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ADOPTION AND PROFITABILTY OF MODERN BEE HIVE TECHNOLOGY IN HARU WOREDA, WEST WOLLEGA ZONE, OROMIA REGIONAL STATE OF ETHIOPIA

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ADOPTION AND PROFITABILTY OF MODERN BEE HIVE TECHNOLOGY IN HARU WOREDA, WEST WOLLEGA ZONE, OROMIA REGIONAL STATE OF ETHIOPIA

A THESIS SUBMITTED TO THE COLLEGE OF BUSSINES AND ECONOMICS IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF AGRICULTURAL ECONOMICS.

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As thesis research advisor, I hereby certify that I have read and evaluated this thesis prepared, under my guidance, by **Yohannes Tibebu Merdasa**, entitled **Adoption and Profitability of Modern Bee Hive Technology in Haru Woreda, West Wollega Zone, and Oromia Regional State of Ethiopia**. I recommend that it to be submitted as fulfilling the thesis requirement.

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As members of the Board of Examining of the Final MSc. thesis open defense, we certify that we have read and evaluated the thesis prepared by **Yohannes Tibebu Merdasa** under the title "**Adoption and Profitability of Modern Bee Hive Technology in Haru Woreda, West Wollega Zone, Oromia Regional State of Ethiopia** and recommend that the thesis be accepted as fulfilling the thesis requirement for the Degree of **Master of science** in Agricultural Economics

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Certification of the Final Thesis

I hereby certify that all the correction and recommendation suggested by the board of\ examiners are incorporated into the final thesis entitled "Adoption and Profitability of Modern Bee Hive Technology In Haru Woreda, West Wollega Zone, Oromia Regional State of Ethiopia " by Yohannes Tibebu Merdasa.

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DEDICATION

This thesis is dedicated to my father (Tibebu Merdasa), my mother (Yemane Tolessa) and my brothers (Bikila Tibebu and Ephrem Tibebu)

STATEMENT OF THE AUTHOR

With my signature below, I declare and confirm that this thesis is my own work. I have followed all ethical and technical principles of guidance of research in the preparation, data collection, data analysis, and compilation of this thesis. Any academic matter that is included in the thesis has been given recognition through citation.

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Yohannes Tibebu Merdasa

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ABBREVIATIONS

AAU	Addis Ababa University
AGP	Agricultural growth product
AMD	Agribusiness and Market Development
CSA	Central Statistical Agency
EARO	Ethiopian Agricultural Research Organization
EBA	Ethiopian Beekeepers Association
EIAR	Ethiopian Institute of Agricultural Research
FAO	Food and Agricultural Organization
FAOSTAT	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
MEFCC	Ministry of Environment, Forest and Climate Change
MOFED	Ministry of Finance and Economic Development
NGO	Non-Governmental Organization
OIE	World Organization for Animal Health
OLS	ordinary least square
PA	Peasant association
TLU	Tropical livestock unit
USAID	United States Agency for International Development

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Abstract

Apiculture is a familiar farming and income generating activity in Haru Woreda and promotional efforts were made to progress it, however no systematic study assessed to evaluate the promotional efforts and people's response to it. This study was conducted to identify factors that determine adoption and profitability of modern bee hive technology. In this study, multistage sampling technique was used to select 138 target respondents from 309 beekeepers. The primary data were collected using an interview schedule and various documents were reviewed to collect the secondary data. Descriptive statistics were used to compare the traditional bee hives and modern bee hives technology with respect to the different attribute under considerations. To analyze the data Logit model was employed to identify the determinants of adoption of modern bee hive and the result showed that education, beekeeping training, availability of accessories, extension contact, access to credit and land holdings are positively and significantly affect adoption of modern bee hive technology. Multiple Linear Regression models was used to identify the determinant factors of profitability of modern bee hives and the result showed that beekeeping training, Availability of accessories assess to extension contact are significantly and positively relationship with profitability of both traditional and modern bee hive technology. To compare profitability between traditional and modern bee hives, the yield and per hive net return gained from homemade and institutional modern bee hive are greater than the yield and net return gain from traditional bee hive. Therefore, policy implication of this study is; development agents, policy-makers, planners of governmental and NGO give attention to promote the adoption and profitability of modern beehive technology for higher production and profit

Keywords: *Adoption, Beekeepers, Logit, Modern Beehives, profitability*

CHAPTER ONE

INTRODUCTION

1.1 Background

Ethiopia is recognized as one of the poorest and most food insecure countries in the world which, contributes in agriculture about 42% of the GDP, employs about 80% of the labor force and around 90% of the total export earnings of the country. The sector is dominated by over 15 million smallholders producing about 95% of the national agricultural production. This explained that generally economy of the country and the food securities of the population depend on small holder agriculture (CSA, 2018).

Beekeeping is one of the agricultural activities that have been promoted worldwide as a major of rural development engine with the bee products through food security and natural conservation. Owing to is varied ecological and climatic conditions, among status of honey and beeswax production of Ethiopia is 10^{th} and 4^{th} in worldwide respectively (Ambaw & Teklehaimanot, 2018).

Concern to the beehives Ethiopia is the fourth largest country next only to India, China and Turkey in the world by having 6,189,329 hives and presently, traditional forest and backyard, transitional and frame/modern bee hives practices are used in beekeeping (Sahle *et al.*, 2018).

With regards to the Africa, the country is 1^{st} in apiculture which is honey producing with the major bee population with over 10 million of bee colonies, from which about 5 to 7.5 million are expected to be hived while the remaining exist in the wild and annual honey production was predictable about 43,373 metric tons which is contributed with concerning 23.5% and 2.35% of African and world's honey production, respectively (Gashaw, 2018).

The major honey and beeswax producing regions in Ethiopia are Oromia (41%), Southern Nations Nationalities, and Peoples' Region (22%), Amara (21%) and Tigray (5%) (Demissie *et al*., 2018). In regions of Ethiopia beekeeping is considered as one of the income-generating activities for resource-poor farmers including women, youth and the unemployed sectors of the community (AAU, 2015; Ajabush, 2018). West Wollega, Jimma, Ilu Aba Bor, Kellam Wollega, Horo Guduru Wollega, Guji, and West Shoa are the highest potential zones for apiculture subsector in the region (Aman *et al*, 2019). Despite the fact that the area of country

has an experienced in practice of beekeeping and is highly suitable for sustaining a large number of bee colonies, the plants and bees depend on renewable natural resources, are constantly under threat from lack of knowledge and appreciation of these endowments. Besides, a lot of million bee colonies are managed with the old traditional beekeeping methods in all parts of the country (Ajabush, 2018).

Beekeeping can help economically vulnerable communities to increase economic stability. Honey production, pollination services, agriculture, and forestry are a few of the economic benefit of beekeeping. Bee products such as propolis, royal jelly, beeswax, and bee venom are also high value but low volume green products. Concerning to the income from bee products, beekeeping create off farm employment opportunities in many fields including hive carpentry, honey trading, renting and hiring of bee colonies for pollination and bee based micro enterprises. Despite of its contribution for smallholder households' income in particular and nation's economy in general, honey production system is very traditional which results in low productivity and poor quality which is less profitability. For example, the 95% of the hives are reported to be traditional and 91% of the total honey produced comes from traditional hives in the country (Kristina & Robert, 2018).

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 wicker containers. Traditional beekeeping does not make use of the better equipment's and modern techniques. As a result, harvesting the produces kills or severely weakens the colony by using fire. Besides, the product obtained from the traditional bee hives is relatively low quality (Teklu, 2017). This low productivity of honey per hive was due to the type of hive beekeeping farmers' use. To improve the low yield of honey per hive different packages was implemented and among them was the introduction of modern bee hive.

Identifying of the determinants of adoption and profitability of agricultural technology is useful for disseminating of technology to increase productivity of agricultural output (Tadele, 2016). Promoting of modern bee hive technology in the region to increase the quantity and quality of honey production and build the capacity of beekeepers for better management of bees and hives for honey and beeswax production (Gidey, 2010; Ajabush, 2018). Ethiopian government tried to set up different mechanism of beekeeping technologies to beekeepers.

For productive of bee production, it is necessary to apply modern bee hive technologies and production methods of beekeeping. In addition, it is necessary to have modern and appropriate equipment to increase the chances of success.

The modern beehive has a production potential of 20-40kg per colony per year of honey while the traditional beehive produces 5-10kg per colony of honey (Holeta Bee Research Center, 2004 ; Demisew,2016). The modern bee hives allow honeybee colony management and use of a higher level technology, with larger colonies and can give higher yield and quality of honey (Aman *et al*., 2019).

1.2 Statement of Problem

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 was also eco-friendly and did not need for scarce land resources and provides job opportunity that generates income (Melaku,2006 ; Workeneh, 2008 ; Ajabush 2018). Enhancing the ability of smallholder farmers to adopt modern beehive technology and improve their profitability is one of the most pressing development challenges. Various factors could limit the farmers' adoption of modern beehive technology and their returns, according to the study by (Ahmed, 2014).

For honey production and success in beekeeping progress is depends on the technology used in the existing of local resources and economic considerations. Choice of bee hive technology should be based on the cost and hive yields based on quality and quantity of honey and availability in relation to local honey potential and cash return, which vary according to geographical location and temperament of both bees and beekeeper (Melaku, 2006) the result showed that Kenyan top bar hive is profitable than traditional hive. But modern bee hives give high quality and quantity of honey than other hives.

Different authors conducted their studies on honey production and facilities, comparative analysis of colony performance, value chain and market supply of honey in the different study area (Awraris *et al*., 2015; CSA, 2016; Kassa *et al*., 2017; Kassa *et al*., 2018).

Modern bee hive technology adoption is affected by socio economic, personal attributes, physiological factor (Melaku, 2006; Tamirat, 2015). Problem associated with those factors are not sufficient and very small to decide adoption of the technology. Because some factors

like technology related factor, institutional factors were not included and determinants of influencing profitability of modern bee hives technology was also not identified. Due to knowledge gap no information to give adoption and profitability of the technology. Therefore this study includes technology related factor, socio economic, personal attributes, physiological factor and institutional factors by using logit model and multiple regression model for adoption and profitability of modern bed hives.

In study of the area, there is no information available on the determinants of the technology adoption status and profitability of the modern bee hives technology and beekeeping practiced is the same on both hives. However, adoption and profitability of the Modern bee hive technology was not studied in the study area. Therefore, the study will be very helpful to generate information new beekeepers and particularly to extension agents who are responsible to offer technological alternatives appropriate to the target and resources of the beekeepers in the study area as well as introducing beekeeping where it is not in practice.

1.3 Objective of the Research

The general objective of the study is to analyze the determinants of adoption and profitability of modern bee hive technology and specific objectives are:-

I. To identify determinants of modern bee hive adoption by the beekeepers.

II. To assess the determinants of profitability of modern bee hive technology by beekeepers.

1.4 Significance of the Study

Haru District has great potential for production of honey, however, there is chronic shortage of adoption of modern beehive technology around area and the profitability is low. Hence it was required to investigate the situation.

The results of this study would be useful for the government or policy makers, donors or NGOs, producers and marketing middlemen for their respective decisions. Besides, it would be a useful reference for researchers and other personnel interested in adoption and profitability issues in similar other areas.

Ministries of agriculture and different Non-Governmental Organizations have also been playing a great role in disseminating modern bee hive. Even though those organizations are contributing much in the dissemination of the technology, there is no adequate study on

adoption and profitability of the technology assess Several factors are 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 dissemination and extension strategies could be implemented. These studies also provide necessary feedbacks to development agents and policy makers about what really works with their clients. The present study is an attempt to examine the profitability and factors affecting the adaptability of the Modern bee hive technology.

1.5 Scope of the Study

The study was restricted to three kebeles of Haru Woreda area, West Wollega Zone of Oromia National Regional State. Cross sectional survey data was used for this study. Moreover, the objective of this study is limited to only adoption and profitability of modern bee hive technology.

1.6 Limitations of the Study

The researcher come upon a number of problems during period of data collection like accessibility of roads and transportation facilities in the peasant association has constrained and was enforced to walk long distance on foot to supervise and enumerators were employed to collect data. During data collection no written sources occur concerning honey production.

1.7 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 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.

CHAPTER TWO

LITERATURES REVIEW.

This chapter gives theoretical highlights for the study. It is organized into sub topics such as definition and concept of adoption, beekeeping and its economic importance, Reviews of theoretical and empirical studies about the models that are chosen for data analysis are presented, beekeeping situation of Ethiopia and conceptual framework are included.

2.1. The Concepts of Technology Adoption

Technology is the way and methods of producing goods and services. It is new to a particular place or group of farmers, but the technology may in use within a particular place or farmers Technology adoption is important because it is the vehicle that allows most people to participate in a rapidly changing world where technology has become main of our lives. Individuals who can't adopt through limit to participate fully in the financial and convenience benefits associated with technology. Understanding the factors influencing technology adoption facilitate us predict and manage who adopt, when and at what conditions. Unfortunately there is no clear definition of technology adoption in large part due to the tremendous variability in types of technology and circumstances under which people adopt them (Loevisohn, *et al*., 2013; Petros & Yishak, 2017).

The author divided adoption of new technology into two as individual and aggregate adoption. Accordingly, they defined individual adoption as the farmer's decisions to take a new technology into the production procedure and the aggregate adoption as the process of diffusion of a new technology within a region or population (Melesse, 2018).

Adoption of new technology in agriculture which occurs due to behavioral changes like desirable changes in knowledge, understanding and ability to apply technological information, changes in emotion behavior such as changes in interest, attitudes, aspirations, values and the like; and changes in overt abilities and skills, is determined by many socio economic factors. Adoption is not a simple and at once activity, but it is a rational process which an individual farmer (decision maker or group of decision maker's family members) goes through for decision making. From the farmers' perspective, the new technology should be economically more advantageous than the existing alternatives. To ensure adoption of

new innovation the fulfillment of specific economic, technical and institutional conditions are needed (Petros & Yishak, 2017; Melesse 2018)

Adoption typically has been viewed from two perspectives. At individual farm level, each household prefer whether or not to adopt and the intensity of adoption. Farm level adoption studies, then, are concerned with the factors influencing the adoption decision either statistically or dynamically by incorporating learning and experience. At macro level, diffusion studies examine how adoption includes across a population or region. Since the objective is to identify specific trends in the diffusion cycle over space and time, diffusion models do not explicitly address the innovation process (Yigezu *et al*, 2015).

The term adoption is the nonstop use of a recommended idea or practice by individuals or groups over a practical long period (Dasgupta, 1989). Technology adoption is a decision to apply an innovation and to continue to use it.

According to the Workneh (2007) adoption of the technology was explained by some terms.

Decision to adopt the technology frequently takes time. People usually do not adopt a new practice or idea as they hear about it.

At awareness step, a person first learns about an innovative idea or product, or practices and only gets general information about idea. No one knows little or nothing about any special qualities, its potential usefulness, or how it would possible work for him/her.

The farmer improves an interest in the new idea that learned about through ready to listen and read, and is motivated to aggressively pursue the information desired.

A person considers the information and indication collected in the previous stages to decide whether the new idea, product, or work is essentially good. This stage will be stated as the `mental trial stage`. To be success, evaluation is included at all stages of the adoption process.

Individual is challenged with a clearly different of problems. At the time of really put the change into experiments.

Adoption: by this stage a person agrees that the innovative idea, product, or work is good sufficient for full balance and continued to use it. Adoption pattern is a function of five features i.e. profitability, riskiness, initial capital requirements, complexity and availability.

2.2 Beekeeping Practice in Ethiopia

The diversified agro climatic conditions of the country make environmental conditions conducive for the growth of over 7000 species of flowering plants of which most are bee plants (Teferi, 2018). Ethiopia has various endemic species of flowering plants.

There are four different types of beekeeping perform in Ethiopia namely, traditional forest, traditional backyard, transitional and modern beekeeping (Teklu , 2017 , Yibrah, 2018; Aman *et al*. 2019). Many of farmer of Ethiopia use traditional technology. The country remains the chief honey producer as well as one of the most beeswax exporters in Africa. However, the contribution of the apiculture in the gross domestic production has not been proportionate with vast numbers of honeybee colonies and the country's probable for beekeeping (Aman *et a*l. 2019).

Traditional, transitional and modern bee hives are used in beekeeping of Ethiopia. About 5,207,300 hives exist in the country out of which about 95.96% was traditional, 1.06% transitional and 2.98% frame hives though the country had large apicultural resource, potential of producing over 500,000 tons of honey per year ,the annual production of honey and beeswax is little compared to its potential (CSA, 2013; Kristina & Robert, 2018). For this reason more than 95% of beekeepers use traditional hive management performed which reduce yield. In most cases Ethiopian apiculture are practice use traditional bee hives which is very difficult to manage honeybees and to produce honey and honey products in the required quality and quantity .The maximum yield obtained from a traditional beehive is very low. (Teferi, 2018).

Beekeeping activity has important contribution economically and ecologically (Ajabush, 2018). This sub sector has remarkable potential to contribute to employment generation, local and global market, livelihood improvement, and biodiversity conservation and helps ensuring economic advantages of women, youths and Ethiopia's geographical position poor households. Development of the Beekeeping practices could significantly enhance crop

production, food security, maintenance of plant diversity and ecosystem stability (Kristina & Robert, 2018).

2.2.1 Beekeeping Practice in the Western Part of Ethiopia

In the region, there is better natural forest and cultivated crops and many hectares of land covered by coffee. In addition, the region has suitable climatic condition. As a result, huge honeybee population exists in the area, mostly practiced in the forest by hanging hives on big trees. It is common to observe up to 50 honeybee colonies in one tree. The honey harvesting method is similar with southern part of the country. However, in this region, after the honey harvest, they shake down the bees and store the empty hives until the next swarming season. In the region, there is cultural belief of the beekeepers that once the colony is touched for honey harvest, the colonies tend to abscond and never stay in their hive. Some of the problems are: hanging the hive on tall tree is difficult to manage the bees properly, forest beekeeping is a very difficult work for women and old men, shaking the bees during honey harvest causes the loss of thousands of colonies every year, the nomadic nature of the bees, forest fire in dry seasons, excessive swarming, lack of knowledge and skill on better handling methods of bees. In this region, transitional, improved, and honey hunting practices are also being undertaken. There are also beekeepers that keep their bees under the roof and use the colony for a long time. Such beekeepers can be used as demonstrators for beekeepers who destroy their colonies during honey harvest in the belief that those bees do not stay in their hives after being disturbed (CSA, 2013).

Whereas, in Central and Eastern highlands; Backyard beekeeping practice is more predominantly exercised in the area. A traditional beehive are prepared from pot, bamboo, locally available shrubs and trees and also reveals that traditional beehives used in the area are cylindrical in shape with the dimension of around one meter in length and a diameter of around 20 cm. It is made up of bamboo and other locally available materials.

2.2.3 Beekeeping Practices in Northern Part of Ethiopia

Indigenous technical knowledge of beekeepers is different from region to region in the country. As a result, beekeepers' practices also show differences. Farmer beekeepers of the Oromia region have well developed local technical knowledge on beekeeping (Nuru, 2002).

They keep their bees in backyard either under separate shelter or around the house wall or even inside the house i.e. with domestic animals and family members without any problem. They hang their beehives inside their living rooms and provide entrances on the sides of the walls. The author further stated that in Tigray some beekeepers keep honeybee colonies inside living rooms and honeybees are sharing the same doors with members of the family. The beekeepers of the area construct beehives for different purposes; for instance, small hive to induce reproductive swarming and big hives for honey production. The beekeepers also practice feeding and moving their colonies to other places for searching bee forage.

2.2.4 Beekeeping Practices in Southern Part of Ethiopia

As the other regions of the country, in this area beekeeping is one of the oldest agricultural practices. Traditional, transitional and improved beekeeping management are being performed. As noted by (Amsalu, 2002) in the south western part of the region particularly (mash area) farmer beekeepers use natural forest only for beekeeping purposes. The forest is distributed among beekeepers and one cannot use for beekeeping without the permission of the forest owner (beekeeper). In some areas of the region as discovered by (Adigaba & Nuru, 2007) every family has its own forestland to use for traditional beekeeping, which is known as kobo. According to kobo system one cannot be allowed to cut a single stick or to hang hives in the forest which is not belonging to it. Even though the practice is not contributing much for the productivity of beekeeping, its contribution is high for forest conservation in the area. Generally in the area, traditional forest beekeeping is predominant. A beekeeper can have 10-200 honeybee colonies. The beekeepers get honeybee colony mainly through trapping swarms. In relation to honeybee management, no attention is paid to honeybee colonies. Beekeepers visit their honeybee colonies during honey harvest. The honey harvesting practice is climbing up the tree and sending the hive with rope or dropping it then harvesting the honey with the mixtures of pollen and beeswax. There are mainly two types of honey; white and yellow or amber. White honey, which is harvested during April to May, has higher value than yellow honey in the surrounding, as it is perceived to be good quality. It is documented that yellow honey is also harvested during September to November. The beekeepers are mainly selling their honey to tej (local beverage) makers and few honey

collectors. The `tej` makers get multiple advantage i.e. selling the `tej` and preparing beeswax, which is sold to beeswax collectors.

2.3 Existing Technology of Beekeeping

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 (Dejene *et al*.1995). 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 (Melesse, 2018).

There are four different types of beekeeping practices in Ethiopia namely, traditional forest, traditional backyard, transitional and modern beekeeping explained as follows.

Traditional forest beekeeping: It is placing of hives in the forest on very tall trees for catching swarms. It is commonly exercised in forest-covered areas of the country where the population of honeybees are abundant. One of the advantage of forest beekeeping is t bees do not cause to harm by the domestic animals and humans and the bees can obtain abundant forage plants in their vicinity. I n another way disadvantages are lack of follow up bees during honey harvesting time as the beekeeper drops down the hive from the tree, it affects the honeybee colony. It is also hazardous for the beekeeper to climb high length tree in night. Traditional honey harvesting is normally undertaken at night and it sometimes involves stripping naked before climbing the trees on which the hives are hanging. However, there are advantages and disadvantages to using traditional style log hives. (Teklu , 2017 , Yibrah, 2018; Aman *et al*. 2019).

Traditional backyard beekeeping: It is undertaken in safeguarded area for honeybees mostly at homestead. The advantages of such performance are: construction is very easy, it does not need improved beekeeping accessories; it does not also want experienced manpower; whereas its disadvantages are inconvenience to start internal check and feeding, in some places the size is too little and reason for swarming, it is not possibilities of supering, there is no divider to distinguish brood chamber and honey chamber (Teklu , 2017).

Transitional beekeeping: It is one of improved methods of beekeeping practices. The types of hives are Kenya Top Bar Hive (KTBH) and Tanzania Top Bar Hive (TTBH). The hives made from timber, mud or locally available materials. The hive holds 27-30 top bars on which honeybees join their combs. The top bars have 3.2cm and 48.3cm width and length, respectively. Transitional (intermediate) beekeeping performance is important, that means, it can be opened simple and fast, the bees are guided into building parallel combs by following the line of the top bars, the top bars are simple not fixed and this facilitate beekeepers to work fast, the top bars are easier to construct than frames, honeycombs can be removed from the hive for harvesting without disturbing combs containing broods, the hive can be suspended with wires or ropes and this gives protection against pests. Transitional beekeeping has disadvantages such as, top bar hives are comparatively more cost than traditional hives, combs suspended from the top bars are more apt to break off than combs which are building within frames (Abebe, 2017).

Modern beekeeping practices: It uses different types of frame hives. Zandar and Lang troth hives are the most common that exist in the country. Dadant, Modified Zandar, and foam hive are found rarely. These hives differ in number and size of frames. The most commonly used hive type in Ethiopia is Zandar type. Improved beekeeping hives have components like brood chamber, super (honey chamber), inner and outer cover. Modern bee hive has advantages comparatively with another hives; it gives high honey yield in quality and in quantity. The other advantages of modern hive is its possibilities of swarming control by supering the bees from place to place for searching honeybee flower and pollination services. On the other hand, its disadvantages are the equipment's are relatively expensive, requires skilled manpower and the equipment needs very specific precaution (Abebe, 2017 ; Aman *et al*., 2019).

2.4 Advantage of beekeeping

Apiculture is by its character doesn't need vast investment, big size of land and difficult technical knowledge. Therefore it is a supreme activity for low level resource poor farmers (Ajabush, 2018).

Apiculture is the most form of agriculture that is important to the environment and provides economic reasons for the retention of native habitats and potentially increases yield from

food and forage crops (Demissie *et al*. , 2019). Beekeeping has various relative advantages and some of them are: Bees are cosmopolitan, Small holders and landless peasants can practice beekeeping, Beekeeping does not compete for resources with other agricultural endeavors and can be run integrally with other agricultural activities., culture does not disturb ecological balance, as may cultivation of crops and practices of animal husbandry, The investment and running costs are relatively low with minimal risk. And also provide a valuable ecological service through their role as a pollinator. The honeybee produces honey, beeswax and propels, the whole family can become involved since men, women, or elder children can do the work in most cases at home, using bees' products, all societies have a wealth of traditional knowledge concerning the healing properties of bee products (CSA, 2013 ; Demissie et al., 2019). Bees offer honey, more energy food supplement that can be sold to earn cash. Honey and wax are used for their medicinal use in traditional cultures. Beekeeping provides the national economy via foreign exchange income from exports. Amount of exports of honey and by products like bees wax are income in Ethiopia (Aman *et al*., 2019).

2.4.1 Export market

Beekeeping products play significant role in the development of national economy. Honey and other export commodities with good potential in many African countries (Paulos, 2012).The developing countries get a chance of money exchange with honey and other apiculture products. Ethiopia exports honey to the countries such as Sudan, Norway, Saudi Arabia, UK, Yemen, Japan, USA and Ethiopia sell abroad honey to European country, U.K. was 30 tons in 2008 others. Between the years of 2008-2011, Ethiopia exported 7,068 tons kg of honey and 6,752 tons of beeswax. As it was increasing from time to time, it reached 4252.8 tons of honey in the year 2011-2016. Currently, the export had reached up to 900 tons per annum (Demisew, 2016). The beeswax price at the domestic market is mostly higher than the international beeswax price which makes beeswax export less profitable in Ethiopia.

In Ethiopia more part of honey is sold for income generation opportunity. The domestic honey market starts at the smallholder bee keeper's level, who majorly sells crude honey to collectors in the nearest town/village markets Beekeepers of the country sell the largest

proportion of their honey during harvest at low price mainly to meet their demand for cash to pay taxes, debts and other social obligation (Demissie *et al.*, 2019).

Honey price is different by region and category of honey. The most expensive is Eastern Tigray‘s white honey, where the current retail price is ETB 170.00/kg Lower retail prices (of around ETB 60–90.00/kg) are observed for other varieties of white honey, depending on the area and the honey ‘s characteristics. The retail prices for yellow honey are around ETB 50– 60.00/kg, while the least expensive red honey is sold at a price of around ETB 45–50/kg (USAID, 2012). Domestic honey consumption is increasing due to highly increasing demand for *tej*, increased consumption of processed table honey in most urban areas and increased demand for honey in the local industries (Assefa , 2011). The total volume of domestic consumption in 2007-2011 was 163,257.42tons, out of which 146,931.67 tons was domestic consumption (USAID, 2012). Recently, country’s domestic honey market is estimated to be 42935 tons out of total 47,706,101 tons (EIAR, 2017; Ajabush, 2018)

2.4.2 Beeswax Production

Bees wax is valuable byproduct of beekeeping that serves beekeepers as source of income. It does not require careful packaging, easy to store and transport (Bradbear, 2009). Beeswax is important to make light candle particularly in the Orthodox churches. In Ethiopia in the year of 2011-2013, about 5000 tons were produced on an average annually. But during the years of 2014-2016, it was increased to 5458.3 tons. The currents annual beeswax production is estimated at 5700 tons. This makes Ethiopia the fourth largest beeswax producing country in the world after China, Mexico and Turkey (Sahle *et al*. ,2018).

2.4.3 Crop Pollination

Honeybees (Apismellifera litorea) being primary pollinating agents help to pollinate flowers, horticultural crops and vegetables worldwide (Porter & Penny, 2017). The contribution of honeybee pollination to crop production and quality has been estimated to be more than the value of honey and wax production. For many crops, pollination may be one of the best ways of improving crop production (Goodwin , 2012). Therefore, honeybees’ pollination has brought about significant economic contribution in crop production and human nutrition security (Ellis et al, 2015). Thus, investment in the apiculture sector means diversifying

income source, enhancing agricultural yield of smallholder farmers, and creating employment opportunities for the youth, women and conserving biodiversity, mitigating climate change and improves exchange of foreign currencies. Overall, investing in the apiculture sector is meant strengthening sustainable socioeconomic development of the society (Demissie *et al.*, 2019).

2.4.4 Source of Immediate Cash Income

Beekeeping plays significant role in supplementing the annual income. Honey production and value addition to its products are vital factors in sustainability of livelihood of poor people (Demissie et al., 2019) .

2.4.5 Job Opportunities

Beekeeping practices create job opportunities for landless men and women for their livelihood as it needs low capital to start (Ajabush, 2018). It could also be observed that many people (intermediaries and traders) participate in honey collection and retailing (at village, district and zonal levels). Hundreds of honey processors are engaged in Tej brewing and exporters are also flourishing. It can also serve as job opportunities to local carpenters and organized youths in construction of bee hives (Demissie *et al.*, 2019).

2.6 Major Constraints of Beekeeping in Ethiopia

2.6.1 Absconding and Migration

Honeybee colonies abandoned and migrated from their hives at any season of the year for different reasons. The occurrence of absconding of bee colonies is more in traditional hives. The main reasons for absconding and migration of bee colonies are lack of forage, incidence of pests and predators, during harvesting, sanitation problem, bad weather condition, and bee diseases, drought, overgrazing, deforestation and shortage of water (Ambaw & Teklehaimanot, 2018).

2.6.2 Honey Bees Pests and Predators

Small hive beetles infest bee colonies (species of the genera Apis and Bombus and stingless bees). The adult beetle is attracted to bee colonies to reproduce, although it can also potentially survive and reproduce independently in other natural environments, using other food sources (OIE , 2017; Ajabush, 2018)

2.7 The Role of Extension for Beekeeping.

The main task of extension in a country of the world in the past was seen to be transfer of new technologies from researcher to the farmers. Now it is seen more as a process of helping farmers to make their own decisions by increasing the range of options from which they can choose, and by helping them to develop insight into the consequences of each option (Ban *et al*., 1996; kindalem, 2019).

Extension plays a great role in popularizing farm technologies. Currently, everyone is found in competitive globalized world. Hence, to make the farmer competent, it is expected from the extension to work closely with farmers than any other times. The role of extension includes: Building the capacity of farmers and farmer organizations to pursue their development goals by articulating high quality demand for services. This can be affected by offering need-based practical training and close follow up which enable them to examine their farming environment comparing with other farming situation. This, in turn, develops farmers' aspiration for change through adopting different farm technologies that is suitable to their farming system. Linking farmers and farmer organizations to other support agencies including markets and input supply systems, creating platforms for their interaction and facilitating negotiation between the different stakeholders. Farmers search for new knowledge and technologies as well as creating partnerships that enhance application of the knowledge and technologies. Facilitate farmers for collective and individual learning about innovations to enhance community's capacity to innovate. Collective action helps to find appropriate solution (Yitbarek, 2017). Hence, learning and experimenting together and sharing experiences that enhance them to understand more about the technology.

Enhancing technology dissemination and adoption is part of an innovation system that starts with the technology development process itself. Concepts of participatory technology development and now integrated agricultural research for development indicate a shift from supply driven to more collaborative ways of generating and disseminating relevant agricultural technologies. This therefore, means that the responsibility to promote technologies cannot be left to extension agencies alone but rather a collective responsibility of researchers, extension agents, farmers and other service provides. Engaging in such collective responsibility demands new skills for integration and working together in

partnership with key stakeholders. Skill for doing so has to be clearly identified and deliberately built in the system (Tadele, 2016 ; Melesse 2018.)

2.8. Profitability of Modern Bee Hive Technology

The probability of adoption of a new technology will depend on the difference in profitability between the new and old technologies, and the ability of the farmer to perceive the advantages and efficiently utilize the new technology (Schultz, 1995). The acquisition of new technology information has been considered a critical factor related to the technology adoption process as farmers are more willing to adopt those technologies about which they have heard or are aware of and which have proved to be profitable (Belets & Birahanu, 2014).

High yields are not sufficient conditions to persuade farmers to adopt a technology. As 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. The necessary condition for adoption of any agricultural technology is that it is acceptable to the farmer (Shakib & Saye, 2016). 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, 1996).

In their study on duration analysis of technological adoption in Ethiopian agriculture reveals that economic motivate are the most important determinants of the time farmers wait before adopting new technology (Legess*e et al*., 2004). The authors further stated that other agricultural inputs (area of farm land, labor, credit), extension services and farmers` personal characteristics (education, gender, age) appear to have had little, if any, effect on adoption behavior.

Using partial budgeting analysis indicated, when added cost (reduced return) and increased return (reduced cost) accounted for both the home made and institutionally prepared KTBH (Melaku, 2006), it was found that both types of KTBH are beneficiary and remunerative According to (Kerealem, 2005) movable comb top bar hives result in higher net return per colony compared with local hives.

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

2.9. Empirical Studies on Technology Adoption

2.9.1. Determinants of Adoption and Profitability of the Technology

2.9.1.1 Determinants of Adoption of technology

The contribution of new technology to economic growth can only be realized when and if the new technology is broadly diffused and used. The 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 maximize utility from the new good, but may also include such "non-economic" factors as the enjoyment of being the first not incorporated 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 initiator and producers of such technologies. The authors discussed the variables often hypothesized by a number of empirical studies to affect farmer's adoption decisions account for farm size, risk and uncertainty, human capital, labor availability, credit constraints, and landownership on factors affecting adoption of agricultural new technologies in Ethiopia by the result of Logit model. (Dill *et al*., 2008 ; Melesse 2018.).

According to the result studied by of Tizita Damte, (2017) using Logit model with title adoption of small scale irrigation in Bona-Zuria Woreda, Sidama Zone, Southern Ethiopia indicated that Education status of the household head was the most common and important variable that is found to identify farmers' agricultural technology adoption behavior according to the deep-rooted that it has a significant positive influence on adoption of technologies. Authors have found out that increasing educated farmers leads to adoption of technology. This means formal education is supposed to be important factor in a way that education would have the capacity to adopt the technology in a proper way and can assure the end target expected from the technology. As a result, education presumed as an important adoption of small scale irrigation explanatory factor in household decision making towards favoring the adoption process.

According to the (Yitbarek, 2017 ; Melesse, 2018) based on factors affecting adoption of maize technologies of farmers the accruement of extension by using Logit results that contact via formal advice refers the involvement of agricultural experts in developing the general cognitive ability of farmers via training, experience sharing and practical help us any assistance that emanate for the proper implementation of the intended technology considered in this study. There is positive relationship between Extension contact and adoption of the technology implies that farmers who have regular contact with extension personnel tend to adoption of legume technologies. This implies that a more frequent contact facilitates the flow of new ideas between the extension agent and the farmer thereby giving a room for adoption (Mesfin, 2017; Dawit & Abdusalem, 2018).

According to the Petros *et al*., (2017) Land holding was continuous variable measured in terms of hectare. Those farmers having larger area of cultivable land were found to user more in irrigation user than their counterpart as the evidences indicated authors like Determinants

of small-scale irrigation use the case of Boloso Sore District, Wolaita Zone, and Southern Ethiopia by using logistic regression. Land was need for implementing and practical of the technology.

According to the (Yitbarek, 2017; Dawit & Abdusalem, 2018) Credit is the lender who decides whether to access or not the credit. This happens in area where there is limitation in accessing the credit service due to fewness of crediting agents. Economists usually view lack of credit as an indication of market failure. Improving credit access often regarded as the key element for increasing agricultural productivity and has been an effective strategy to enhance smallholder productivity and alleviate poverty. It enables to relax the liquidity constraints that smallholder farmers' face to improve their risk bearing capability, influencing adoption of new technology. Credit access can have positive affect adoption of technology many adoption studies considered credit availability with respect to the presence or not the credit service. However, farmers are sensitive to the cost of money, delivery the credit and returns of investment. Credit access was expected to influence level of adoption positively. Access to credit is measured in terms of whether respondents have got any form of credit for agricultural purposes. It was dummy variable and expected that credit enhance the probability of adopting improved chickpea technologies (Berihun *et al.*, 2014; Afework, 2015 ; Mesfin ,2017).

Total livestock owned was a continuous variable measured in Tropical Livestock Unit (TLU). The sources show that the higher the total livestock owned by the respondent the higher the probability of participation in small-scale irrigation practice (Hadush, 2014; Shelame *et al* , 2017). This result could be related with the possibility of using the livestock sale at the time of technology as a source of income that can be used for expending on adoption of the technology.

Experience of house hold head was a continuous variable measured which was an individual is exposed to the innovation's existence and gains some understanding of how it performs .Having experience of the technology was crucial for effective and efficient utilization of the technology. So, it expected that beekeepers who have sufficient knowledge of the technology adopt then technology. Dawit & Abdusalem, (2018)

Family size is the number of people living in a house as a parents, children, and relatives leaving together. It is a continuous variable which indicate the number of person living in the house of the farmers. This indicates the family with large number is has a capacity in adopting the new technology during their farm production effort by Negera & Getachew (2014) Factors affecting adoption of chemical fertilizer by smallholder farmers in Guto Gida Distirict was explained.

Age of household head is measured in numbers of years. Older have good experience in crop production than younger. However, when household head is older, he or she may also reduce the flexibility to accept new technologies based on the risk. Therefore, it is difficult to determine the sign of the factor on the adoption of chickpea technology (Berihun *et al*., 2014; Mesfin ,2017).

Availability of accessories of the new technology and all other necessary inputs to small holders at the right time and place and in the right quantity and quality should be increase (Shumat, 2011; Shelame *et al* , 2017).

As Petros *et al*., (2017) studied on determinants of small-scale irrigation use the case of Boloso Sore District, Wolaita Zone, and Southern Ethiopia using logistic regression, obtaining training on the technology influence adoption of the technology. This implies that beekeeping training was very important to explain awareness on the technology as well as to make the beneficiary more productive.

Gender of house hold measured dummy variables which takes a value of 1if the household is male and 0 if female. The studies conducted on this variable male-headed household have more access to improved check pea technologies, land and extension than male headed household (Kinfe *et al*., 2012; Muhammad *et al*., 2013)

Income of the household is positively and significantly influencing adoption of agricultural technology. The farmers with higher income can easily buy the inputs required for than lower income households. (Kinfe et al., 2012; Abebaw *et al*., 2015; Temesgen, 2017). Income of the household is the total family income gain from farm and off farm sources measured in Birr and As (Melaku, 2006) expected that the higher income increases ability of farmers to afford adoption and farmers having a large area for their apiary site encourage the practicing

the Kenya top bar hive technology. Hence it is stated that the both variables large area for their apiary site and income would show a positive relation with adoption the Kenya top bar hive technology.

Honeybee pests, disease and predators reduce honeybees, as the consequence, the hive products are highly affected. It was hypothesized that the adoption of beekeeping technology would be negatively affected by the existence of honeybee disease, pests and predators in the study area (Workneh, 2008).

2. 9.1.2 Factors Influencing Profitability of the technology

Some factors identified to influence profitability of agricultural technology at farm level. These include production costs, yield, farm size, which also influences yield, experience in production of crop which impacts on yield, , family size, labor revenue and income were positive relationship and distance to market and production cost were negatively relationship with profitability. This result was studied by Paul, (2011) an assessment of factors influencing the profitability of bean production in Zambia by using multiple regression model.

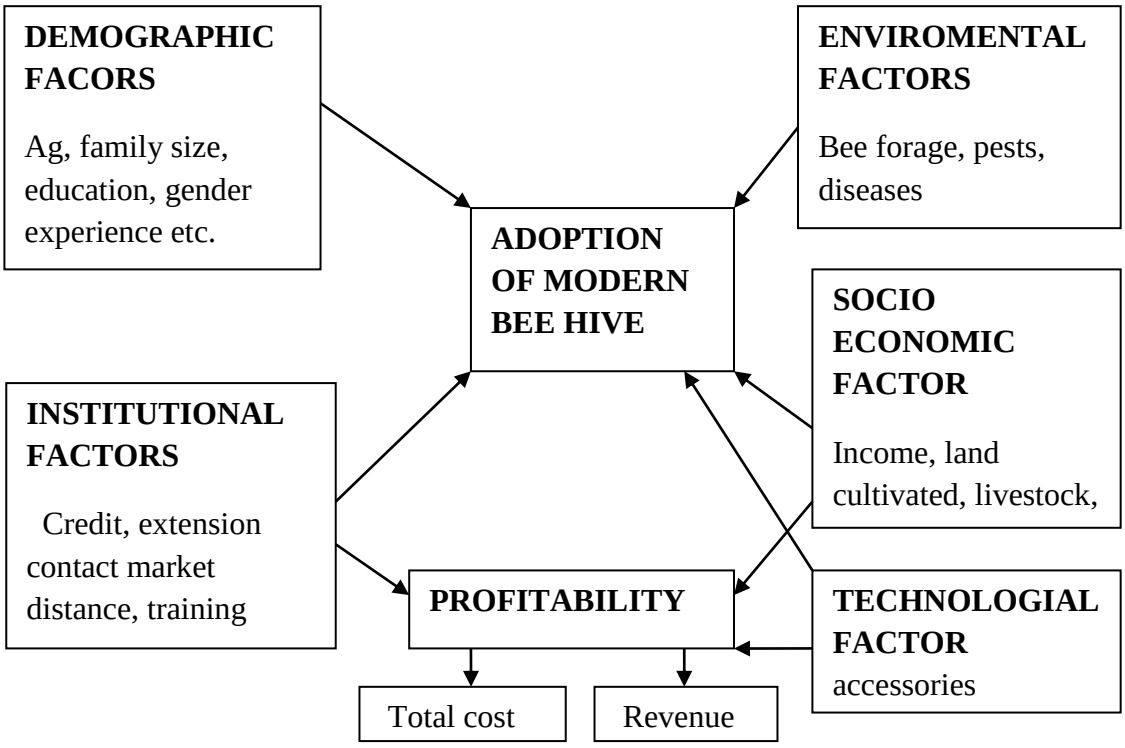
For farmers in Africa and elsewhere, net productivity is critically dependent on crop prices, level of output, and production costs)., farm location, interaction between production costs and farm gate price as well as the interaction between the varieties used and fertilizer applied were significant in explaining the observed sorghum gross margins (Astewel , 2010 ; Saimon, 2016 ; Melesse, 2018). In another study, (Sulumbe, *et al*., , 2010) looked at the profitability of cotton production under sole-cropping in Nigeria; they reported that, family size, income and extension were positively related to cotton output.

According to the result studied by Teresa and Lirag (2019) Determinants of Profitability of Sweet Potato Production in Camarines Sur, Philippines, Access to credit and extension contact increases profitability of the production.

Acording to the Ahmed, (2017) studued on Comparative analysis of profitability of honey production using traditional and box hives Saud by using OLS model results indicated that Reveneu of box hive increases profitability of box hive technology.This implies reveneu of box hive was better than tradional bee hives

2.10 Conceptual Framework

There are many factors that influence the adoption and profitability of modern bee hives. The findings of different studies conducted on adoption of the technology in different parts of the world gives an indication on different factors that can influence the adoption and profitability of modern bee hives of bee keepers. These factors which affect beekeepers' in adoption of modern bee hive are categorized into demographic, socio-economic, institutional and technological factor and environmental factors are source variables either negatively or positively influence adoption of modern bee hive among user and non-user (traditional bee hive user) by beekeepers. Whereas for profitability, factors which affect beekeepers in profitability of modern bee hive are classified into socio-economic, institutional and technological factor, total cost and revenue of the bee hive are source variables either negatively or positively relationship with profitability of modern bee hive among user and non-user (traditional bee hive user).



Source own computation, (2019)

Figure: 1 Conceptual Framework

CHAPTER THREE
RESEARCH METHODOLOGY

Haru district was purposively selected for this particular study because there is high potential of honey production but modern bee hive is not adopted as traditional hive. It was one of the Pilot Learning Sites of agricultural production growth (AGP) project of Ministry of Agricultural that is being implemented by office of fishery and Livestock Woreda.

The information discuss in this session includes the features of the study area where the research would be conducted and the methodologies adopt in the sampling and data analysis. The collection of information included primary data from sample households and review of secondary data from the Woreda agricultural office, CSA and other line governmental and nongovernmental organizations.

3.1 Description of Study Area

3.1.1 Location and physical features

Haru District is located in the west Wollega Zone, Oromia National Regional State, 464 km West of Addis Ababa. The Woreda has 29 peasant associations among 26 rural and 3 urban. The altitude of the Woreda range between 1500 to 2050 meters above sea level, constituting percent 85.3% and 14.7% midland agro ecologies respectively. The Woreda is characterized by steep, slightly steep and plain with slope 20%. The mean annual rainfall is 1700mm (HWOA, 2018).

3.1.2 Population situations and area coverage

The area coverage of the woreda is estimated to be 56393.19hec having of arable land 12785hec, grazing land 580hec, forest 14067hec and irrigation land 848hec, no productive land 940.2201hec, wetland 1663.75hec and water bodies 95.975hec , coffee 24931.54hec and vegetables 481.705hec, (HWOA, 2018). The total population of the woreda is 105,296 the male and female are 50596 and 54700 respectively in this case the male and female accounted for 48 percent and 52 percent, respectively

In food insecure Woredas, the national and regional agricultural policy underscores beekeeping to be the preponderate activity to mitigate the problem. To achieve this target the

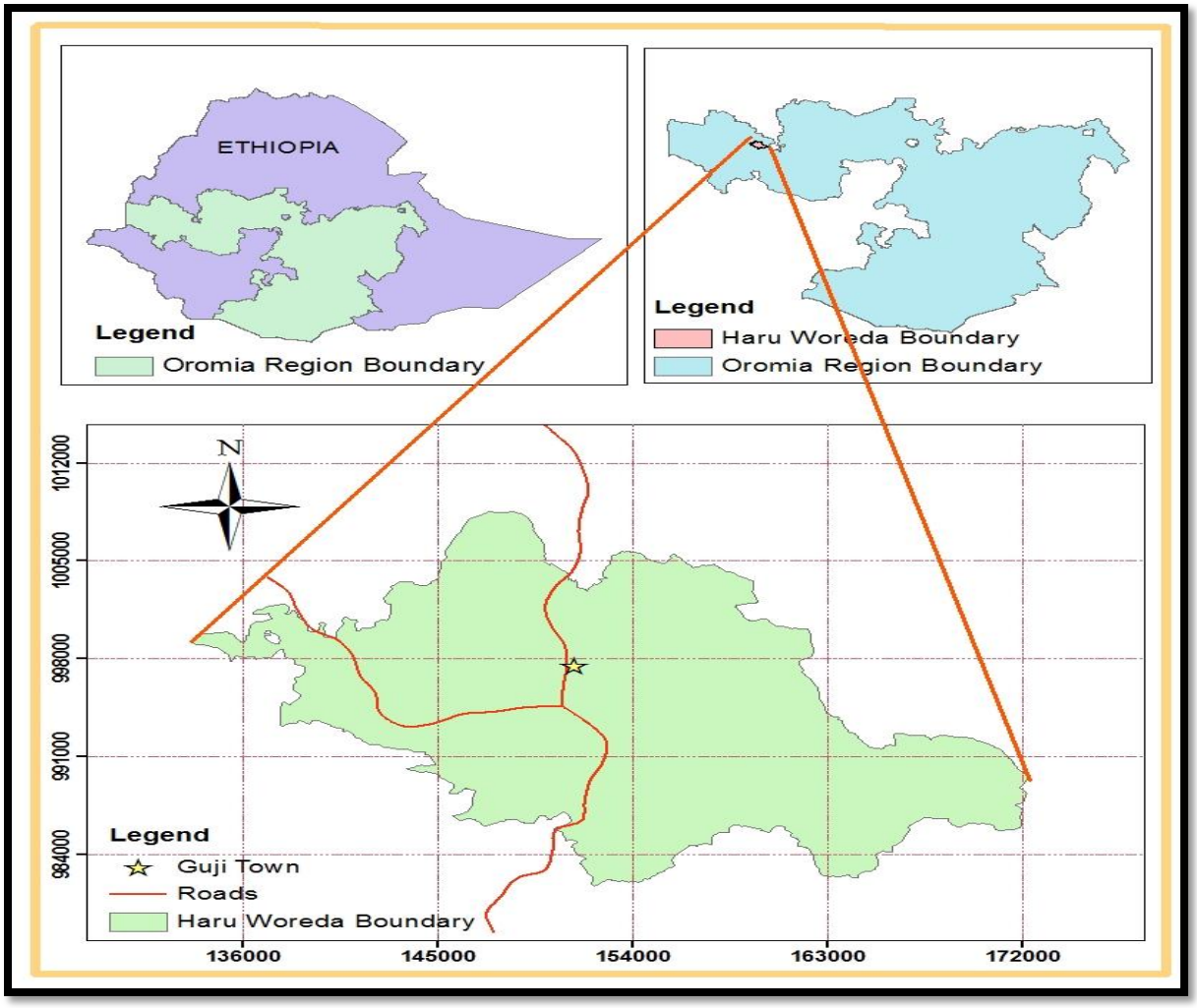
region assigned 2millon birr budget plan for the study Woreda to implement the agricultural program on selected area in 20017/2018.

3.1.2 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 23 agents include18 Development Agents and 5 leader of Development agent that are responsible for providing the necessary technical supports required by the farmers. Development agents vary depending on the steep, slightly steep and plain coverage of the kebele; the overall average being 650 persons. To upgrade the skill and learning capacity of farmers the country revised the extension policy in the year 2017/2018. 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 development agents have been recruited and enrolled in TVET (Technical Vocational Education and Training) and Ethiopian university to acquire the required skills.

3.1.3 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.



Source: Haru Woreda Agricultural Office

Figure 2: Map of Study Area

3.2. Research Design

The research design for this particular study comparative cross-sectional survey study with both quantitative and qualitative components were conducted.

3.3 Data sources, types and collection methods

The study was generated relevant data from both primary and secondary sources. As primary data, it was collected through questionnaire from sample respondents. The questionnaire was prepared based on the study objectives. Following this, interview schedule was used to collect data from the selected respondents. In addition to interview schedule, key informants

interview was employed to collect the required primary data that guide discussion with the concerned bodies to obtain in-depth information about different issues related to the study objectives. With regard to secondary sources; data was collected from review of different documents includes research works, books, office documents, journals, articles, etc. that had been written by different scholars on the related issues.

Primary data were collected through personal interviews by trained enumerators were 138 respondents (62 from technology users and 76 from non-users) at the time of survey using semi-structured survey questionnaire from 309 selected households'. The questionnaire was used to collect information based on socio-economic, personal factors, institutional and environmental characteristics on explanatory variables i.e., include factors influencing adoption of bee hive technologies, and their profitability by comparing traditional and modern bee hive related to cost and returns from them. Both quantitative and qualitative data were collected from farmers. The enumerators and respondents were given training to equip them with the necessary interviewing techniques. Finally enumerator was resume collecting data using the survey (questionnaire) with close supervision of the researcher.

3.4. Sampling procedure and Sample Size

For this study area multistage sampling method was applicable. Woreda was purposively selected because there was high potential of honey production but modern hives technology were not disseminated as traditional hives even there was no limitation of resource. Kebele were randomly selected by using simple random sampling technique among 26 rural kebele 3 kebele selected for this study. Stratified random sampling was employed for selection of farmers. The beekeepers were stratified as modern hive user and non-modern hive user (traditional user). The study then applied simple random sampling to come up with the right interval on which the respondents were randomly picked. The study used Cochran (1963) formula to calculate the sample size based on the sampler proportions which was appropriate of the sample size of study area.

Z = the value corresponding to the level of confidence required (in this case 1.96

Corresponding to 95% level of confidence)

P = estimated level of an attribute that is present in the population (0.1 variability)

Q% = estimated level of the attribute that is not present in the population (0.9)

E% = desired level of precision (in this case 5%)

This compute as:

$n = \frac{Z^2 x\ PxQ}{E^2} = \frac{1.96^2\ x\ 0.1x\ 0.9}{0.o5^2} = 138.$

Table 1: Sample respondent selection across Peasant Associations.

	Kebele/Peasant Association area	Total house hold	Number of beekeeper house hold	traditional bee hive user		Modern bee Hive user		Total sample
				HH	Sample	HH	Sample	
1	Genata Abo	1216	73	60	21	13	9	30
2	Chonge	1411	124	90	32	34	22	54
3	Sedale	746	112	64	23	48	31	54
	Total	3373	309	214	76	95	62	**138**

Source: Own survey result (2019)

3.5 Methods of Data Analysis

3.5.1 Determinants of adoption of Modern Beehive Technology

Whether or not a farmer adopt 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 modern hive, the value (y=1) and for a farmer who does not use, a value (y=0) will be assign. Several models such as simple correlation, linear probability function, etc., can use to analyze adoption behavior of farmers. But this models have limitations in that the t-ratios are incorrect, exhibit hetroscedasticity, non-normality, their estimated probabilities (Pi) may be greater than one or below zero, and assume Pi raise 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 study, logit model was selected for the following reasons: Logit models are nonlinear (in the parameters) statistical models that achieve the objective of relating the choice probability Pi, to explanatory factors in such a way that the probability remains in the (0, 1) interval (Griffiths E.W., Hill, C. R. and Judge, G. G., 1993).) The logistic function represented a close approximation to the cumulative normal and is simpler to work with. The close similarity between the Logit and probit models is dichotomous dependent variables and; 3) In many cases logistic regression is prefer 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. Following (Gujarati, 1995) and (Aldrich, J.H. and Nelson, F. D., 1984)the logistic distribution for the adoption of modern bee hive can be specified as:

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

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

$$Z_i = \alpha + \sum \beta_i X_i \quad (5)$$

α is intercept, β_i is a vector of unknown slope coefficients and X1, X2,----- Xn represent the n explanatory variables.

The Logit model assumes that the underlying stimulus index (Zi) was a random variable which predicts the probability of adoption of modern hive. The slope tells how the log-odds in favor of adopting modern hive 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 & Nelson, 1984) in a ratio form.

If P_i is the probability of adopting the modern hive, then 1- P_i represents the probability of not adopting and can be written as

$$1\text{-}P_i = 1 - \frac{1}{(1+e^{-z}\, i)} = \frac{e^{-z}\ i}{(1+e^{-z}\ i)} = \frac{1}{1+e^{z}i} \qquad (6)$$

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

$$\frac{P_i}{1-P_i} = \frac{1+e^{z}i}{(1+e^{-z}\, i)} = e^{z}\, i \qquad (7)$$

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.

$$L_t = L_n\left(\frac{P_i}{1-P_i}\right) = \text{Ln}\left(e^{\beta_{o+\sum_{j-i}^{n}\beta_o X_j}}\right) = Z_i = \beta_o + \sum_{j-i}^{n}\beta_j X_{ji} \qquad (8)$$

Where, L_i is log of the odds ratio in favor of modern hive adoption, that 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:

$$Z_i = \beta_o + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots\ldots + \beta_n X_{ni} + U_i \qquad (9)$$

The marginal effect of a particular variable on the probability that a particular household decide to adopt is given by:

∂p/∂xk =bk*p*(1-p)

After having the significant factors influencing the adoption decision of farmers, it was appropriate to understand the relative importance of these factors. This can be measure by examining elasticity of variable, as the percentage change in probabilities that 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 associate with P_i, vary the X_j of interest by some small amount and re-compute theP_i, and then measure the rate of change as dP_i/dX_j, where d$X_j$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 & Nelson, 1985)

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

$$= P_i(1 - P_i)\hat{\beta}_j \qquad (10)$$

.

3.5.2.2 Testing for Multicollinearity

Prior to the estimation of the Logit model, multicollinearity diagnosis among the independent variables to unravel the net effect of each variable on the fitted model. This was 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 relate in the particular sample at hand (Gujarati, 1995). For this study Variance Inflation Factor (VIF) can identify the collinear continuous explanatory variables, which is given, by the formula as shown below.

$$\text{VIF} = \left(1 - R_j^2\right)^{-1}$$

Where R_j^2 is the R^2value when the Jth continuous explanatory variables regress on the remaining continuous explanatory variables (Gujarati, 1995). This is 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

more than 10, the variable is said to be extremely collinear. Likewise to identify the collinearity among the qualitative explanatory variables contingency coefficients are computed using the formula shown below.

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

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

Once the estimate coefficients for the fitted model are known, the step 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 relate with 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., $L_{maxx.}$

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

$$-2(\ln Lo/\ln L_{maxx.}) = -2(\ln Lo - \ln L_{maxx})$$

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 is used, which is specified as.

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

Descriptive analysis can identify to observe the profile of the sample respondents to assess the similarities and differences between the adopters and non-adopter. For the analytical methodologies, the researcher use stata version 13 software.

3.5.2 Profitability Analysis

For the profitability analysis comparison of the net return gained from traditional hive and modern consider in per hive basis for the modern hive adopters and non-adopters. Therefore data for different cost items, their cash outlay can collect for each individual that was using the different types of hives to come up for the total cost for the activities. Likewise the yield from traditional and modern hive would be taken from the total revenue those can generate for the activities. Category of cost includes equipment, price of both hives, labor feed cost, bee shed, Category of benefits (revenue from honey selling). Net return analysis (institution made and traditional hive) and a partial budgeting (yield and net returns) employ focusing only in change income and expenses (in this case modern hive). The Total Cost was used to estimate both the fixed and variable costs involve in establishing beekeeping in the study area. Fixed costs did not change with changing production level in the short run while variable costs change with the level of production. This objective was achieved by estimating the fixed costs, variable costs and the total cost (Mansfield, 1990) as follows:

Estimating Total Cost

The total cost was estimated by summing up the total fixed and variable costs incurred in honeybee keeping in the study area. It is given as;

$$TC = TFC + TVC \quad (3.1)$$

Where, TC = Total cost

TFC = Total fixed cost

TVC = Total variable cost

Total Fixed cost

They were cost incur whether or not production has taken place. For this study, the fixed cost will consider depreciation of the fixed items at the present year. The fixed cost component in the apiculture include: Smoker, Protective clothing (bee suit), hand (rubber) gloves, protective footwear (rain boot), a simple knife (hive tool), a hive brush, bee hive and others. The Total Fixed Cost (TFC) is given as;

$$TFC = \sum_{i=1}^{m} D_j Y_j \quad (3.2)$$

Where: TFC = Total Fixed Cost

D_j = Unit depreciation on fixed item j Y_j = Quantity of fixed item j

m = Number of input used

Depreciations on fixed assets can be determined by straight line depreciation method (Cost for the present year) or first year of production. This is given as;

Depreciation per year = $\left(\frac{\text{cost of asset} - \text{residual value}}{\text{use full life}}\right)$ (3.3)

Total Variable Cost

Variable costs were all costs that change in roughly direct proportion to the level of activity. Variable costs were usually avoidable when the enterprise is dropped or discontinued and they can be controlled directly. These affect decision making. For the purpose of this study, the major variable costs associated with beekeeping were the cost of feeding, smoking material, transportation and others. Total Variable cost (TVC) is given as;

TVC = Cost of labor + Cost feed of + …… + Cost of transportation. (3.4)

$$TVC = \sum_{i=1}^{m} V_j Y_j$$

Where, TVC = Total Variable Cost V_j = Unit cost of the variable input j

Y_j = Quantity of variable input j m = Number of input used

Estimating Returns

Output data collect on yield and selling prices of honey and bee wax from beekeeping. The prevailing prices of honey compute by determined the mean of respondents' selling prices and various market prices of honey in the study area.

Net Returns (profit)

This is given as;

NR = TR – TC (3.7)

Where, NR = Net Returns

TR = Total Revenue TC = Total Cost

Multiple Linear Regression Models

Multiple linear regression models preferred to relate effect of explanatory variables on the profitability of technology. In such model, each value of the independent variable (xi) was regressed against the value of the level of technology profitability (y). Each hypothesized explanatory variable was captured in view of future scenario which measures the status of farmers' response towards the technology package assumed in this study. According to (Maddala (1992))the multiple linear regression equation is specified as:-

$$Y = a + \beta_{1X_i}\ \beta_{2X_{2i}} + \beta_{3X_{3i}} + \beta_{4X_{4i}} + \beta_{5X_{5i}} + \beta_{6X_{6i}} + \beta_{7X_{7i}} + \beta_{8X_{8i}} + \beta_{9X_{9i}} + + \beta_{5X_{5i}} + \beta_{10X_{10i}} + \beta_{11X_{11i}} + U_i$$

Where, Y, is the dependent variable which measures the of profitability of modern bee hives and traditional hives:-

i - Individual observation

X_1 - Extension contact

X_2 - Access to credit

X_3 - Labor

X_4 - Market distance

X_5 -income of house hold

X_6 -bee keeping training

X_7 - Experience of house hold

X_{10} - Availability of accessories

X_{11} - Family size

u_i= the error term of the model

α-The constant term (intercept)

β - Regression parameter for the explanatory variables which indicates the slope of predictor variable.

3.6 Definition and Measurement of variables

1.6.1 Determinants of adoption of modern bee hives

Adoption of modern bee hive technology was significantly influenced by personal, environmental, socio economic and institutional factors. Adoption of modern hive technology was the dependent variable of the study. It was represented by 1 if the beekeepers adopt the modern hive and 0, otherwise.

The independent variables that influence the adoption of modern hive technology was selected based on literatures and personal experience. It was discussed as follows:

Age of house hold head (Age):- Age of farmers could generate or erode confidence. With age farmers can become more or less risk averse to new technologies. However, there were mixed results as to the direction of influence. Therefore, in this study it was hypothesize that age of household head are more likely to affect modern bee hive technologies negatively or positively. It was assumed that households with an older age have control over more resources and more experienced, a better reputation, and more responsible. In other words, as the age of the household head increases, the probability of adoption decreases.

Gender of the house hold head (Gender): This variable was found that as the probability of adoption of modern hive higher for male headed household as compared to female headed households as sources from different studies (Kinfe *et al*., 2012; Muhammad *et al*., 2013; Gebrehaweria *et al*., 2014). Therefore, this variable was hypothesized as, if the household head was female there would be low probability of adoption of modern hive beekeeping and less area of land to be cultivated when found using of technology.

Household Head Educational Status (EDUCT): This variable was found by different researchers as the literate respondent most probably participate in small-scale irrigation practice than illiterate counterparts (Edo, 2014; Walellign *et al*., 2018). Based on these reasons, this variable was hypothesized as being more an educated the respondent had more probability of using modern bee hive than counterparts.

Access to Credit (ASSCREDT): Financial constraints are difficult to attain maximum production and adopt new technologies (Hassen Beshire, 2014; Afework & Lemma, 2015 ; Mesfin, 2017; Dawit & Abdusalem, 2018). It was expected that credit increase the probability of adoption of the modern hive technology. Farmers has a capacity to buy modern bee hive with accessories

Extension Contact (EXTCONT):- Household who Participation in the field day and training was expected to positively influence farmers' adoption of improved chickpea technology (Mesfin, 2017; Walellign *et al*., 2018). The positive effect of the extension contact on the adoption of modern hive implies that farmers who have regular contact with extension personnel tend to adopt of the modern bee hive. This implies that a more frequent contact facilitates the flow of new ideas between the extension agent and the farmer thereby giving a room for adoption.

Beekeeping Training (BKEPTRA):- Training was very important to create awareness on the technology as well as to make the beneficiary more productive (Abebaw et al., 2015; Nhundu et al., 2015;Shelame et al , 2017; Dawit & Abdusalem, 2018). Training might have inculcated technical competency, more exposure to the subject matter and convince to adopt the improved and increase the profitability of technologies in the farms. Obtaining the training on the technology has positive influence on the adoption of the technology.

Availability of Accessories (AVASCER):-The availability of the new technology and all other necessary inputs to small holders at the right time and place and in the right quantity and quality should be ensured. It was dummy variable and will be measured using 1 if the accessories are available and 0, otherwise. Therefore, the availability of accessories in the area facilitates adoption of the technology (Shelame *et al* , 2017

Land Holding Size (Cultivated Land Size) (LANHOLD): Those farmers having larger area of cultivable land were found to user more in modern hive than their counterpart as the evidences indicate (Tamirat, 2016). Large size of cultivated land is sometimes seen as social status. Because the status they have in the society may encourage those farmers to use in modern hive farming to maintain their status in the society. Therefore, this variable was expected as influencing the adoption of modern hive farming positively.

Total Livestock Owned (TLU) (**LVSSHOLD**) :- The sources show that the higher the total livestock owned by the respondent the higher the probability of participation in small-scale irrigation practice (Hadush, 2014; Shelame et al , 2017). This result could be related with the possibility of using the livestock sale at the time of modern hive as a source of income that can be used for expending on adoption of the technology. This means the wealth can be used for more investment. Therefore, this variable was expected to enhance the adoption of modern hive bee keeping

Experience of House Hold Head (EXPER): Experience was an individual is exposed to the innovation's existence and gains some understanding of how it performs .Having experience of the technology was crucial for effective and efficient utilization of the technology. So, it expected that beekeepers who have sufficient knowledge of the technology adopt the modern hive concerning to the colony multiplication and harvesting honey system (Shelame *et al* , 2017).

Family Size (FMLYSZE): Farmers with larger family size have a capacity to adopt the technology, to satisfy the need of their family. Hence, it was expected that household with large family would adopt the technology more (Dawit & Abdusalem, 2018).

Total annual income of the household head (LNANUINC): which was the total annual income measured in Ethiopian Birr. Total annual income of house hold head was positively and significantly influencing adoption of agricultural technology. The higher the total income of the household, the higher the probability of adoption of modern bee hives by bee keepers. This could be the case if the farmers with higher income can cover the modern bee hives cost easily than lower income households. The farmers with higher income can easily buy the inputs required for modern bee hives than lower income households. Therefore, this variable was influencing the adoption of modern bee hives positively (Kinfe *et al*., 2012; Abebaw *et al*., 2015; Temesgen, 2017).

Table 2: Summary of variables on determinants of adoption of the modern bee hives.

Variables name	Measurement	Unit	Expected sign
Age	Continuous	Year	- +
Educational	Continuous	Grade	+
Family size	Continuous	Number	+
Access to Credit	Dummy	Yes=1, no= 0	+
Extension Contact	Continuous	Frequency	+
Beekeeping training	Dummy	Yes=1, no= 0	+
Availability of accessories	Dummy	Yes=1, no= 0	+
Livestock holding	Continuous	TLU	+
Annual income	Continuous	Birr	+
Experience of house hold head	Continuous	Year	+
Sex	Dummy	Yes=1, no= 0	-
Land holdings	Continuous	Hectare	+

1.6.2 Determinants of profitability of modern bee hives by beekeepers

Profitability of modern bee hive technology was significantly influenced by below explanatory variables. Determinant of profitability of modern hive technology was the dependent variable of the study. It was a continuous variables that measured by Birr.

Access to Credit (ASSCREDT): Financial constraints are difficult to attain maximum production and profitability of new technologies. There was positive relationship between credit and profitability of modern bee hives. It was expected that credit increase profitability of modern bee hive technology ((Saimon, 2016; Yitbarek. 2017; Teresa and Lirag, 2019).

Extension Contact (EXTCONT):-. There was positive relationship between extension contact and profitability of modern hive implies that farmers who have regular contact with extension personnel tend get more profitability of modern bee hive than non-user of modern bee hive ((Saimon, 2016; Yitbarek. 2017; Teresa and Lirag, 2019).

Beekeeping Training (BKEPTRA):- Training was very important to create awareness on the technology as well as to make the beneficiary more productive Training might have

inculcated technical competency, more experience to the subject matter increase the profitability of technologies in the farms level. Obtaining the training on the technology has positive influence profitability of the technology.

Availability of Accessories (AVASCER):- Accessories were very important to make foundation sheet on which the bees develop the cells especially during harvesting of honey. Therefore, the availability of accessories in the area facilitates profitability of the technology. Availability of Accessories increases production of technology (Shumat Asefa, 2011; Melesse, 2018). It was expected that availability of accessories influence positively profitability of modern bee hives

Family Size (FMLYSZE): Farmers with larger family size with active labor more profitable from the technology, to satisfy the need of their family. Hence, it was expected that household with large family influence profitability of the technology (Shelame *et al* , 2017; Melesse, 2018).

Experience of House Hold Head (EXPER): Experience was an individual is exposed to the innovation's existence and gains some understanding of how it performs .Having experience of the technology was crucial for effective and efficient utilization of the technology. There was positive relationship between total cost and profitability of the technology (Ahmed, 2014).

Labor availability: Availability of labor was to influence the profitability of the technology. Beekeeper with larger number of workers was profitable from the technology and it is expected to influence profitability positively (Paul, 2011).

Market distance: Distance to the nearby market and the frequency of contact that the beekeeper maintains with it is expected to influence the profitability of the innovation. Beekeeper near to the market receives valuable information. Therefore, there was negative relationship between market distance and profitability of the technology (Paul, 2011).

Table 3: Summary of variables on factors influencing of profitability of the modern bee hives.

Variables name	Measurement	Unit	Expected sign
Total cost	Continuous	Birr	+
Family size	Continuous	Number	+
Access to Credit	Dummy	Yes=1, no= 0	+
Extension Contact	Continuous	Frequency	+
Beekeeping training	Dummy	Yes=1, no= 0	+
Availability of accessories	Dummy	Yes=1, no= 0	+
Labor availability	Continuous	Man day	+
Annual income	Continuous	Birr	+
Experience of house hold head	Continuous	Year	+
Distance from market	Continuous	Km	-
Revenue	Continuous	Birr	+

CHAPTER FOUR

RESULTS AND DISCUSION

This chapter presents the results and discussion of the study. It is divided into three subsections; the first sub section summarizes results by using descriptive statistics to describe the characteristics of sampled households by using explanatory variables. The second sub-section focuses on profitability of comparing modern hive and traditional hive. The third sub section presents the results from econometric analysis that identifies the determinants factors adoption of modern hive bee keeping.

4.1. DESCRIPTIVE STATISTICS RESULTS

4.1.1 Demographic Characteristics of Household

Table 4: Demographic characteristics of household

	Total Observation =138				User =62				Non User =76			
variable	Age	Family size	Education	Experience	Age	Family size	Education	Experience	Age	Family size	Education	Experience
Mean	48.7	7.06	3.98	2.6	48.06	7.41	5.77	0.22	49.4	6.78	2.51	6.45
Std. Err	12.7	3.48	2.81	0.22	13.1	3.99	2.4	2.4	12.6	2.99	2.18	0.31
Min	21	2	0	1	21	1	2	3	25	2	0	1
Max	68	12	9	18	68	15	9	13	68	12	8	18
T-value age = 0.59 T-value of family size = -1.26 T-value of education = -8.2 T-value of experience = 0.87												

Source: Own survey result (2019)

The average age of the household heads in the study area was 48.7years with a minimum of 21 and maximum of 68 years. The age of the household head influences whether the household benefits from the experience of an older person, or has to base its decisions on the risk-taking attitude of a younger farmer. But there is no a significant difference in the distribution of household head age between modern bee hive users and non-users households (see table 4).

Among the respondents of adopters and non-adopters 88.71% and 85.53 %, respectively are male. The remaining is female. Related to this male headed households dominate the area. With regard to marital status of the respondents 88.4% are married and the remaining 6.5% and 5.1 % are widow and widower, respectively (Table 5)

Table 5: Gender and marital status distribution of household head

Gender of household head	Non-adopter n=76		Adopter n=62		Total observation = 138	
	respondents	Percent	respondents	Percent	respondents	Percent
Female	11	14.47	7	11.29	18	13
Male	65	85.53	55	88.71	120	87
Marital status						
Married	67	88	55	88.7	122	88.4
Widow	9	12	-	-	9	6.5
Widower	-	-	7	11.3	7	5.1

Source: Own survey result (2019)

Family size:

The mean family size of the total sample households in the study area was about 7, with minimum and maximum family size of 2 and 12 respectively (Table 4). The descriptive analysis revealed that there was no significant difference in the family size of households between users and non-users modern hive bee keeping.

Education Level: The mean years of education of the total households in the study area was 3 in terms of years of schooling, whereas the non-user and user had a mean education level of 2 and 4 years of schooling, respectively (Table 4). There was significant difference in the education level between user and non-user modern hive bee keeping household heads at 1% level of significance. The result indicates that, the education level of the user was better as compared to non-user of modern bee hives. This is consistence with the result of (Tadele, 2016 ; Shelame et al , 2017; Dawit &Abdusalem, 2018).

Experience of bee keepers: - The mean beekeepers experience of the total households in the study area was 2.6 years, with minimum and maximum experience of 1and18 years,

respectively. But the mean beekeepers experience of the non-user of modern bee hives was 6.45 with the minimum and maximum experience of 1 and 18 respectively (Table 4). The descriptive analysis revealed that there was no significant difference in the Experience of bee keepers of households between users and non-users modern bee hive technology.

4.1.2 Socio-Economic Characteristics of Households

Table 6: Socio-Economic Characteristics of Households

variable	Total Observation =138		User =62		Non User =76	
	Land holding	Livestock	Land Holding	Livestock	Land holding	Livestock
Mean	1.51	3.09	1.91	2.81	1.18	3.3
Std. Err	1.14	2.57	1.23	2.67	0.95	2.48
Min	0.015	0	0.012	0	0.025	0
Max	5	15	4	8	5	15
T-value of land holding = -3.98 T-value of livestock = 1.2						

Source: Own survey result (2019)

Land Holding Size: This was also used in the analysis of the characteristics of the farm household in the study area. The result of the descriptive analysis shows that the mean cultivable land size calculated for the total sample households in the study area was 1.51 ha, with minimum and maximum land size of 0.015and 5 ha, respectively. On the other hand, the mean land size of the household for non-user was found to be 1.18 ha, with the minimum and maximum cultivable land size of 0.25 ha and 5 ha, respectively, where as that of the user is 1.91 ha, with minimum and maximum of 0.025 ha and 5 ha, respectively. The descriptive analysis revealed that there was significant difference in the cultivable land size of households between user and non-user modern beehive bee keeping at 1% level of significance (table 6). The users have higher cultivable land size on average when compared to that of nonusers. This is consistence with the result of (Tamirat, 2015; Tadele, 2016).

Livestock Holding Households

Livestock production plays an important role in the study area. Farmers rear livestock for various purposes such as for food (source of egg, milk and meat), means of transport, animal dung for fuel wood and organic fertilizer, and means of transport and source of cash for urgent needs Livestock is also considered as a measure of wealth in the rural area. Farm households having a number of livestock are considered as wealthy farmer in the farm community. Livestock holding widely varied among the sampled households (Table 6). The average size of livestock holding in tropical livestock unit (TLU) for the total sampled households was found to be 3.09 with standard deviation 1.14. Average holdings for user and non-user modern hive bee keeping households were 1.91 and 1.18 TLU with standard deviation of 2.20 and 0.95 respectively. The survey result shows that user households possessed relatively higher number of livestock than nonuser modern hive bee keeping households even though the t-value shows that there is no significant mean difference between two groups.

4.1.2.1 Source of Income

Household gross income is derived from agricultural (crop, livestock and honey) sales and value of crops, honey and livestock products retained for household consumption. In the case of beekeeper, individual household cropping income and cash crop income like coffee. The no non-farm incomes were also computed as part of gross household income (Table 7).

Table 7: Source of Income of house hold

Variable	Total Observation =138			User =62			Non User =76		
	On farm Income	Income selling	Total annual income	On farm Income	Income selling	Total annual income	On farm Income	Income selling	Total annual income
Mean	12378	9304.	24329.	11244.7	11631.5	26087.6	13302.	7405.3	22894
Std.Dv	10291	5420.9	13566.	10710.	4700.5	14835.9	99113	5251.5	12349.
Std. Err	876	461.5	13566.	1360.2	596.9	1884.1	1136.9	602.39	1416.6
T-value of On farm Income = 1.1701 T-value of Income selling = -4.9273 T-value of Total annual = 1.3798									

Source: Own survey result (2019)

Household total annual Income: The total mean annual household income in the study area was 24329.31ETB. From the total mean annual income of a household, cropping contributes share (on farm income) (51%) and livestock and honey production (49%) (Table: 7). the total income difference between adopter and non-adopter household is statistically insignificant (table 6). But 26087.6 ETB and 22894.89 ETB mean total income of adopter was greater than non-adopter of modern bee hive respectively.

Total on farm income: Total cropping income is the amount of mean annual income of a household obtained from types of cropping systems. The mean annual on farm income of sample households from cropping income in the study area was 12378.09 ETB per year. The total mean annual 13302.68 ETB and 11244.71 ETB cropping income of non-adopter households was substantially higher than that of adopter of modern bee hive households respectively. The t-test shows that there is insignificant difference between two groups (table 7).

Livestock income: Sale of live animals and their products are the main livestock-related income sources in the study area. The livestock income category includes income from the sale of livestock, livestock products (i.e. butter, eggs, honey etc.). The mean annual on farm income of sample households from livestock income in the study area was 9304 ETB per year. The mean livestock income for adopter and non-adopter household was 11631.52 ETB and 7405.36 ETB respectively. Adopter of households had larger livestock income than non-adopter households. Based on the results of t-test statistically there is a significant difference between two groups (table 7). This implies that more livestock for the purpose of buying of modern bee hive and accessories.

4.1.3 Institutional Characteristics Table

8: Frequency of Extension Contacts

Variable	Total Observation =138 Extension Contacts	User =62 Extension Contacts	Non User =76 Extension Contacts
Mean	2	0.98	2.62
Std. Err	1.183	0.44	0.894
Min	0	1	2
Max	7	8	7
T-value of Extension Contacts = 15.09			

Source: Own survey result (2019)

Extension Contacts: - explained in terms of opportunities times of adoption on the events i.e., household who Participation in the field day and training. The mean frequency of extension contact of sample households in the study area was 2 times per months. The total mean frequency 0.89 times and 0.98 times extension service of non-adopter households was substantially higher than that adopter for of modern hive households respectively. This implies that a more frequent contact facilitates the flow of new ideas between the extension agent and the farmer thereby giving a room for adoption. Based on the results of t-test statistically there was a significant difference between two groups (table 8). This is consistence with the result of (Mesfin, 2017; Dawit & Abdusalem, 2018).

4.2. Major constraints of beekeeping in the study area

In order to utilize the beekeeping sub sector, identifying the existing constraints and searching for solutions are of paramount importance. The participants identified seven major constraints. All problems cannot be solved at once because of time and capital shortage. As a result, prioritization of the problems was made to identify the most important constraints that hinder the development of beekeeping sub sector in the study area. The constraints can also hinder adoption of modern hives (Table 8).

Table 9: Ranking of beekeeping constraints in the study area

S/n	Constraints	Frequency	Rank
1	Disease and pest	54	1
2	Pesticides and herbicides application	52	2
3	Death of colony	36	3
4	Marketing problem	23	4
5	Lack of beekeeping skill	12	5
6	Swarming	6	6
7	Absconding of Honeybees	3	7

Source: Own survey result (2019)

4.2.1 Major Beekeeping Practices

From the survey result beekeepers are under taking different measures to feed honey bees' swarm especially during the dry season when it becomes difficult for workers bees to find flower from the forest. Therefore, some of beekeepers feed their honey bee by provided that some feed substances like sugar, flour of beans, chickpea and peas and water, plant flowering or trees near their home or back yard use in dry season . There are other activities to be done in beekeeping like: swarm catching, transferring, hive inspection, honeybee feeding, honey harvesting, honey extraction and marketing.

Traditional way of beekeeping does not require any special method of honey harvesting method and the beekeepers just take away the crude honey and sell including its comb mostly of the time without extract the honey using their hands. But modern beehive adopters use honey extractor to harvest honey. All of the adopters get modern beehive accessories like honey extractor, Queen Catcher, Casting mold from Bureau Livestock Development. Those materials are bottleneck because they are expensive and not available in the market.

Table 10: Beekeeping practice

s/no	Beekeeping practice		Adopter	Non adopter	% of Yes
		Yes	52	0	38%
1	Honey bee feeding	No	10	76	
		Yes	44	6	36%
2	Preparing of plant flowering	No	18	70	
		Yes	60	43	67%
3	Colony protecting	No	2	33	

Source: Own survey result (2019)

4.3. Determinant Factors Affect Adoption of Modern Bee Hive Bee Keeping

The Logit model was employed to estimate the effects of the hypostasized independent variables on adoption of modern hive beekeeping status of households. The model estimated groups of adoption of modern hive and non-adoption of modern hive accurately. Six significant variables were identified out of the eleven variables by estimating a Logit model. Among the factors considered in the model, education of household, landholding, Beekeeping training, access to credit, Availability of accessory and Extension contact significantly affected adoption of modern hive bee keeping.

4.3.1. Results of multicollinearity diagnosis

Before the estimation of the parameters of the model, it is crucial to look into the problem of multicollinearity or associations among the potential explanatory variables. If there is multicollinearity problem: standard errors are inflated (creates very large standard errors), sign of the coefficients may be opposite of hypothesized direction. Thus, the existence of serious problem of multicollinearity among the variables is examined by the help of Variance inflation factor (VIF) for the continuous variables (see appendix C) and the values of contingency coefficient (CC) for the dummy variables (see appendix D). For the continuous variables the VIF greater than ten reveals strong correlation and measures inflation in variance due to multicollinearity and the value of contingency coefficient is based measure of association where a value of 0.75 and above shows the existence of strong multicollinearity problem. This is because, for all continuous explanatory variables,

the values of VIF are by far less than10. Based on the results of VIF, the data had no serious problem of multicollinearity. Therefore, these continuous explanatory variables were included in the model.

Heteroskedasiticity (see appendix F) and omitted variables were checked by Breusch-pagan test and Ramsey RESET test (see appendix G), Model Specification Link test (see appendix E) that shows there were no problem in the model for adoption of modern bee hives.

Table 11: The Logistic Regression on adoption of modern bee hive Result

Variables	Odds Ratio	Std. Err	P>|z|	Marginal effect dy/dx
Sex	0.133627	0 .2125613	0.206	- 0.4507
Age	0 .9803888	0 .039704	0.350	- 0.0048033
Education	4.532374	2.260415	0.002 ***	0.3664995
Land holding	6.996971	4.940772	0.006 ***	0.4718071
Livestock holding	1.147308	0.2995209	0.599	0.0333261
Beekeeping training	2646.329	6523.682	0.001 ***	0.9309531
Access to credit	1135.351	3728.972	0.032 **	0.9074196
Availability of accessory	95.57605	170.5223	0.011 **	0.6869532
Extension contact	6.748456	5.903155	0.029 **	0 .4630369
Family size	1.184199	0.243039	0.410	0.0410012
Experience	0.9055964	0 .1949858	0.645	- 0.0240482
Annual income	2.741293	4.115509	0.502	0.2445591
Cons.	6.66e-15	6.76e-13	0.003	
LR chi2 (11) = 160.07	*** ** and * Significant at 1% level, 5% and 10% respectively			
Prob > chi2 = 0.0000				

Source: Own survey result (2019)

Educational level of the respondent: - As the result, the educational level of the bee keepers was positively and significantly to influence the adoption of modern hive beekeeping at 1%. Because educated people has involuntary to adopt new technologies. This implies that

as the educational grade level of farmers is increased, farmers' ability to get, process and use information for their ability of deciding to adopt modern bee hive will also be increased. Its marginal effect shows that one additional education grade level to farmer's household head will increase the probability to adopt modern bee hive by 36.64% marginal effect, holding other factors constant (Table 11 or appendix I). This is consistence with the result of (Tadele, 2016 ;Shelame et al , 2017; Dawit &Abdusalem, 2018).

Landholding: positively and significantly affect adoption of modern bee hive households at significant level of 1%. Because own farm land can facilitate experimentation of modern bee hives technologies for with homestead, planting flora and feeding place. This implies that farmers having area for their apiary site encourage and motivate practicing the modern bee hive beekeeping technology. As land holding of the household head leads by one hectare the probability of farmer's modern bee hive adoption decision increases by 47% marginal effect, holding other variables constant (Table 11). This is consistence with the result of (Tamirat, 2015; Tadele, 2016).

Beekeeping training: - The positive and significantly influence adoption modern bee hives of the technology at 5%. Because farmers who have clear information about the use and the method of implementing the technologies had the highest opportunity to adopt the technology during harvesting and catch queen of bee. The marginal effect showed that change from participant to non-participant on training will change probability of adoption by 93% (Table 11). This is consistence with the result of (Mesfin, 2017; Dawit & Abdusalem, 2018).

Access to credit: - Access to credit was positive and significant influence on adoption of modern bee hive at 5% significance level. The reason behind this is that those farmers who had access to credit sources will be able to buy modern beekeeping equipment and hives better than others that didn't have access to credit. The marginal effect showed that change from user of credit to non-user of credit will change probability of adoption by 90.74% (Table 11). This is consistence with the result of (Tadele, 2016; Dawit &Abdusalem, 2018)

Availability of accessory: -availability of accessories significantly affect at 5%. This implies that the higher access of the modern bee hive's equipment owned has a chance to adopt modern bee hives technology. Accessory enhanced the adoption of modern bee hive those

accessories like smoker, veil, gloves, overall, boots, water sprayer, bee brush etc. used for this technology. Based on the result, adoption of modern beehives technology increases by factor 68.7% of house hold who had accessories of modern hives beekeeping (Table 11). This is consistence with the result of (Shumat, 2011; Zebib, 2014).

Access to extension service: - has positive influence on the probability of modern hive adoption at 5% significance level. Extension service indicated that households who get more extension service have a probability to adopt than households with no or little extension service of their counterparts. Access to extension service is offering information and creating awareness, extension service like advices, training during harvesting, management of hives and catch queen and show technical aspects. Keeping other variables constant, adopters had 46.3% higher probability of adopting of modern bee hive, unlike their counterparts (Table 11). This is consistence with the result of (Mesfin, 2017; Dawit & Abdusalem, 2018).

4.4. Profitability Analysis

4.4.1 Comparing the Profitability of Modern Bee Hives and Traditional Bee Hives

The comparison of modern bee hive user and non-user group is specified in below tables.

Table 12: Modern bee hive user

	Obs	Mean	Std. Dev	Min	Max
Number of modern bee hives	62	1.69	0.98	1	4
Yield per modern bee hives in kg	62	31.25	2.02	26	35
Total yields in kg	62	52.53	30.53	28	136
Unit price in kg/birr.	62	92.80	10.55	70	112
Total price in kg/birr	62	4997.35	3160.58	2100	13600
Profit	62	3581.92	2137.444	730	10100
Total revenue	62	8171.96	3793.37	3150	19260
Total cost	62	2725.194	1662.45	1200	6320

Source: Own survey result (2019)

Table 13: Traditional bee hive (nonuser of modern bee hives)

	Obs	Mean	Std. Dev	Min	Max
Number of traditional bee hives	76	11.51	7.99	2	34
Yield per traditional bee hives in kg	76	5.2	1.58	3	8
Total yields in kg	76	50.98	36.06	8	165
Unit price in kg/birr.	76	75.39	2.68	78	82
Total price in kg/birr	76	3864.96	2725.96	616	12870
Profit	76	1433.36	912.47	90	4845
Total revenue	76	3602.90	1886.75	616	11628
Total cost	76	2329.53	1686.78	390	7140

Source: Own survey result (2019)

Based on below table 12 mean number of modern bee hives, mean yield per modern bee hives in kg , mean total yields in kg , mean unit price in kg/birr, mean total price in kg/birr, mean Profit, mean total revenue and mean total cost were 1.62, 31.25, 52.53 , 92.80, 4997.35, 3581.92, 8171.96 , 2725.194 respectively . Whereas for traditional bee hives, mean yield per traditional bee hives in kg , mean total yields in kg , mean unit price in kg/birr, mean total price in kg/birr, mean Profit, mean total revenue and mean total cost were 11.51, 4.51, 50.98, 75.39 , 3864.96, 1433.36, 3602.90, 2329.53 respectively (table 13). These results imply that, modern bee hive honey production system was more costly and requiring more working capital compared to the traditional honey production system. The net profit for modern bee hive uses were higher that of their counterparts. The modern bee hives technology has been shown to have a higher profitability than the traditional bee hive as shown by the private and social profits which is more efficient to compensate its extra costs.

4.4.2. Category of cost

The analysis was done to arrive at per hive net return from modern hive and traditional hive. The comparison in the modern hive user group was made in two categories, namely kept only homemade modern hive and kept only institutionally provided hives.

For this study, the respondents replied the cost items and their cash expend that were made to run the traditional and modern hive honey production. Service life of the equipment's was

also estimated by farmers. Except for the institutionally provided modern hive, homemade modern hive were constructed from locally available construction materials. The components of the cost items considered are as follows (see table 14).

Equipment: Regardless of the available technologies the ranges of equipment's (accessory hive tools) that are used by the respondents was found to be uniform. Hence an average price of 122.5 birr and a 3-year service life based on data generated from each respondent. Households who either own large number of hive or run both modern hive and traditional hive together were found to be indifferent in terms of the type and holding size of equipment, and hence the same cost was considered for modern hive users. Some equipment like queen excluder, casting mold and honey extractor is not occurring. Because farmer use the equipment during harvesting and catching queen get from office of Haru Woreda Livestock and Fish.

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 her bear arduous egg laying duties. The average cost of a colony was 512 birr. 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. Animals dung was used to plaster the inner sides of the hive. The cost of a medium size traditional hive was estimated to be 45 birr with service life 6 years

i) **Homemade modern hive:** To promote the modern hive 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 modern hive locally. The price was carefully collected from the respondents and estimated to be 1500 birr service life with 10 years.

ii) **Institutionally** provided modern hive are supplied by Haru agricultural office. The hives that are being used are acquired from different sources and programs. To come up with average price, the 2018/19 selling price of 1800 birr associated service life of 10 years was considered.

Labor: labor is needed for hive placement, colony installation, disease and pest inspection, dearth period colony protection and honey harvesting should be substantiated in terms of their labor requirements. Modern hive users in the study area follow the poor 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 50 birr for family labor in the study area during the year. Since harvesting labor also depends on the yield gained, for the modern hive users 3 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/Beso/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 5 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 modern hive was placed in the same shelter together. Hence an expense of 3500 birr and 15 years were assumed for the construction cost and service life, respectively for both the adopter and non-adopter groups.

4.4.3 Net return analysis

In table 15 the different cost items the adopters and non-adopter groups incurred and the revenue generated is revealed for the home made modern bee hive, institutionally provided modern bee hive and traditional bee hive on a per hive per annum source. 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 modern hive, institutionally provided modern hive and traditional hive was 30 kg, 31.25 kg and 5.2 kg, respectively. The result justifies that, by using the modern bee hive, the respondents gain

better yield than the traditional hive. Similarly, modern hive that is provided institutionally shown a yield increment by 1 kg when compared with the yield gained from homemade modern bee hive. The net return analysis shows farmers obtain net return of 1797.17, 1862.56and 33.57birr/hive/annum from homemade modern bee hive, institutional modern bee hive and traditional bee hive, respectively. The net return obtained from both types of modern hive was higher than the traditional hive. Institutional modern bee hive generates higher return than the home made modern hive. This is consistence with the result of (Melaku, 2005; Wongelu, 2017).

In this study area modern bee hive technology was generally profitable. The table below shows that total revenue was more than the total cost incurred by the respondents. All things being equal, greater effort in honey production will enhance the income of the respondents.

Table 14: Inputs costs, gross income and net returns (birr/head) per hive per annum

item	User(62)		Non user (76)
	Homemade	Institutional	traditional
yield of honey (kg/hive)	30	31.25	5.2
Market price of honey (birr/kg	92.80	92.80	75.39
Gross income (birr/hive)	2784	2900	392
Labor cost	150	150	75
Feed costs	5	5	5
bees wax cost	250	250	-
Interest on variable costs (10%)	40.5	40.5	8
Total variable costs	**445.5**	**445.5**	**88**
Depreciation for hive	150	180	7.5
Depreciation for equipment	40.83	40.83	40.83
Depreciation for colony	64	64	64
Depreciation for bee shelter (shed)	233.3	233.3	123.5
Transport (in birr)		20	
Interest on fixed cost (10%)	53.2	53.81	34.6
Total fixed cost	**541.33**	**591.94**	**380.2**
Total production cost	**986.83**	**1037.44**	**358.43**
Net return (birr/hive)	1797.17	1862.56	33.57

Source: Own survey result (2019)

For this study the total number of hives for the entire sample respondents was 1544, the average holding size being 11.2 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; for the homemade modern bee hive 336 kg honey yield and 20128.3 birr net return can be generated; for the institutional modern hive a yield and net return that amounts to 352.8 kg and 20860.67 birr respectively can be secured; from traditional hive 58.24 kg and 376 birr yield and net return can be obtained, respectively (Table 14). Therefore, we can see that if the respondents keep modern bee hive 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 15: Yield gain and net return from average holding size of hive by respondents

	Homemade modern bee hives	Institutional bee hives	Traditional hive
Number of hive	11.2	11.2	11.2
Yield gain (kg)	336	352.8	58.24
Income (birr)	20128.3	20860.67	376

Source: Own survey result (2019

4.4.4 Partial Budgeting

Yield is an important determinant factor in adopting the technology. In the study area the minimum and maximum honey yield per annum for modern bee hive is 26 and 35 kg, respectively. The mean annual honey yield is 31.25 kg. The price of one kg pure honey was ETB 70 at farm gate and ETB 112 at nearby Zonal town but on average 92.80 birr. Hence, beekeepers could get ETB 2187.5-3500 gross benefit per hive/annum. This is consistence with the result of (Melaku, 2005; Ahmed, 2014; Ahmed, 2017).

The partial budgeting reveals that adoption of modern bee hive does result in additional income to the extent of ETB 2131 the study area (Table 16). The income is around three times what one would obtain from the traditional hive. Melaku (2005) using partial budgeting analysis also concluded that both the homemade and institutionally made Kenya Top Bar Hive (KTBH) were beneficial and remunerative. As noted by the author, movable top bar hives result in more net return per colony compared with traditional hives. Comparison of transitional hive with modern hive was not included in this analysis, as the transitional hives were not used in the study area.

Partial budget which depends on 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 (Melaku, 2005 & Workeneh, 2008). 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 modern hive, institutionally provided modern hive 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 modern hive and institutional modern hive in comparison with that of the traditional hive. This result is similar with other finding (Melaku, 2005 & Workeneh, 2008). The analysis of each alternative was carried out on an individual basis as shown below.

Table 16: partial budgeting for modern and traditional bee hives

Additional cost (ETB)	Modern bee hives	Traditional hives	Additional returns)	Modern bee hives	Traditional hives
Transport	20	-	Honey yield	2900	392
Interest on loan	40.5	8			
Feed cost	5	5			
Pure beeswax	250	-			
Labor cost	150	75			
Total cost	465	88			

Net income from modern bee hive (2900– 465) = ETB 2435.

Net income from traditional hive (392 – 88) = ETB 304.

Incremental net benefit per modern bee hive (net income of modern bee hive minus net income of traditional = 2435- 304 = ETB 2131. * Ethiopian birr (ETB). In Jan 2018, USD 1 = ETB 29.

Source: Own survey result (2019)

4.5. Factors Affecting of Profitability of Modern Bee Hives by Bee Keepers

Before the estimation of the parameters of the model, it is crucial to look into the problem of multicollinearity or associations among the potential explanatory variables. The existence of serious problem of multicollinearity among the variables is examined by the help of Variance inflation factor (VIF) for the continuous variables (see appendix C) and the values of contingency coefficient (CC) for the dummy variables (see appendix D). For the continuous variables the VIF greater than ten reveals strong correlation and measures

inflation in variance due to multicollinearity and the value of contingency coefficient is based measure of association where a value of 0.75 and above shows the existence of strong multicollinearity problem. This is because, for all continuous explanatory variables, the values of VIF are by far less than10. Based on the results of VIF, the data had no serious problem of multicollinearity and Heteroskedasiticity. Therefore, these continuous explanatory variables were included in the model.

By estimating of the OLS profitability determinants for modern bee hives user and non-user (traditional hives) headed households and pooled are presented in Table16. All the determinants of profitability were not found to be significant as evidenced by significant t-value and p-value at level of probability. The coefficients of multiple determinations indicate that the variation in modern and traditional bee hives output per hives associated with the factors of profitability specified in the models was 71% and 91% and 60% in pooled, modern bee hives user and traditional bee hive user data set, respectively.

In this model, determinants of profitability of modern bee hive is dependent variables and eleven explanatory variables (input variables) were included and specified by natural logarithm except dummy variables, among four variables namely; Beekeeping training, Availability of accessories, total revenue and Income were statistically significant relationship with profitability of modern bee hives and traditional bee hives (Table 16 and appendix J).

The model estimation was predicted in a manner that the profitability of modern bee hives user and nonuser (traditional).

Table 17: Factors affecting of Profitability of modern bee hives (OLS)

	Pooled (138)			User (62)			Non user (76)		
Variable	Coeffici	SE	T – value	Coeffic	SE	T-value	Coeffic	SE	T-value
Extension contact	1.798*	0.74	2.43	0.35	0.672	3.2	0.160	0.196	0.82
Access to credit	0.0022	0.008	0.28	-0.021	0.18	-0.12	0.237	0.61	0.39
Beekeeping training	0.27*	0.11	2.46	-0.0025	0.23	-0.11	0.693 *	0.21	3.3
Accessories	0.43*	0.13	3.31	-0.112	0.144	-0.77	0.2039	0.298	0.29
Market distance	0.00096	0.012	0.08	0.0227	0.0050	0.45	0.220	0.21	1.05
Labor	0.0003	0.123	0.000	-0.066	0.073	-0.90	-0.1625	0.321	-0.51
Experience	-0.005	0.086	-0.05	0.0015	0.081	0.000	-0.031	0.102	-0.31
Family size	-0.0024	0.002	-1.21	0.036	0.023	0.16	0.1020	0.114	0.54
R^2	0.69			0.82			0.64		
observation	138			62			76		
F(11,64)	23.25			6.967			21.46		
Prob > F	0.0000			0.0000			0.0000		

* ,** and *** Significant at 1% level, 5% and 10% respectively

Source: Own survey result (2019)

Access to extension service: - has positive influence on the profitability of both hive at 1% significance level. Extension service indicated that households who get more extension service have a more than households with no or little extension service of their counterparts. Access to extension service is offering information and creating awareness, extension service like advices, training during harvesting, management of hives and catch queen and show technical aspects. Profitability of both hives increase by factor 1.79% unlike their counterparts (Table 11). This is consistence with the result of (Mesfin, 2017; Dawit & Abdusalem, 2018).

Beekeeping training (bkeptra):- In this study, Beekeeping training had positive and a statically significant relationship with profitability of modern bee hives and traditional bee hives (pooled) at 1%. Keeping other variables constant, trainers had 0.27 more profitable of both hives, unlike their counterparts (see table 17 or appendix J). Because beekeepers that have clear information about the use and the method of implementing the technologies had the highest opportunity for profitability of the technology. This is consistence with the result of (Bekele & Maryam, 2014).

Availability of accessories (avascer):- availability of accessories significantly influence of the technology at 1%. This implies that the higher access of the modern bee hive's accessories owned are more profitable. Because using of accessories is important to get pure honey at time of harvesting. Based on the result, profitability of both beehives technology increases by factor 0.43 of house hold who had accessories of modern bee hives, unlike their counterparts (Table 17). This is consistence with the result of Shumat, (2011).

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary

A rise in agricultural output and farm income seems to have limited scope in view of the structural constraints. Therefore, subsidiary enterprises could be overcome the problem in augmenting household incomes generates order to perpetuate the livelihood. This can be success based on choice and adoption of modern beehive technology relative to cost and cash return and hive production based on quality and quantity of honey. In study area modern hive is not disseminated when we compare with traditional hive due to lack of information of the technology.

The study was conducted with the objective of examining adoption and profitability of modern bee hive technology in Haru Woreda, West Wollega Zone. This study was under taken in three Peasant Association selected purposively. The data was collected from 138 households by employing multi-stage sampling technique method from the adopters of modern bee hive and non-adopters group from the total beekeepers population. Cross-sectional data were used which was primary data pertaining to 2018/19 or 2010/11 E/C-crop year were collected using a structured questionnaire by assigned of enumerators and Secondary data were obtained from different organizations.

For method of data analysis Econometric software called “STATA13” was used to estimate descriptive statics, Logit and Multiple Regression Model in assessing the adoption and profitability of modern bee hive technology. To identify fitness of the model; multicollinearity specification test and hetroskadisity was checked.

5.2. Conclusion

The specific objectives of this study was to identify the different institutional, demographic, socioeconomic, environmental and technology related factors that determines the adoption of modern hive and to assess the determinants of profitability of modern bee hive technology by beekeepers.

Logit model was used to examine the factors determining adoption of modern bee hive technology and T-test was used for descriptive statics .Based on Econometric model results out of 11explanatory variables, six of them were found to be positively and significant affect adoption of modern bee hive beekeeping technology. These variables were Education and lands holding of house hold are significantly at 1%. Whereas beekeeping training, Access to credit, Availability of accessory and Extension contact, are significantly at 5%.

Multiple linear regression models was employed to identify the determinant factors of profitability of modern bee hives among adopter and non-adopter and the result showed that beekeeping training was significantly and positively relationship with profitability of traditional and modern bee hive technology at 5%. Availability of accessory was significantly and positively relationship with profitability of traditional and modern bee hive technology at1%.

As the result, the educational level of the bee keepers was positively and significantly influences the adoption of modern bee hive. The educational level of farmers increases, farmers' ability to get, process and use information for their technology decisions.

Credit access had significant and positive influence on adoption and profitability modern bee hives technologies in the study area. Credit access can provide financial problems to use modern bee hives inputs and help agricultural investment decision in the study area. However, Haru Woreda Saving and Credit by Primary Cooperatives farmer is the only source of credit which is not enough for investment on beekeeping activities.

Access to extension service is also positively influence adoption of modern bee hive. Extension workers could play a key role in transferring knowledge to the rural people easily there about the technology through technical advice, training on field demonstrations giving aware of the profitability of technologies and willing to adopt new.

Bee keeping training participation had significant and positive influenced on the adoption modern hive technologies. Training participation can improve farmers' skill, knowledge and perception about this technology.

Availability of accessory is positively influence adoption and profitability of modern hive because it needs accessory during harvesting and catch queen bees to keep in hives. Accessories like smoker, veil, gloves, overall, boots, water sprayer, bee brush used for this technology. Bur casting mold and Honey presser are bottle neck because during harvesting farmers get from office of livestock and fish of the Woreda.

Own farm land can facilitate experimentation with new agricultural technologies like used for shading of hive in homestead, planting flora. Farmers having a large area for their apiary site encourage and motivate practicing the modern bee hive beekeeping technology.

Annual income had positive and a statically significant relationship with profitability of modern bee hives. This result means that bee keepers could increase their levels of assets (income) to gain more profits, by expanding more technology.

Revenue or net return of the technology had positive and a statically significant relationship with profitability of the traditional bee hives and modern bee hives (pooled). When revenue of modern bee hives is greater than revenue of traditional bee hives which raise profitability.

Total cost of modern bee hives had negative and a statically significant relationship with profitability of modern bee hives. When cost of modern bee hives and equipment increases profitability of the technology decrease.

Modern bee hives have two sources, namely homemade modern bee hive and institutionally modern bee hive. To compare profitability between traditional and modern bee hives, the yield and per hive net return gained from homemade and institutional modern bee hive were greater than the yield and net return gain from traditional bee hive.

Partial budgeting result beekeepers are financially profited owing to deciding to adopt modern bee hive. The total benefit found from modern bee hive exceeds the benefit from traditional hive. In this case both institutional and homemade modern hive more profit than traditional hive.

Major problems of beekeeping sub sector were identified in the study area. Based upon the ranking result disease and pest, Pesticides and herbicides application, death of colony, marketing problem, swarming and absconding of honeybees were found to be the major constraints in the beekeeping development of the districts.

5.2. Recommendations

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

- Institutionally and homemade modern bee hive give a better yield than traditional hive. Researchers and development workers have to search other alternatives like the modifications of the technology using locally available materials to reduce the cost of the technology. In another way local artisans should be trained about the construction of modern bee hive using locally available material to ensure the supply of low cost modern bee hive.
- Extension contact between beekeepers and extension agents should be further strengthened and by increasing frequency of contact to promote modern bee hive technology that focuses on a practical approach and information about knowledge of the technology. Agricultural extension services have to be provided to farm households including those farmers who are far from development agent offices. Training should also be given by giving attention to wise way of using different chemicals specially herbicides to minimize the death of honey bees. Modern bee hive can be more effective if it is attended by the promotion of hive shading, supplementary feed, bee forage, improved and protection, honeybee colony multiplication and post-harvest handling practices. Extension and NGOs can assist the enterprise in demonstrating their reared honeybee colony to the surrounding beekeepers and other similar areas Extension agent visit has the potential to enhance dissemination and management technology by aware of available information to the farmers and government policy makers to give more attention to new technology.
- Provision of credit services to beekeepers to widen the financial bases of poor beekeepers. Beekeepers can use the credit to buy modern beehive with its accessories

like honey extractor, smokers, brush, gloves, wax stumper and others. Beekeeping cooperative should be strengthened and members are encouraged to pool their resources together to attract credit from financial institutions. Cooperative office of the district and NGOs need to come together to strengthen the existing beekeepers cooperative as they can provide to encourage saving and credit cooperative and good learning environment for similar areas. Government should be encouraging cooperatives services and micro financial institutions strengthen and attract them in terms of number and capacity to reach the rural households need.

- Bee-keeping equipment assess to supply or made accessible to the farmers and great attention has to be given to increase productivity and to take appropriate management practices of modern beehives which can positively affect the probability of adoption of modern beehives and capacitating of the farmer to save and credit as primary cooperate the farmer to buy accessories like casting mold and honey extractor.
- Appropriate prevention and controlling methods of pests and predators, especially ants, wax moth and birds; have to be further studied by biological researchers. Also, appropriate coping mechanisms for bee-keeping during drought have to be further studied by biological researchers.
- Education level of house hold head and practical knowledge of the technology were found to be positively and significantly influencing adoption decision of modern bee hive. The educated beekeepers can easily understand the basic management practices of beekeeping and they also know the advantage that is obtained from improved beekeeping by comparing with traditional beekeeping. Hence, it is appropriate for research, beekeeping extension and NGOs to target them during on-farm research and modern bee hive technology promotion as they can easily understand about the technology which, in turn, helps for convincing the others to adopt the technology.

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APPENDIX

Appendix A: Conversion factor used to calculate man equivalent.

Age group(years)	Man days (MD)	
	Male	Female
<10	0	0
10-13	0.2	0.2
14-16	0.5	0.4
17-50	1	0.8
>50	0.7	0.5

Source: Stock, et al., 1991

Appendix B: Conversion factors used to estimate Tropical Livestock Unit equivalents.

Animal category	TLU
Calf	0.25
Donkey (young)	0.35
Weaned calf	0.34
Camel	1.25
Heifer	0.75
Sheep and goat (adult)	0.13
Cow and ox	1.00
Sheep and goat (young)	0.06
Horse	1.10
Donkey (adult)	0.7
Chicken	0.013

Source: Stock, et al., 1991

Appendix C: Results of multicollinearity test: Variance inflationfactor for the continuous explanatory variables.

Variable	VIF	1/VIF
exper	1.25	0.798559
lnanuinc	1.23	0.812349
educt	1.18	0.848273
extcont	1.16	0.863757
lanhold	1.15	0.870782
age	1.12	0.893883
fmlysze	1.09	0.921645
lvsshold	1.04	0.959218
Mean VIF	1.15	

Source: Own survey result (2019)

Appendix D: Results of multicollinearity test: Contingency coefficient for dummy variables.

	sex	bkeptra	asscredt	avascer
sex	1.0000			
bkeptra	0.0635	1.0000		
asscredt	0.1303	0.3913	1.0000	
avascer	0.0984	0.3653	0.2702	1.0000

Source: Own survey result (2019)

Appendix E: Model Specification Linktest

Source	SS	df	MS	Number of obs = 138
				F(2, 135) = 155.00
Model	23.7863356	2	11.8931678	Prob > F = 0.0000
Residual	10.3585919	135	.07673031	R-squared = 0.6966
				Adj R-squared = 0.6921
Total	34.1449275	137	.249233048	Root MSE = .277

```
     admodhv |      Coef.   Std. Err.      t    P>|t|     [95% Conf.
Interval]
-------------+----------------------------------------------------------
-------
        _hat |   1.252557   .1570478     7.98   0.000     .9419646
1.563149
      _hatsq | -.2385881   .1382186    -1.73   0.087    -.5119419
.0347657
       _cons |    -.02458   .0376328    -0.65   0.515    -.0990062
.0498461
------------------------------------------------------------------------------
-------
```

Source: Own survey result (2019)

Appendix F: Hetroskadisity

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of adoption of modern hive
         chi2(1)      =     0.52
         Prob > chi2  =     0.4715
```

Source: Own survey result (2019)

Appendix G: T o check omitted variables

```
    estat ovtest

Ramsey RESET test using powers of the fitted values of admodhv
       Ho:  model has no omitted variables
                 F(3, 122) =     22.80
                  Prob > F =      0.0000
```

Source: Own survey result (2019)

Appendix H: logistic result of modern bee hives

```
                                                  Number of obs   =
138
                                                  LR chi2(12)     =
160.07
                                                   Prob > chi2     =
0.0000
Log likelihood = -14.910086                       Pseudo R2       =
0.5430

------------------------------------------------------------------------------
-------
```

adoption	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
gender	.133627	.2125613	-1.27	0.206	.005914	3.019294
age	.9803888	.039704	-0.49	0.625	.9055787	1.061379
educt	4.532374	2.260415	3.03	0.002	1.705333	12.04599
lanhold	6.996971	4.940772	2.76	0.006	1.753279	27.92345
lvsshold	1.147308	.2995209	0.53	0.599	.6878	1.913807
bkeptra	2646.329	6523.682	3.20	0.001	21.09976	331902.2
asscredt	1135.351	3728.972	2.14	0.032	1.817296	709307.8
avascer	95.57605	170.5223	2.56	0.011	2.895177	3155.172
extcont	6.748456	5.903155	2.18	0.029	1.215131	37.47881
fmlysze	1.184199	.243039	0.82	0.410	.7920061	1.770602
exper	.9055964	.1949858	-0.46	0.645	.593828	1.381048
lnanuinc	2.741293	4.115509	0.67	0.502	.1445589	51.98358
_cons	6.66e-15	1.34e-13	-1.63	0.003	5.30e-32	835.7448

Source: Own survey result (2019)

Appendix I: Marginal effects after logistic

Marginal effects after logistic
y = Pr(adoption)(predict)
= .41348307

variable	dy/dx	Std. Err.	z	P>|z|	[	95% C.I.	]	X
gender*	-.4507	.2798	-1.61	0.107	-.999102	.097702	.869565	
age	-.0048033	.00975	-0.49	0.622	-.023907	.0143	48.7826	
educt	.3664995	.12043	3.04	0.002	.130468	.602531	3.91304	
lanhold	.4718071	.16544	2.85	0.004	.14755	.796064	1.51011	

```
lvsshold |   .0333261      .06258    0.53   0.594   -.08933  .155982
3.38365
 bkeptra*|   .9309531      .06685   13.93   0.000   .799932  1.06197
.297101
asscredt*|   .9074196      .11932    7.61   0.000   .673563  1.14128
.608696
 avascer*|   .6869532      .16038    4.28   0.000   .372611   1.0013
.724638
 extcont |   .4630369      .22932    2.02   0.043   .013574    .9125
2.88406
 fmlysze |   .0410012      .04968    0.83   0.409  -.056378  .138381
5.7029
   exper |  -.0240482      .05232   -0.46   0.646  -.126597    .0785
5.21739
lnanuinc |   .2445591      .36375    0.67   0.501  -.468373  .957491
9.73062
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(*) dy/dx is for discrete change of dummy variable from 0 to 1
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Source: Own survey result (2019)

Appendix J: Questioners

ADOPTION AND PROFITABILTY OF MODERN BEE HIVE TECHNOLOGY IN HARU WOREDA, WESTWOLLEGAZONE, ORMIA REGIONAL STATE OF ETHIOPIA

Instruction

1. Understand clearly all the questions before stating the interview
2. Introduce yourself to the respondents and make them clear about the objective of the interview
3. Be patient during the interview and express yourself in understandable way to the respondents.
4. Reliable information leads to right generalization. Hence, please write the beekeepers own response properly for each question.

Date of interview_____ Peasant association_____

Code_____

1. Personal Information

1.1 beekeeper house hold information

1.2. Sex_____ Age of house hold in years_____

1.3. Have you attended formal education Yes 1 No 0

1.4.1 If yes, what is the highest grade you complete? _____

1.5.2. If no, a. Cannot read and write b. read and write

1.6. Total family size _____

1.61 How many children under 15 years? _____

1.6.2 How many of your house hold member are adults (15-64) years?_____

1.6.3 How many elder your house hold member (above 64)? _____

1.7. Number of family members working off farm_____

1.8 Family members undertaking full time farming activities

Male _____ Female _____ Total _____

1. 9) No of family members working on farm _____

1.10) if the farmer has farm labor shortage___ Yes □ No □

1.11) If yes, for which kind of the farming activities rank for the farming activities

Livestock rearing____ crop production____ soil conservation activities_____

Beekeeping____ marketing____ and others____

1.12**. Family Labor**

5.1.2.1. Did you use family labor for honey production purpose in 2018/19 production season?

Yes ☐ No ☐

5.1.2.2. If your answer for the above question is 'yes', fill the following table

No.	Hired labor	Total in number	Total days worked (transporting, feeding, harvesting and etc.)
1	Men [17-50 year]		
2	Women [17-50 yea]		
3	Male children [14-16 year]		
4	Female children [14-16year]		
5	Children [10-13year]		
6	Elder men (>50year)		
7	Elder women (>50year)		

2 . Beekeeping

2.2. When did you start beekeeping? _____Years

2.3. How did you start beekeeping? 1. By catching the swarm 2. By purchasing the honeybee colony 3 Through inheritance 4. Any other (specify) _____

2.4. Where do you keep your honeybees? 1. Backyard 2. In forest 3.. Under the roof

4. In the house 5. Any other (specify)_____

2.41 cost of shade keep your hive_____ and how many service life year?_____

2.5. Are you aware of modern hive? Yes □ No □

2.5.1. If yes, from whom you hear about it? 1. Extension agent 2. Radio 3. Field day 4. Neighbor 5. Chart and poster 6. Any other (specify)_____

2.6. Have you ever used modern hive? Yes □ No □

2.6.1 If yes, are you using modern hive? Yes □ No □

2.6 .2 If yes, when did you start utilizing modern hive? _____ E.C

2.6.3. If yes, what is the source of your modern hive?

Sources	Traditional	Intermediate	modern hive
Constructed by beekeepers			
Constructed by local craftsmen			
Supplied by organizations			

2.6.4. If no, why did you not use modern hive? 1. It is expensive 2. It is not available 3. It needs skill 4. Lack of awareness 5. Any other (specify)_____

2.7. Can you buy modern hive whenever you want to buy? Yes □ No □

2.7.1 If yes, you have one or two modern beehives why did you not increase? 1 It is expensive 2. It is not available 3. It needs skill 4. No bee forage 5. Lack of land 6. Satisfaction with the existing number 7. Any other (specify)_____

2.8. Did you use modern hive equipment for 2018/19 production season? Yes ☐ No ☐

2.8.1 if yes fill the Items that are used for beekeeping below

Materials	Home made		Locally made and purchased		Provide on credit (purchased)		Donated by GO or NGO's		Service life time(year)
	Amount	Birr/ETH	Amount	Birr/ETH	Amount	Birr/ETH.	Amount	Birr/ETH	
Institutional Modern bee hive									
Homemade Modern hive									
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 strain material)									
Explain another if there									

2.8.2 If no, why? 1. Not found 2. Expensive 3. I use traditional 4. Any other_____

2.18. Is there any bee-keeping equipment that is unavailable? Yes 1 No 1

2.8.1If yes list the names_____

2.8.2 If no from where you get this accessories during harvesting and catch queen? 1. NGO 2. government (Office of Livestock and Fish) 3. Neighbor beekeeper (primary cooperatives)

2.9. Have you constructed hive shading? Yes □ No □

2.9.1 If no, why did you not construct hive shading? 1. Lack of wood 2. The temperature is not hot 3. Any other _____

2.10 Are you feed your honey bees Yes □ No □

2.10.1 What kind of feed you offered to your honeybees?

No	Types of feed	Amount offered per day per colony(kg)	Period of the year (month)	Costs per kg (ETB)
1	Besso			
2	Shiro			
3	Sugar syrup			
4	Honey + Water			
5	Others (specify)			

2.13. Are there constraints of honeybees in your apiary? Yes □ No □

2.13.1. If yes, what are the major problem found in your apiary? Rank the pest causing the highest damages as below.

S/no	Constraints	Rank
1	Disease and pest	
2	Pesticides and herbicides application	
3	Death of colony	
4	Marketing problem	
5	Lack of beekeeping skill	

2.14.2. If there are ants, do you use improved ant protection method? Yes 1 No 0

2.14.2.1. If yes, what types of ant protection methods you use? 1. Cone shape lamera 2. Cone shape plastic 3. Burned oil 4. Any other_____

2.15 Do you practice colony multiplication? Yes 1 No 0

how many to bought your colony_____ and service time years?_____

2.15.1. If yes, what type of colony multiplication methods do you practice? 1. Overcrowding 2. Splitting 3. Any other_____

2.16. Do you get pure beeswax? Yes □ No □

2.16.1 If yes, how do you get? 1. by purchasing 2. Extracting crude beeswax 3. Any other (specify)_____

2.16.2 if no how many you buy bees wax_____

2.17. How do you handle your honey? 1. By storing in the recommended equipment (plastic jar) 2. By storing in moisture free area 3. By extracting and purifying properly 4. By using all the methods mentioned above 5. Any other (specify)_____

2.18. Is there any absconding from your modern hive? Yes □ No □

2.18.1. If yes, what are the reasons for absconding? 1.Lack of feed 2.Honeybee enemies 3.Honeybee disease4.Indiscriminate agrochemical application5.Any other (specify)_____

2.18.2. If yes, what is the mechanism do you use to stay the honeybee colonies in the new hive?

1. Using queen cage 2. Cutting the wing of the queen

3. Fixing the queen excluder on the entrance of the hive 4. Any other (specify)_____

2.18.3. If yes, how many colonies did you lose this year? _____colonies.

2.19. How do you get extra honeybee colonies for the absconded colony? 1. By caching the swarm 2. By purchasing 3. Multiplying the colony 4. From family 5. Any other (specify)_____

3.Farm characteristics

3.1) Total Farm Size_____ hectare

3.2) Grazing area_____ hectare

3.3) Cultivated area_____ hectare

3.4) Fallow land_____ hectare

3.5) Homestead (hectare) _____

3.6) Others, Specify_____ hectare

3.7) Did you lease in land during the last crop season? Yes 1 No 0

3.8) If Yes what was the area of land leased in? ____ha and what the area of owned land?____ ha

3.9) Did you leased out your land during 2018/19 E.C.? yes □ No □

3. 10) If yes, area of land leased out during 2018/19. _____ hectare

4) **Income**

4. 1 **Crop Production**

Crop Grown, Area Cultivated ,Production and disposal of major and minor crops (Meher and Belg), 2018/19.

Crops Grown	Area Planted (hek)	Total Production Obtained kun)	Unit price (birr/kun)	Amount Consumed at home(kun)	Amount sold to Market (kun)	Lent to Others (kun)	Total Value (birr)
Maize							
Coffee							
Teeff							
Sorghum							
Barely							
Faba Bean							
Field pea							
Others							

4.2) Livestock holding

Income Generated from Livestock Selling, 2018/19

Livestock type	Sold during the year		Total Value in birr
	Number	Price Birr	
Cow			
Calf			
Ox			
Weaned Calf			
Horse			
Mule			
Heifer			
Donkey (young)			
Donkey			

(adult)			
Sheep and Goat (adult)			
Sheep and Goat (young)			
Chicken			
Others			

4.2.1). Did you sell livestock products (milk, butter, hides and skin, etc.) in 2018/19 ? 1) yes □ No □
4.2.1.1) If so, how much did you get during 2018/19 ? _____birr
4.2.3) Did you sell crop residue in the same year? Yes □ No □
4.2.4) If yes, how much birr did you generate? ____birr
4.2.5) Did you sell honey and beeswax in the same year? yes □ No □
4.2.6) If yes, how much birr did you generate? ___birr
4.2.7) If you did not sell honey and beeswax during 2018/19, what were the reasons? 1.price too low
2. no surplus to be marketed 3. Marketing places too far 4. others(specify)
4.2.8) What are the produces you get from your hive?
Honey_____ Beeswax_____ Others, specify_____
4.2.8.1) Where do you sell your hive products?
1. at farm gate 2. taking to local market
4.2.8.2) For how far do you have to walk from your home to sell your products? ____ kms and _____ birr pay for transportation service
4.2.8.3) Who is responsible for selling the products? 1. husband 2. wife 3. children 4. others
4.2.8.4) At what season do you sell your farm produces? _____
4.2.18.5) Were you satisfied with the prices you received for the products? Yes □ no □
4.2.8.6) If not, for which hive products were you dissatisfied? _____
4.2.8.7) What are the major bee product marketing constraints you have observed? (specify

Honey Production by Sample Respondent in 2018/19.

Type of Hive	NO of hives	Total Yield/year(kg)	Average honey yield/harvest/hive(k g		Average beeswax yield/harvest/hive(k g)		Average length of one harvest (no of days)	Unit price (birr) of honey		Total price
			1st Harvest	2nd Harvest	1st harvest	2nd harvest		At farm	At market	
Traditional										
Institutional Modern hive										
Homemade modern bee hives										

Disposal of products gained in 2018/19 E.C

Type of item	Quantity produced (kg)	Unit price (birr)	Disposal of product						Total Value (birr)
			Home consumption		For sale		Free gift to others		
			Quantity (kg)	Value (birr)	Quantity (kg)	Value (birr)	Quantity (kg)	Value (birr)	
Honey									
Bees wax									

4.3 Nonfarm income

Activity	Income	Remark
	Amount (Eth. birr) per year	
Remittance income		
Sale of Firewood		
Sale of Handicraft		
petty trade		
Sales of stone		
Hair dressing		
Sales of wood (Charcoal)		
Sales of local drink		
if others, specify		

5. Credit

5.1 Have you ever used credit for beekeeping? Yes □ No □

5.1.1. If yes, from where did you get the credit? 1. From government 2 . From non-government 3. Primary saving and credit cooperative 4. Any other (specify)_____

4. For what purpose you applied for credit? (More than one option is possible)

Purpose	Yes	No	Purpose	Yes	No
To buy beekeeping inputs	☐	☐	For food purchase	☐	☐
To buy accessories	☐	☐	For health service	☐	☐
For other agricultural investment	☐	☐	For house improvement	☐	☐
To start up new business	☐	☐	Other (specify) _____		
For education	☐	☐			

5.1.2. If yes, what amount of loan did you get in the last year? _____Birr

5.1.3 If no, what was the reason? 1. Not available 2. Interest rate is high 3. Lack of collateral 4. Any other (specify)_____

5.2. What is the repayment period of your credit? 1. One year 2. Two years 3. Three years 4. Four years 5. Five years

5.3. How did you repay your credit? 1. By selling the hive product 2. From other sources 3. Any other (specify)_____

5.4 if yes, how much of interest rate you pay_____

. If "no" to question no. 5.1, why did you not received the total amount of credit you applied for?

Reason	Yes	No
Lack of collateral	☐	☐

Lending policy of the institution ☐ ☐

Other (specify) _____ ☐ ☐

5.5 If your answer for question 'no' why you didn't apply for credit in 2018/19?

Reason	Yes	No	Reason	Yes	No
No need, household has enough	☐	☐	No bank account	☐	☐
Too high interest rate	☐	☐	Not a member	☐	☐
Lack of collateral	☐	☐	Fear of losing collateral	☐	☐
Lack of supplier	☐	☐	Fear of being rejected	☐	☐
Don't know where to apply	☐	☐	Don't like to be indebted	☐	☐
Other (specify) _____					

5.6) 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____

5.7) Is there any organization working on beekeeping activities in your PA? yes □ No □

5.8) If yes, which organizations are working on beekeeping? _____

5.9) If yes, specify the supports you have got so far. _____

6 Extension Contact

6.1 Do you have contact with extension agent? Yes □ No □

6.1.1 If your answer for the above question is 'yes', how many times did the extension workers give you advisor and training services for 2018/19 production season? _____

6.2. What kind of hive products did you produce before using modern hive? 1. Crude Honey 2. Crude Beeswax 3. Crude honey & beeswax 4. Any other (specify)_____

6.5 What kind of hive products did you produce after using modern hive? 1. Pure Honey 2. Pure Beeswax 3. Queen rearing 4. Pure honey and beeswax 5. All products mentioned above

7 **Beekeeping Training**

7.6 Did you ever get beekeeping training? Yes □ No □

7.1.1 If yes, from where did you got the training 1. Research center 2. Agricultural and rural development 3. Non-Governmental Organization (NGO)

4. Any other (specify)_____

7.2.2. If yes, on what area did you get training? 1. Colony multiplication 2. Bee management 3. Hive products 4. Marketing 5 harvesting of honey and catching queen using modern bee hive equipment

7.3.3. If yes, what methods were employed during training? 1. Lecture 2. Demonstration 3. Group discussion 4.

Combination of all 5. Any other_____

7.4.4. If yes, did you find the training useful? Yes □ No □

7.4.1 What changes in the training would have made it more useful?

1. Understanding effective way of using modern hive and accessories
2. Understanding improved beekeeping management (feeding, inspecting, supering etc.)
4 understanding about harvesting honey on traditional hives to protect bees
3. Any other (specify)_____

7.4.2. If yes, can you undertake transferring of honeybee colony from traditional to modern hives? Yes □ No □

7..4.3. If yes, can you undertake honey extraction using honey extractor? Yes □ No □

7..4.4. If yes, can you make foundation sheet using casting mold? Yes □ No □

7..4.5. If no, what was wrong with the training? 1. It focuses only on theory 2. The training duration is too short 4. Lack of experienced trainer 5. It was not based on my need 6. Any other (specify)_____

7.5. How many times did you get beekeeping training? _____ times.

7.5.1. If you got the training two or more times, how did you find it? 1. It was repeated on the same topic and not

useful 3. Any other (specify)_____ 2. It was organized on different topic and I got more skill

7.6. Have you ever visited beekeeping demonstration site? Yes □ No □

7.6.1.If yes, where did you visit? 1. Neighbor apiary site 2. Agricultural and Rural Development demonstration site 3. Research center 4. Nongovernmental organization demonstration site 5. Any other (specify)_____

7.6.2. If yes, who organized the visit? 1. Agricultural and rural development 2. NGO 3. Research center 4. Personal 5. Any other_____

7.6.3. If yes, what new things you learn during the visit? 1. Appropriate site selection 2.Appropriate apiary management 3. Any other (specify) _____

7.6.4. Do you make experience sharing with beekeepers using modern hives? Yes □ No □

7.6.4.1 If yes, on what occasion do you undertake? 1. During formal PA meeting 2.During beekeeping training 3. During `idir` meeting 4. Any other_____ 7