances ability to acquire and use information required for production. Therefore, emphasis has to be given towards strengthening farmers' knowledge on improved haricot bean production by arranging training, field visit and demonstration. In this regard more demonstration sites for improved agronomic practices technologies should be organized to increase awareness of the farmers in the study area towards improved haricot bean varieties and associated agronomic practices.

Farmers' deviation from recommended package practices was found partly due to low extension service and also lack of financial capacity of farmers to apply fertilizer according to recommendation. Therefore, extension service provision has to be strengthened so as to improve farmers' access to information and extension advices. Moreover, improving credit access is crucial.

There is also a need to formulate a package of practices on bean cropping system that can be tested and recommended to farmers based on their area of production. Beside this

there is a need for recommendation on optimum fertilizer and seed rate for bean/maize intercropping system.

Attention has to be given to women household headed to empower them and participate in improved haricot bean production activities through delivering agricultural input credits as to increase production and productivity to improve their livelihood status.

Farmers have their own preference criteria for adoption among the released varieties, which in most cases not considered by research and extension. Therefore the research and extension system has to give more attention to participatory research which considers farmers' priorities and needs.

## 7. REFERENCE

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## 8. APPENDICES

Appendix 4. Conversion factor used to compute man equivalent (Labour Force)

Age group (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	0.8
Greater than 50	0.7	0.5

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

Appendix 5. 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	Camel	1.25
Heifer	0.75	Sheep & Goats (adult)	0.13
Cow and ox	1.00	Sheep & Goats (young)	0.06
Horse	1.10	Chicken	0.13
Donkey (adult)	0.70		

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

Appendix 6. Distribution of selected households by sex & kebele within adoption category

Name of kebeles	Adoption category					Sex of house hold		
	Non adopters	Low adopters	Medium adopters	High adopters	Total	Male	female	Total
Dehub kege	9	0	21	8	38	32	6	38
Dehub mesenkela	6	0	12	9	27	23	4	27
Soyama	4	3	14	5	26	19	7	26
Semen qege	0	2	21	0	23	23	0	23
Tula	6	1	13	16	36	34	2	36
Total	25	6	81	38	150	131	19	150

Source: Own survey, 201

Appendix 4. Mean annual income from haricot bean production in Birr

Adoption category	Mean	SD	Minimum	Maximum
Non adopters	0.0	0.0	0.0	0.0
Low	708.00	651.43	120.00	1450.00
Medium	662.80	518.05	72.00	2400.00
High	1086.70	880.40	120.00	3200.00
Total	768.93	649.66	72.00	3200.00

Source: Own survey, 2010

Appendix 5 Distribution of sample adopter by growing year and varieties.

No	Type of varies	Year of starting cultivation	No of house hold among adopters
1	Nasir	2004	84
2	dimtu	2004	12
3	Ibado	2005	29
4	Omo-95	2006	6
5	Awasa dume	2007	41

Appendix 6 Disease occurrence report by the respondents

Disease occurrence	Frequency	Percent
Yes	5	3.4
No	145	96.6
Total	150	100

Appendix 7 Distribution of respondents by measure used when disease strike

Measure taken to avoid disease problem	Frequency	Percent
No disease	146	97.4
Indigenous measures	2	1.3
Nothing	2	1.3
Total	150	100

Appendix 8 Frequency of contact with extension agent

Frequency of contact with extension agent	Adoption category								Total	
	Non adopter		Low adopter		Medium adopter		High adopter			
	No	%	No	%	No	%	No	%	No	%
Never	19	76	3	50	20	24.7	2	5.3	44	29.3
Once in a week	3	12	0	0	8	9.9	10	26.3	21	14
Twice in a week	1	4	1	16.7	14	17.3	9	23.7	25	16.7
Monthly	0	0	2	33.3	24	29.6	14	36.8	40	26.7
Yearly	2	8	0	0	18.5	3	3	7.9	20	13.3
Total	25	16.7	6	4	81	54	38	25.3	150	100

Appendix 9 Distribution of respondents in relation to area under local and improved variety and average yield

	Area of local Variety In hectare	Yield per hectare	Area of improved Variety in hectare	Yield per hectare
Mean	0.32	6.62	0.22	10.12
Minimum	0.07	5.9	0.06	8.6
Maximum	0.60	8.5	0.50	14.2

Appendix 10 Distribution of Sample households in their age category

Age category	Adoption category				Total
	Non adopter	low adopter	medium adopter	High adopter	
25-35	9	3	30	11	53
36-45	10	0	32	20	62
46-55	1	2	15	5	23
56-65	3	1	4	1	9
>65	2	0	0	1	3
Total	25	6	81	38	150

Appendix 11 Distribution of Sample households' in their family size

Age category	Adoption category				Total
	Non adopter	low adopter	medium adopter	High adopter	
1-5	18	2	18	8	46
6-10	3	4	43	12	62
>10	4	0	20	18	42
Total	25	6	81	38	150

Appendix 12 Education level of sample house hold

Education level	Adoption category				Total
	Non adopter	low adopter	medium adopter	High adopter	
Illiterate	21	4	45	20	90
1-6	2	1	14	7	24
7-12	2	1	22	11	36
Total	25	6	81	38	150

Appendix 13 Problems on haricot bean seed purchased from market for haricot bean production

Problems on haricot bean seed	Frequency	Percentage
Not available	28	18.6
Not timely available	29	19
Quality problem	81	54.4
Expensive	6	4
Quality problem and Expensive	6	4
Total	150	100

Appendix 14 Problems on fertilizer purchased from market for haricot bean production

Problems on fertilizer	Frequency	Percentage
Not timely available	1	0.7
Quality problem	59	39.3
Expensive	42	28
Quality problem and Expensive	48	32
Total	150	100

Appendix 15 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	98.8	1.2	0	0	0	100
Contact(model) farmer	21.7	1.3	14.0	46.3	16.7	100
Fellow farmer	20.0	0.7	22	54	3.3	100
PA leader	26.6	12.4	33.0	27.3	0.7	100
NGO	81.2	18.8	0	0	0	100
Cooperative	90.7	7.2	2.1	0	0	100
Neighbors/ friends	0	0	0.6	32.7	66.7	100
Input dealers	50.7	47.7	1.6	0	0	100
Agricultural professionals	11.4	16.3	47.0	25.3	0	100

Appendix 16 Market price of improved of haricot bean seed in 2009/2010

Type of haricot bean	Price at farm get in BIRR			Price at market in BIRR		
	Average	Minimum	Maximum	Average	Minimum	Maximum
Ebado	6.00	4.50	8.00	7.00	6.00	10.00
Awasa dume	5.00	4.00	6.50	6.00	5.00	8.00
Dimtu	5.00	4.00	6.50	6.00	5.00	8.00
Nasir	6.50	4.00	7.00	7.00	5.50	9.00
Omo 95	5.00	4.00	6.00	6.00	5.00	7.00
Local	3.50	3.00	5.00	4.50	3.50	6.00

## Appendix 17. Interview schedule

Date of interview -----

Number (code) -----

Peasant Association -----

Name of enumerator -----

### **1. Farmer 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/ Total Farming experience of the household head in years -----.

1.6/ Haricot bean Farming experience of the household head in years-----

1.7/ Household demographic characteristics.

SN	List of family members	Sex	Age	Education level
1.				
2.				
3.				
4.				
5.				
6.				
7.				

### **2. House hold Ownership**

#### **2.1/ Land ownership in 2001/2002E.C**

Land allocation	Land size (in timad.)
Coverage of land for haricot bean	
Land covered by other pulses	
Land covered by cereals	
Fruits	
Coffee	
Enset	
Homestead + others	
Total	

**2.2/ Livestock ownership by the end of 2001/2002 EC production season Tir 2002EC**

Types of animal	No	Types of animal	No
Cows		Sheep	
Oxen		Donkey	
Heifers		Poultry	
Bulls		Horse	
Calves		Others	
Goats		Total	

**2.3/ Household labor availability in 2001/2002 EC**

Age category	Male No	Female No	*Activities participated in haricot bean production
<15years			
16-65 years			
>65			
* Haricot bean production activities includes: - 1) Land preparation 2) sowing 3) Weeding 4) Harvesting 5) Threshing 6) Transportation 7) Storage 8) Marketing 9) others (specify			

**3. Economic variables**

**3.1 Crop production by the household in 2001/2002 production season E.C.**

Types crop grown	Area coverage(ha)	yield/ha	Total yield	*Type of production
Local haricot bean				
Improved haricot bean (food type colored)				
Improved haricot bean export type white				
Maize				
Coffee				
Vegetables				
Fruits				
Enset				
Others				
*Type of production 1) Sole/mono/ cropping 2) intercropping 3/ both				

**3.2/ Household's annual farm income from sale of crops /2001/2002E.C/ in quintals**

Types crop grown	Annual harvest	consumed	Gift	sold		Total price
				Amount	Unit price	
Local haricot bean						
Improved haricot bean						
Maize						
Coffee						
Dry chary						
Red berry						
Vegetables						
Fruits						
Enset						
Others						
Total						

**3.3/ Income from sale of livestock/2001/2002 E.C /**

Animal type	Number sold	Unit price	Total sale price	*Purpose
Oxen				
Cows				
heifers				
Bull				
Calves				
Goats				
Sheep				
Donkey				
Horse				
Poultry				
Hide				
Others				
Total				

\*Purpose includes 1) For purchasing farm inputs 2) For settling debts  
 3) For buying clothes for family 4) For buying food grains 5) Others (Specify) -----  
 -----

**3.4/ Income from sale of livestock products/2001/2002 E.C/**

Product type	Amount collected per year	Consumed	Sold	Unit price	Total revenue	*Purpose Of sale
Milk						
Butter						
Egg						
*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) -----						

**4. Income from participation in off-farm activities.**

4.1. / Do you have off-farm activities?

1/ Yes  0/ No

4.2/ If yes, type of work:

1/Trading  2/Laborer  3/Carpenter  4/Civil servant  5/Other

(specify) \_\_\_\_\_

4.3/ For what purpose do you use the income from off-farm activities?

1) To purchase household items  2) to purchase farm inputs  4) to settle debts   
5) to buy food

**5. Access to services**

**5.1/ Market centers accessible to you**

Name of the market	Distance (Km)	Mode of transport	Transport cost (birr/Qt)	Commodities sold at market place
Aposto				
Yirgalem				
Della				
<b>Mode of transport; 1=feet 2= bus</b> ` <b>Commodity; 1 = cereals 2= haricot bean 3=coffee 4 = fruits &amp; vegetables</b>				

**6/ Credit accessible to you**

6.1/ Have you obtained credit for haricot bean production in the last three years?

1) Yes  2) No

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

Source -----

Amount (in Birr) -----

6.3/ 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) -----

6.4/ Have you obtained credit improved haricot bean in kind?

- 1) Yes  2) No

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

Source -----

Amount (in K/gram) -----

**7. Extension services**

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

7.2/ How frequently do the extension agents visit you?

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

7.3/ when does extension agent visit you? a) During land preparation  b) During sowing

- d) When disease/ pest occur  d) during harvesting  e) others (Specify)

7.4/ Do you visit extension agent? 1) Yes  2) No

7.5/ 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)

7.6/ 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 (1)	Once in a year (2)	Monthly (3)	Weekly (4)	Daily (5)	
Researcher						
Contact farmer						
Fellow farmer						
PA leader						
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) ----- -----						

7.7/ When have you first heard of improved variety of haricot bean? \_\_\_\_\_

7.8/ From who/ which source? \_\_\_\_\_

7.9/ Which improved variety of haricot bean have you first grown?

1) -----2) -----3) -----4) others (specify) -----

7.10/. Why did you choose this particular variety first? -----

7.11/ Which improved varieties of haricot bean you have grown so far? when you have grown them?

Variety name	First grown Year	Duration of use (Years)		* Reason for stopping if not using now
		From	To	
Ebado				
Awasa dume				
Dimtu				
Omo95				
Nasir				
DRK				
Kranscope				
* Reason for stopping 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) ----- -----				

7.12/ Have you participated in field day/ visit in the last five years?

1) Yes  2) No

If yes, how many times -----

Who arranged for you? 1) OoARD  2) Research  3) NGO  4) Others (Specify)

7.13/ Have you ever received training in haricot bean production in the last five years?

1) Yes  0) No

If yes, how many times -----

Who arranged for you? 1) OoARD  2) Research  3) NGO  4) Others

7.14 Have you conducted demonstration in the last five years? 1) Yes  2) No

If yes, how many times? \_\_\_\_\_

With whom you conducted demonstration? 1) OoARD  2) Research  3) NGO

4) Others-----

**8. Market related variables**

8.1/ What was the average market price of the seed of haricot bean last year?

Type of haricot bean	Price at		*To whom you Sell the product
	Farm get	market	
Improved varieties			
Ebado			
Awasa dume			
Dimtu			
DRK			
Nasir			
kranscope			
Local			
*To whom 1) to whole seller 2) to retailer 3) to direct consumers 4) cooperative 5/farmers			

8.2/ Have you changed to whom you sell the seed of haricot bean in the last 2-3 years?

1=yes  0=No

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

8.4/. What was the change? \_\_\_\_\_

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

1) Decreasing  2) stagnant  3) increasing

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

-----

8.7/ In your view how do you see the selling price of the seed of haricot bean? -----

-----

Haricot bean type	Price condition				
Haricot bean type	Price condition				
	Very poor(1)	Poor (2)	Moderate(3)	Good (4)	Very good (5)
Improved seed					
Local seed					

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

Inputs	Price condition					Remark
	Very expensive(1)	Expensive (2)	Moderate (3)	Less expensive (4)	Not expensive (5)	
Improved varieties						
Fertilizer						
Labor						
(others specify)						

8.9/. Do you get market price information on haricot bean?

1) Yes  2) No

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

sources of information	How often you contact them					Which source you prefer
	Never	Once in a year	Twice in a year	quarterly	Weekly	
DA						
Trader						
Neighbor farmer						
Others /specify/						

8.11/ What do you think the major marketing problems with regard to haricot bean marketing on improved variety? -----

**9/ Membership of farmer's association**

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

Organization)	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			
Other/specify			

**10 Access and utilization of farm inputs for haricot bean production**

**(2001/02 production season)**

10.1 Which type of agricultural inputs do you use for haricot bean production and what are the sources?

Input type	Specific name	Did you use in 2001/02 1=yes 2=No	Input availability 1=Available 2= scarcely available 3= not available	Timely availability 1= timely available 2= Some times on time 3 =never available	Quality of input 1= Good quality 2= moderate 3= Poor quality	If yes, Source 1 =yes 2 =No			
						Market	ARD O	cooperative	other
Improved seed of haricot bean	Ebado								
	Awasa dume								
	Dimtu								
	DRK								
	Nasir								
	cranscope								
Local seed	Wahe								
Fertilizer	DAP								
	Urea								
Others									

**10./2 Quantity of inputs purchased /used for haricot bean production and their price in 2001/2002 E.C**

Input type	Specific name	Quantity purchased/used (kg)	Unit price (Birr/ kg)
Improved seed of haricot bean	Ebado		
	Awasa dume		
	Dimtu		
	DRK		
	Nasir		
	cranscope		
Local seed of haricot bean	Wahe		
Fertilizer	DAP		

	Urea		
Others(Specify)			

10.3/ Can you purchase the required amount of inputs as you need (Availability)1) Yes

2) No

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

Inputs	Problems				Remarks
	Not available	Not timely available	Quality problem	Expensive	
Haricot bean seed					
Fertilizer					
Others(Specify)					

10.5/ How much does the timeliness of availability of inputs affect your level of input adoption? Tick

No effect(1)	Affected less(2)	Some what affected(3)	High effect(4)	Very high effect(5)

**11. Intensity of adoption of improved haricot bean varieties and it's agronomic practices**

11.1/ In the last three years production season what kind of haricot bean varieties did you use? 1) Local  2) improved  3) both

11.2/ Which type of cropping do you used for haricot bean production?

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

11.3/ If you are intercropping, with which crop do you intercrop?

1) Maize  2) Enset  3) chat  4) coffee  5) other crop/specify

11.4/. Which method of sowing you used in haricot bean cultivation?

1) Row planting  2) Broadcasting  3) Both

11.5/ If your answer is spacing, to which variety you used this method?

1) Local  2) improved  3) Both

11.6/ Did you apply fertilizer in haricot bean production? 1) Yes  0) No

11.7/ If your answer is yes, to which variety you applied fertilizer?

1) Local  2) improved  3) both

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

11.9/ If you apply DAP fertilizer in haricot bean production, what amount of /kg/ fertilizer

Do you apply per hectare? 1) 100kg  2) 50-80kg  3, less than 50 kg

11.10/ If you did not apply fertilizer in haricot bean production, what is your reason  
Reason for not applying \_\_\_\_\_

11.11/Did you encounter disease problem in haricot bean cultivation in 2001/2002 E.C production

season? 1) Yes  0) No

11.12/ If yes, what kind of measure did you take?

1) Local  2) improved  3) Nothing

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

11.14/ did you come across weed problem in 2001/2002 E.c haricot bean cultivation?

1) Yes  0) No

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

**12. Intensity of adoption of improved haricot bean varieties & its agronomic practices in 2001/2002 E.C**

Subject	Name of the HB variety grown	Area coverage /timad/	Seed rate (kg/)	Intra row spacing (cm)	Inter row spacing (cm)	Fertilizer rate Kg		Yield /timad
						DAP	Urea	
Total area allocated for improved haricot bean	Ebado							
	Awasa dume							
	Dimtu							
	DRK							
	Nasir							
	Kranscope							
Total area allocated for local haricot bean	Wahe							

13.1/ Do you expect low price in haricot bean? 1/ yes 0/ No

13.2/ When you expect low prices?



## **9. BIOGRAPHY**

The author, Alemitu Mulugeta Ayalew was born October 1967 GC in Addis Ababa, Ethiopia. She attended her elementary and junior school education in Negus W/Giorgis Now edget besera elementary and secondary school, and later attended her High-school education in Addis ketema comprehensive secondary school. After completion of her high school education, she joined Ambo Junior College of Agricultural and completed her Diploma program in General Agriculture in 1985. She was employed in Ministry of Agriculture in SNNPRS and served the organization in different Woreda. She join at Debub University now Hawassa University for her degree program and graduated in Plant production & dry land farming /PPDF/ in 2004. After completion of the under graduate degree, she also served in Awassa zuria Woreda Agriculture & Rural Development Office which is found in Sidama Zone SNNPRS as natural resource management & land administration desk head and She got an opportunity to join Hawassa University to attend her post graduate study in 2008. The author is married and has two children.