ADOPTION AND PROFITABILITY OF KENYAN TOP BAR HIVE BEE KEEPING TECHNOLOGY: A STUDY IN AMBASEL WOREDA OF ETHIOPIA

M.Sc. Thesis

MELAKU GORFU

April 2005

Alemaya University

ADOPTION AND PROFITABILITY OF KENYAN TOP BAR HIVE BEE KEEPING TECHNOLOGY: A STUDY IN AMBASEL WOREDA OF ETHIOPIA

A Thesis Submitted to the Faculty of the

Department of Agricultural Economics, School of Graduate Studies

ALEMAYA UNIVERSITY

In Partial Fulfillment of the Requirements for the Degree of

MASTER OF SCIENCE IN AGRICULTURE

(AGRICULTURAL ECONOMICS)

BY

MELAKU GORFU

April 2005

Alemaya University

ALEMAYA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

As members of the examining Board of the Final M.Sc. Open Defense, we certify that we have read and evaluated the thesis prepared by: Melaku Gorfu. Entitled: Adoption and Profitability of Kenyan Top Bar Hive Bee keeping Technology: A Study in Ambasel Woreda of Ethiopia and recommend that it be accepted as fulfilling the thesis requirement for the degree of Master of Science in Agriculture (Agricultural Economics).

________________	________________	________________
Name, Chairman	Signature	Date
Dr.R.S.L. Srivatstava	________________	________________
Name, Major Advisor	Signature	Date
Legesse Dadi (Ph.D)	________________	________________
Name, Co-advisor	Signature	Date
________________	________________	________________
Name, Internal Examiner	Signature	Date
________________	________________	________________
Name, External Examiner	Signature	Date

Final approval and acceptance of the thesis is contingent upon the submission of the final copy of the thesis to the Council of Graduate Studies (CGS) through the Departmental Graduate Committee (DGC) of the Department Agricultural Economics.

I hereby certify that I have read this thesis prepared under my direction and recommend that it be accepted as fulfilling the thesis requirement.

________________	________________	________________
Name of Thesis Advisor	Signature	Date

DEDICATION

I dedicate this thesis to my family, for standing by me with affection and love throughout

STATEMENT OF THE AUTHOR

First, I declare that this thesis is my bonafide work and that all sources of material used for this thesis have been duly acknowledge. This thesis has submitted in partial fulfillment of the requirements for an MSc degree at the Alemaya University and is deposited at the University Library to be made available to borrowers under rules of the Library. I solemnly declare that this thesis is a first of its kind and not submitted to any other institutions anywhere for the award of any academic qualifications.

Brief quotations from this thesis are allowable without the special permission provided that accurate acknowledgment of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in 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 material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

Name: Melaku Gorfu   Signature: ________

Place: Alemaya University, Alemaya

Date of Submission: -----------------

ACRONYMS AND ABBREVIATIONS

ANRSBOA	Amhara National Regional State Beauro of Agriculture
AWOA	Ambasel Woreda Office of Agriculture
BCR	Benefit Cost Ratio
CIMMYT	International Maize and Wheat Improvement Center
CSA	Central Statistical Authority
DA	Development Agent
DR	Discount Rate
GDP	Gross Domestic Product
HBRC	Holeta Bee Research Center
ITC	International Trade Center
IRR	Internal Rate of Return
KTBH	Kenyan Top-Bar Hive
LIMDEP	LIMited DEPendent variables
masl	Meter above sea level
ME	Man-Equivalent
MEDaC	Ministry of Economic Development and Cooperation
MOA	Ministry of Agriculture
NGO	Non Governmental Organization
NPV	Net Present Value
TLU	Total Livestock Unit
VIF	Variance Inflation Factor

BIOGRAPHY

The author was born in Addis Ababa in September 1969 of his father Mr. Gorfu Woldemariam and his mother Mrs. Abaynesh Meimen.

He received his primary education in Keranio Medhanialem, Woreda 24 and junior secondary school education in Tesfa Kokeb, Woreda 4 and completed his secondary education at Ayer Tena Senior Secondary School, Woreda 24 of Addis Ababa.

After successfully passing his Ethiopian School Leaving Certificate Examination (ESLCE), he joined the then Alemaya University of Agriculture in September 1986 and graduated in July 1990 and was awarded B.Sc. (Animal Science) degree.

Shortly after his completion, he was employed by the Ministry of Agriculture of Ethiopia and deployed at South Wollo Administration Zone. The various responsibilities assigned to him under the Zonal Agricultural Office include: an Expert in the Livestock and Fisheries Department for three years, as Team Leader for four years and Head of Woreda Agricultural Office for five years. Finally the author enrolled in Alemaya University for the M. Sc. (Agricultural Economics) degree in the year 2002.

ACKNOWLEDGMENT

I wish to thank the Almighty for giving me the chance to enjoy the fruits of my endeavor.

I am very grateful to my advisor Professor Dr.R.S.L. Srivastava, Professor of Production Economics, Department of Agricultural Economics, for accepting me as his advisee, for his professional supports and due concerns from the very start of designing the research proposal up to thesis write-up.

I also owe gratitude to my co-advisor Dr. Legesse Dadi, Project Planning, Monitoring and Evaluation Department Head, Ethiopian Agricultural Research Organization, for his invaluable supports in designing research questionnaire, data collection and thesis write-up.

It is my pleasure to thank Dr. Bekabil Fufa, Department of Agricultural Economics, for the help he provided in commenting and correcting the sampling methodology and showing the way to take care of the problems.

My heart-felt appreciation goes to South Wollo Administration Office of Agriculture without whose permission to join the M.Sc. program would not have been possible.

In addition, I am very indebted to Yilma Muluken and Solomon Zeberga, intimate friends, for their excellent support; especially in handling software programs and then unveiling the avenue towards success. My warm thanks are extended to my colleagues Yimer Getahun and Gizachew Abegaze, for their unfailing encouragement in the course of the entire work. I also indebted to my colleagues Matios Tefera and Daniel Tekle, without whose facilitation the data collection would have been very unwieldy.

Finally, my overwhelming acknowledgment goes to my entire family for being compliant and standing by me when the going got rough, especially, my younger sister Selamawit Gorfu, for providing me computer facilities, without whose support the timely completion of the thesis would have a difficult task.

TABLE OF CONTENTS

TABLE OF CONTENTS (*Continued*)

TABLE OF CONTENTS (*Continued*)

LIST OF TABLES

TABLES (Continued)

LIST OF FIGURES AND MAPS

LIST OF TABLES IN THE APPENDIX

Appendix Tables **Pages**

ADOPTION AND PROFITABILITY OF KENYAN TOP BAR HIVE BEE KEEPING TECHNOLOGY: A STUDY IN AMBASEL WOREDA OF ETHIOPIA

ABSTRACT

The data for this study was taken from Ambasel Woreda of Amhara National Regional State. A simple random sampling was employed to draw a total of 100 respondents for the study. Primary data from the respondents and secondary data from different organizations were collected and used for the study.

Descriptive statistics were used to compare the technologies of beekeeping i.e., the traditional indigenous technology and the improved Kenyan Top Bar Hive technology (KTBH) with respect to the different attributes under considerations. An in-depth assessment in relation to beekeeping characteristics of the groups was made. Logit model was used to identify the factors influencing the adoption of KTBH. For the Logistic regression model 14 variables were included and analyzed. Of these four variables, namely farming experience, perception of timely supply of the technology, visit of apiary and extension contact were found to influence the adoption of KTBH significantly. Profitability analysis was employed to compare per hive net return between traditional hive and KTBH. Benefit-cost ratio was also analyzed to measure the feasibility of a proposed project using each type of hive. Different components of costs, annual yield and income for the two types of hives were considered for the profitability analysis and partial budgeting. Home made KTBH and institutionally provided KTBH were compared independently against the traditional hive. The result revealed that the yield and per hive net return obtained from the home made KTBH and institutional KTBH is greater than the yield and net return from traditional hive. Beekeeping using KTBH results a higher Benefit Cost Ratio (BCR), Net Present Value (NPV) and Internal Rate of Return (IRR) than the traditional hive. Implications of this study are that targeting experienced farmers, encouraging apiary visit, timely supply of KTBH, improving extension contact, and promotion of KTBH utilization are the utmost priority areas of interventions to promote the adoption of KTBH for higher production and profit.

1. INTRODUCTION

1.1. Background

Agriculture is the major economic sector of Ethiopia contributing for nearly 50 percent of the GDP and providing employment for 85 percent of the population. It also accounts for 90 percent of the export revenue and satisfies 70 percent of raw material requirements of the country's industry (Minale, 2002).

However, in spite of its highest share in the country's economy, the performance of the agriculture sector is very poor. There has been no discernable trend in the growth of agriculture; it grew at an average rate of only 1.7 percent per year during the period 1974-1999, which is very low as compared to its growth rate of in the 1960’s (Minale, 2002). During 1960’s the growth rate of the agriculture sector was 2.1 percent (IEG, 1968).

According to official data, the per capita food production in the country has been declining for nearly over 30 years and the ability of the country to feed its growing population, (3% per year), is deteriorating from bad to worse. The output per capita was 180 kg in 1980, 150 kg in 1990 and 97 kg in 1994 (Medreke, 2001). The decline in output was 30 kg from 1981 to 1990 and to 53 kg from 1990 to 1994. This is a decrease of food output by 45 percent from 1985 to 1998. As a result of the prevailing food insecurity, Ethiopia has become the world’s largest food aid recipient country. The demand for food aid has been increasing to the tune of 2.3 percent per annum, accounting for 9% of total supply (Debebe, 2000). While food aid per capita per year in Ethiopia is 12 kg, it is 9 kg for Sub-Saharan countries (Hansjorg, 2000).

Among the major factors behind the poor performance of Ethiopian agriculture are diminishing farm size and subsistence farming, soil degradation, inadequate and variable rainfall, tenure insecurity, weak agricultural research base and extension system, lack of financial services, imperfect agricultural markets and poor infrastructure (Befekadu and Berhanu, 1999).

Because of low productivity and low income from agriculture, farmers are resorting to subsidiary enterprise to augment their incomes and thereby to ensure and improve their livelihoods. Beekeeping is one of such enterprises being practiced by a number of farmers in the study area as well as elsewhere. In fact with an estimated income of birr 360-480 (US$45-60) million annually from the total annual honey production, beekeeping plays a significant role in the national economy of the country serving as a source of additional income for hundreds of thousands of farmers.

The ideal climatic conditions and diversity of floral resources allow the country to sustain around 10 million honeybee colonies, of which 7 million are kept in local bee hives by farmers. The remaining exists in the forests as wild colonies (EMA, 1981). It makes the country as one with the highest bee density in Africa. At the world level, Ethiopia is fourth in beeswax production after China, Mexico and Turkey. In terms of output also, Ethiopia is the largest honey producer at 24,000 tonnes per annum accounting for 24% of the African production, representing a value of about 450 million Birr (Greiling, 2001). Beekeeping supports the national economy through foreign exchange earnings. With an estimated production of 3200 tonnes beeswax per year, Ethiopia is one of the four biggest wax exporters (China, Mexico and Turkey being the other three) to the world market.

Despite the fact that the country has a long established practice of beekeeping and is highly suitable for sustaining a large number of bee colonies, the bees and the plants they depend on, like all renewable natural resources, are constantly under threat from lack of knowledge and appreciation of these endowments (Girma, 1998). Besides, several million-bee colonies are managed with the old traditional beekeeping methods in all parts of the country.

The traditional beehives are simple cylindrical containers for housing the bees and their combs. They are hives with fixed honeycombs, usually in hollow logs or in clay or wicken containers. Traditional beekeeping does not make use of the improved equipments and modern techniques. As a result, harvesting the produces kills or severely weakens the colony. Besides, the product obtained from the traditional hives is of relatively low quality due to the presence of debris in the honey.

During the last 20 years there has been a small but a steady interest in the use of improved bee keeping methods; and farmers keep around ten thousand top-bar hives and thirty thousand frame hives (MOA, 2003). Frame hives are only going to work to advantage if they are properly used as per the prescribed technology. There is no evidence of frame hives having been adopted by the genuine peasant farmer in central Africa, outside of any project subsidization. This may be because of the high cost of improved hives, their non-availability and/or their sub-standard construction by untrained local artisans and aggressiveness of the African bees (Paterson, 2000). Virtually all the frame hives in Africa have been project related in some way or kept by beekeeping hobbyists or enthusiasts, often expatriates.

However, in the past few years the Kenyan Top Bar Hive (KTBH), which is the well known type of movable comb frameless hive, has been introduced and is now being widely promoted. It is an intermediate technology hive that offers a cheap alternative system for those who use fixed-comb hives. The main claimed advantages of a movable comb frameless hive are that it is much cheaper and easier to construct than the frame hive and requires less materials (Sperling, 1980). Besides, it provides ease of opening, the top bars guide the bees into building parallel combs, easily removed, and easier to construct than frames. Bees can be controlled easily during harvesting and inspection of combs, and the hive is light and easily transportable.

1.2. Statement of the Problem

Transforming agriculture and expanding its productive capacity is a prerequisite for sustained economic growth. In Ethiopia, owing to population pressure, the average farm size has shrunk from over two ha a few years ago to less than one ha in recent years. A rise in agricultural output and farm income seems to have limited scope in view of the structural constraints; and therefore, subsidiary enterprises can be helpful in augmenting household incomes. In this context beekeeping is considered to be an income-yielding activity that fits well with the concept of small-scale agricultural development. Besides, it is also ecofriendly and does not compete for scarce land resources, and provides off-farm employment and income generating opportunity.

Studies have shown that the potential for honey production and success in beekeeping development is dependent first and foremost on the quality and quantity of bees and bee flora available. Secondly, success is dependent upon the technology used in the light of local resources and economic considerations (Paterson, 2000). But the question of which hive is best for beekeeping in the developing world goes beyond beekeeping and enters the realm of economics and development theory (Berube, 1996). Choice of hive technology should be based on the cost and ease of hive production and availability in relation to local honey potential and cash return, which vary according to geographical location and temperament of both bees and beekeeper.

Nowadays, in Ethiopia as elsewhere in the world, there are three main distinct types of hives that are used by beekeepers. These are the movable frame hive, the movable comb hive and the fixed comb, each type constituting different varieties according to the environment and the material available. And from beekeeping point of view except for a few studies that dealt with bee biology, studies in terms of production system and economic aspects of beekeeping are non-existent. One cannot audaciously suggest about the characteristics of beekeepers and the prons and cons of the different types of hives that are kept by the beekeepers. Therefore this study will have a paramount importance in laying the foreground and materializing the existing gap in the subject matter.

In the study Woreda, beekeeping is practiced using the fixed comb hive or the KTBH or both under the same traditional management system. However, information in terms of the attributes that contribute to their adoption, and productivity under actual field conditions is lacking. Therefore, the study would be very helpful to new beekeepers and particularly to extension agents who are responsible to offer technological alternatives appropriate to the goals and resources of the beekeepers in the study area as well as introducing beekeeping where it is not in practice.

In the last 25 years efforts have been made to ensure better return from beekeeping activities by introducing movable comb hives- framed and frameless. But rapid and successful expansion of modern honey production technology is constrained by: the shortage of improved quality equipment, high price of improved equipment, lack of knowledge and training about the management of modern frame hives and others factors like insecticide spraying and absence of marketing system for table quality honey (Dereje, 2002). Moreover, studies that are aimed to identify the associated socioeconomic attributes in the adoption and economics of the introduced hive technologies are non-existent.

Therefore, this study examines the profitability of the Kenyan Top Bar Hive beekeeping technology (KTBH) vis-à-vis that of traditional technology and the factors influencing the adoption of the KTBH with its associated attributes as mentioned in the background in the selected areas.

1.3. Objectives of the Study

The following are the specific objectives of this study:

1. To assess the productivity and profitability of the Kenyan Top Bar Hive by comparing the users and non-users of the technology, and

2. To identify the factors that determine the adoption of the Kenyan Top Bar Hive technology by the farmers.

1.4. Significance of the Study

Cognizant of the fact that technologies help boost productivity in developing countries, socio-economic and policy research activities, nowadays, have particularly been concerned with the development and/or choice of appropriate agricultural technology strategy and policy. It is imperative the technologies to be recommended for adoption should not only be farmer-friendly but should also ensure adequate economic returns and maintenance of natural resources.

Assessing the adoption potential of a practice involves determining its biophysical performance, its profitability, and its acceptability to farmers (CIMMYT, 1993). Diffusion of innovations in agriculture represents a complex phenomenon, which occurs in an unpredictable fashion. Several factors are intricately related to the process which include, besides other things, clients' characteristics, community norms in which they live, socio-economic and technological nature of the innovations themselves, and the role of the government in providing extension and support services. The objective of such studies is to identify and determine the target group and farming systems or locations where technology diffusion and extension strategies could be implemented. These studies also provide essential feedbacks to development practitioners and policy makers about what really works with their clients.

The understanding of the relative cost and profitability of newly introduced technologies is an essential prerequisite to the formulation and implementation of technology dissemination programs based on their remunerative capacity.

The present study is an attempt to examine the profitability and factors affecting the adaptability of an improve technology of bee hive, i.e. the Kenyan Top Bar Hive technology.

1.5. Scope and Limitations of the Study

Unlike other agricultural activities, improved technology of beekeeping is not wide-spread in the region. Among the few Woredas undertaking this activity, the study area is the front-liner in introducing and disseminating the technology. The reason for the study to be confined in this woreda is that the prevailing resource limitation does not allow encompassing other woredas in the study. Hopefully, the findings of the study will be sound enough in addressing the problems of the Woreda studied and may also provide the basis for assessing the potential impact of the technology in other areas.

1.6. Organization of the Thesis

This thesis constitutes five major sections. In the first and introductory sections subtopics that are discussed includes, background, statement of the problem, objectives of the study, significance of the study and scope and limitations of the study. The second section elaborates a review of some theoretical and practical conceptualizations in respect to the subject matter and the models used for the study. A brief description of the study area and a thorough explanation of the methodologies used for the study are presented in section three. The findings of the study are presented in the result and discussions part in section four. Finally section five deals the summary and conclusions that are drawn from the study. Appropriate interventions and policy implications are highlighted in this section.

2. REVIEW OF LITERATURE

This section discusses the pattern of beekeeping and its economic importance from Ethiopia's perspective and highlights the different types of hives beekeepers work with today. Reviews of theoretical and empirical literatures that deal about the models that are chosen for data analysis are presented.

2.1. Beekeeping in Ethiopia

Of all the countries in the world, probably none has a more ancient tradition of beekeeping than Ethiopia. The hieroglyphics of ancient Egypt refer to this land as a source for honey and beeswax. The dissemination of Christianity moreover strengthened the beekeeping system because of its demand for wax for religious ceremonies. Regarding the traditional beekeeping in Ethiopia, no recorded information is available as to when and where the practice was started first. It is assumed, however, that the traditional bee-husbandry may have been started some where between 3500-3000 B.C in the Northern Regions along with the early settlement of people (Ayalew, 2001).

Among the many factors that make beekeeping an appropriate activity for particularly poor rural people, the major ones are: 1) It does not involve mass feeding of bees, because the insects can provide their own food all year round, and there is no over-wintering bee management; 2) All the necessary inputs required for beekeeping are available locally. Some may be wasted if bees are not kept, e.g. pollen and nectar from flowering plants; 3) It improves the ecology. It helps plant reproduction. Bees do not over-graze as other animals do; 4) The honeybee produces honey, beeswax and propolis. These are non-perishable commodities that can be marketed locally or abroad; 5) Honey and beeswax can be produced in semi-arid areas that are unsuitable for any other agricultural use or in areas where agriculture is prevented by mountainous conditions; and 6) It requires no land in order to keep bees.

2.2. Areas of Ethiopia where Beekeeping is Practiced

On the basis of physiographic and climatic features Ethiopia has been divided into three major traditional agro-ecological zones based on altitude measured in Meters Above Sea Level (masl), these are: "Kolla" (500-1500m), "WoniaDega" (1500-2500m), and "Dega" (2500-3500m). Due to its diverse climatic conditions, the country is a home to some of the most diverse flora and fauna in Africa. Its forests and woodlands grow diverse plant species, over 7000 species of flowering plants, that provide surplus nectar and pollen to foraging bees (Edwards, 1976). Beekeeping is widespread in Ethiopia and is carried out, to varying extents, in almost all areas of the country.

The suitability of an area for honey production depends partly on climatic factors and partly on local vegetations. The areas that are not well suited to beekeeping are generally those areas that are in turn not suited to the settlement of man; for example, the desert areas and the very high mountain areas. Regions where larger areas of the natural vegetation have been changed due to the cultivation of non-nectar yielding crops, notably cereals, are generally not suitable to honey production. There may, however, be suitable smaller areas within larger general areas that are generally not so suited to apiculture. Broadly speaking, the dry areas of thick bush are good bee habitats, especially because these areas tend to have well defined seasonal patterns and distinct flowering periods. The indigenous forest areas are good, as are the more open low altitude woodland areas found in tsetse fly belt to the west of the country.

2.3. Value of the Apicultural Industry in Ethiopia

Their cosmopolitan distribution, multipurpose nature and relative simplicity in management combine to make bees a natural agricultural supplement for many types of farm system in developing countries (Keinath *et al.*, 2000). Bees provide honey, a high energy food supplement that can be sold to earn cash. Bees also provide wax, which has a number of uses. Both honey and wax are valued for their medicinal use in traditional cultures. Bees also provide a valuable ecological service through their role as a pollinator.

The country as indicated by International Trade Center (ITC) (1986) had contributed 23.28 percent to the total African honey production and 2.03 percent to the total world honey production in 1976. This went up to 23.58 percent and 2.13 percent for the total African and world honey production, respectively in the year 1983. Moustafa (2000) had tried to show the profile of beekeeping in East Africa and North East Africa (Appendix Table 7).

Honey and Beeswax production estimated at 19600 tonnes in 1980/81 has increased to 23520 tonnes in 1996/97 showing an annual average growth rate of 1.5 percent over the period resulting per capita honey consumption of about 0.5 kg per annum. However, per capita production of honey and beeswax estimated at 0.6 kg per head in 1980/81 has decreased to 0.4 kg per head in 1996/97 (MEDaC, 1999). Of the total 110 million birr gross value of livestock products that constituted egg, honey, and beeswax and sheep wool in 1980/81, honey and beeswax accounted for 52.4 percent of the earning.

A number of people in the country entirely depend on traditional beekeeping and honey selling for their livelihoods. The basic economic pillars of the land use systems are the use of non-timber forest products for cash, especially beekeeping, for subsistence and *enset*-based agricultural system (Westphal, 1975). Yearly income of south west Ethiopian farmers from beekeeping amounts on ranges about 800-2000 Ethiopian birr per year, equivalent to 80 to 200 US dollar (Hartmann, 2004). Honeybee and their products provide direct cash income for beekeepers. For instance, Nuru (2002) indicated that in Tigray, the price of one established bee colony in a traditional hive ranges from 250-300 birr which is worth enough to buy about 3-5 sheep and goats or a heifer.

Beekeeping is also believed to play a significant role in the food security of the country through honeybee pollination services of major cultivated crops. The ecological function of bees has even a higher economic importance than the direct beekeeping products. According to Hartmann (2004), " Researches indicate bees can benefit 250-300 folds through pollinating particularly pulse seeds and vegetables in raising the production higher than their direct products- honey and wax". The global estimate of the value of the service of pollination is US$ 65-70 billion, representing a 46 percent loss of global harvests.

Beekeeping supports the national economy through foreign exchange earnings. For example, during the early 1970's exports of bees-wax were 500-700 tonnes per annum earning some 3 million birr (MOA, 1984). As noted in the Amharic version of Comprehensive Honey and Beeswax Development and Marketing Plan (2003), the crude honey produced in the country will not compete in the international market, even though it satisfies local demand; in that an average of 3.2 tonnes per annum has been exported to neighboring countries over the years 1997-2002 as shown in Table 1.

Table 1. Annual Export of honey and beeswax (1997-2002)

Year	Honey (tonne)	Value in Birr	Wax (tonne)	Value in Birr
1997	4.35	165,994	240.71	7,173,728
1998	1.28	35,609	955.66	13,549,025
1999	6.85	216,209	266.91	7,249,295
2000	1.49	28,083	294.94	7,352,471
2001	2.66	64,609	226.00	4,750,304
2002	2.99	78,447	232.98	4,743,289
Average	3.27	98,158.5	369.53	7,469,685.3

Source: Ministry of Trade and Industry, Government of Ethiopia, Annual External Trade Statistics, (1997-2002) for Honey and Beeswax.

Similarly, the above table explains an average of 369.5 tonnes of wax was exported per year over the period, which in turn generated over Birr 7.46 million per annum to the national economy.

2.4. Existing Methods of Beekeeping

The bee is still essentially a wild insect. One of the great things about beekeeping is the many ways that bees can be housed and managed for greater production. However, control over bee genetics and behavior has not been achieved to the same degree as with other domesticated animals and plants.

2.4.1. Traditional beekeeping

This term covers the use of traditional techniques of harvesting honey and beeswax from bees, using various traditional styles of hives and other equipment. This system uses fixed-comb hives which are no more than man made cavities. The materials, from which beehives are traditionally made in Ethiopia are clay, straw, bamboo, *enset* leaves, bark, dung, wood (Hartmann, 2004).

Traditional beekeeping is of two types-forest beekeeping and backyard beekeeping. In some places, especially in the western and southern parts of the country, forest beekeeping by hanging a number of traditional hives on trees is widely exercised. In most of the other parts of the country, backyard beekeeping with relatively better management is common (Nuru, 2002). In the former case, traditionally it is a men's job as the ones who are not able to climb high trees because of physical reasons, cannot become a beekeeper. The most important impact of this system is that it connects the farmers' economies with the preservation of these trees.

This method does not make use of the improved equipment and modern techniques. Honey is harvested by the use of fire or live torches, which burn the insects to death. Often the queen bee, essential to the colony, is killed in the process, and that, of course, dooms the colony. This kind of honey hunting is like the farmer who kills his cow in order to milk it. Lack of honey harvesting techniques might be the main cause of a currently tremendous decline of the bee population, besides ecosystem degeneration. Gezahegne (2001a) stated that under Ethiopian farmers' management condition, the average amount of crude honey produced from traditional hive is estimated to be 5 kg per hive per year.

2.4.2. Intermediate technology beekeeping

Moveable-comb hives are often called transitional hives or intermediate technology hives. It is a type of beekeeping intermediate between traditional and modern beekeeping methods. Transitional beekeeping started in Ethiopia since 1976 and the types of hives used are: Kenya top-bar hive (KTBH), Tanzania top-bar hive and Mud- block hives. Among these, KTBH is widely known and commonly used in many parts of the country (HBRC, 1997). It was developed for use in Kenya in the 1970's, and offers a relatively large number of management options when compared with some other intermediate technology hives. Its simple design also allows for the use of a wide range of materials.

Generally, top-bar hive is a single story long box with slopping sidewalls inward toward the bottom (forming an angle of 115^{o} with the floor) and covered with bars of fixed width, 32 mm for east African honeybees (Segeren, 1995; Nicola, 2002). It is an ideal accommodation for the aggressive tropical bee, and therefore it is highly recommended for use by beginners (Adjar, 1990). The hives are excellent for dealing with strains or species that are naturally very defensive since the hive is disturbed less as harvesting of combs, or inspections of brood areas, is done.

2.4.3. Modern (Moveable-frame) beekeeping

Modern beekeeping methods aim to obtain the maximum honey crop, season after season, without harming bees (Nicola, 2002). Modern movable- frame hive consists of precision-made rectangular hive boxes (hive bodies) superimposed one above the other in a tier. The number of boxes is varied seasonally according to the requirements. It is a beekeeping system that allows for the interchanging of combs both within and between colonies. It offers a wide range of management options, but it is relatively expensive. Moreover, its optimum utilization depends on inputs that are often difficult for small farmers to obtain.

Practical movable- frame hive was made in 1851 by Lorenzo Lorraine Langstroth in U.S.A. (Crane, 1976; Vivian, 1985). Later on different countries developed their own movable frame hives (for instance Zander, Dadant) and Langstroth was the prototype of movable frame hives used to day. In many countries Langstroth hive boxes have proved to be convenient for handling and management.

In Ethiopia about 5 types of movable frame hives were introduced since 1970 (HBRC, 1997) and the most commonly used are: Zander and Langstroth style hives. Based on the national estimate the average yield of pure honey from movable frame hive is 15-20 kg/year, and the amount of beeswax produced is 1-2% of the honey yield (Gezahegne, 2001a).

2.5. Development and Extension Services in Relation to Beekeeping

Apicultural research is new in Ethiopia. Holeta Bee Research Center (HBRC) founded around 1964, was the pioneer institution mandated to undertake research in areas that include: improving the quality of hive products, identification and development of races, evaluation of honey plants, improvement of traditional bee-keeping and beekeeping equipment, and investigation of diseases (Moustafa, 2000). The various organizations and institutions that have made substantial efforts to raise income from selected potential areas of the country includes: i) "The European Development Fund" beekeeping project mobilized in 1977 in Gambella District; ii) A "Beekeeping Development Project" that was carried out in Wolayita; iii) "Land Potential of Coffee and Oil Crops, Apiculture Component" a project initiated in 1988 to make preliminary assessment of the suitability of "Western Forest of Kaffa" for the production of crops, other than coffee; iv) "Assistance in Apiculture Development" in 1988, a project that aimed to increase production of honey in Ethiopia through the introduction of modern beekeeping. In addition, beyond workshops and trainings that are organized by the Ministry of Agriculture, courses in Apiculture are offered at Alemaya University and Veterinary faculty of Addis Ababa University at Debre Ziet.

As indicated in the recently issued Amharic version of Comprehensive Honey and Beeswax Development and Marketing Plan (2^{nd} Draft document), the country has set a long-term plan to raise the current 30,700 tonnes of honey and 3020 tonnes beeswax annual yield to a level of

149,056 tonnes and 9928.96 tonnes of honey and beeswax, respectively. It is also planned to export 80 percent and 50 percent of the total honey and beeswax production (MOA, 2003).

In the 3 years (2003-2005) development strategic plan of the Amhara National Regional State (ANRS), objectives have been set to introduce improved and intermediate beekeeping technologies to moist and moisture stress areas respectively. In these objectives it has planned to increase the number of top-bar hives from 8,081 to 996,000; box hives from 1,691 to 66,400, to boost the honey yield from 2.8 million kg to 19.29 million kg and to increase the participation of women in beekeeping by 30 percent (BOA, 2003a).

2.6. Profitability of Improved Technologies

High yields are not sufficient conditions to persuade farmers to adopt a technology. As is the case of any business, farming with technology application must be basically profitable, or at least more profitable than any other alternative. While standard agricultural budgets omit various hidden costs, such as long queues, bribes, favors etc, they do provide a simple accounting of the financial costs and benefits to farmers of alternative production strategies (Gavaian and Gemechu, 1995).

As noted by Janson (1993) a necessary condition for adoption of any agricultural technology is that it is acceptable to the farmer. Not only should the proposed innovation result in a worthwhile monetary benefits (i.e. reduce the unit costs of inputs in the production process), as calculated over the entire period of the investment, but also the individual periods' cash flow stream should suit farmers' needs. Thus, a farmer is unlikely to make an investment which, although resulting in an overall monetary benefit, is likely to result in cash flow problems in any year during the investment period.

Greater financial benefits may arise through increased biophysical productivity or through reduced input costs. Researchers assessed biophysical productivity and financial net benefits by comparing results on treatment plots with those on control plots, which represented farmers' current practices. Financial analysis were based on the costs and returns of that farmers faced. Partial budgets were drawn up for those practices that had limited impacts on the costs and returns of an enterprise, as in the case of fodder trees for dairy cows in central Kenya (Franzel *et al.*, 1996).

A partial budget is a technique for assessing the benefits and costs of a practice relative to not using the practice. It thus takes into account only those changes in costs and returns that result directly from using a new practice (Upton, 1987). Where a practice had substantial effects, as for hedgerow intercropping, enterprise budgets were used (Swinkels and Franzel, 1997). Data for a single period are usually inadequate for evaluating the performance of a given technology. Therefore, cost benefit analysis, also called investment appraisals (Upton, 1987), were developed for estimating costs and benefits over the lifetime of an investment. Average values for costs and returns across a sample of farmers were used to compute net present values.

2.7. The Process of Adoption of New Technologies

As one of the objectives of the present study is to identify the factors determining the adoption of improved beekeeping technology, and since the studies on this aspect were found to be lacking; a review of studies of technology adoption in the field of agriculture in general has been presented below. This was found to be helpful in hypothesizing the variables of technology adoption in beekeeping and in conceptualizing the models for in depth analysis of the hypothesized factors.

Historically, the original diffusion research was done as early as 1903 by the French sociologist Gabriel Tarde who plotted the original S-shaped diffusion curve (Rogers, 1962). However, two rural sociologists at Iowa State University, Bryce Ryan and Neal C. Gross created the emergence of the basic paradigm for early innovation diffusion research that gained recognition, when they published the results of their hybrid corn study in 1943.

According to Feder *et al.* (1985), adoption may be defined as the integration of an innovation into farmers' normal farming activities over an extended period of time. The authors classified adoption into farm level adoption and aggregate adoption. They further made a distinction between models of individual adoption (farm-level), which refer to static character of technology transfer, and models of aggregate adoption, which are dynamic and derive analytically the behavior of the diffusion process over time. The frequency distribution of adopters over time follows a bell-shaped curve and its cumulative frequency looks like the S-shaped curve (Rundquist, 1984).

Final adoption at farm level of the individual farmer is defined as the degree of use of a new technology in the long-run equilibrium when the farmer has full information on potentiality of a new technology (Feder *et al.*, 1985). In the context of aggregate adoption behavior, the same authors defined the diffusion process as the spread of a technology within a region. They further observed that, immediate and uniform adoption of innovation in agriculture is quite rare. In most cases adoption behavior differs across socio-economic groups and over time. Some innovations have been widely accepted while others have been rejected or adopted by only a very small group of farmers.

Mosher (1979) has also similar idea but he underlined the importance of information. He noted that because of fear of risks associated with the introduction of new technologies, at early stages, few adopters acquire full information. In this respect, Bayerlee and Hass de polance (1986) also reported that the adoption pattern of a particular component is a function of profitability, riskinness, divisibility, or initial capital, complexity and availability.

According to Dasgupta (1989), the adoption process is conceptualized to include several mental stages through which an individual passes after first hearing about an innovation and finally deciding to adopt or reject it. The process generally includes five stages: awareness, interest, evaluation, trial and adoption. The time between the awareness of an innovation and its adoption is called adoption period and length of adoption period varies not only from individual to individual but also from practice to practice (Feder *et al.*, 1985; Dasgupta, 1989). They also noted that, farmers are categorized, according to their tendency to adopt as innovators, early adopters, followers and laggards.

The implication of S-shaped curve is that few individuals initially adopt new technologies. However, as time goes, an increasing number of adopters appear, in the end, the path of the diffusion curve slows and begins to level off attaining its peak. The implication is that because of fear of risks associated with introduction of new technologies, at early stages, few adopters obtain full information. The long run upper limit or ceiling on aggregate adoption is determined by the economic characteristics of the new technology and by the state of the economy (Griliches, 1980).

As noted by Rogers (1962), Tardes' (1903) S-shaped curve is of current importance because "most innovations have an S-shaped rate of adoption curve". Some new innovations diffuse rapidly creating a steep S-curve; other innovations have a slower rate of adoption, creating a more gradual slope of the S-curve. The rate of adoption, or diffusion rate has become an important area of research to sociologists, economists and more specifically, to advertisers. Mansfield (1961) hypothesized that the S-shaped diffusion curve is a function of the extent of economic merit of the new technology, the amount of investment required to adopt the new technology and the degree of uncertainty associated with the new technology.

To shift from resource based to a more science-based system of agriculture, the agricultural research sector (technology invention/adoption) will have to play an increasingly important role in improving agriculture productivity (Dinal and Lisa, 1995a). It is estimated that human knowledge gets doubled in every seven years (Morris and Elkins, 1978). This has been due to the continuous research activities with their costly endowments. Thus, an information explosion phenomenon occurs at the research system. On the other hand, unlike the invention of a new technology, which often appears to occur as a single event or jump, the diffusion of that technology usually appears as a continuous and rather slow process. The technology diffusion system represents a gloomy picture, for 90 of every 100 inventions, which took decades of work, get lost (Lionberger and Gwin, 1982). Clearly, a chronic 'information crisis' exists in the linking system and most severely in the client system. Yet, it is diffusion rather than invention or innovation that ultimately determines the pace of economic growth and the rate of change of productivity. Rosenberg (1972) noted "in the history of diffusion of many innovations, one can't help being stuck by two characteristics of diffusion process; its apparent overall slowness on the one hand, and the wide variations in the rates of acceptance of different inventions, on the other hand."

As described by Seclar (1973; cited in Dejene, 1995), adoption of new technologies on a regular basis, among others, induce a dynamic growth process that enable the agricultural sector to produce food cheaply and releasing labor to the non-agricultural sector. There is an argument among researchers in developing countries that the introduction of improved agricultural techniques or technologies increases the production and income of subsistence farmers. However, the introduction of these improved technologies in many of the developing countries has only been partially successful as measured by observed rate of adoption (Gershan *et al.*, 1981).

2.8. Models for Analyzing the Factors in Technology Adoption

The decision to adopt a technology or not is a binary decision. It can be represented as a qualitative variable whose range is actually limited. This variable is limited because it can only take on two values: 1 or 0 (adopt or not adopt). Aldric and Nelson (1984) noted that the regression model places no restrictions on the values that the independent (exogenous) variables take on, except that they not be exact linear combinations of each other. The author added that the dependent variable, however, is assumed to be continuous. But if Yi, the dependent variable, can take on only two values (say zero and one) the violation of this assumption is so egregious as to merit special attention.

As reported by Hill and Kau (1973; cited in Mulugeta, 2000), the dichotomous nature associated with the decision to adopt or reject a technology implies that there exists a breaking point or threshold in the dimension of the explanatory variable below which the stimulus elicits no observable response. This is to mean that only when the strength of the stimulus reaches the threshold level, does the reaction occur and additional increase in stimulus strength results in no effect on the observed response. Hill and Kau (1973) forwarded and applied specialized models to identify relevant economic stimuli, to provide the magnitude of their effects, and to estimate the threshold levels of response.

Adoption decisions can be analyzed with binary choice models. The main assumptions underlying these models are: 1) the economic agent is faced with a choice between two alternatives e.g. adopt or not adopt a technology (KTBH in our case) and 2) the choice the agent makes will depend on his/her attributes or characteristics. The conceptual framework is to build a model which will allow us to predict how a particular economic agent with given attributes will decide. In other words, the objective of such a model is to determine the probability of a particular agent making one choice rather than the alternative (Pindyck and Rubinfield, 1981).

In most of the studies on adoption behavior the dependent variable is constrained to lie between 0 and 1 and the models used are exponential functions (Kebede *et al.*, 1990). However, the decision to adopt a new technology can be very effectively captured using binary choice models. Binary choice models are appropriate when the decision making choice between two alternatives depends on the characteristics of the problem. Three types of models have been proposed in the econometric literature for estimating binary choice models: the linear probability, logit, and probit models represented by linear probability function, logistic distribution function and normal distribution function, respectively. These functions were used to approximate the mathematical relationships between explanatory variables and the adoption decision that is always assigned qualitative response variables (Gujarati, 1995; Pindyck and Runbinfeld, 1981).

The major point that distinguishes these functions from the linear regression model is that the outcome variable in these functions is dichotomous (Hosmer and Lemeshow, 1989). Besides, the difference between logistic and linear regression is reflected both in the choice of a parametric model and in the assumptions. Once this difference is accounted for, the methods employed in analysis using logistic regression follow the same general principles used in linear regression (Hosmer and Lemeshow, 1989).

Although Ordinary Least Squares (OLS) estimates can be computed for binary model, the error terms are likely to be heteroscedastic as it depends on the value taken by Xi, and leading to inefficient parameter estimates. Application of a linear probability model to this type of problem suffers from a number of deficiencies (Amemiya, 1981; Aldric and Nelson, 1984; Capps and Kramer, 1985; Gujarati, 1995), particularly, the one associated with the estimated probabilities in some cases being greater than one or lesser than zero. Though this defect can be corrected by defining F=1 if F(Xi' b) > 1 and F=0 if F (Xi B) < 0, the procedure produces unrealistic kinks at the truncation points (Amemiya, 1981).

As noted by Aldric and Nelson (1984), it makes little sense to choose a functional form that satisfies a 0 and 1 constraint only by the imposition of artificial constraints on the range of values the regression coefficient may assume. Though its computational simplicity makes it preferable to be used frequently in the early years of econometric applications to obtain quick estimates in a preliminary stage, neither the Ordinary Least Square nor the Weighted Least Square estimators avoids the inherent weakness of the model mentioned above (Amemiya, 1981).

These deficiencies could be circumvented through the use of a monotonic transformation (probit or logit specification), which guarantees that predictions lie within the unit interval (Capps and Kramer, 1985). The fact that the models exhibit a cumulative distribution function enables to solve these problems. The use of probit and logit models, which give maximum likelihood estimates, overcome most of the problems associated with linear probability models and provide parameter estimators which are asymptotically consistent, efficient and Gaussian so that the analogue of the regression t-test can be applied.

The exact form of each S-shaped curve, slope and asymptote of diffusion pattern may differ depending on the theory and models used to describe the diffusion process (Legesse, 1998). The models that generate S-shaped curve include logistic function, the Gompertz function, the modified exponential function, the cumulative normal distribution function and the cumulative log-normal distribution function.

The choice of a model with non-linear specification is dependent strictly upon the distribution of the disturbance term, u, and among these the normal and logistic are two of the most commonly assumed distributions, providing still another rationale for their importance (Aldric and Nelson, 1984). The authors added that the choice between the logistic and normal curves revolve around practical concerns such as the availability and flexibility of computer programs and personal preference and experience as they are so similar as to yield essentially identical results with an estimated choice probabilities that differ by less than .02. They further noted, probit and logit models employ normalization factors of 1 and 1.813, respectively giving an approximate factor ratio of 1.8 and an analysis applied to the same set of data using these models should produce coefficient estimates that differ approximately by a factor of proportionality, and that factor should be 1.8.

Amemiaya (1981) proposed a value of 1.6 to be approximate more closely and the most accurate value of the factor lies somewhere in the neighborhood of these two values. He further emphasized that care must be taken in choosing the appropriate model in cases like extremely large number of observations and with a heavy concentration of observation in the tails of the distribution where estimates from logit and probit may differ substantially. Thus in the univariate dichotomous model, it does not matter much whether one uses a probit model or logit model. In multiresponse or multivariate models, however, the probit and logit models differ from each other more substantially.

Available evidence shows that the logistic function is the most frequently used function in adoption studies. According to Hosmer and Lemeshow (1989), there are two primary reasons for choosing the logistic distributions: from mathematical point of view; it is an extremely flexible and easily used function; and it lends itself to a meaningful interpretation. Maddala (1983) and Shakya and Flinn (1985) have recommended probit models for functional forms with limited dependent variables that are continuous between 0 and 1, and logit models for discrete dependent variables.

2.9. Empirical Studies on Technology Adoption

The contribution of new technology to economic growth can only be realized when and if the new technology is widely diffused and used. According to Hall and Khan (2002), decisions to begin using the new technology are often the result of a comparison of the uncertain benefits of the new invention with the uncertain costs of adopting it, whereas in the case of consumers, the benefits are the increased utility from the new good, but may also include such "non-economic" factors as the enjoyment of being the first on the block with a new good, the availability of complementary skills and inputs, the strength of the relation to firm's customers, and the importance of network effects. The authors remarked that an understanding of the factors affecting this choice was essential both for economists studying the determinants of growth and for the creators and producers of such technologies.

Numerous empirical technology adoption studies have been conducted for the last many years by different researchers. In this section attempts will be made to illustrate the reviews made and implications forwarded based on the findings that has been drawn from the studies.

Feder *et al.* (1985) reviewed theoretical developments and empirical studies on adoption of agricultural innovations in developing countries. They showed the dependency of observed diffusion patterns on complex relationships between factors such as risks associated with the new technologies, farmers' attitudes towards risk, fixed adoption costs and cash availability. The authors discussed the variables often hypothesized by a number of empirical studies to influence farmer's adoption decisions account for farm size, risk and uncertainty, human capital, labor availability, credit constraints, and landownership and rental arrangements.

Batz *et al.* (1999) conducted a study in Meru district of Kenya to assess the influence of technology characteristics on the rate and speed of adoption of dairy technologies, showed that among the hypothesized attributes the influence of relative investment was smaller than relative complexity and relative risk although strong influence of relative complexity and relative risk of the technologies on the adoption can be explained by the characteristics of farmers and farming circumstances. The study highlighted the development of risk reducing technologies with a low complexity that would be advisable as compared to the technologies that should be replaced.

Adesina *et al.* (2000) reported that sex of the farmer, extension contact, farmers' group membership and areas facing fuel wood scarcity to have higher adoption of alley farming whereas areas with very high population pressure exhibited lower adoption. They finally underscore that econometric modeling using farmer and village characteristics, socioeconomic and institutional variables can lead to more effective targeting to farmers and locations where higher adoption rates may occur.

A study conducted by Ayuk (1996) in the central plateau of Burkinafaso using a logit model integrating technology profitability as explanatory variable indicated that water availability and the profitability of the technology itself enhance the probability of adopting live hedges. The results provide an insight into conditions that should be taken into consideration when targeting farmers for this agro forestry technology.

Okoye (1996) in Nigeria showed that income, farm size and attitude to risk were the most important factors in the adoption of recommended soil erosion control practices while employment, farm output prices and interest rate influenced the adoption of traditional soil erosion control practices; finally recommending to bestow due attention to these variables in erosion control practice adoption program.

A Logistic regression employed by Arellanes and Lee (2003) in hillsides of Honduras showed that plots with irrigation, plots farmed by their owners, plots with steeper slopes, previous use of leguminous cover crops, soil amendments (including chemical fertilizers), and commercial vegetable production were more likely conditions associated with minimum tillage adoption. However, farmer household characteristics are not generally found to represent significant influences on adoption. Importantly, household income does not appear to be a determinant of adoption, suggesting that minimum tillage is an appropriate low input technology for resource poor households. Results from studies like these, they noted, are useful in targeting low-input technologies and programs promoting them among the farm household population.

A multivariate regression model used by Sharma (1997), in India showed that tenure status, social status, extension contacts, access to credit, education and age of the farmer were significant determinants in adoption of Alkali Land Reclamation Technology indicating extension visits and more liberal access to credit are likely to increase the adoption of the technology and will have a critical role in policy design to increase agricultural production.

Adoption studies carried out by Huque *et al.*, (1996) using a correlation analysis in Bangladesh revealed that farm size, potato farm area, extension contact and attitudes towards improved practices were significantly related with the adoption of improved practices of potato. However, farmer's age, education and organizational participation were not related with adoption.

In the same analogue, various empirical studies on the adoption of improved agricultural technologies have been carried out in Ethiopia. These are summarized below.

Bezabih (2001) made a study employing a Tobit model and reported that land quality, level of household income, extension information through radio program and seed quality index are significant factors influencing multiple technology adoption of new maize variety and chemical fertilizer package. He noted that useful policy implications, among others, are that enhancing adoption of agricultural technology requires increasing household's disposable income (e.g. through good price policy) and increasing farmers' access to agricultural information combined with research aiming at improving the quality of varieties is essential.

A similar study in Jimma zone, by Degnet *et al.* (2001) using linear discriminant function analysis showed that adopters and non-adopters of high yielding maize varieties were differentiated using a linear combination of extension contact, knowledge of fertilizer use and its application rate and amount of on-farm cash income. The authors underscored that adopters had higher frequency of contact with extension agents, higher off farm cash income and better knowledge of fertilizer use and its rate of application than non-adopters. The study implies that agricultural policies and supportive services have to be designed to suit the felt needs and circumstances of heterogeneous groups of farmers.

Berhanu (2002) employed Logistic regression model and analyzed factors affecting the adoption of crossbred dairy cows in Degam and Girar-Jarso districts of Ethiopia. His findings have shown that total livestock owned, distance between residence and market, farm size, bull service, total local breed livestock owned, extension contact, feed shortage and off-farm income significantly influenced its adoption. The study substantiates these factors to be a paramount in policy designs in order to increase the participation of farmers in dairy development activities involving new technologies.

A study conducted by Mulugeta (2000) in Central Highlands of Ethiopia Salale area showed that land security, size of cultivated land, technology specific characteristics, formal schooling, wealth status of the household, availability of off-farm income and assistance from different sources were important determinants of adoption of physical soil conservation practices. A similar study by Adebabaye (2003) in South Gondar Farta district of Ethiopia reported that participation in conservation programs, land security, perception of soil erosion problem, the available land labor ratio and education level were found to be important and significant factors to have affected adoption of improved soil conservation technologies positively. However, the important explanatory variable extension contact was found to be not significant.

Techane (2002) used Tobit model to analyze determinants of fertilizer adoption in the major cereal producing areas of Ethiopia. The result of his study have shown that except off-farm activity, proportion of sloppy land and illness of the household head, a marginal change in other significant variables have positive influence on the intensity of fertilizer use.

Wolday (1999) conducted a study on the major factors which influence the use of improved seeds in Ethiopia and reported that price, access to credit, fertilizer use, economic status of the household, land owned, visits of extension agents and infrastructural development are the principal determinants to the adoption of improved seeds. Asfaw *et al.* (1997) pointed-out that farm family household characteristics such as labour, farm size and oxen, credit provision and extension services have influenced adoption of maize production technology in Bako area of Ethiopia. They also reported that extension service significantly influenced the adoption of improved maize variety while availability of credits and education significantly influenced the use of fertilizer. Besides, row planting was positively related to the farmer's formal education and oxen ownership.

Lelissa (1998) used Probit and Tobit models to identify the determinants of adoption and intensity of fertilizer use in Ejere District, West Shewa, Ethiopia. He tried to analyze eighteen explanatory variables, to identify determinants of fertilizer adoption and reported that age, use of animal dung and land renting out have negative and significant influence, while access to credit and oxen ownership have positive and significant influence. He also reported that high altitude, use of animal dung and distance from fertilizer marketing centers have negative and significant influence on the intensity of fertilizer use, while access to credit, level of education, extension service, oxen ownership, value cost ratio and number of family size have positive and significant influence.

In a nutshell, one can learn from the review section that determinants of technology adoption encompass characteristics of the technology, features of the farming system, market and policy environments as well as socio-economic characteristics of the decision-making unit. The studies also provide essential feedbacks to biological scientists about what really works with their clients let alone identifying and determining the target group and farming systems or locations where technology diffusion and extension strategies could be implemented.

3. RESEARCH METHODOLOGY

The information discussed in this session includes the features of the study area where the research was conducted and the methodologies adopted in the sampling and data analysis. The information collected includes primary data from sample households and secondary data from the Woreda agricultural office, CSA and other line governmental and non-governmental organizations.

3.1. Description of Study Area

3.1.1. Location and physical features

The study was conducted in Ambassel Woreda, located in the South Wollo Administrative Zone, Amhara National Regional State, 463 km north of Addis Ababa and 70 km away east of the zonal capital Dessie along the main road to Gojam. The Woreda has 23 rural kebeles and one urban kebele. Wochale, a place where the popularly known 1891 Ethio-Italy treaty was signed is the capital town of the Woreda.

The altitude of the Woreda range between 1550 and 3500 meters above sea level, constituting 32 percent, 48 percent and 20 percent Dega, Weyenadega and Kola agro ecologies, respectively. The Woreda is characterized by highly rugged topography dominated by mountains. A slope gradient above 25 percent alone constitutes 59 percent of the total area of the Woreda.

3.1.2. Population situations and area coverage

The area coverage of the woreda is estimated to be 919 km^2 having 23756, 4214, 24095, 33292, 6953 and 390 hectares of arable land, grazing land, forest and wood land, non-productive land, homestead and water bodies, respectively (AWOA, 2004). The total population of the woreda is 140,363; the male and female accounted for 49 percent and 51 percent, respectively.

The estimated average family size was 4.91 persons per household. Of the total population, 95 percent and 5 percent are rural and urban dwellers, respectively. The population density of the study Woreda, is 153 persons per km^2 which is higher than the regional average (111 persons per km^2) (CSA 2002). During the 1998/99 crop-season, average land holding in the woreda was 1.32 hectares per household. The average cultivable land per household is 0.47 ha.

3.1.3. Agriculture

The livelihood of the population in the Woreda depends on agriculture. Agriculture is the major source of food and cash needs of farmers. In the study Woreda, mixed farming is practiced and both crop and livestock activities are equally important.

3.1.3.1. Crop production

The cropping seasons are Meher and Belg contributing respectively 75 percent and 25 percent of the production of major crops. The major crops cultivated during the 2003/04-crop season, in order of importance were barley, wheat, teff, maize and peas with an average estimated yield of 9, 10, 7, 12 and 6 quintals per ha (AWOA, 2004). The annual production of the farmers does not cover their subsistence requirements throughout a year due to shortage of arable land and erratic nature rainfall. The undulated terrains, which are subject to severe soil erosion, make the condition more unwieldy.

3.1.3.2. Livestock production

Livestock keeping is one of the integral parts of the farming system in the study Woreda. Livestock contribute to the daily food needs of the family, serves as source of cash income and security in time of adversity. It also supports crop production by providing draught power, manure and transportation services. Cattle, small ruminants and equines are the dominant livestock types kept by the farmers in the woreda. Depending on the area's agro ecology and resource base camels, poultry and beehives are also kept by the farmers.

The Woreda livestock population is estimated to be 73018 cattle, 64057 sheep, 54885 goat, 14200 donkey, 1849 mule, 130306 poultry and, 8176 beehive (CSA 2002). Average herd size, poultry and beehive ownership per household are 7.2, 4.5 and 0.28, respectively.

3.1.3.3. Beekeeping activity

Beekeeping in the Woreda is a traditional exercise carried out in all agro ecologies. The system is characterized by stationary backyard beekeeping. The hunting of honey from wild colonies in forests and crevices is rarely practiced in this Woreda. Women are rarely involved in beekeeping, perhaps either due to ignorance or past beliefs related to the nature of the work. The woreda is endowed with different natural vegetation on which the bees forage to make honey.

Crude honey is the only hive product that generates money for the farmer. Very often the honey produced is sold and consumed without being processed. To satisfy immediate cash needs, most farmers are obliged to sell their produce at the peak of the harvesting season when products flood the markets and prices are low.

Hitherto not much attention has been paid to the quality of hive products in the Woreda, since, as elsewhere in the country, local markets do absorb crude products as they are offered for sale. The absence of lucrative markets makes beekeepers to sell their honey to the widespread traditional beverages markets. Traditionally, the honey that is most preferred for the local drinks is a grade in which brood, pollen and wax are mixed. Hence, there is no incentive for the beekeeper to produce quality honey. However, in recent times efforts have been made to boost the yield of hive products both in quantity and quality. The regional state has set a short-term plan to raise the daily per capita income of the people to a level of 10 birr by the year 2005/06 (ARSBOA, 2004).

The study Woreda is one of the 47 Woredas categorized as food insecure and moisture deficit. In food insecure Woredas, the national and regional agricultural policy underscores beekeeping to be the preponderate activity to mitigate the problem. For the year 2004/05, 64824 households in 25 woredas were targeted to undertake beekeeping using Kenyan Top Bar and other types of modern hives. To achieve this target the region assigned 3.04-million birr budget plan for the study Woreda to implement the program on 1850 selected households.

3.1.4. Agricultural extension service

In order to realize the desired development in those countries where agriculture is the major means of survival, every effort towards growth should focus on the rural farming community. System has to be designed to establish a regular network of technology transfer and feedback with the community. In this context extension services play a vital role in channeling the appropriate know-how to the farmers.

In the study area there are 34 Development Agents (DA) that are responsible for providing the necessary technical supports required by the farmers. The number of farmers served by each DA varies depending on the weather, terrain and area coverage of the kebele; the overall average being 830 persons.

To upgrade the skill and learning capacity of farmers the country revised the extension policy in the year 2001. The plan revised gives priority in establishing farmers training centers (FTC) and assigning three Development Agents who have a diploma in specialized fields of agriculture in each kebele. This would enable farmers to get in touch and make use of new ideas and technologies on a variety of subjects to improve their livelihood. Taking this into consideration during the last three years a number of DA's have been recruited and enrolled in TVET (Technical Vocational Education and Training) to acquire the required skills.

3.1.5. Marketing

Efficient marketing system has substantial importance in improving the productivity of agriculture by providing incentives to farmers. The major objective of the farmers in the study areas is to satisfy their subsistence requirement. As a result, the farmers themselves consume much of what is produced. However, farmers sell part of their production in order to purchase household goods and farm inputs. Market participants in the study area include farmer-merchants and other traders supplying and exchanging inputs and basic consumer goods. The system, however, offers narrow opportunity to promote market-oriented production.

Figure 1. “Map” of Ethiopia showing the study area

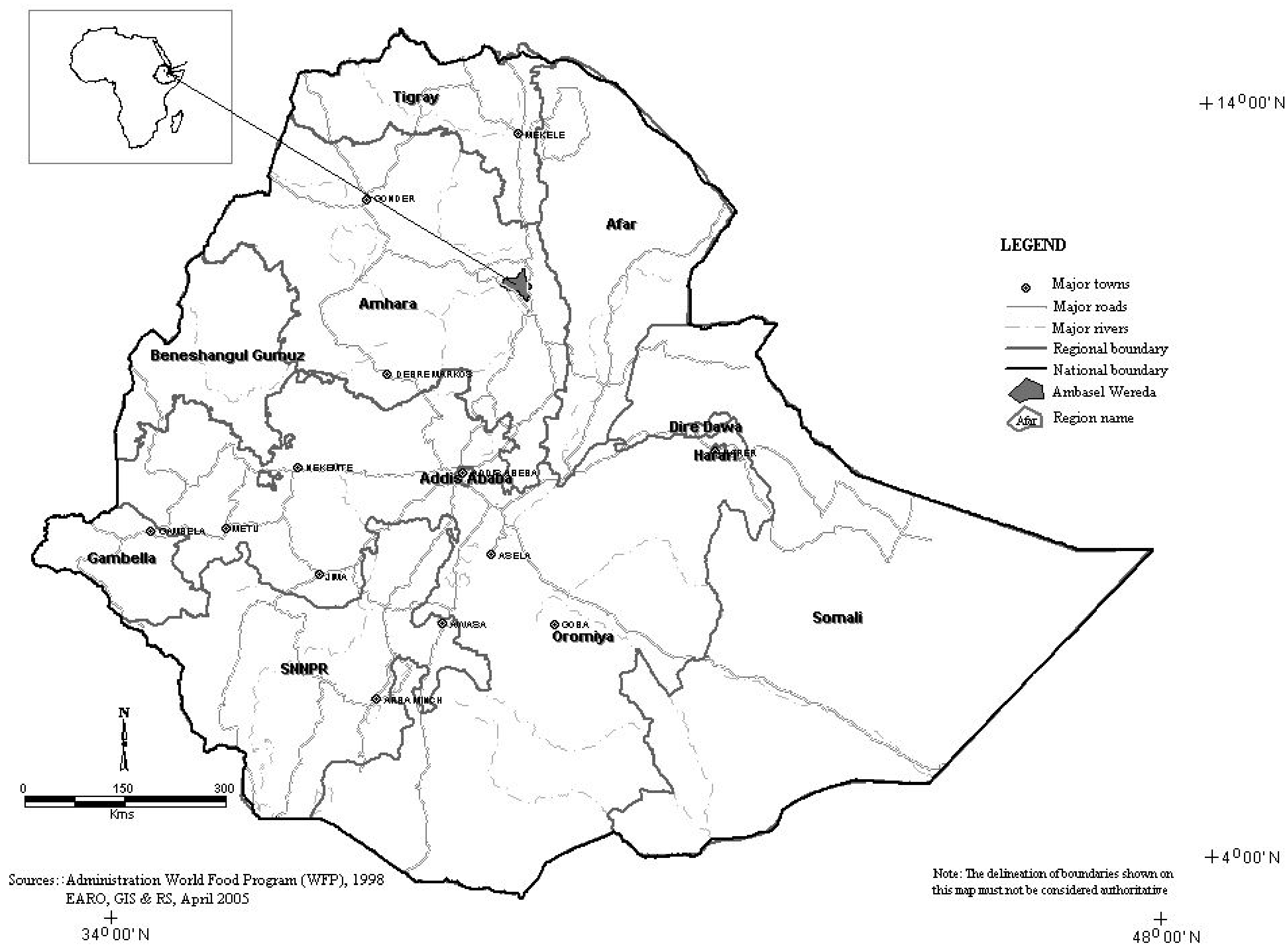
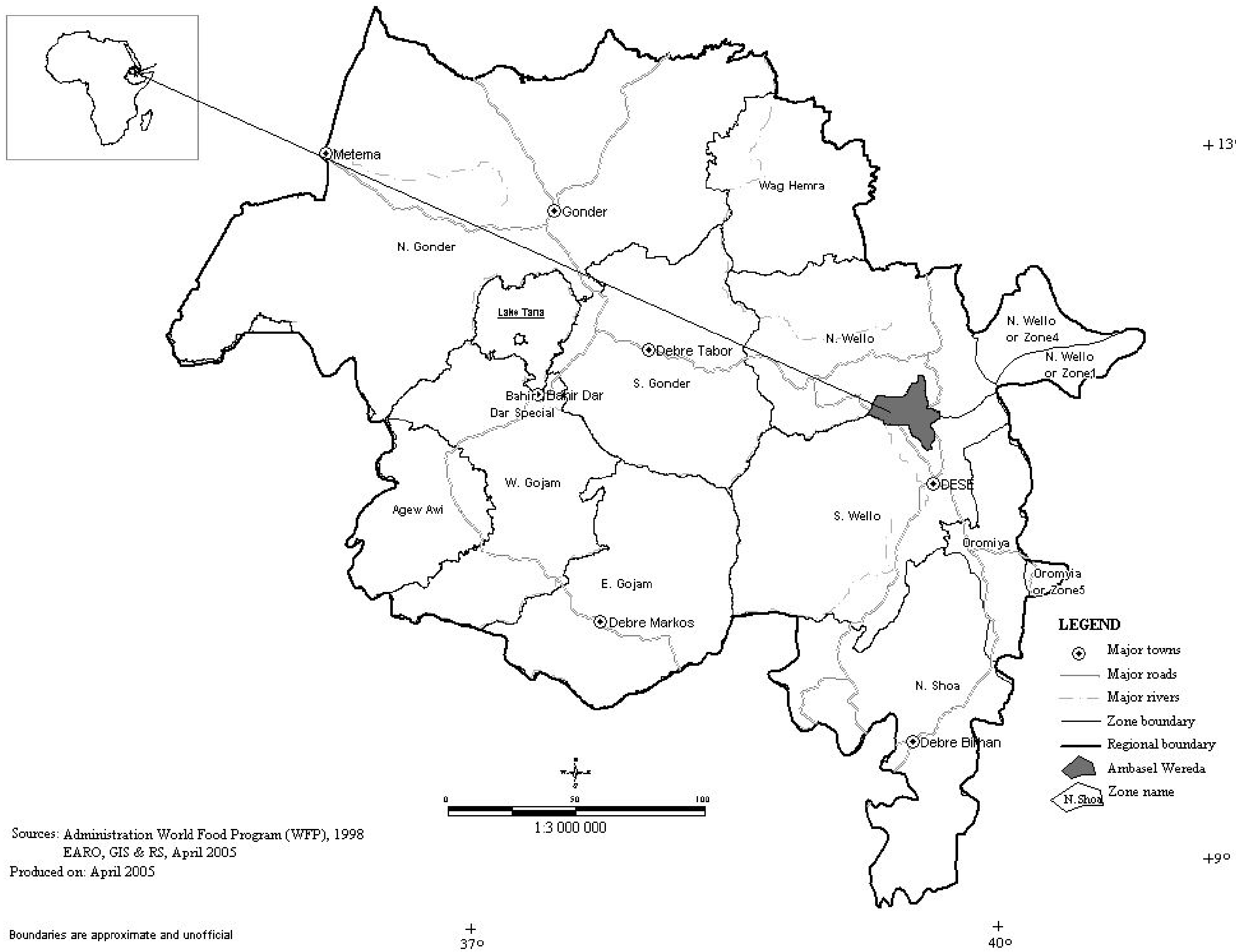


Figure 2. "Map" of Amhara National Regional State showing the study area



3.2. Sampling Procedure

3.2.1. Selection of study area

The Ambasel Woreda was purposively selected for the study because of the fact that the Kenyan top-bar-hive beekeeping technology is widely popularized and assumed to be accepted relative to the other woredas in the region. Three kebeles, namely Tisa, Robit and Golbo were also purposively selected using the same criteria.

3.2.2. Selection of farmers

At the very start of the study period a preliminary survey was made to have an insight about the area. And it was learned that available documents at the Woreda and kebele level indicate only the total number of beehives but not the number of beekeepers found in each kebele. Thus, the respective Development Agents prepared list of beekeepers for the targeted kebeles. To select farmers for the study the list of beekeeper was divided into two groups: 1) adopters of Kenyan top-bar hives, and 2) non-adopters of Kenyan top-bar hives. When sampling frame was designed it was found that the proportion of adopters in the total beekeepers population was only 27 percent. Therefore, to have adequate representation of different types of KTBH users for the profitability analysis choice based sampling was employed for each group to determine the total sample size to 100. To select farmers from each kebele a simple random sampling technique was used.

As noted by Greene (1998), choice based sampling technique is a deliberate sampling so that one or the other outcome is over represented in the sample in relation to its population proportion so as to learn more about the decision process. He added that to avoid some biases that can occur in the estimation, it is necessary to scale down the over-represented outcome and scale up the under represented outcome by computing a ratio value of their population proportion to sample proportion in order to obtain the right mix in the sample. This can be handled simply by using a weighting variable during estimation to re-weight the observations. For this study the proportion of the KTBH users and non-users group in the total population and in the sample was 27 percent and 73 percent, and 46 percent and 54 percent, respectively. Therefore the weighting variable can usually be created with a single command as follows:

$$WT = (.73/.\ 54)*(Y=0)+(.27/.\ 46)*(Y=1)$$

Where; WT is the name of the weighting variable that is created by scaling the adopters (y=1) down and the non-adopters (y=0) up using the factors in the equation to obtain the right mix in the sample.

Table 2. Distribution of sample respondents in selected Kebeles

Kebele	Household Total (N^{o})	Number of beekeepers	KTBH non-users (in N^{o})		KTBH users (in N^{o})		Sample Total (N^{o})
			Household	Sample	Household	Sample	
Tisa	1817	73	62	17	11	7	24
Robit	2389	80	63	17	17	11	28
Golbo	1182	121	75	20	46	28	48
Total	5388	274	200	54	74	46	100

Maddala (1992) pointed out that, if we use the logit model, the coefficients are not affected by the unequal sampling rates for the two groups. It is only the constant term that is affected. In this case the constant term needs to be decreased by log P_1- log P_2, where P_1 and P_2 are the proportion of observations chosen from the two groups (in this case adopters and non-adopters, respectively), and the logarithm is the natural logarithm. Maddala noted that if the interest is mainly in examining which variables are significant, there is no need to make any changes in the estimated coefficients for the logit model. On the other hand, if the estimated model is going to be used for prediction purposes, an adjustment in the constant term is necessary.

3.3.Methods of Data Collection

Both primary and secondary data were used in this study. The primary data pertaining to the year 2003 were collected from sample respondents during October and November 2004 through a structured questionnaire. The questionnaire was designed to generate data on some social, institutional, economic variables and input output data. Rationales like reputation to related duties, social acceptance, knowledge of the selected kebeles, educational background and communication with local language were used to recruit three enumerators who were assigned one kebele each. They were trained thoroughly about the objectives and the contents of the questionnaire and how to administer it.

Contents of the questionnaires were refined and verified based on a pretest that were made on individuals engaged in beekeeping before embarking into the formal survey. Prior to interviewing the selected respondents, care was taken to acquaint the problem of beekeeping and to create a sense of confidence among them in order to get a reliable data. The technique used for primary data collection was interview method. Continuous supervision was also made by the researcher himself to reduce error during data collection and to make corrections right on the spot.

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

3.4. Methods of Data Analysis

3.4.1. Profitability analysis

For the profitability analysis, comparison of the net return gained from traditional hive and KTBH was made in per hive basis for the KTBH adopters and non-adopters. Therefore data for different cost items, their cash outlay, their service period were collected for each individual that are using the different types of hives to come up for the total cost for the activities. Likewise the yield from traditional and KTBH was taken in a similar fashion to arrive at the total revenue generated for the activities.

Based on the available information a partial budgeting was employed focusing only on the changes in income and expenses that would result from implementing the specific alternative (in this case KTBH). To derive the net benefit of the alternative activities the total cost was subtracted from the total benefit. Finally if the net benefit was positive, the conclusion drawn could be that the activity has economic advantages. However, if the net benefit was negative, the recommendation was, it would be better off to stay using the current situation.

Finally cost benefit analysis technique was employed to assess the worth of a project for the different types of hives using discounted measures of project worth, Benefit-cost ratio (B/C ratio), Net present worth (NPW) and Internal rate of return (IRR). According to Gittinger (1982) discount rate is the interest rate used to determine the present worth of a future value by discounting.

Following Gittinger (1982), NPW is the discount stream of expected receipts from the project and the project's cost, and specified as:

$$NPV = \sum \frac{(B_t - C_t)}{(1+i)^t} = \sum \frac{B_t}{(1+i)^t} - \sum \frac{C_t}{(1+i)^t} - C \qquad (1)$$

Where; t is time horizon from year 1 to year n, C_t and B_t represents total cost and total benefit in year t, respectively, i is interest rate and C is initial cost.

IRR is the rate of discount that reduces the net present value of a project to zero, and specified as:

$$IRR = r_1 + (r_2 - r_1) * \left(\frac{NPV_1}{NPV_2 + NPV_2} \right) \qquad (2)$$

Where, r_1 is the lower discount rate, r_2 represents higher discount rate; and NPV_1 and NPV_2 are NPV at the lower and the higher discount rate, respectively.

B/C ratio is obtained by dividing the present value of the benefit stream by the present value of the cost stream. It is specified as:

$$B/C = \frac{\sum \frac{B_t}{(1+i)^t}}{\sum \frac{C_t}{(1+i)^t}} \qquad (3)$$

3.4.2. Determinants of adoption of KTBH technology

Weather or not a farmer adopted a new technology assumes a yes or no answers, a typical case of dichotomous variable. For such type of response, a discrete model is a popular tool of analysis. In this model, the dependent variable is a binary assuming two values, 0 and 1. Hence, for a farmer who uses the Kenyan top bar hive, the value (y=1) and for a farmer who does not use, a value (y=0) will be assigned.

Several models such as simple correlation, linear probability function, etc, can be used to analyze adoption behavior of farmers. But these models have limitations in that the t-ratios are incorrect, exhibit hetroscedasticity, non-normality, their estimated probabilities (P_i) may be greater than one or below zero, and assume P_i increases linearly with X (Maddala, 1983, Gujarati, 1995). The logit and probit models overcome these problems since both are based on a cumulative distribution function.

For the present study, however, we selected the logit model for the following reasons: 1) Probit and logit models are non linear (in the parameters) statistical models that achieve the objective of relating the choice probability P_i, to explanatory factors in such a way that the probability remains in the (0,1) interval (Griffiths, *et al*., 1993); 2) The logistic function is used because it represents a close approximation to the cumulative normal and is simpler to work with. The close similarity between the logit and probit models is confined to dichotomous dependent variables and; 3) In many cases logistic regression is preferred to the probit due to its link to other models such as linear probability model, and its simpler interpretability as the logarithm of the odds ratio and its eminence effort to retrospectively collected data analysis (Mcculaah and Nelder, 1998).

Following Gujarati (1995) and Aldrich and Nelson (1984) the logistic distribution for the adoption of Kenyan top bar hive can be specified as:

$$P_i = \frac{1}{\left(1 + e^{-z}i\right)} \tag{4}$$

Where, P_i is the probability of adoption of KTBH technology for the ith farmer, e represents the base of natural logarithms and Z_i is the function of a vector of n explanatory variables (X's) which is an underlying and unobservable index for the ith farmer (when Z_i exceeds some threshold level (Z*), the farmer is observed to be an adopter; otherwise he is a non adopter when Z_i falls below the threshold value), and expressed as

$$Z_i = \alpha + \sum \beta_i X_i \tag{5}$$

Where α is the intercept, β_i is a vector of unknown slope coefficients and X_1, X_2,----- X_n represent the n explanatory variables.

The logit model assumes that the underlying stimulus index (Z_i) is a random variable which predicts the probability of adoption of KTBH. The slope tells how the log-odds in favor of adopting KTBH practices change as independent variables change.

One way of approaching the (0, 1) constraint problem that is imposed on the probability is to transform P to eliminate one or both constraints (Aldric and Nelson, 1984) in a ratio form.

If p_i is the probability of adopting the Kenyan top bar hive, then $1 - P_i$ represents the probability of not adopting and can be written as

$$1-P_i = 1-\frac{1}{\left(1+e^{-z_i}\right)} = \frac{e^{-z_i}}{\left(1+e^{-z_i}\right)} = \frac{1}{(1+e^{z_i})} ....(4)$$

Dividing equation (1) by equation (4) and simplifying gives

$$\frac{P_i}{1-P_i} = \frac{1+e^{z_i}}{\left(1+e^{-z_i}\right)} = e^{z_i} \qquad (7)$$

Equation (5) shows the odds ratio, which defines the probability of adoption relative to non-adoption. Finally, the logit model is obtained by taking the logarithm of equation (5) as follows:

$$L_i = Ln(\frac{P_i}{1-P_i}) = Ln(e^{\beta_o+\sum_{j=1}^{n}\beta_o X_{ji}}) = Z_i = \beta_0 + \sum_{j=1}^{n}\beta_j X_{ji} \qquad (8)$$

Where, L_i is log of the odds ratio in favor of KTBHs adoption, which is not only linear in X_j, but also linear in the parameters. Thus, if the stochastic disturbance term, (U_i), is introduced, the logit model becomes:

$$Z_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + ... + \beta_n X_{ni} + u_i \qquad (9)$$

This model can be estimated using the iterative maximum likelihood (ML) estimation procedure.

After having identified the significant factors influencing the adoption decision of farmers, it is appropriate to understand the relative importance of these factors. This can be measured by examining elasticities of variable, defined as the percentage change in probabilities that would result from a percentage change in the value of these variables. One way to do this is to select interesting values of the exogenous variables and compute the associated P_i, vary the X_j of interest by some small amount and re-compute the P_i, and then measure the rate of change as

dP_i/dX_j, where dX_j and dP_i stand for percentage changes in the continuous explanatory variable (X_j) and in the associated probability levels (P_i), respectively. When dX_j is very small, this rate of change is simply the derivative of P_i with respect to X_j and is expressed as follows (Aldrich and Nelson, 1985):

$$\frac{dP_i}{dX_j} = \frac{e^{Z_i}}{(1+e^{Z_i})^2}\hat{\beta}_j \qquad (10)$$

$$= P_i(1-P_i)\hat{\beta}_j$$

3.5. Parameter Estimation

In linear regression the method used most often for estimating unknown parameters is least squares. Here we choose those values of the coefficients, which minimize the sum of square deviations of the observed values from the predicted values (Hosmer and Lemeshow, 1989). The method of least squares with its associated assumptions yields estimators with a number of desirable statistical properties. Unfortunately, when the method of least squares is applied to a model with a dichotomous outcome the estimators no longer have these same properties (Hosmer and Lemeshow, 1989; Gujarati, 1995).

When using either probit or logit model with individual observation the most suitable estimation technique is that of maximum likelihood (Pindyck and Rubinfeld, 1981). The estimation procedure has a number of desirable statistical properties. All parameter estimators are consistent and also efficient asymptotically, i.e., for large sample. In addition, all parameter estimators are known to be (asymptotically) normal, so that the analog of the regression t test can be applied. As noted by Pindyck and Rubinfeld (1981) and Gujarati (1995), the method of maximum likelihood consists in estimating the unknown parameters in such a manner that the probability of observing the given Y's is as high (or maximum) as possible.

3.6. Testing for Multicollinearity

Prior to the estimation of the logit model, multicollinearity diagnosis among the independent variables should be undergone to unravel the net effect of each variable on the fitted model. This is due to the fact that multicollinearity is essentially a sample phenomenon in the sense that even if the X variables are not linearly related in the population, they may be so related in the particular sample at hand (Gujarati, 1995). For this study Variance Inflation Factor (VIF) was used to identify the collinear continuous explanatory variables, which is given, by the formula as shown below.

$$VIF = (1-R_j^2)^{-1}$$

Where R_j^2 is the R^2 value that was found when the J^{th} continuous explanatory variable was regressed on the remaining continuous explanatory variables (Gujarati, 1995). This was done for each continuous variables included in the model. And since the VIF is the term in the computation of the variance of each partial regression coefficient, as a rule of thumb, if the VIF of a variable exceeds 10, that variable is said to be highly collinear.

Likewise to identify the collinearity among the qualitative explanatory variables contingency coefficients were computed using the formula shown below:

$$C = \sqrt{\frac{\chi^2}{n + \chi^2}}$$

Where, C= coefficient of contingency, χ^2 = a Chi-square random variable and n = total sample size.

Once the estimated coefficients for the fitted model are known, the steps that remains will be to assess the significance of the estimates in the model. This usually involves formulation and testing of statistical hypothesis whether the independent variables in the model are significantly related to the outcome variable (Hosmer and Lemeshow, 1989).

To test the significance of all or subset of the coefficients in the logit or probit model when maximum likelihood is used, a test using the chi-square distribution replaces the usual F test (Pindyck and Rubinfeld, 1981). Therefore to test the entire logit model, we first evaluate the likelihood function Lo when all parameters (other than the constant) are set equal to zero, and then we evaluate the likelihood function at its maximum i.e., L_{max}.

Therefore following Pindyck and Rubinfeld (1981), Hosmer and Lemeshow (1989), Greene (2003), the test statistic is specified as:

$$-2(\ln Lo/\ln L_{max}) = -2(\ln Lo - \ln L_{max}),$$

The test statistic follows a chi-square distribution with k degrees of freedom, where k is the number of parameters in the equation (other than the constant). To measure goodness of fit the likelihood ratio index was used, which is specified as:

$$\text{Likelihood Ratio Index (LRI)} = 1-(\ln L_{max}/\ln Lo)$$

Descriptive analysis was employed to observe the profile of the sample respondents to assess the similarities and differences between the adopters and non-adopters. More weight has been given in the discussion of respondents with respect to their beekeeping.

For the analytical methodologies followed two statistical packages were used: SPSS for WINDOWS and LIMDEP econometric software. The former package was used for econometric, descriptive and profitability analysis while the later was put into use only for econometric analysis.

3.7. Definition and Measurements of Variables in the Model

In this study adoption of KTBH was treated as a dichotomous dependent variable, i.e.; it took the value 1 if the farmer adopts and 0 otherwise.

Different theoretical and empirical studies conducted elsewhere on factors influencing adoption of agricultural technologies indicate the role of many social and economic factors in determining farmer's adoption decision. The independent variables of the study were those which were expected (hypothesized) to have association with the adoption of agricultural technologies on basis of past research studies, and *a priori* knowledge of the study area. It was thus hypothesized in this study, that the following farm and farmer characteristics influence the farmer's decision.

Education level of the household: This refers to the number of years of formal schooling a household head has attended. The higher the education level, the better would be the attitude of the farmer towards better technological methods of production. It is expected that those farmers with higher formal education are more likely to use KTBH because of less conservative thinking and their capacity to easily acquire news about the associated benefits and cost of the technologies. Thus, education level is hypothesized to influence decision on using KTBH positively.

Farming experience of the household head: This implies number of years since he/she has embarked on farm operations. Farmers having a longer farming experience are in a better position to know about the potential benefits of new technologies than farmers with shorter farming experience Moreover, farmers with longer farming experiences will have a cumulative knowledge of the entire farming environments. This in turn enables them to adopt KTBHs earlier than farmers with short farming experience. In this study, this variable is hypothesized to be positively correlated with adoption of KTBH.

Leadership position of the household: It is a dummy dichotomous variable taking a value 1 if the farmer was in a leadership position during the study year, and 0 otherwise. Farmers who bear the responsibility to execute and organize on the behalf of the community get the chance to acquire timely and vital information from government officials and change-agents. Thus, being a leader is expected to affect adoption of KTBH positively.

Beekeeping experience of the household: It refers to the number of years the farmer engaged in beekeeping activity. Having cumulative knowledge of how to keeping bees is a prerequisite to his ability to obtain, process and use information relevant to the practice. Therefore a positive relationship between the variable and the probability of adoption is hypothesized.

Farm size: This refers to the total area of farmland that a farmer owns. Many agricultural innovations require substantial economic resources of which land is the principal one. Farm size is often correlated with farm income and wealth, which may ease the liquidity constraint to invest in procuring new agricultural technologies. Therefore, those farmers with larger farm size are expected to have cash to buy KTBH for their beekeeping activity.

Homestead size: it refers to the proportion of the total land holding, that is regarded as the compound of the farmer including the backyard that is found around the farmers' residence. Very often beekeepers establish their apiary site in this parcel of their farm area so that they can mange the venture properly. And hence those farmers having a large area for their apiary site encourage practicing the KTBH technology and it shows a positive association with adoption.

Income of the household: It refers to the total family income of the farmer from farm and off-farm sources measured in Birr. It is expected that the higher the level of income obtained the better would be the ability of farmers to afford adoption of the KTBH, and hence it is hypothesized that the variable would exhibit a positive relation with adoption.

Total livestock holding: It is a continuous explanatory variable and refers to the total number of livestock the household own in terms of TLU. It is assumed that household with larger TLU can have a better economic strength and financial position to invest in new technologies than those household with less number of TLU. Therefore, the variable has positive association with the adoption of KTBH technology.

Perception of timely supply of the technology: It is a dummy dichotomous variable taking a value 1 if the farmer feels confident in the timely availability of KTBH, and 0 otherwise. Any uncertainty in timely supply of a technology can result switching of farmers decision towards more reliable alternative ventures. Therefore having a better perception and confidence in timely supply of a technology would have better likelihood of adoption. It is therefore, hypothesized to be correlated positively.

Extension contact: This refers to the number of contacts with extension agents that the sample farmer made in a month. Farmers who have a frequent contact with extension agents are expected to accept and practice new ideas faster than those farmers who made few contacts. It is therefore, hypothesized that extension contact correlates with decision to adopt KTBH positively.

Apiary visit: It is a dummy dichotomous variable taking a value 1 if the farmer ever visited neighborhood or distant farmers' apiaries facilitated by any pertinent organization, and 0 otherwise. Experience sharing between or among farmers is one of the communication methods to disseminate new ideas within the farming community. And those farmers participating in the program are more likely to adopt the KTBH practice than farmers who have not got the chance. And it is, therefore, hypothesized to correlate positively with adoption.

Beekeeping training: It is a dummy variable taking a value 1 if the farmer ever attended any formal training in the area of beekeeping, 0 otherwise. Therefore, it can be hypothesized that those farmers who got this opportunity are expected to acquire better knowledge about the subject matter and motivated to adopt the KTBH technology. And it shows a positive association. Poor access to technical support causes great difficulties for any beekeepers that adopt modern beekeeping equipment. Because it renders the beekeeper to follow traditional management approaches while using modern hives and fail to reap full benefits from their investment (Gichora, 2003).

Support: It is a dummy variable taking a value 1 if the farmer got assistance in beekeeping during the study year, 0 otherwise. It refers to any form of assistance extended to the farmer in the area of beekeeping activity. It is obvious that unlike other agricultural activities beekeeping activity is not widely practiced among the farming community. Taking this into account to raise the contribution of the sector some supports were made through institutions to encourage the participation of farmers. Hence, assistance (material, technical and any other incentives) from any source encourages the farmers to decide adoption of the KTBH technology.

Off-farm income: It represents part of the total amount of income measured in birr that is earned from non-agricultural activities. This additional income increases the farmers' financial capacity and is expected to increase the probability of investing in new technologies. Hence, availability of off-farm income is hypothesized to be one of the factors that influence adoption of KTBH positively.

Ownership of a radio: It is a dummy variable taking a value 1 if the farmer owns a radio, and 0 otherwise. The country's radio broadcasting service agricultural extension program provided by MARD (Ministry of Agricultural and Rural Development) and other development stakeholders are the major source of agricultural information in the nation in general and in the study area in particular. Farmers owning a radio can access the opportunity easier than the ones that have not a radio. Therefore, the variable is hypothesized to relate positively with adoption of KTBH.

4. RESULTS AND DISCUSSION

4.1. Socio-economic Characteristics of Sample Households and the Status of Beekeeping

This section provides the profile of the sample respondents and traces the difference between the users and non-users of the technology with regard to the their socioeconomic endowments.

4.1.1. Household characteristics

The average family size of the sample farmers in the study period was 5.13 persons, with maximum and minimum family size of 9 and 1 person, respectively. This variable can indicate the food needs and competition for resources available. The figure was 5.39 and 4.91 persons for the users and non-users of the KTBH technology, respectively (Table 3). However, the difference turned out to be insignificant statistically.

Table 3. Distribution of sample family members by age

Age category	Users (n=46)		Non-users (n=54)		Total sample (n=100)	
	No	%	No	%	No	%
<10	36	30.3	39	31.2	75	30.7
10-14	32	26.9	29	23.2	61	25.0
15-65	46	38.6	54	43.2	100	41.0
>65	5	4.2	3	2.4	8	3.3
Mean family size (N^{o})	5.39		4.91		5.13	
T-value		1.384				

Concerning the age of the household nearly half (48%) of the household heads were in the age group of 41-65 (Table 4). This proves that beekeeping is an important economic activity that creates employment for the rural community productive age group. For the users and the non-user the mean age being 45.7 and 41.7, respectively showing no statistically significant difference. While the mean age of the households head was 43.87, the minimum age being 23 and the maximum 80 years.

Table 4. Distribution of sample household head by age

Age category	Users (n=46)		Non-users (n=54)		Total sample (n=100)	
	N	%	n	%	n	%
18-40	19	41.3	26	48.1	45	45.0
41-65	22	47.8	26	48.2	48	48.0
>65	5	10.9	2	3.7	7	7.0
Mean age (year)	45.7		41.7		43.87	
T-value			1.346			

Of the total sample household studied 96 percent were male headed (Table 5). This conforms with the traditional thinking that beekeeping to be men's job due to physical reasons it claims. The female headed households or the households with all members being female are non-users of the technology. As a result the significant χ^2 test indicates the adoption of KTBH relates with sex of the household at 10 percent probability level.

Table 5. Distribution of sample respondents by sex of household heads

	Users (n=46)		Non-users (n=54)		Total sample (n=100)		χ^2
Sex	n	%	n	%	n	%	
Male	46	100	50	92.6	96	96.0	3.549*
Female	0	0	4	7.4	4	4.0	

*Significant at 10% probability level

Most of the sample household heads (94%) are married while 2 percent, 3 percent and 1 percent are single, divorced and widowed, respectively.

4.1.2. Educational status of family head

The average number of years of formal schooling completed was 3.41 years for the beekeepers. Among the sample respondents 19 percent had not received any education, while 13 percent could only read and write. The rest attended from elementary to high school level. More specifically, 54 percent, 6 percent and 8 percent of the sample respondents had attended elementary school, junior, secondary and high school, respectively (Table 6).

Table 6. Educational status of the head of the household, by farmer group

Educational Status	Users (n=46)		Non-users (n=54)		Total sample (n=100)	
	n	%	n	%	n	%
Illiterate	10	21.7	9	16.7	19	19.0
Read and Write	4	8.7	9	16.7	13	13.0
Elementary (1-6)	26	56.5	28	51.8	54	54.0
Junior (7-8)	2	4.4	4	7.4	6	6.0
High School (9-12)	4	8.7	4	7.4	8	8.0
Mean	3.52		3.31		3.41	
T-value		0.325				

4.1.3. Land holding and land rent type

As a result of mountainous topographical nature of the woreda, shortage of productive land in particular and arable land in general characterizes the prevailing farming system. As can be seen from Table 7, the average land holding of the sample farmer during the study year was 1.2 ha which is slightly less than the woreda average of 1.32 ha.

A considerable proportion of the sample respondents (17 %) owned farms of 0.5 hectares or less. Similarly 54 percent and 29 percent owned farms of 1.5 hectares or less and 1.51 hectare or above, respectively. There is no statistically significant difference in holding size between the users and non-users group.

Table 7. Distribution of households by the available land holdings.

Holding size	Users (n=46)		Non-users (n=54)		Total sample (n=100)	
	n	%	n	%	n	%
≤0.5	9	19.6	8	14.8	17	17.0
0.51-1.5	24	52.2	30	55.6	54	54.0
≥1.51	13	28.2	16	29.6	29	29.0
Mean (ha)	1.195		1.192		1.194	
t-value			0.21			

On the other hand 62 percent of the sample farmers involved in renting systems indicating that sample farmers in the study area derive a part of their income from contractual land tenure arrangements (Table 8).

Table 8. Distribution of households by land rent type

Farmer type	Rented-in Land		Rented-out Land	
	n	%	n	%
Users (n=46)	24	52.1	6	13.0
Non-users (n=54)	28	50.0	4	7.4
Total sample (n=100)	52	52.0	10	10.0
Mean size (ha)	0.336		0.04	

Accordingly those engaged in rented-in and rented-out being 52 percent and 10 percent, having an average size of 0.336 ha and 0.04 ha, respectively. Those farmers who rented-in land were found to be relatively progressive and have a better economic position whereas women and aged farmers who are unable to make use of their farm land because of shortage of farm implements and physical reasons were found to have rented out their land.

4.1.4. Major crops produced and yield

The productivity of the land in the study area is very poor mainly as a result of poor fertility of the soils. This poor soil fertility is due to continuous soil erosion and loss of topsoil over the past years, which is exacerbated by the sloppy terrain of the landscape.

Table 9. Average area and production of major crops on sample farmers

Type of crop	Users (n=46)		Non-users (n=54)		Total sample (n=100)	
	Area (ha)	Yield (qt.)	Area (ha)	Yield (qt.)	Area (ha)	Yield (qt.)
Teff	0.48	2.90	0.45	3.00	0.46	2.95
Sorghum	0.49	4.13	0.49	6.34	0.59	5.30
Pea	0.20	0.70	0.19	0.86	0.20	0.77

As can be seen from Table 9 above the area coverage and the productivity of the major crops grown is very low so as to sustain its livelihood.

4.1.5. Livestock production

As an integral part of the mixed farming system, livestock production plays a substantial role in the household food security in the study area. It meets urgent financial need, dietary requirements, loan repayment and overall cash security of the households. As shown in Table 10, mean TLU kept by the users and non-users of KTBH during the study period was 3.73 and 3.51, respectively. There is no significant difference between the two groups in terms of livestock holding size.

Table 10. Distribution of sample households by livestock holding in TLU

TLU	Users (n=46)		Non-users (n=54)		Total sample (n=100)	
	n	%	n	%	n	%
0-2	10	21.7	17	31.5	27	27.0
>2-4	13	28.3	20	37.0	33	33.0
>4-6	17	37.0	7	13.0	24	24.0
>6-8	5	10.8	8	14.8	13	13.0
>8	1	2.2	2	3.7	3	3.0
Mean	3.73		3.51		3.61	
T-value	0.504					

4.1.6. Family labor structure

The labor requirement for the different agricultural activities in the study area is often met by family labor. It was found that the mean labor available for the users and non-users of KTBH to be 2.75 and 2.59 ME, respectively. As shown below in Table 11, the available mean labor for the entire sample was 2.67 ME.

Table 11. Distribution of sample households by labor availability (Man Equivalent)

Amount of labor	Users (n=46)		Non-users (n=54)		Total sample (n=100)	
	n	%	n	%	n	%
0-2	18	39.1	23	42.6	41	41.0
>2-4	21	45.7	28	51.8	49	49.0
>4-6	7	15.2	3	5.6	10	10.0
Mean	2.75		2.59		2.67	
T-value	0.752					

4.1.7. Experience in beekeeping

The level of beekeeping experience was taken to be the number of years that an individual was continuously engaged in beekeeping. More than a quarter (26%) of the respondents had above 10 years of beekeeping experience. The average experience for the entire sample was 8.85 years, the minimum and maximum experience being 1 years and 60 years, respectively. This shows that the activity was introduced or started in the area, about more than half a century ago. The mean comparison of KTBH users and non-users shows that no statistically significant difference is observed in terms of beekeeping experience as shown in Table 12.

Table 12. Distribution of respondents by beekeeping experience and apiary distance

Attributes	Users (n=46)		Non-users (n=54)		Total sample (n=100)	
	n	%	n	%	n	%
Beekeeping experience (year)						
1-5	25	54.3	33	61.1	58	58.0
6-10	8	17.4	8	14.8	16	16.0
>10	13	28.3	13	24.1	26	26.0
Mean experience	9.92		7.93		8.85	
T-value	0.998					
Distance of Apiary (meter)						
0-5	32	69.6	32	59.3	64	64.0
6-10	10	21.8	12	22.2	22	22.0
11-100	2	4.3	7	13.0	9	9.0
>100	2	4.3	3	5.5	5	5.0
Mean distance	4.78		8.95		7.04	
T-value	-1.287					

When we come to the distance of the apiary* 86 percent of the sample respondents' apiary is located with a distance of 10 meter apart from their residences. The average distance of apiary for the sample respondents was 7.04 meter (Table 12). Moreover the mean apiary distance between the users and non-users has shown no significant difference.

With regard to the initial base to start beekeeping in Table 13, 10 percent of the respondents were introduced to beekeeping through inheritance from parents, whereas 39 percent and 48 percent of the farmers started the activity through catching swarms and buying colonies, respectively. Similarly 3 percent of the farmers started through institutional and friends/family supports. From this one can learn the limitations in knowledge transfer from elders to the novice and the need for a credit scheme for the purchase of bee colonies to attract beginners.

Table 13. Distribution of sample respondents by their base in starting beekeeping and mode of handling beehives

Attributes	Users (n=46)		Non-users (n=54)		Total sample (n=100)	
	n	%	n	%	n	%
Base to start beekeeping						
From parents	8	17.4	2	3.7	10	10.0
Catching swarms	14	30.4	25	46.3	39	39.0
Buying	21	45.7	27	50.0	48	48.0
Others (NGO support)	3	6.5	-	-	3	3.0
Location of Beehive						
Backyard	38	82.6	43	79.6	81	81.0
Eaves of the house	5	10.9	7	13.0	12	12.0
Inside the house	2	4.3	2	3.7	4	4.0
On outside trees	1	2.2	2	3.7	3	3.0

* Apiary is the name given to the beekeeping environment, and the number of hives set determines its size

As to the choice of the place to install the hive 81 percent of the respondents established their apiary at the backyard of their house. It was also reported that those farmers who put the hives at the eaves of their house, inside the house, and on trees were estimated to be 12 percent, 4 percent and 3 percent, respectively (Table 13)………Being out of the scope of the present study, this aspect has not been examined. This necessitates further study on the performance of bee colonies that are subject to a range of varying environmental conditions………

4.1.8. Total number of hives and size of holdings by sample respondents

About 89 percent of the beekeepers interviewed used traditional hives at differing holding size. Among the users of KTBH, all but 24 percent made use of traditional hives also during the study period. No other type of movable comb or movable frame hive was reported during the data collection period. Altogether there were 258 traditional hives reported amongst the total sample respondents (Table 14).

Table 14. Holding sizes of traditional hive by sample respondents

Number of hive	Users (n=46)			Non-users (n=54)			Total sample (n=100)		
	n	%	Total no of hives	n	%	Total no of hives	n	%	Total no of hives
Nil	11	23.9	-	-	-	-	11	11.0	-
1-5	32	69.6	69	50	92.6	109	82	82.0	178
6-10	1	2.2	6	3	5.5	25	4	4.0	31
>10	2	4.3	34	1	1.9	15	3	3.0	49
Total	46	100	109	54	100	149	100	100	258
Average size (N^{o})		2.36			2.76			2.58	
T-value			-0.643						

The study further shows that many (82%) of the respondents kept 1-5 traditional hives, the maximum number of traditional hives owned by an individual in the survey being 21. The total number of KTBH owned by the beekeepers was noted to be 76. The highest number of KTBH owned by an individual was 5 (Table 15).

Table 15. Holding sizes of KTBH by sample respondents

Number of hive	Users (n=46)			Non-users (n=54)			Total sample (n=100)		
	n	%	Total no of hives	n	%	Total no of hives	n	%	Total no of hives
Nil	-	-	-	54	100	-	54	54	-
1-3	43	93.5	63	-	-	-	43	43	63.0
>3	3	6.5	13	-	-	-	3	3	13.0
Total	46	100	76	54	100	-	100	100	76
Average size (N^o)		1.65			-			0.76	

4.1.9. Beekeeping equipments and capital requirements

During the survey respondents were found to make use of hives that were drawn from different sources. It was found that all of the beekeepers that run traditional hive construct the hives by themselves. Likewise 67.4 percent of respondents who use KTBH prepare the hives by their own. Whereas 32.6 percent the farmers make use of KTBH that are prepared in manufacturing centers and provided by institutions.

When asked to list the equipment they use including their market prices and lifetime, the respondents mentioned a wide range of accessories, prices and service periods that goes hand in hand with beekeeping practices. The full range of accessories, one can expect the following: smokers, bee veils, boots, glove, overalls, bee brush, water sprayer, queen catcher, knife, honey presser, honey container, honey extractor and capping fork. It was learned in the study that except the known basic hive tools many of the materials are either non-existent or kept by quite few number of respondents.

4.1.10. Honey output of beekeepers

Honey is harvested in the study area from September to December (the peak period) each year. Among the total respondents 59.2 percent of the respondents harvest twice within this period of the year whereas 40.8 percent of the farmers harvest only once in the same period. It was reported that any yield obtained in the remaining periods of the year would be left as a food for the colony to strengthen it for the coming harvest.

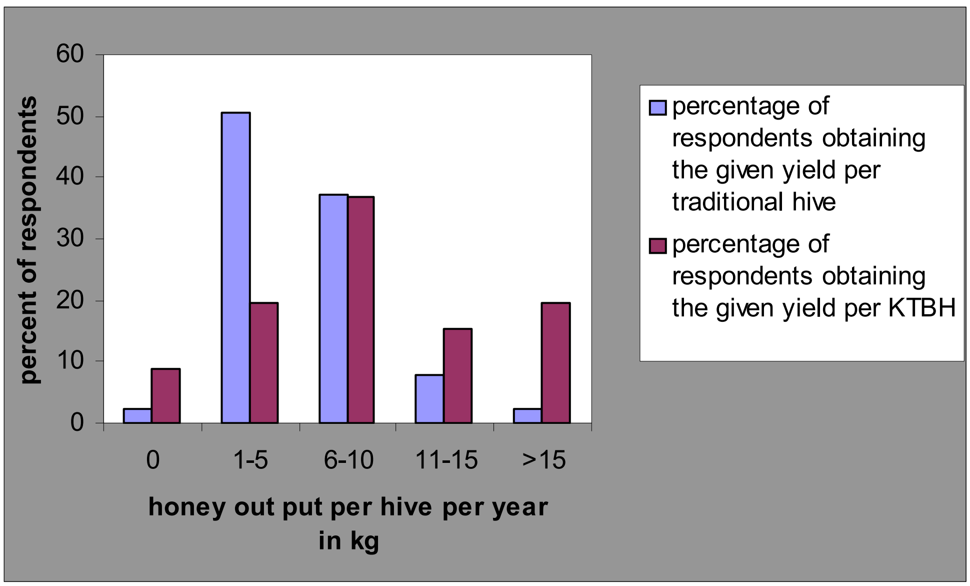


Figure 3. Honey output of traditional and KTBH by sample respondents

Figure 3 illustrates the honey output (in kilograms) of traditional and KTBH per hive. It further shows that 2.2 percent of users of traditional hive harvest no honey, while 50.6 percent and 37.2 percent of the users of traditional hive harvest between 1 and 5 kg and between 6-10 kg of honey per hive, respectively. Similarly 7.8 percent and 2.2 percent of the traditional hive users were estimated to harvest between 11 and 15 kg and greater than 15 kg of honey per hive, respectively. It was found that the average yield obtained from traditional hive users per year per hive was 6.11 kg, the maximum yield being 25 kg.

In the same analogy, 8.7 percent of users of KTBH harvest no honey during the year, while 19.5 percent and 36.9 percent of the users of KTBH harvest 1-5 kg and 6-10 kg of honey per hive, respectively. Similarly 15.2 percent and 19.5 percent of the KTBH users were estimated to harvest between 11 and 15 kg and greater than 15 kg of honey per hive, respectively. It was learned that the average yield obtained from KTBH users per year per hive was 8.93 kg, the maximum yield being 50 kg.

4.1.11. Annual income earned from beekeeping

Tables 16 and 17 below show the total annul honey yield and the per annum income of the sample respondents during the study period, respectively. With an average holding of 3.34 hives, more than a third of the respondents gain between 0 and 10 kgs of honey annually. Although size of hive holding per head differs between the users and non-users group, the per hive basis computation between traditional and KTBH has shown that the users of the technology enjoy a relatively better yield.

Table 16. Distribution of respondents by annual total yield gained from all hives

	Users (n=46)		Non-users (n=54)		Total sample (n=100)	
Honey yield (kg)	n	%	n	%	n	%
0	-	-	2	3.7	2	2.0
1-10	10	21.7	24	44.5	34	34.0
11-20	13	28.3	18	33.3	31	31.0
21-50	19	41.3	8	14.8	27	27.0
51-100	4	8.7	2	3.7	6	6.0
Total yield (kg)[a]	1149		910		2059	
Mean yield (kg)[b]	24.97		16.85		20.59	
t-value	2.179**					

** Significant at 5% probability level

[a] The total yield for KTBH users also includes the yield gained from traditional hive that is simultaneously kept by the group

[b] The yield from the average hive holding size for the groups, 4.01 and 2.76 for user and non-users, respectively

Equivalently, with the given size of holding, almost half (48%) of the respondents earn within the range of 100-300 birr. It can be justified that the high revenue made possible for the users of KTBH could be because of the adoption of the improved technology, as no difference in management practices could be observed between the two groups.

Table 17. Distribution of respondents by annual total income gained from all hives

Income earned in birr	Users (n=46)		Non-users (n=54)		Total sample (n=100)	
	n	%	n	%	n	%
0	-	-	2	3.7	2	2.0
1-100	9	19.6	24	44.5	33	33.0
101-300	26	56.5	22	40.7	48	48.0
301-500	7	15.2	4	7.4	11	11.0
501-1000	4	8.7	2	3.7	6	6
Mean (birr)[b]	244.46		176.48		209.05	
t-value	2.066**					

** Significant at less than 5% probability level

b- The income of KTBH user includes the earn from traditional hive that is kept simultaneously by the group and from the average hive holding size given in Table 16

4.1.12. Uses of honey produced

Honey harvested by the sample farmers in the study area was meant for versatile purposes. Except for the inconsiderable amount that was extended as a gift, much of the collected honey is consumed and sold during harvesting time when honey is glut in the market. However, the amount of honey sold is much more than the amount of honey consumed by the households. Thus the average amount of honey that was consumed, sold and given as a gift by the sample respondents estimated to be 4.4 kg, 15.85 kg and 0.34 kg, respectively (Table18).

Table 18. Disposal of honey products by the sample households

Description	Users (n=46)	Non-users (n=54)	Total sample (n=100)
Consumed average (kg)	4.63	4.20	4.40
Sold average (kg)	19.19	12.82	15.85
Gifted average (kg)	0.60	0.11	0.34

It was observed that 56 percent of the beekeepers sell their honey produce at home with undesirable farm gate prices while 44 percent reported to sell their produce at normal weekly markets that was very often located in the Woreda capital (Table 19). As learned during the survey there were no marketing institutions, which ensure a regular and efficient service of purchasing the harvest from the beekeepers. However, today measures are being taken to distribute beehives and to disburse loans for beekeeping via service cooperatives.

Table 19. Distribution of number of respondents by place of product sale

Product sale	Users (n=46)		Non-users (n=54)		Total sample (n=100)	
	n	%	n	%	n	%
Farm gate	31	67.4	25	46.3	56	56
Daily market	15	32.6	29	53.7	44	44

4.1.13. Problems in beekeeping

Beekeepers are facing problems which are militating against the success desired in honey production. Major problem in beekeeping arise from bee characteristics and/or environmental factors that are beyond the control of the beekeepers. Farmers identified and prioritized the major problems in order of importance. A summery of all sample respondents' reaction is presented in Table 20

Table 20. Beekeeping problems encountered by sample respondents

Type of problem	% of beekeeper replied (n=100)
Lack of beekeeping equipments	94
Pests, predators and diseases	75
Inadequate honey bee colony	72
Drought (lack of rainfall)	59
Lack of bee hive	52
Shortage of bee forage	48
Pesticides and herbicides application	40
Migration	27
Marketing	26
Shortage of water	16
Absconding[1]	13
Death of colony	11
Swarming[2]	3

It can be seen from the table that the most serious problem encountered by the beekeepers in order of their importance were lack of beekeeping equipments, followed by pests, predators and diseases, inadequate honeybee colony, drought, and lack of beehive.

Those sample farmers who used KTBH also reported their perception about the advantage and disadvantage of using KTBH. (Table 21 and 22)

[1] Running away of bees that belongs to no one, and it is not a reproductive mechanism but purely a survival device.
[2] The act of a family of bees leaving their home to establish a new home elsewhere for reproductive purpose.

Table 21. Lists of KTBH advantages perceived by the users group

Type of advantages	Number of respondents (n =46)	
	n	%
Better quality honey	46	100
Better honey yield	46	100
Avoidance of bee killing upon harvesting	46	100
Ease of inspection and management	42	91
Labor efficiency	41	89
Durability of the hive	40	87
They are easier to construct	34	74
Combs can be reused	29	63
Subdue aggressive colonies	24	52
Low incidence of absconding	10	22

As shown in Table 21 low yield, mass killing of bees in harvesting and mess in inspection of hive that were experienced for fixed comb hives are mitigated by using KTBH. As documented by Amhara Region Agricultural Research Institute (ARARI) (2004) Kenyan top bar hive was not only found best for its relatively high honey yield, good quality and price but also it is too easy to construct from cheap local materials, to harvest and to inspect hive.

Table 22. Proportion of KTBH users based on their perceived disadvantages

Description	Number of respondents (n =46)	
	n	%
Difficult in constructing the proper hive design	43	93
Delay to have strong colony	39	85
Failure to regulate temperature change	37	80
Breaking of combs	33	72
Absconding	26	56

Most of the KTBH used by the respondents is prepared locally and ARARI (2004) also confirmed that the yield from locally made Kenyan top bar hive was comparable and similar to the institutionally manufactured one. The needed space between two combs often depends on the type of bee race. As a result failure in precision in constructing the hive brings about reduction in yield (Table 22).

4.2. Profitability Analysis

In order to compare the performances of the Kenyan top bar hive and the traditional hive yield, the cost incurred and net returns obtained by the adopter and non-adopter groups were recorded and compared. The analysis was done to arrive at per hive net return from KTBH and traditional hive. The comparison in the KTBH user group was made in two categories, namely those sub-group that kept only home made KTBH and sub-group that kept only institutionally provided hives.

4.2.1. Category of cost

For this study, the respondents replied the cost items and their cash outlays that were made to run the traditional and KTBH honey production. Service life of the equipments was also estimated by farmers. Except for the institutionally provided KTBH, home made KTBH were constructed from locally available construction materials. The components of the cost items considered are shown below.

Equipment: Regardless of the available technologies the range of equipments (accessory hive tools) that are used by the respondents was found to be uniform. Hence an average price of 15.54 birr and a 3-year service life was assumed based on data generated from each respondent. Households who either own large number of hive or run both KTBH and traditional hive together were found to be indifferent in terms of the type and holding size of equipments, and hence the same cost was considered for KTBH users.

Bee colony: Bee colony was found to be the main cost for both groups. The price paid to purchase bee colony was estimated using the opportunity cost of bee colony at the current market. The average service life for specific queen-led colony was considered to be 8 years. Root (1985) also pointed out that the queen is expected to live a good old age of 8 years despite she bears arduous egg laying duties. The average cost of a colony was 119.20 birr for the year 2003/04. The colony for each hive was assumed to have same age and strength.

Traditional hive: For the area under study traditional hives are often made from wood. Fermented mud and animal dung were used to plaster the inner sides of the hive. The cost and service life of a medium size traditional hive was estimated to be 6.85 birr and 6 years, respectively. Though no survey has ever been made to know the price of traditional hive in the study area, it was learned through personal communication that the price of traditional hive in Holeta area is 8-12 birr.

Kenyan Top Bar Hive: These are of two types, i) Home made KTBH: To promote the KTBH technology among poor farmers and to reduce the cost of capital, different trainings were conducted that enables farmers to develop their skill in order to construct KTBH locally. Except for the design and additional parts required, the materials used for KTBH construction are not different from those used for traditional hives. The price and service life was carefully collected from the respondents and estimated to be 14.1 birr and 6 years, respectively. ii) Institutionally provided top bar hives are constructed in specialized manufacturing centers like Kombolcha Research center. The hives that are being used are acquired from different sources and programs. To come up with average price, the 2003/04 selling price of 126.4 birr was taken. An Associated service life of 10 years was considered.

Labor: Though different authors repeatedly emphasize the labor needed for beekeeping to be insignificant, hive placement, colony installation, disease and pest inspection, dearth period colony protection and honey harvesting should be substantiated in terms of their labor requirements. KTBH users in the study area follow the traditional management system and didn't invest any additional labor specific to the technology. Hence to end up at best estimate an average labor requirement of 1.5 man-days per year for traditional hive was accounted using the opportunity cost of 4 birr for family labor in the study area during the year. Since harvesting labor also depends on the yield gained, for the KTBH users 2 man-days per hive was estimated.

Feed cost: There is no as such frequent experience in maintenance feeding of bee colonies during dearth period in the study area. Most of them replied to feed small amount of '*Shiro*[1] powder.' Looking the homogeneity among farmers some representative value for every farmer should be set so that to complete the computation. Hence an average of 2 birr (prevailing cost of 1 kg '*Shiro* powder') per hive per year was taken.

Bee shed: It is a form of house constructed in the apiary at the backyard of the respondents' resident to shelter and protect the bees from sunlight, rainfall and pest and other enemies. It is constructed from hay or straw roofs and wooden walls and stands. In the study area an average size of shelter can accommodate large number of hives because the hives are placed adjacent to each other. Both the traditional and Kenyan top bar hives were placed in the same shelter together. Hence an expense of 100 birr and 15 years were assumed for the construction cost and service life, respectively for both the adopter and non-adopter groups.

4.2.2. Category of benefits

Beekeeping could generate a range of hive products. It was learned that in the study area only honey is sold. All other products are not sold. Therefore, to get the total revenue from each type of hive the honey yield obtained from respondents in the course of the year was multiplied by selling price.

[1] *Shiro* is finely ground spiced flour from roasted pulses

4.2.3. Net return analysis

In table 25 the different cost items the adopters and non-adopter groups incurred and the revenue generated is revealed for the home made KTBH, institutionally provided KTBH and traditional hive on a per hive per annum basis. For the fixed items (hives, equipment, bee colony and bee shed) their yearly depreciation value was accounted to set annual cost. Depreciation for the fixed costs was estimated using the straight-line method. Interest on variable cost and fixed cost was considered using the prevailing bank deposit rate.

As indicated in the result below, per hive yield gain from the home made KTBH, institutionally provided KTBH and traditional hive was 7.51 kg, 12.02 kg and 6.11 kg, respectively. The result justifies that, by using the KTBH the respondents gain better yield than the traditional hive. Similarly, KTBH that is provided institutionally shown a yield increment by 4.51 kg or 60 percent when compared with the yield gained from home made KTBH.

The net return analysis shows farmers obtain net return of 34.83, 68.61, and 23.78 birr/hive/annum from home made KTBH, institutional KTBH and traditional hive, respectively. The net return obtained from both types of KTBH was higher than the traditional hive. Institutional KTBH generates higher return than the home made KTBH.

Table 23. Inputs costs, gross income and net returns (birr/head) per hive per annum

Item	Users of KTBH (n=46)		Non-users (n=54)
	Home made hive (n=35)	Institutional hive (n=11)	Traditional hive n=(54)
Income			
Total yield of honey (kg/hive)	7.51	12.02	6.11
Market price of honey (birr/kg)	10.00	10.00	10.00
Gross income (birr/hive) (D)	75.1	120.2	60.75
Inputs			
Labor cost	8.00	8.00	6.00
Feed costs (*Shiro*)	2.00	2.00	2.00
Interest on variable costs (3%)	0.3	0.3	0.24
Total variable costs (A)	10.3	10.3	8.24
Depreciation for hive[a]	2.35	12.64	1.14
Depreciation for equipment (33%)	5.18	5.18	5.18
Depreciation for colony 12.5%)	14.9	14.9	14.9
Depreciation for bee shelter (shed) (6.7%)	6.67	6.67	6.67
Transport (in birr)[b]	-	0.7	-
Interest on fixed cost (3%)	0.87	1.20	0.84
Total fixed cost (B)	29.97	41.29	28.73
Total production cost (A+B)=C	40.27	51.59	36.97
Net return (birr/hive) (D-C)	34.83	68.61	23.78

a-Depreciation for institutional KTBH is 10% and for home made KTBH and traditional hive is 16.6%

b-Transport fee is considered to take the hive from Kombolcha Research Center to study area

For this study the total number of hives for the entire sample respondents was 334, the average holding size being 3.34 hive. If we consider the yield and net return that is obtained from the given holding size for the different types of hives under study, the result is: i) for the home made KTBH 25.08 kg honey yield and 116.3 birr net return can be generated; ii) for the institutional KTBH a yield and net return that amounts to 40.15 kg and 229.1 birr,respectively can be secured; iii) from traditional hive 20.41 kg and 79.42 birr yield and net return can be obtained, respectively (Table 26). Therefore, we can see that if the respondents keep KTBH instead of traditional hive for the prevailing average number of hive, they can be more beneficial and raise the profit earned from their business.

Table 24. Yield gain and net return from average holding size of hive by respondents

Type of hive	Nº of hive	Yield gain (kg)	Income (birr)
Home made KTBH	3.34	25.08	116.3
Institutional KTBH	3.34	40.15	229.1
Traditional hive	3.34	20.41	79.4

4.2.4. Partial budgeting

The success of partial budget depends on prediction accuracy, which depends on the accuracy of the information and estimates it contains. Factual information includes current costs of the factors of production, cost of capital, current commodity prices, or other items pertinent to the particular decision (Pierce, 1997). Only the costs and returns that change by proceeding with the alternative plan should be included in the partial budget. The unit used to analyze may be any size (depending on the change): the whole crop, one acre of crop, one head of cattle or the entire herd.

For this study the average yield, the gross income and the net return is compared among the homemade KTBH, institutionally provided KTBH and traditional hive beekeeping alternatives on per hive basis using standardized price. Those costs that vary across the treatments (hive, transport, interest and labor) are considered. Obviously the yields of all hive types would be realized in a one year period, and therefore, the plan is designed to show only a per annum profile of the cost and returns that vary for the home made KTBH and institutional KTBH vis-à-vis that of the traditional hive. The analysis of each alternative was carried out on an individual basis as shown below.

Table 25. Partial budget for home made and institutional KTBH (per annum per hive)

Column 1	Amount (birr)		Column 2	Amount (birr)	
	Home made KTBH	Institutional KTBH		Home made KTBH	Institutional KTBH
Additional Cost			Additional return		
Cost of hive	1.21	11.5	Honey yield	14.35	59.45
Cost of labor	2	2			
Cost of transport	-	0.7			
Interest cost	0.09	0.42			
Total added cost	3.3	14.62	Total added return	14.35	59.45
Reduced return	-	-	Reduced cost	-	-
Total reduced return	-	-	Total Reduced cost	-	-
Total negative benefit	3.3	14.62	Total positive benefit	14.35	59.45
Net Change in Income from home made KTBH = 14.35-3.3=11.05					
Net Change in Income from institutional KTBH = 59.45-14.62=44.83					

As shown in Table 27 change in income per home made KTBH hive over a one year period was positive and indicates the potential increase in net return if the change is made. Similarly it was also found to be plausible and beneficial if a shift made to institutional KTBH as it brings a positive change in income.

4.2.5. Cost benefit analysis

A tentative plan for starting up beekeeping based on regional plan for 2004/05 fiscal year was prepared. This will help to assess the financial feasibility of the different alternative hives. Accordingly the study period price was used to make the projections. The plan was based on the following assumptions:

1. The project life was assumed to be 30 years.
2. The study period price of inputs and output was used in the analysis.
3. The life of equipment, bee colony and bee shed was assumed to be 3, 8 and 15 years, respectively.
4. The life of home made KTBH and traditional hive was assumed to be 6 years. While the life of institutional hive was assumed to be 10 years.
5. Interest rate was assumed based on the prevailing bank loan rate i.e. 10.7%.

The initial investment of the proposed project using 12 hives is presented in Appendix Table 6. Except for the cost of hives the initial capital expenditure for bee shed, equipment and bee colony was similar for all types of hives. Operation costs considered were labor and feed. Transport cost was accounted for institutional KTBH.

To prepare the projections, the regional annual plan of 12 hives per head was considered. Therefore the cost and benefit stream for the specified time horizon (30 Years) was prepared for all types of hives. According to the region annual plan, the initial investment capital was provided through credit with an interest cost of 10.7%. A long-term credit with a grace period of three years was disbursed. Farmers are expected to repay the principal amount and the outstanding capitalized interest rate at the beginning of the fourth year. Therefore interest cost was included in the total cost stream.

Cost items that will finish their service life in the course of the project life will be reinvested at the end of their depreciation period. For example a new investment cost for equipment will be injected every three years. Moreover, Residual (salvage) value was considered and included in the benefit stream for those items having a remaining service life at the end of the project period. In Table 28 the cost and benefit stream that is calculated in terms of present worth (PW) using 10.7 percent and 50 percent Discount rate (D.R) for the different types of hives is summarized.

Table 26. Present Worth (PW) of total cost and benefit stream for the different types of hives

Type of hive	PW of total cost stream at 10.7% D.R	PW of gross benefit at 10.7% D.R	PW of total cost at 50% D.R	PW of gross benefit at 50% D.R
Traditional	3547.55	6529.09	1385.76	1451.43
Home made	3926.52	8024.0	1497.59	1764.00
Institutional	6292.78	12873.04	2598.73	2875.36

Based on the result shown in the above table, the Benefit Cost Ratio (BCR), Net Present Worth (NPW) and the IRR for the different types of hives using 10.7 percent discount factor is calculated as follows (Table 29):

Table 27. Project worth of the different types of hives using discounted measurements

Type of hive	BCR (birr)	NPW (birr)	IRR (birr)
Traditional	6529.09/3547.55=1.84	6529.09– 3547.55= 2981.5	57.3%
Home made	8024.0/3926.52 = 2.043	8024.0-3926.52 = 4097.46	59%
Institutional	12873.04/6292.78= 2.045	12873.04-6292.78= 6580.55	67%

As indicated in the Table by using all the available types of hives one can accrue a positive benefit. For a project to be feasible the B/C ratio should be greater than or equal to one. More specifically, for the traditional, homemade and institutional KTBH an amount of 1.84, 2.043 and 2.045 birr gross benefit is obtained for every 1 birr cost injected, respectively. The Internal Rate of Return (IRR) that makes the NPW zero is 57.3 percent, 59 percent and 67 percent for traditional, home made and institutional KTBH, respectively. Although all types of hives were beneficial and bear higher returns, the result emphasizes to give more weight in the utilization of KTBH.

4.3. Results of the Logistic Regression Model

The selection of the variables for the study was done on the basis of theoretical explanations, findings of empirical studies and *a priori* knowledge. Based on these nine continuous and six discrete variables were selected. The explanatory variables hypothesized to influence the adoption of KTBH in the study area are elucidated in Appendix table 3.

Initially explanatory variables were checked for the existence of multicollinearity (Appendix Table 4 and 5). The test shows that there is no sever collinearity among the explanatory variables. There was an association between the support and visit of apiary, and visit of apiary and beekeeping training variables in the dummy categories. Looking into the contributions of the variables to the estimated model the support variables was dropped from the analysis.

To employ the logistic regression analysis, the important explanatory variables were selected and maximum likelihood estimates of the coefficients (β_j) were computed. The estimated coefficients of the logit model for the adoption of KTBH technology are presented in Table 23. Most of the explanatory variables showed the expected signs.

Table 28. Maximum likelihood estimates of the logit model.

Variable	Coefficient (β_j)	Odds ratio Exp(β_j)	Wald statistic	Significance level
Constant	-4.0993	0.0148	-3.047	0.023***
Education	0.0015	1.012	0.010	0.920
Farm experience	0.0527	1.054	3.048	0.08*
Leadership	0.1286	0.879	0.032	0.859
Beekeeping experience	-0.0171	0.983	-0.250	0.617
Land holding	0.0882	1.092	0.022	0.882
Size of homestead	2.6623	14.329	0.790	0.969
Income	-0.0005	1.000	-0.908	0.341
Livestock holding	0.0061	1.006	0.002	0.969
Perception of timely supply of the KTBH	2.2902	0.101	5.175	0.023**
Extension contact	0.3125	1.367	8.814	0.003***
Visit of Apiary	1.9553	0.142	5.231	0.022**
Training	0.2603	0.771	0.138	0.710
Off-farm income	0.0005	1.001	0.302	0.582
Ownership of radio	0.6737	0.510	0.999	0.317

Log likelihood function=-40.04

Restricted log likelihood= -68.994

Likelihood Ratio Index (McFadden R^2) =0.42

Chi-squared (χ^2) = 57.914

Correctly Predicted=82.0 percent

Sensitivity= 76.1 percent

Specificity= 87.0 percent

***, ** and * are significant at 1 percent, 5 percent and 10 percent probability level, respectively.

The goodness-of-fit measurements of the model are also given in the Table. The likelihood ratio index confirms that of the total variation the dependent variable attributes 42% was accounted for by the independent variables in the fitted model. The computed log likelihood ratio statistic (Chi-square) exceed the Chi-square critical values at 1 percent significance level confirming that the independent variables taken together influence the adoption of KTBH technology.

Another goodness of fit measurement is computing the ratio of number of correct predictions to total number of observation for both adopters and non-adopters to find the number of observations that are correctly predicted. The method is based on the principle that if the estimated probability of the event is less than 0.5, the event will not occur and if it is greater than 0.5 the event will occur. The result shows that the logistic regression model correctly predicted about 76 percent and 87 percent adopters and non-adopters, respectively. The higher values of the sensitivity and specificity measurements indicate the better classification of the events using the specified model.

The estimated coefficients of the logit model revealed that except for beekeeping experience and income variables all the remaining variables included in the model have expected sign.
Of the fourteen factors analyzed, the adoption of KTBH was significantly associated with four variables, namely farm experience, perception of timely supply of the technology, extension contact, and apiary visit. The coefficients of the remaining variables are not statistically different from zero at the conventional level of significance.

4.3.1. Factors affecting adoption of KTBH technology

Household farming experience: This variable has shown to influence the adoption of KTBH significantly at 10 percent probability level. Experienced farmers can have a thorough understanding about the farming scenario with a resultant cumulative knowledge for contributions of each enterprise. Thus, they easily manage to develop the decision to use newly introduced technologies than those farmers having less farming experience. The finding was consistente with Legesse (1992) who found similar result in his analysis of factors influencing adoption of wheat and Maize technologies in Arsi Negele, Ethiopia.

Perception of timely supply of the technology: In the estimated model this variable reflects a positive relation with adoption of KTBH at 5 percent level of significance. Thus when the farmer switches from a view of suspicion to feeling of certainty in the timely supply of KTBH the odds ratio in favor of adoption raises by 0.101. Seasonal nature of agricultural activity needs timely supply technological inputs to enhance the participation of farmers. And hence the attitude of farmers on the availability of input upon demanding affects adoption decision. The result of this study was consistent with the finding of Berhanu (1993) and Chilot *et al.* (1996).

Extension Contact: The logit model estimated indicates that extension contact is associated positively and significantly with the adoption of KTHB at 1 percent probability level. The positive effect of the extension contact on the adoption of KTHB implies that farmers who have regular contact with extension personnel tend to adopt KTHB than those who have less extension contact. This implies that a frequent contact facilitates the flow of new ideas between the extension agent and the farmer thereby giving a room for adoption. The result was in agreement with the finding of Berhanu (2002) and Lelissa (1998).

Visits to apiaries: This variable was related with the adoption of KTBH significantly at 5 percent significance level. In the study area field visits and demonstration sites are considered as a media to transfer new ideas and relevant knowledge to the farming community. In this regard development agents and other pertinent stakeholders have tried to mitigate the knowledge gap by arranging apiary visits to enhance farmers skill. This would enable the farmers to implement and get advantage of testing the new idea in order to raise its farm revenue. The significant association of the variable from the result implies that the more farmers gain the chance to attend the apiary visit program the higher the likelihood the farmer to adopt KTBH.

4.3.2. Marginal effect of significance explanatory variables

All variables that come up to be significant for the estimated model do not have a similar contribution to the adoption decision of the farmer. To disentangle and rank the individual effects of the variables in order of their importance the odds log, odds ratio and probability of KTBH adoption of a typical farmer were computed using mean values for the continuous explanatory variables and the most frequent values of the qualitative variables.

Given this, the predicted stimulus index (Zi) or log-odds ratio in favor of KTBH adoption for the typical farmer having the values taken care of is –1.6606. Therefore, the odds ratio and probability of the typical farmer to adopt KTBH is 0.1996 and 0.1597, respectively. This is further elucidated in table 24.

Table 29. Changes in Probability of Adoption as a Result of Changes in Qualitative Explanatory Variables.

Variables	Probability	Change in probability	Percentage (%)change
Typical farmer	0.1597		
Typical farmer but reliable in KTBH availability	0.6523	0.4926	308.5
Typical farmer but visited other's apiary	0.5731	0.4134	258.9

Note: A typical farmer is a farmer for whom qualitative variables are set at most frequent zero values. The variables can be referred in Appendix Table 3.

It has been learned that when farmers perceive timely supply of KTBH, the probability of adoption increases by 0.4926 (or raised by 308.5%). Similarly, the probabilities of adoption among farmers with a typical profile but have an apiary visit are computed to be 0.5731 (or an increment of 258.9%). As a result, one can note the existence of variability among the significant discreet variables in their effect towards the probability of KTBH adoption.

The relative importance of the continuous explanatory variables in the adoption decision is measured by the elasticities. Thus, for typical farmer elasticity computation involves only the significant quantitative explanatory variables. Based on this, increasing the farming experience by one year increases the probability of adopting KTBH by 0.72 percent.

Likewise increasing the frequency of extension contact by one unit raises the typical farmer's probability of KTBH adoption by 4.65%. In so doing one can substantiate the effect brought by the significant quantitative variables toward probability of adoption. Finally it should be remembered that this forecast probability (Pi) is based on the specific values (mean) of the explanatory variables and is subject to variation due to changes in the values of any of these variables.

5. SUMMARY AND CONCLUSIONS

5.1. Summary

In the past few decades, Ethiopia has been experiencing successive drought, an overwhelming population explosion, an immense environmental degradation that have led the country to a sever shortfall in domestic food supply. To revert the phenomena the country has to pry on every possible income-generating alternative in order to perpetuate the livelihood of its people. In this regard beekeeping can be assumed the utmost priority to meet the vision though neglected in the development themes for a long time.

In view of this, some efforts were begun to tap the potentials of the sub-sector through the introduction of modern honey production technologies, improved hives. Sporadic attempts were made to produce and disseminate various types of beehives and bee keeping equipments that are thought to be appropriate in respect to the selected areas.

The objectives of this study were i) to assess the profitability of KTBH over the traditional hive by comparing the net return gained by the KTBH adopters and non-adopters, ii) to identify and analyze the different socioeconomic, environmental and technology related factors that determines the adoption of KTBH in Ambasel Woreda.

The study woreda is located in Amhara Regional State of South Wollo Administrative zone and constitutes 23 kebeles. The study was undertaken in three purposively selected kebeles where the technologies were widely promoted.

The data used for the study was collected from 100 households who were drawn by employing choice based sampling technique from the adopters of KTBH and non-adopters group from the total beekeepers population. Primary data pertaining to 2003/04-crop year were collected using a structured questionnaire by help of enumerators. Secondary data thought to be relevant for study were obtained from different institutions.

It was learned that adopters of KTBH used hives that came from two sources, namely home made KTBH and institutionally constructed KTBH. Therefore the comparison of profitability was extended to include home made and institutionally constructed KTBH and the traditional hive. The result of the cost return analysis is summarized below.

1. Comparison of yield and net return per hive showed that home made KTBH and institutional KTBH gives 7.51 kg and 12.02 kg honey yield gain and 34.83 birr and 68.61 birr net return, respectively. While traditional hive gives 6.11 kg and 23.78 birr yield and net return, respectively. Thus yield and net return obtained from institutional KTBH is greater than both the home made KTBH and the traditional hive. While home made KTBH gives better yield and net return than the traditional hive.

2. The partial budget analysis indicated, when added cost (reduced return) and increased return (reduced cost) accounted for both the home made and institutionally prepared KTBH; it was found that both types of KTBH's are beneficiary and remunerative.

3. The B/C ratio shows that a project using all types of hives was feasible. Higher benefit was realized by institutional KTBH when compared to the home made KTBH and traditional hive.

Explanatory variables assumed to affect adoption of KTBH were considered. A binary logit model was employed to estimate the magnitude and direction of coefficients. In addition, descriptive statistics were used to compare the two groups in terms of the different attributes. The result revealed that except for the beekeeping activity no substantial difference was exhibited between the users of KTBH and the non- users groups.

Among the variables included in the model the coefficients of the variable farming experience, apiary visit, extension contact, and the perception the household in timely supply of KTBH availability were significantly different from zero. The remaining variables were found to have statistically insignificant contribution towards adoption of KTBH technology at conventional probability level.

The number of extension contact made was found to influence adoption of KTBH technology positively and significantly at 1 percent probability level. Therefore, emphasis should be given to assign sufficient number of development agents that are equipped with knowledge and skills so that farmers can access support that help them to scale up their knowledge towards enhancing their creativity and productivity.

Apiary visit and KTBH adoption were positively and significantly related at 5% probability level. This implies the extension program should give emphasize in establishing demonstration apiaries so that farmers can share new ideas among each other and further enable to test them at their own locality. This can be achieved through organizing and facilitating experience-sharing programs at different levels.

Farm experience had a positive relationship at 10 percent probability level. Those farmers who have longer farming experience tend to adopt KTBH earlier than those farmers with limited experience. It is assumed that increased experience in farming not only enables the farmer to be familiar with the environmental elements but also increases his/her capability and skill towards testing and adopting new ideas and technologies. Hence such farmers should be targeted to facilitate the adoption of KTBH.

Farmer's perception of timely supply of KTBH is found to be positively and significantly related with adoption of KTBH. Naturally all the existing agricultural activities of every household are performed simultaneously within a specified season. In other words, all the available resources at disposal of farmers are mobilized and disbursed during this period. This implies the need to supply KTBH timely to ensure its adoption.

5.2. Conclusions and Recommendations

Based on the findings of the study the following points are considered as an essential areas of intervention that need due consideration:

1. Institutionally provided KTBH give a better yield than both the homemade KTBH and the traditional hive, therefore a credit scheme should be established to support the farmers so that they can acquire KTBH and other accessories to boost bee farming.

2. Institutionally provided KTBH should be distributed in the appropriate working season. This will avoid any suspicion that is felt by the farmer in relation to the extension service provided and further motivates and invites new farmers to the program.

3. Extension contact between beekeepers and extension agents should be further strengthened by reducing farmer to DA ratio and by increasing frequency of contact to promote modern beekeeping technology that focuses on a practical approach.

4. Demonstration apiaries should be established close to the beekeepers to provide them the opportunity to gain practical experience in modern beekeeping methods under local conditions. Beekeeping is culturally defined as a male occupation, therefore women should be encouraged to participate and receive training in modern beekeeping methods.

5. The beekeeping extension program should give more weight in participating experienced farmers, because they have a better likelihood to adopt the technologies earlier than those farmers having less experience. Therefore trainings, experience sharing and any beekeeping fairs should prioritize these farmers to easily popularize the technologies.

6. It was found that all of the wax produced in the area is either discarded as waste or put into domestic use for religious purpose. Therefore some processing and marketing mechanisms should be designed to ensure more benefit from the activity. Traditional or mechanical methods of purifying wax are a very difficult task. Therefore a modern processing unit that collects raw wax from the farmers should be established at access place. The domestic cost of one kg of purified wax in the current market price is estimated above birr 30.

7. Adopters of KTBH do not place much value on accessories and continue to follow traditional colony management, honey harvesting and processing methods after installation of

top bar hives. Technical support is, therefore, essential for those who purchase this type of equipment to help them acquire the added benefits of movable comb technology in comparison to the traditional fixed comb hives and so that they can realize good returns in investment.

8. To ensure a reliable market outlet for the beekeepers marketing organizations (for e.g., cooperatives) should be established to allow farmers sell their products at fair price. Service cooperatives and other honey marketing institutions should be further strengthened to involve in communicating the honey producers and the ultimate consumers so that the farmers can sell his/her produce at a competitive product price.

9. In many cases, if the proper design of the hive is maintained the yield and quality of honey obtained from locally made KTBH is comparable to the institutionally prepared KTBH. Therefore local artisans should be trained about the construction of KTBH using locally available material to ensure the supply of low cost KTBH.

6. REFERENCES

Adebabay Mengist. 2003. Factors influencing adoption of soil conservation practices in south Gondar. The case of Farta District, MSc. Thesis, Alemaya University, 129p.

Adesina, A.A., Mbila, D., Nkamleu, G.B., Endamana, D. 2000. Econometric analysis of the determinants of adoption of alley farming by farmers in the forest zone of southwest Cameron. *Agricultural Economic Systems and Environment*. 80: 255-265.

Adjare, S.1990. Beekeeping in Africa. Apiculture promotion unit, technology consultancy center university of science and technology, Kumasi, Gana.

Aldrich, J.H. and Nelson, F. D. 1984. Linear Probability, Logit and Probit Model: Quantitative Applications in the Social Science. Sera Miller McCun, Sage Pub. Inc, University of Minnesota and Iola, London. 47p.

Amemiya, T. 1981. Qualitative response models: A Survey. *Journal of Economic Literature.* 19: 1483-1536.

ARARI, 2004. On farm research highlights. Improving livelihoods: The Case of Doyach Sub-Watershed, Legambo Wereda. NRM series No 3, April .

Arellanes, P. and Lee, D.R 2003. The determinants of adoption of sustainable agriculture technologies: Evidence from the Hillsides of Honduras. Department of Applied Economics and Management, Cornell University, Ithaca,NY, 14813, USA. 693-99.

Asfaw Negassa, Gunjal, K., Mwangi, W. and Beyene Seboka. 1997. Factors affecting the adoption of maize production technologies in Bako area, Ethiopia. *Ethiopian Journal of Agricultural Economics.* 1: 56-69.

AWOA (Ambasel Woreda Office of Agriculture). 2004. First round pre harvest crop assessment 2003/2004. South Wollo Administrative Zone.

Ayalew Kassaye. 2001. Promotion of beekeeping in rural sector of Ethiopia. Proceedings of the Third National Annual Conference of Ethiopia Beekeepers Association (EBA), September 3-4, 2001, Addis Ababa, Ethiopia, pp.52-58.

Ayuk, E.T. 1996. Adoption of agroforestry technology: The case of live hedges in the central plateau of Burkina faso. International Centre for Research in Agroforestry (ICRAF), Nairobi, Kenya.Vol. 54, NO. 2, pp. 189-206.

Batz,F.J.; Peters, K.J. and Janssen,W. 1999. The influence of technology characteristics on the rate and speed of adoption. Agricultural Economics. 21: 121-130.

Befekadu Degefe and Berhanu Nega (eds.). 1999. Annual report on the Ethiopian economy. The Ethiopian Economic Association, Vol. 1. 429p.

Bekele Hundie. 2001. Factors influencing input loan repayment performance of smallholders in Ethiopia: the case of Oromia and Amhara national states: M.Sc Thesis, Alemaya University of Agriculture, Ethiopia.

Berhanu Bedassa. 2002. Analysis of factors affecting the adoption of crossbred dairy cows in the central highlands of Ethiopia: The case of two districts in North Shoa Zone. Msc. Thesis Presented To The School Of Graduate Studies Alemaya University. 138p

Berhanu Taye. 1993. An analysis of factors influencing consumption and access to fertilizer credit in western Shoa. M.Sc Thesis, Alemaya University of Agriculture, Ethiopia.

Berube, C. 1996. The Kenya-top-bar-hive as a better hive in the developing World. Island Crop Management. Email: uc779 (at) freenet.victoria.bc.ca. Apiservices - Virtual Beekeeping Gallery – Homepage.

Bezabih Emana. 2001. Determinants of multiple technology adoption: Defining adopters and emprical analysis. *Ethiopian Journal of Agricultural Economics.* 5: 23-39.

BOA (Bureau of Agriculture). 2003a. Amhara National Regional State (ANRS) Bureau of Agriculture, Strategic plan document. BOA, Bahir Dar, Ethiopia. Pp.75-77.

BOA. 2004. Regional honey and beeswax development plan for 2004/2005. Livestock and Fisheries Desk. Amahra National Regional State.

Byerlee, D. and Hosse de Polanco, E. 1986. Farmers' stepwise adoption of technological packages: Evidence from the Mexican Altiplano. *American Journal of Agricultural Economics.* 68: 519-527.

Capps. O. Jr. and Kramer. R. A. 1985. Analysis of food stamp participation using qualitative choice models. *American Journal of Agricultural Economics.* 67: 49-59.

Chilot Yirga, Shapiro, B.I.and Mulat Demeke. 1996. Factors influencing adoption of new wheat technologies on Wolmera and Addis Alem areas of Ethiopia. *Ethiopian Journal of Agricultural Economics*.1: 63-84.

CIMMYT, 1993. The Adoption of Agricultural Technology: A Guide for Survey Design. Economics Programme. International Maize and Wheat Improvement Center, Mexico, D.F. 88p.

Crane, E. 1976. The World's beekeeping - past and present. In: Dadant and Sons (ed.), The Hive and the Honey Bee. Dadant and Sons, Inc, Hamilton, Illinois, U.S.A., pp1-38.

CSA (Central Statistics Autority). 2002. Statistical Abstract 2002, Ethiopia, Addis Abeba.

Damodar N.G. 1995. Basic Econometrics. Third edition. United States of Military Academy, West Point. 838p.

Dasgupta, S. 1989. Diffusion of Agricultural Innovations in Village India. Wiley Eastern. Ltd. Com., New Delhi, India. 193p.

Debebe Habtewold. 2000. Food aid and its impact on peasant livelihood strategies. In-(ed). The Proceeding of Food Security and Sustainable Livelihood in Ethiopia, FSS, Addis Abeba Ethiopia.

Degenet Abebaw, Belay Kassa and Aregay Waktola .2001. Adoption of high yielding maize varieties in Jimma Zone: Evidence from farm level data. *Ethiopian Journal of Agricultural Economics.* 5: 41-62.

Dejene Aredo .1995. Transforming agriculture: A conceptual framework. In Dejene Aredo and Mulat Demeke (eds.). Ethiopian Agriculture: Problems of Transformation. Proceeding of the Fourth Annual Conference on the Ethiopian Economy, A.A.

Dereje Woltedji .2002. Holeta Bee Research, Terminal Report (1990-2002). 23p.

Dinal L. U. and Lisa Schwartz. 1995a. Public and private role in agricultural extension, beyond farmers' practices frontiers, World Bank Discussion Paper. Vol.236, Washington D.C.

Edwards, S. 1976. Some Wild Flowering Plants of Ethiopia. Addis Abeba University Press, Addis Abeba, Ethiopia.

EMA (Ethiopian Mapping Agency). 1981. National Atlas of Ethiopia. EMA, Addis Abeba, Ethiopia. 93p.

Feder, G., Just, R.E. and Zilberman, D. 1985. Adoption of agricultural innovation in developing countries. A survey. *Economic and Cultural Change*. 33: 255-299.

MEDREK .2001. A monthly newsletter. Forum for social studies publication.Vol. 3. No 2

Franzel, S., Arimi, H., Murithi, F., Karanja, J. 1996. Boosting milk production and income for farm families: The adoption of Calliandra calothyrsus as a fodder tree in Embu District, Kenya. *East Africa Agricultural and Forestry Journal.* 61: 235-251.

Gavaian, S. and Gemechu Degefa. 1996. The profitability of wheat production in Ethiopia. The case of Tiyo area in Arissi Zone. *Ethiopian Journal of Agricultural Economics.* 1: 38-62.

Gershon F, O' Mara Gerald, T. 1981. Farm size and adoption of green revolution technologies. *Economic Development and Cultural Changes*. 30: 59-76.

Gezahegne Tadesse. 2001a. Beekeeping (In Amaharic). Mega Printer Enterprise, Addis Ababa, Ethiopia.

Gichora M. 2003. Towards realization of Kenya's full beekeeping potential: A case study of baringo District. In Denich, M., Martius, C., Giesen, N. (eds). *Ecology and Development Series* No. 6. 169p.

Girma Deffar. 1998. Non-wood forest products in Ethiopia. EC-FAO Partnership Programme (1998-2000). Addis Ababa.

Gittinger, J. P. 1982. Economic Analysis of Agricultural Projects. Second Edition, The Johns Hopkins University Press. 505p.

Greene, H.W. 1998. LIMDEP. Version 7. User's Manual, Revised Edition. Econometric Software, Inc. 925p.

Greene, H.W. 2003. Econometric Analysis. Fifth edition. First Indian Reprint. Newyork University. 1026p.

Greiling, J. 2001. Beekeeping in Ethiopia: history, status and outlook. Agricultural advisor to harmony company. Lecture given on the 12th December, 2001 in Gurage Zone of the Southern Regional State.

Griffiths E.W., Hill, C. R. and Judge, G. G. 1993. Learning and Practicing Econometrics; John Wiley and Sons, Inc.USA. 896p.

Griliches, Z. 1980. R&D and the productivity slow down. *American Economic Review*. 70: 343-48

Hall, B.H. and Khan, B. 2002. Adoption of New Technology. University of California at Berkeley. New Economy Handbook.

Hansjorg, N. 2000. Food Aid: Missed opportunity latent potential for poverty reduction and alleviation in Ethiopia (unpublished). Paper at the Conference on Ethiopian International Institute for Peace and Development- May 2000.Addis Abeba.

Hartmann, I. 2004. No tree, No bee-no honey, no money. The Management of Resources and Marginalisation in Beekeeping Societies of South West Ethiopia. Paper submitted to the Conference: Briding Scales and Epistemologies, Alexandria, March 17-20, 2004.

HBRC (Holeta Bee Research Center). 1997. Beekeeping Training Manual (unpublished), HBRC, Holeta, Ethiopia.

Hosmer, D. W. and Lemeshow, S. 1989. Applied Logistic Regression. A Wiley-Interscience Publication, New York. 307p.

Huque, M. M., Rashid, M. H. and Rahman, M. L. 1996. Adoption of improved practices by potato farmers. *Bangladesh J. Agricultural Economics*. 19: 59-69.

IEG (Imperial Ethiopian Government). 1968. Third Five-Year Development Plan (1968-1973). Berhana Selam printing press. A.A. Ethiopia. 440p.

ITC. 1986. Honey: A study of major market, International Trade Center: UNCTAD/GATT, Geneva.

Jansen, H. G. P., 1993. Ex-ante profitability of animal traction investments in semi-arid sub-saharan Africa: Evidence from Niger and Nigeria. International Livestock Centre for Africa (ILCA), Sub-Humid Research Site, PMB 2248, Kaduna, Nigeria. P323-349.

Kebede, Y., Gunjal, K. and Coffin G. 1990. Adoption of new technologies in Ethiopian agriculture: The case of Tegulet-Bulga District, Shoa Province. *Agricultural Economics*. 4 :27-43.

Keinath, S. and Downs, M.C. 2000. Why beekeeping is so cool. Students of FW 571 "Trees in Agricultural Systems" - at Michigan Technological University.

Legesse Dadi. 1992. Analysis of factors influencing adoption and impacts of wheat and maize technologies in Arsi Negele, Ethiopia. M.Sc. Thesis, Alemaya University of Agriculture, Ethiopia. 119p.

Lelissa Chalichissa. 1998. The determinants of adoption, intensity and profitability of fertilizer use: The case of Ejere District, West Shoa Zone. M.Sc. Thesis, Addis Ababa University, Ethiopia. 75p.

Lionberger, H.F. and Gwin, P.H 1982. Communication Strategies: A Guide for Agricultural Change Agents. Illinois: The Interstate Pub. Inc. 265p.

Maddala, G.S. 1983. Limited Dependent and Qualitative Variables in Econometrics. Cambridge University Press. 400p.

Maddala, G.S. 1992. Introduction to Econometrics. Second Edition. Florida and Ohio State University, Prentice hall Pub. Comp., New York. 631p.

Mansfield, E. 1961. Technical change and rate of limitation. *Econometrica*, 29: 741-766.

McCullagh, P. and Neledr, J. A. 1989. Generalized Linear Models. Chapman and Hall, London. 2nd edn. 511p.

MEDaC. 1999. Survey of Ethiopian Economy: Review of Post Reform Development (1992/93-1997/98). Addis Abeba. 511p

Meles Minale. 2002. Production incentives in Ethiopian agricultural exports: Impact of trade and macroeconomic policies. Agricultural Policy in Ethiopia's Development: scope, issues, and Prospects, Proceeding of the 6th Annual Conference of Agricultural Economics Society of Ethiopia, August. A.A. 145-157.

Ministry of Agriculture (MOA). 1984. Apiculture Project Main Report. Australian Agriculture Consulting and Management Company, Addis Abeba. 58p

Ministry of Agriculture. 2003. Comprehensive Bees and Beeswax Development and Marketing Plan (CBMP). 2nd draft. Addis Abeba.

Morris, J. M. and Elkins, E. A. 1978. Library Searching: Resources and Strategies. N.Y: Jeffrey Norton Publication.

Mosher, T. A. 1979. An Introduction to Agricultural Extension. Singapore University Press for the Agricultural Development Council.

Moustafa H. H. 2000. Beekeeping in Africa: north, east, north-east and west African countries. Plant Protection Dept., Faculty of Agriculture, Assiut University, Assiut. Apiacta 1. P 32 – 48.

Mulugeta Enki. 2000. Determinants of adoption of soil conservation practices in central highlands of Ethiopia: The case of three Woredas of Salale. M.Sc. Thesis, Alemaya University, Ethiopia. 108p

Nicola, B. 2002. Taking the sting out of beekeeping. Arid Lands Information Network- East Africa (CD-Rom). Nairobi, Kenya.

Nuru Adgaba. 2002. Geographical races of the honeybees (Apis mellifera L.) of the northern regions of Ethiopia. Ph.D Dissertation. Rhodes University, South Africa.

Okoye, C.U .1996. Comparative analysis of factors in the adoption of traditional and recommended soil erosion control practices in Nigeria. Centre for Rural Development and Cooperatives, University of Nigeria, Nsukka, Nigeria. Soil and Tillage Research 45 (1998) 251-262.

Paterson, P.D. 2000. The basis for success in beekeeping within development projects. Apiservices - Virtual Beekeeping Gallery – Homepage.

PierceV. 1997. Partial budgeting. University of Missouri Commercial Agriculture. July 9. Pp 1-3.

Pindyck, R. S. & Rubinfield, D. L. 1981. Econometric Models and Economic Forecasts. 2^{nd}edn. McGraw-Hill, New York. 627p.

Rogers, E. M. 1962. Diffusion of Innovation. The Free Press, New York. 376p

Root, A.I. 1985. Encyclopedia of Bee Culture (An Encyclopedia Pertaining to Scientific Practical Culture of Bees). International Books and Periodicals Supply Service. 703p.

Rosenberg, N. 1972. Factors affecting the diffusion of technology. explorations in econmic-history. 10: 3-33. Reprinted in 1976, Perspectives on Technology, Cambridge: Cambridge University Press. p189-212.

Rundquist, F. M. 1984. Hybrid Maize Diffusion in Kenya. Land University, CWK Gleerup.

Segeren, P. 1995. Beekeeping in the Tropics. 5^{th} ed. Agrodok-series No 32, CTA/AGROMISA, Wageningen, The Netherlands.

Shakya, P.B. and Flinn, J.C. 1985. Adoption of modern varieties and fertilizer use on rice in the Eastern Terrai of Nepal. *Journal of Agricultural Economics*. 36: 409-419.

Sharma, V. P. 1997. Factors affecting adoption of alkali land reclamation technology: An application of multivariate logistic analysis. *Ind. Jn. of Agri. Econ*. 52: 244-51.

Sperling, D. 1980. The movable comb: frameless hive "appropriate technology" alternative to the Langstroth hive? Bethesda, Mary land and Dewey M.Caren university of Maryland, *American Bee Journal*. 120, Nos 1-12.

Storck, H., Emana, B., Adnew, B., Borowiecki, A. and W/Hawariate, S. 1991. Farming systems and farm management practices of smallhoders in the Hararghe highlands. Farming Systems and Resource Economics in the Tropics, Vol. 11, Wissenschaftsverlag, Vauk, Kiel, F.R. Germany.

Swinkels, R., Franzel, S. 1997. Adoption potential of hedgerow intercropping in the maize-based cropping systems in the highlands of western Kenya. Part II: Economic and farmers' evaluation. *Experimental Agriculture*. 33, 211-223.

Techane Adugna. 2002. Determinants of fertilizer adoption in Ethiopia: The case of major cereal producing areas, M.Sc. Thesis, Agricultural Economics, Alemaya University, Ethiopia. 92p

Upton, M., 1987. African Farm Management. Cambridge University Press, Cambridge.

Vivian, J. 1985. Keeping Bees. Williamson Publishing Co., Charlotte, U.S.A

Westphal, E. 1975. Agricultural systems in Ethiopia. Centre for Agricultural Policy and Documentation, Agricultural Research Report, Wageningen. No. 826.

Wolday Amaha. 1999. Improved seed marketing and adoption in Ethiopia. *Ethiopian Journal of Agricultural Economics.* 3: 41-81.

7. APPENDICES

7.1. Appendix I. Tables

Appendix table 1. Conversion Factors used to estimate Man-Equivalent(ME)

Age Group	Male	Female
<10	0	0
10__13	02	0.2
14__16	0.5	0.4
17__50	1	0.8
>50	0.7	0.5

Source: Bekele Hundie (2001).

Appendix table 2. Conversion Factors Used to Estimate Tropical Livestock Unit (TLU)

Livestock Type	TLU (Tropical Livestock Unit)
Calf	0.20
Weaned Calf	.34
Heifer	.75
Cows/Oxen	1
Horse/Mule	1.10
Donkey	.70
Donkey(Young)	.35
Sheep/Goat	.13
Sheep/Goat (Young)	.06
Camel	1.25
Chicken	.013

Source: Storck *et al*., (1991)

Appendix table 3. Description of Explanatory variables

Variables	Description	% with a Value 1	Mean ± SD
Education	Years of formal schooling completed by household head		3.14 ± 3.56
Farm experience	Experience of the hh in farming		25.92± 13.59
Land holding	Size of operating land holding in hectare		1.19± 0.66
Size of homestead	Size of homestead in hectare		0.16±0.166
Beekeeping experience	Beekeeping experience in years		8.85± 10.03
Income	Total family income		925.69 ± 893.75
Livestock holding	Total livestock holding in TLU		3.61± 2.149
Extension contact	Number of farmers visit per month (day)		3.30±4.04
Off-farm income	Income from off farm activity (birr)		195.91± 430.56
Leadership	1, if the farmer has a leadership; 0 otherwise	37	
Perception of timely supply of KTBH	1, if KTBH is timely available; 0 otherwise	18	
Visit of Apiary	1, if the farmer ever visit apiary, 0 otherwise	37	
Training	1, if attendance of training on beekeeping	48	
Support	1, if the farmer got any assistance, 0 if not	35	
Ownership of radio	1, if the farmer owns a radio, 0 otherwise	34	

Note: Sample Size, N= 100

Appendix table 4. VIF of continuous explanatory variables (X_i) hypothesized for the study

Variables	R_i^2	VIF
Education	0.36	1.56
Farm experience	0.44	1.80
Land holding	0.29	1.40
Homestead size	0.16	1.19
Beekeeping experience	0.30	1.43
Income	0.45	1.83
Livestock size	0.50	1.98
Extension contact	0.06	1.06
Off-farm income	0.50	1.98

Appendix table 5. Contingency Coefficients of the hypothesized discreet explanatory variables

	Leaders hip	Perception of timely supply of KTBH	Visit of apiary	Training	Support	Ownership of radio
Leadership	1	0.07	0.25	0.35	0.33	0.12
Perception of timely supply of KTBH		1	0.12	0.22	0.03	0.06
Visit of apiary			1	0.48	0.46	0.23
Training				1	0.42	0.19
Support					1	0.17
Ownership of radio						1

Appendix table 6. Annual input out put profile of beekeeping using 12 hives for the different types of hives

Description	Type of hive		
	Traditional	Homemade	Institutional
Initial capital[1] expenditure (birr)	1628.14	1715.14	3146.74
Bee shed	100	100	100
Equipment	15.54	15.54	15.54
Bee colony	1430.4	1430.4	1430.4
Bee hive	82.2	169.2	1516.8
Transport	0	0	84
Operational cost (birr)			
Feed cost	24	24	24
Labor cost	48	72	96
Depreciation costs (birr)			
Bee shed	6.67	6.67	6.67
Equipment	5.18	5.18	5.18
Bee colony	178.8	178.8	178.8
Bee hive	13.7	28.2	151.68
Transport	0	0	8.4
Interest on capital[2]	174.2	183.51	336.7
Total cost per year (birr)	450.55	498.36	807.43
Total yield (Kg)	73.32	90.12	144.24
Gross income (birr)	733.2	901.2	1442.4
Net return (birr)	282.65	402.84	634.97

Note

Initial capital=Total fixed cost – Operational cost

Interest on capital=Initial capital*10.7%

Appendix table 7. Beekeeping in North East and East African countries

Country	Area (1000km2)	Bees	No. MH (1000s) (year)	No. of Tr. H (1000s) (year)	No. of Colonies per km2	M.B (year)	No. of Beekeepers (1000s) (year)	No. colonies/ beekeeper	Total honey (tones) (year)	Mean honey (kg/year)	Population 1000s (year)	Honey gm/person
Kenya	583	Ama, Amli, Ams, Amm	2100 (1984)	100 (1985)	3.6	(1955)	(-)	(-)	11970 (1985)	5.7	28300	423
Tanzania	945	Ama	1500	Most (1982)	1.60	(1950)	(-)	(-)	11550+	7.7	28500	450.3+
Uganda	236	Ama	43 (1984)	Most (1984)	0.18	(1978)	(-)	(-)	172+	4	21300	0.008+
Ethiopia	1222	Amab, Amy, Ams, Amm.	2520 (1984)	5000 (1996)	2.10	(1970)	1000 (1976)	7.52	23000 (1996)	8.3	56000	410.7
Somalia	638	Amla, Amc	few (1986)	100 (1986)	0.16	(1970)	3 (1995)	33.30	350 (1995)	3.5	9300	37.6
Sudan	2506	Amc, Amsu, Af	50 (1994)	250 (1994)	0.12	(1960)	50 (1994)	6	1800 (1994)	6	28100	64.1

Source: International Federation of Beekeepers Association, Apicata 1/2000

Amla (*A.m. lamarckii*); Amc (*A.m. carnica*); Ama (*A.m. adansonii*); Amli (*A.m. litorea*); Ams (*A.m. scutellata*); Amm (*A.m. monticola*); Amab (*A.m. abyssinica*); Amy (*A.m. yemenitica*); Amsu (*A.m. sudanesis*); Af (*Apis florae*);
No information about, Djibouti, Eritrea,; (-), No information; +,estimated numbe
M.H, Tr. H, M.B, are Modern Hive, Traditional Hive and Modern Beekeeping, respectively

7.2. Appendix II. Survey Questionnaire

1) General Information

1. Name of the PA____ code____
2. Name of the respondent__________
3. Name of the interviewer (enumerator)______signature____date_____

2) Household head Characterstics

1) Sex: 1.1) Male_____ 1.2) Female______

2) Age______Years

3) Marital Status: 1.1) Married_______ 2.2) Unmarried_____2.3) Divorced_____
   2.4) Widowed______

4) Education

5) Can you read or write? Yes_____ No________

6) If yes no of years of formal education______years

7) How long have you been farming_________years?

8) Family Size________

Appendix table 8. Family size of the Respondents in 1996E.C

No	Name	Sex		Age	Relation	Level of education
		Female	Male			
1						
2						
3						
4						
5						

9) Number of family members working off farm_______

10) Family members undertaking full time farming activities
   Male _____ Female ______ Total ______

11) No of family members working part time on farm _______

12) If the farmer have farm labor shortage___ 1. Yes 2. No

13) If yes, for which part of the farming activities give rank for the farming activities
   Livestock rearing____ crop production____ soil conservation activities_____

Beekeeping____marketing____and others____

14) Tell me the type of house you reside?_____

15) Have you participated in social organizations? _______ 1. yes 2. no____

16) If yes, in which were you participated? 1. PA counsil 2.Sub PA excutions 'idir'

3. Service cooperative 4. Elders (youth or women) association 5.Idir or'mehibar

6. others (specify) ___

3) Bee Keeping Activities

How did you start beekeeping?

1.1) From parents Yes ____No_____1.2) Catching swarms Yes ___No___

1.3) Buying Yes _____ No_____ 1.4) Others (specify) _______

2) How long have you been keeping bees?________years

3) Where did you keep your bee colonies?

3.1) Backyard _________

3.2) Under the eaves of the house ___________

3.3) Inside the house _________

3.4) Hanging on trees near homestead__________

3.5) Hanging on trees in forests __________

4) What was the origin of the hive you own?

5) Distance of apiary from residence ______km

Appendix table 9. Sources of Beehives

Sources	Traditional	Intermediate	Movable-frame
Constructed by beekeepers			
Constructed by local craftsmen			
Supplied by organizations			

6) Which of the following beekeeping equipments and protective materials you have?

Appendix table 10.Items that are used for beekeeping

Materials	Home made	Locally made and purchased	Provide on credit (purchased)	Donated by GO or NGO's	Price (ET Birr)	Service period (years)
KTBH						
Traditional hive						
Smoker						
Veil						
Gloves						
Overall						
Boots						
Water sprayer						
Bee brush						
Queen catcher						
Chisel						
Knife						
Honey container						
Honey presser						
Casting mold						
Uncapping fork						
Honey extractor (any straining material)						
Honey container						

) What kind of feed you offered to your honeybees?

Appendix table 11. Feeds that are offered to bees by the beekeepers

Types of feed	Amount offered per day per colony(kg)	Period of the year (month)	Costs per kg (ETB)
Besso			
Shiro			
Sugar syrup			
Honey + Water			
Others (specify)			

8) Among your families, who does predominantly take care of Beekeeping

1. wife 2. children 3. hired labour 4. husband 5. others (specify) ________

9) Pests and Predators of bee colonies

1.Do you have the above problems? yes ____no____

2.If yes, what are the major pests/predators of bee colonies?

(Mention according to order of importance). 1. _________ 2. _________ 3. __________

3.Which one of the hive is highly susceptible (less resistant) to the problem? (user)

local_____KTBH_____

4.Have you ever got colony treatment services? Yes____ no____

10) What are the major constraints of beekeeping in the area? (Prioritize them)

Appendix table 12. Constraints that prevailed in beekeeping activity

No	Causes	Rank	What measures will be taken?
1	Bee hives		
2	Beekeeping equipments / materials		
3	Inadequate honeybee colony		
4	Shortage of bee forage		
5	Shortage of water		
6	Drought (lack of rainfall)		
7	Absconding		
8	Pests and predators		
9	Diseases		
10	High temperature		
11	High wind		
12	High rainfall		
13	Pesticides and herbicides application		
14	Death of colony		
15	Migration		
16	Swarming		
17	Storage facilities		
18	Marketing		
19	Others (specify)		

11) Are you participating in beekeeping extension packages in 1996E.C?

Yes _____2. No_____

4.Farm characteristics

1) Total Farm Size________hectare

2) Grazing area_________ hectare

3) Cultivated area________ hectare

4) Fallow land__________ hectare

5) Homestead (hectare) ______________

6) Others, Specify__________ hectare

7) Did you lease in land during the last crop season? Yes_____No_____

8) If Yes what was the area of land leased in? ____ha and what the area of owned land?____ha

9) Did you leased out your land during 1996 E.C.? yes____ no___

10) If yes, area of land leased out during 1996E.C. _____ hectare

5) Income

1) Crop Production

Appendix table 13. Crop Grown, Area Cultivated ,Production and disposal of major and minor crops (Meher and Belg), 1996 E.C.

Crops Grown	Area Planted (Timad)	Total Production Obtained Qt)	Unit price (birr/qt)	Amount Consumed at home(Qt)	Amount sold to Market (Qt)	Lent to Others (Qt)	Total Value (birr)
Teff							
Barely							
Sorghum							
Wheat							
Lentils							
Faba beans							
Field pea							
Lin seed							
Oats(shallo)							
Others							
Total							

2) Livestock holding

Appendix table 14. Income Generated from Livestock Selling, (1996 E.C.)

Livestock type	Born during the year	Sold during the year		Died during the year	Existing during the year (1997/98)	Total Value in birr
		No	Birr	No	No	
Oxen						
Cow						

Bull						
Heifer						
Calf						
Goat						
Sheep						
Horse						
Donkey						
Mule						

1). Did you sell livestock products (milk, butter, hides and skin, etc.) in 1996 E.C?

1) y es____ no____

2) If so, how much did you get during 1996E.C? _____birr

3) Did you sell crop residue in the same year? Yes___ no___

4) If yes, how much birr did you generate? ____birr

5) Did you sell honey and beeswax in the same year? yes_____ no___

6) If yes, how much birr did you generate? ___birr

7) If you did not sell honey and beeswax during 1996 E.C, what were the reasons? 1.price too low 2. no surplus to be marketed 3. Marketing places too far 4. others(specify)

8) Do you undertake some additional income generating activities of off farming? yes___ no____

9) If so, amount of income you earned from off-farm activities during 1996 E.C.

6). Marketing and Prices

1) What are the produces you get from your hive?

Honey_____ Beeswax_______ Others, specify__________

2) Where do you sell your hive products? 1. at farm gate 2. taking to local market

3) For how far do you have to walk from your home to sell your products? ____ kms.

4) Who is responsible for selling the products? 1. husband 2. wife 3. children 4. others

5) At what season do you sell your farm produces? _________________________

6) Were you satisfied with the prices you received for the products? Yes____ no_____

7) If not, for which hive products were you dissatisfied? _________________

8) What are the major bee product marketing constraints you have observed? (specify)

Appendix table 15. Honey and Beeswax Production by Sample Respondent in 1996E.C.

Type of Hive	NO of hives	Total Yield/year(kg)	Average honey yield/harvest/hive(kg)		Average beeswax yield/harvest/hive(kg)		Average length of one harvest (no of days)
			1st harvest	2nd harvest	1st harvest	2nd harvest	
Traditional							
KTBH							

Appendix table 16. Disposal of products gained in 1996E.C

Type of item	Quantity produced(kg)	Unit price (birr)	Disposal of products						Total Value (birr)
			Home consumption		For sale		Free gift to others		
			Quantity (kg)	Value(birr)	Quantity (kg)	Value(birr)_	Quantity (kg)	Value (birr)	
Honey									
Beeswax									

7). Use of new technologies

1) Have you ever heard the existence of improved beehives? Yes____No_____

2) Have you ever-used improved beehives? Yes____ No_____

3) Have you ever used Kenyan Top Bar Hives (KTBH)? yes_____ no_____

4) When did you start using it?

5) Did you use KTBH during the last crop season? Yes____ No_____

6) If Yes why do you use the KTBH

Easily available____ Ease of management_____Locally prepared___Too Cheap_____Convinced of benefits____

Others, specify_____

7) If no, why didn't you use the KTBH?

The hive is not available_____Too expensive_____Not convinced of benefits____ Never heard of KTBH____

Others, specify

8) What is the length of time since you first heard of KTBH?______years

9) From whom/where did you first heard about the KTBH beehive?

1) Development agent_____ 2) Neighbor______

3) Farmers' organization (PA, SC etc) _____ 4) Radio______

5) Others ,specify______

10) From where do you usually get the KTBH?

1) MOA______2) Own making_______ 3) Market_____

4) NGO________ 5) Others, specify______

11) Is KTBH available on time? Yes_____ No_____

12) Can you purchase the amount you need every year? yes____ no_____

13) If No, why?

1) Not available_______ 2) Too expensive_______

3) Cash shortage_________ 4) Was not sure of benefit________

5) Own making____________ 6) Not better than local hive______

7) Others (like labor shortage), specify_____

14) Do you purchase KTBH every year?

yes_____ no_______

15) How many times have you purchased KTBH hives since you started using it?___

16) Have you ever used feed related technologies? Yes______ no_____

17) Do you grow nectar producing plants? Yes______no______

8. Farmers Perception and attitude about the Traditional and KTBH

8.1 Perception of advantages using of the KTBH (by the users)

1) Permanent/durability of the hive____

2) Labor efficient (i.e. low management requirement, cost effectiveness (low cost)____

3) Ease of inspection and management _______

4) Low incidence of absconding and pest and disease_______

5) Avoidance of bee killing upon harvesting______

6) Ease of subduing aggressive colonies______

7) Better quality of honey ____

8) Better yield of honey____

9) They are easier to construct_____

10) The combs are easily removable can be replaced without destroying the them_____

11) if others, specify_____

8.2 Perception of disadvantages using of the KTBH (to be answered by all groups)

1) Failure to regulate temperature change____

2) Absconding_____

3) It is difficult to move the colonies without breaking the combs______

4) Difficulty in constructing the proper hive design locally_______

5) Delay to have strong colony_________

8.3 Perception of advantages of using traditional bee hives

1) Materials for their construction are usually readily available and they are cheap (free)__.

2) Beeswax production is relatively high. (There is a ready local market for beeswax in some areas.)____

3) They are traditional, and methods are established for working with them____.

8.4 Perception of disadvantages of using traditional bee hives

1) Examination of the colony condition and hive manipulations are impossible_____.

2) Swarming is often common because of limited space____.

3) Brood is often lost in harvesting honey____.

4) Honey quality is usually low

9. Extension Contact and Training

1) Have you ever consulted development agent? yes_____ no_______

2) How many times per month do usually discuss agricultural matters with the development agent_______days/month.

3) Have you ever been received extension service on beekeeping activity? yes___no___

4) How many times per month did you receive extension advice on beekeeping in 1996E.C______1. once 2. twice 3. three times 4. if more (specify) ____

5) Distance to extension center__________Km

6) Have you ever attended any demonstration, field days arranged by development agent or visited research centers? Yes_____no_____

7) Have you ever-visited apiaries of other farmers, arranged by development agents Yes______no______

8) Has there been any demonstration facilitated by MOA in your apiary? Yes____no____

9) Have you ever attended any training in beekeeping? Yes____no____

10) Do you have a radio? Yes_____ no______

11) How many days do you listen to agricultural news per week? _____

10. Credit, financing and institutional support information

1) Have you ever-obtained credit for your farming operation? Yes____ no____

2) If yes, for what purpose? _____

3) What were your sources of credit?

1) Micro finance institution______ 2) MOA________

3) Service Cooperative______ 4) Relatives______

5) NGO______ 6) Merchant________

7) Others, specify_____

4) Did you receive credit for your farming activity during the last crop season?

yes_____ no_______

5) Did you receive credit for your beekeeping activity during the last crop season?

Yes_____ no______

6) If yes, tell the amount borrowed______ and the interest rate______?

7) If No, why?

1) High interest rate____ 2) No money for down payment______

3) No credit for the programme______ 4) Others, specify_______

8) If you have not used credit for KTBH purchasing so far, what are the main reasons?

9) Do you have a debt that is not paid back? Yes____no_____

10) If yes amount of principal_____, and amount of interest____

11) If debt is not paid, why?

12) What are the major problem you face to get input on credit?

1) Debt collection problem______2) Inaccessibility of credit agent_____

3) Lack of low cost credit____4) Unavailability of credit_____5) others, specify____

13) Is there any organization working on beekeeping activities in your PA? 1. yes 2. no

14) If yes, which organizations are working on beekeeping? ____________________

15) Have you been supported by any of the organizations to undertake beekeeping activities? Yes______no______

16) If yes, specify the supports you have got so far. _____________________