ANALYSIS OF ADOPTION AND FINANCIAL RETURNS OF MODERN BEEHIVES IN GERA DISTRICT, JIMMA ZONE, OROMIA ETHIOPIA

MSC THESIS

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Analysis of Adoption and Financial returns of Modern Beehive in Gera District, Jimma Zone, Oromia Ethiopia

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By

Yohanis Kasahun Getahun

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Jimma, Ethiopia

DEDICATION

I dedicate this Thesis work to my grandfather Mr. Getahun Balcha, not alive now, who I lost during my study period and to my beloved mother for nursing with affection and love and for her dedicated partnership in the success of my life.

STATEMENT OF THE AUTHOR

By my signature below I hereby declare that this thesis is my work and that all sources of materials used for this thesis have been duly acknowledged. I have followed all ethical and technical principles of scholarship in the preparation, data collection, data analysis and compilation of this thesis. Any scholarly matter that is included in the thesis has been given recognition through citation. This thesis has been submitted in partial fulfillment of the requirements for M.Sc. degree in Agricultural Economics at Jimmaa University. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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BIOGRAPHICAL SKETCH

The author was born in East Hararghe zone Gursum district in 1988. He completed his primary education in Fugnan Bira primary school and his secondary school in Gusrum senior Secondory School in Gursum district. He attended his preparatory school at Chercher Senior Secondary School in Chiro town. He then joined Haramaya University in October 2007 and graduated with BSc degree in Agricultural Economics (AgEc) in July 2010. Soon after graduation he served in Jimma zone Gera district as an expert in agricultural and rural development office for three years and head of different governmental offices for four years until he joined Jimma University for his postgraduate study in October 2017.

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ABBREVIATIONS AND ACRONYMS

AGP	Agricultural Growth Program
ANRO	Agricultural and Natural Resource Office
ATA	Agricultural Transformation Agency
CSA	Central Statistical Agency
CBA	Cost benefit analysis
EHBPEA	Ethiopian Honey and Beeswax Producers And Exporters Association
FAO	Food and Agricultural Organization
FTC	Farmers Training Centres
GTP	Growth and Transformational Plan
HBRC	Holeta Bee Research Center
JICA	Japan International Cooperation Agency
KTBH	Kenyan Top Bar Hive
NGOs	Non-Governmental Organizations
OCSSC	Oromia Credit and Saving Share Company
PADETS	Participatory Demonstration and Training Extension System
SPSS	Statistical Package for Social Sciences
TLU	Tropical Livestock Unit
TTBH	Tanzanian Top Bar Hive
WoLFRDO	Woreda Livestock and Fishery Resource Development Office

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ABSTRACT

The objective of this study was to analyze adoption the adoption and financial returns of modern beehives in Gera district Jimma zone, in Ethiopia. The study was based on cross sectional data collected from 197 randomly selected beekeepers selected using two stage sampling procedures. Descriptive statistics, econometric model and partial budget technique were employed to analyze the data. Logit model results showed that adoption of modern beehive is positively and significantly affected by age, education status, income from other non-farm activities, extension contact, access to training and livestock holding, while distance from nearest market it affect negatively and significantly. The partial budgeting result revealed that the yield and per hive net return obtained from modern beehive is greater, which makes smallholder beekeepers earn three times higher net return than traditional beehive. Major challenges that hinder modern beehive utilization were identified. Ranking revealed that honeybee pest and predators, absconding, inaccessibility of modern beehive and accessories, financial limitation, high cost of modern beehive and accessories and poor quality of training were the major challenges. Despite all these challenges, there is an enormous opportunities to enhance the quantity & quality of honey yield in the district by utilizing modern beehive well. This study suggests that the high importance of institutional and government support in the areas of education, extension service, training and infrastructural development (especially market). Therefore, policy and development interventions should give emphasis to the improvement of such institutional support system and so as to achieve the adoption practice which increases production and productivity of small scale farmers.

Key words: *Modern beehive, Gera district, partial budgeting, adoption, Beekeeping*

1. INTRODUCTION

This section discusses about the overall introductory parts of the study which consists background of the study, statements of the problem, research questions and objectives of the study. This section also discusses about the significance, scope and limitation of the study.

1.1. Background of the study

Beekeeping can be sources of valuable economic strength and an important occupation to enormous numbers of rural people's livelihoods worldwide (FAO, 2012). Honey production and beekeeping are environmentally friendly practices and relatively easy to engage in. A wide range of potential of economic contributions can be provided by this beekeeping activity (Minja and Nkumilwa, 2016). Two main economic values could be derived from engaging in beekeeping. The first one is income generation from marketing honey and its by-products and the second one is the creation of non-gender-biased employment opportunities except for traditional forest way of beekeeping which needs climbing big trees which is hard for women. The purely biological nature of bees' activities, such as plant pollination and conservation of natural flora is another benefit of beekeeping (Bradbear, 2009). Currently, bees pollinate approximately 30% of our world's food supply and 90% of all wild plants (Ollerton *et al.,* 2011). This means that every third bite of food we take was made possible by bees. It also means that much of our plant biodiversity depends on bees. Plant biodiversity provides many services to humans such as medicine and climate control (Deirdre, 2013). Beekeeping can coexist almost without difficulty with regular farming activities, such as growing crops, horticulture production, and animal husbandry. But to coexist it needs to be handled properly.

Modern beekeeping in Europe, (the modern system of managing honey bees), emerged about the 18^{th} century when European understanding of bee colonies and their biology made it possible to construct movable comb hives so that honey could be harvested without destroying the entire colony (Crane, 1999). According to Crane (1999) these methods were perfected in Northern America where the European honeybee was being reared by immigrants from Europe.

Africa remained on tradition beekeeping (the old system of managing honeybees) and it has the longest history of traditional beekeeping. Honey hunting and use of traditional beehives is still thriving in many countries of Africa. In Africa, traditional beekeeping is more common than modern beekeeping (Affognon *et al.*, , 2015). Countries such as Sudan, Uganda, Somali and Ethiopia largely use traditional beehives compared to countries such as Kenya, South Africa and Tunisia among others. In comparison to Europe, beekeeping in Africa is practiced as a supplemental income source to households (Dietemann *et al.*, 2009; Carroll and Kinsella, 2013).

Beekeeping in Ethiopia is common and one of the agricultural activities which is practiced by many farmers. Honey and bees wax are the major bee products used for domestic consumption and export earnings, and also plays source of cash income for the rural community. Ethiopia, with around 23.6% of African and 2.1% of the world production, is the leading honey producer in Africa and is one of the ten largest producers of honey and beeswax in the world (FAOSTAT, 2015)**.** According to survey results of CSA 2017, traditional, transitional and improved beehives were recognized for honey production in Ethiopia with total of more than 6.52 million beehives exist, out of which about 6.32mil (96.98%) are traditional, 69,399(1.06%) transitional, and 127,373(1.97%) modern beehives. In Ethiopia, traditional beekeeping is the oldest and the broadly practiced, which have been carried out by the people for many years. Several million bee colonies are managed with the same old traditional beekeeping methods in most parts of the country (CSA, 2017).

According to Holeta Bee Research Centre, there are four different types of beekeeping practices in Ethiopia namely, traditional forest, traditional backyard, intermediate/ transitional and modern beekeeping (HBRC, 2004). Traditional forest beekeeping is characterized by placing of hives in the forest on very tall trees for grasping swarms. It is commonly exercised in forest-covered areas of the country where there is abundant number of bee colonies (Gebretsadik and Negash, 2016). In some places, especially in the western and southern parts of the country, forest beekeeping by hanging a number of traditional hives on trees is widely practiced. The traditional backyard beekeeping is undertaken in protected area for honeybees mostly at homestead. It is mostly practiced with different types of traditional hives. The most common type of traditional hives, known to have been used in

traditional forest as well as traditional backyard is the simple cylindrical type. The transitional beekeeping system is one of the improved methods of beekeeping practices. The use of transitional beekeeping started in Ethiopia since 1976. The types of hives used include Kenyan to-bar hive (KTBH), Tanzanian top-bar hive (TTBH) and Mud-block hives (HBRC, 2004). Among these, KTBH is widely known and commonly used in many parts of the country. Modern beekeeping aimed at harvesting maximum honey season after season without harming the bee colony. It uses different types of frame hives. Zander and Langstroth hives are the most common that exist in the country. The most commonly used hive type in Ethiopia is Zandar type (HBRC, 2004).

Under Ethiopian farmers management condition it is reported that the average amount of honey produced from traditional and transitional beehive is estimated to be 5-6 kg and 7-8 kg per hive per year, respectively. The average yield of honey from modern beehive is 15–20 kg/year (HBRC, 2004). This low productivity of traditional beekeeping was due to the type of hive beekeeping are using. Different beekeeping technologies were introduced and implemented to boost honey production and productivity. Modern beehive is one of the beekeeping technologies introduced to optimize the honey yield season after season without harming bees. This modern beehive consists of accurately made rectangular box hives put one on the other in a tier in three orders.

In Oromia region beekeeping is one source of income for smallholder farmers, as the products had high demand. All the three types of beekeeping were practiced in the region. According to the report of CSA, a total of 3,185,361 hives existed in the region, of which 97.3 percent were traditional hives and 20,490 tons of honey was produced with an average productivity of 6.72 kg per hive, of which 95.7 percent was produced from traditional hives (CSA, 2017).

Gera district is one of the major honey producing districts in Oromia region and also one of the most promising areas for the production of honey (Yoshimasa, 2014). According to the woreda livestock and fisheries resource development office (WoLFRDO) currently beekeeping is practiced by using all the three types of beehive with high proportion of

traditional beehive especially in forest beekeeping areas which indicates that the number of modern beehive is very low as compared to traditional hives (WoLFDRO, 2017).

In order to improve beekeeping sector, selection and adoption of beehive types has to be based on productivity, availability and profitability. So far, there is no study conducted to assess the determinants of adoption of modern beehive and its financial return under the environmental conditions of the study area. Thus, it is essential to identify the determinants of beehive technology adoption, the financial returns of modern beehive utilization and the major challenges of utilizing this technology in the study area. Bradbear

1.2. Statement of the problem

The Ethiopian government, realizing the potential of beekeeping sub sector of the country in 1965, established beekeeping demonstration stations at Holeta, Nekemt, Jimma and others. These demonstration stations aimed at introducing improved beekeeping technologies (box hives, casting mold, honey extractor, honey presser, smoker, water sprayer, veil, and glove) which initially imported from abroad now then which is being produced by different private sectors and enterprises to the beekeepers and to offer beekeeping training for farmers and experts. These beekeeping demonstration stations are working hard on supporting the farmers in honey production by focusing on the use of modern technologies including modern beehive and as a result numerous changes have been recorded.

In order to improve the honey yields both in quantity and quality governmental offices and different Non-Governmental Organizations have introduced modern beehives throughout the country including the study area Gera district. In the study area modern beehive has been disseminated on cash and on aid basis by different organizations like WoLFRDO, JICA, Aspire, AGP and potential suppliers of the modern hive. According to the WoLFRDO modern beehive is introduced in the district before 2 decades, but still most small scale farmers use traditional beehive and thus financial benefit they are gaining is very low as compared to the modern beehive. Even if the productivity capacity of modern hive is high and efficient, the adoption rate of this technology is found at low level in the study area (WoLFRDO, 2017).

Due to the existence of many constraints, the honey sub sector production and productivity is low and it is now contributing much lower than its potential to the regional and national economy. Even if the intervention of the government to minimize the sub sector constraints is taken as a good practice, the beekeepers are not still producing the amount what they are supposed to produce (Yirga and Teferi, 2010).

According to different studies conducted on the adoption of modern beehive such as Gebremichael (2012), Gebiso (2016), Sheleme (2016), Hailesilase (2016), Abeje *et al.*, (2017) and Tarekegn, *et al.*, (2018) almost all beekeepers know the presence of modern beehives technology, but they most of them did not adopt and benefited because of different reasons like personal, economic, institutional and infrastructure and demographic factors. Studies conducted on adoption of modern beehive mostly focused on identifying the determinant factors affecting modern beehive adoption. In this study however, in addition to identifying the determinant factors of modern beehive adoption, it estimates the costs and benefits attributed to beekeeping using modern beehive and traditional beehive. Moreover, most beekeepers in the study area buy and start to use modern beehive but cease to use it continuously year to year due to different reasons so the challenges and opportunities of modern beehive utilization in the study area after adopting was also studied. Moreover, in the study area such studies were not conducted still now to identify and analyze the determinants of adoption of modern beehives and its financial returns.

Therefore, based upon the abovementioned realities conducting the study regarding to the adoption and cost benefit analysis of modern beehive is important. This study identify the determinants of adoption of modern beehive and its financial returns as well as the core problem of not more success of beekeepers by using modern beehive in Gera district, where comparatively high vegetation cover, bee flora and bee colonies are more available when compared to other parts of the country.

1.3. Research questions

This study is expected to answer the following research questions.

- What are the factors that determine the adoption of modern beehive among the small holder farmers in the study area?
- Does utilization of modern beehives makes small holder farmers financially beneficial as compared to that of traditional beehive in the study area?
- What are the challenges and opportunities of modern beehive utilization in the study area?

1.4. Objectives of the study

1.4.1.General objective

The general objective of this study was to analyze the adoption and financial returns of modern beehive by smallholder farmers in the study area.

1.4.2.Specific Objective

- To analyze the determinants of modern beehive adoption by small holder farmers
- To analyze the financial returns of beekeeping using modern beehive in the study area.
- To identify the challenges and opportunities of modern beehive utilization in the study area

1.5. Significance of the Study

Understanding the socio economic factors that determine the adoption of a given technology is crucial for transfer of that recommended technology. This study is expected to provide detailed information on the determinants of modern beehive adoption, its financial return as well as challenges and opportunities of utilizing modern beehive. Different groups and individuals are expected to be benefited from this research output. By using the results of this study the key stakeholders of the beekeeping industry are expected to improve the

adoption level of modern beehive and increase the income generated from the industry thereby improves the living standard of the farmers. Moreover the finding of this study is also expected to contribute for the growing body of literature and can serve as a reference material for further study conducted regarding to related topics.

1.6. Scope and limitation of the study

This study focuses on assessing the determinants of adoption and analysis of its financial returns as well as challenges of utilization of modern beehive by sampling only 197 smallholder farmers that are adopters and non-adopters of modern beehive. In addition to these sample respondents was taken from four kebeles in the study area. In this regard, the results may not entirely be representative of the whole county or the entire country due to the sample size and difference in socioeconomic, environmental and other factors among different areas of the country. However, the research recommendations may as well be applicable to other areas having similar ecological and socio-economic characteristics.

1.7. Organization of the thesis

This thesis is organized to five chapters. The first chapter is introduction which is already discussed. Chapter two reviews literatures about various perspectives of modern beehive adoption. Chapter three was devoted to methodology which describes the study area, sources, type and methods of data collection, sample size and sampling techniques and methods of data analysis. Chapter four explains about results and discussion of variables affecting adoption of modern beehive and partial budgeting. The last section concludes the finding of the study and provides necessary recommendations.

2. LITERATURE REVIEW

Under this section the different literatures reviewed which related to the selected topic will be presented. This section focuses mainly on theoretical, empirical and conceptual frameworks of the study.

2.1. Definition of basic terms and concepts

2.1.1. Adoption

Feder *et al., (*1985), defined adoption as the degree of use of a new innovation in long-run equilibrium, when a farmer has full information about the new technology potential. According to Feder *et al.,* (1985) adoption is classified into individual and aggregate adoption depending on its coverage. Individual adoption stands for the farmer's decisions to introduce a new technology into the production process. Aggregate adoption on the other hand is the process of transmission of a new technology within a region or population as a whole. The study of modern beehive adoption is referring to the first type of adoption. The adoption pattern of a technological change in agriculture is not uniform at the farm level; it is a complex process, which is governed by many socio-economic factors. According to Salim (1986) cited in Muya (2014) the farmers' socio-psychological system and their degree of readiness, exposure to improved agricultural technologies, the institutional factors and the farmers' resource endowment are some of the factors of considerable importance in bringing about the technological change in agriculture. The term adoption is regarded as a variable representing behavioral changes that farmers undertake in accepting new ideas and innovations in agriculture.

The term behavioral change refers to anticipated change in knowledge, understanding and ability to apply technological facts, changes in feeling behavior such as changes in interest, attitudes, aspirations, values and the like; and changes in overt abilities and skills (Ray, 1999). Feder, *et al.,* (1985) also defined adoption as the degree of use of a new technology when a farmer has full information about the technology and its own potential. The authors also defined the second category, aggregate adoption, as a process by which a new technology diffuses or spreads within a region. According to Rogers definition adoption is the mental process through which an individual passes from first hearing about a given

technology to final decision to adopt. Rogers and Shoemaker (1971) defined technology adoption as the judgment made by a farmer to completely use a new technology as the best sequence of action available. The authors further explained that adoption or refusal of an innovation is a decision to be made by an individual.

According to Dasgupta (1989), the adoption process is considered to include several mental stages through which an individual passes after first hearing about an innovation and finally deciding to accept and implement or reject it. The process generally includes five stages: awareness, interest, evaluation, trial and adoption. The time between the awareness of an innovation and its adoption is called adoption period and the length of adoption period varies from individual to individual as well as from practice to practice. Ban and Hawkins (1996) also defined technology adoption as a decision to apply an innovation and to continue to use it. Generally adoption is a function of five features of the technology which are relative advantage or profitability, compatibility or riskiness, complexity, tradability/divisibility, or initial capital requirements, and obtainability (Rogers, 1983).

2.1.2.Technology adoption and decision making

Technology adoption is a decision making process in which an individual goes through a number of mental stages before making a final decision to adopt an innovation. Decision making, in relation to technology adoption, is the process through which an individual passes from acquiring knowledge of an innovation, forming an attitude towards an innovation, decision to adopt or not adopt implementation of the new idea and endorsement of the decision (Ray, 1999). Within the farm household, the ability to make decisions regarding to resource use and technology adoption varies according to age, gender and other categories. The actual decisions can depend on a complex bargaining process among household members. Beyond the household, group processes and the ability to harness them can also play a crucial role in adoption decisions. Moreover, decisions about new technology are frequently encouraged by an intervention in the form of a project (Cramb, 2000).

As Dasgupta (1989) noted that the decision to adopt usually takes time. Normally people do not adopt a new practice or idea as soon as they hear about it. They go through a series of distinguishable stages which include awareness, interest, evaluation, trial and adoption.

Another classification of innovation decision making is given by Rogers, (1983) who identifies five stages, i.e. knowledge, persuasion, decision, implementation and confirmation.

According to Rogers (1983) all farmers do not adopt a given technology at the same time, rather they adopt in order time sequence. Based on the time when farmers first begin using a new technology, they identified and described five possible adopter categories in any social system: innovators, early adopts, early majority, late majority, and laggards. In describing the characteristics of these groups, Rogers suggest that the majority of early adopters are expected to be more educated, venture some, and willing to take risks. In contrary to this group the late adopters are expected to be less educated, conservative, and not willing to take risks.

According to Ehui *et al (2004)* a new technology alone does not guarantee a wide spread adoption and efficient use. To efficiently utilize a given technology a specific technical, institutional and economic conditions needs to be fulfilled. From the farmers' economic perspective, the new technology should be more profitable than the existing alternatives. Technically, the new technology should be easy to manage and adapt to the surrounding socio-cultural situations. Similarly, the availability of the new technology and all other necessary inputs at the right time and right place and in the right quantity and quality should be ensured. In addition, the socio-economic and other demographic factors of a farmer may influence the farmer's decision of either adopting a given technology or not. Hence, the farmer's observed adoption choice for an agricultural technology is likely to be the result of a complex set of interactions between comparable technologies and the farmer's socioeconomic and demographic factors (Ehui *et al.,* 2004).

Wetengere, (2010) observed that when a technology is introduced in a given area, the choices available to farmers are not just adoption or rejection rather some parts of a technology or modification and re-invention may be options too. Farmers' choice whether to adopt an entire package of a recommended technology or just some parts of a technology is influenced the availability of household resources, the degree to which the technology is appropriate for the farmer's farming environment, economic motivation, farmers' characteristics and the farmers' objective for undertaking the activity.

2.1.3.Beekeeping and beehives

Beekeeping

Beekeeping (or apiculture) is the maintenance of bee colonies, commonly in man-made hives, by humans. Most such bees are honey bees in the genus *Apis*, but other honey-producing bees such as *Melipona* stingless bees are also kept. A beekeeper (or apiarist) keeps bees in order to collect their honey and other products that the hive produces (including beeswax, propolis, flower pollen, bee pollen, and royal jelly), to pollinate crops, or to produce bees for sale to other beekeepers. A location where bees are kept is called an apiary or "bee yard". Beekeeping can be undertaken by anyone who has enough ability and determination to look after the bees properly, enough courage to work with bees, and enough money to buy bees and equipment (FAO, 2012).

Honey bee nests

Honey bees use caves, rock cavities and hollow trees as natural nesting sites. In warmer climates they may occasionally build exposed hanging nests. Members of other subgenera have exposed aerial combs. The nest is composed of multiple honeycombs, parallel to each other, with a relatively uniform bee space. It usually has a single entrance (FAO, 2012).

The bees often smooth the bark surrounding the nest entrance, and the cavity walls are coated with a thin layer of hardened plant resin (propolis). Honeycombs are attached to the walls along the cavity tops and sides, but small passageways are left along the comb edges. The basic nest architecture for all honeybees is similar: honey is stored in the upper part of the comb; beneath it are rows of pollen-storage cells, worker-brood cells, and drone-brood cells, in that order.

Beehives

A beehive is an enclosed structure man-made in which some honey bee species of the subgenus *Apis* live and raise their young. Though the word beehive is commonly used to describe the nest of any bee colony, scientific and professional literature distinguishes nest from hive. Nest is used to discuss colonies which house themselves in natural or artificial

cavities or are hanging and exposed. Hive is used to describe an artificial, man-made structure to house a honey bee nest. The beehive's internal structure is a densely packed group of hexagonal prismatic cells made of beeswax, called a honeycomb. The bees use the cells to store food (honey and pollen) and to house the brood (eggs, larvae, and pupae).

Beehives are hollow containers that can be closed and are made to house bees. Beekeeper made hive to provide his honeybees with somewhere they can live, visit plants and produce honey, so that the beekeeper can then conveniently remove the honey without disturbing the bees. To this end, humans have developed various styles of hive. Three types of hives are commonly practiced in the world. These are traditional, transitional and modern hives or fixed comb hive moveable top-bar hive and moveable frame hive (HBRC, 2004 and FAO, 2012).

Traditional (fixed-comb) hives are no more than man-made cavities with a hole in it for the bees to get in and out. These can be hollowed-out logs, bark cylinders, clay pots, wooden boxes, baskets of straw, bamboo, or wicker, mud-plastered wicker containers, or discarded metal cans or drums. In this type of hive the bees attach the combs directly to the upper surfaces of the hive and usually to the sides. Combs can be removed from such hives only by cutting them out, and it is impractical to replace them (HBRC, 2004 and FAO, 2012).

Transitional (intermediate or moveable-comb) is one of the improved methods of keeping bee using top bar-hives. Top-bar hive is a beehive of any size or design in which bees are expected to build their combs down from the top bars instead of attaching combs to the ceiling of the hives as in the case of traditional fixed beehive (Crane, 1999). Types of hives used in transitional beekeeping are Kenya top bar hive (KTBH), Tanzania top bar hive (TTBH) and Mud hive (MH) (HBRC, 2004).

Modern (Moveable-frame or Lang troth) hives is a box hive beekeeping in which combs are built in rectangular frames which may be removed from the hive for inspection or honey harvesting and then return back to the hive for the honeybees to use again. These hives permit the ultimate in manipulation and interchanging of comb. Not only can frames be

interchanged, but so can boxes. Such a system permits a high level of management or "high-tech" beekeeping (HBRC, 2004).

2.2. Improved beekeeping technology development

As stated in Holeta Bee Research Center (2004) the foundation of the whole of our modern beekeeping technology development can be traced back to the Langstroth`s practical application of the concept of the bee space in 1851. The rapid development of modern beekeeping can be attributed to four very important discoveries. The first was construction of movable frame hives in 1806. The second was The application of `bee space` by Langstroth in 1851, and the subsequent development of the modern movable frame hive. Bee space which is 9.5mm air gap between the frames or combs and the hive walls and covers respected by bees. Bee space has high value in the development of improved box hive. If the bee space is wider, unwanted comb is built which makes it difficult to move frames freely. The third was the development of beeswax foundations press in 1857, which make sheets of beeswax with identification of the cell bases. Lastly the fourth was the discovery of centrifugal honey extractor in 1865. In the same year, queen excluder was invented. It helps to protect queen and drone from passing to the honey chamber i.e. the brood could be kept out of the honey stored frames. Generally, the pattern of improved beekeeping was established in the half century between 1851 and 1900 (HBRC, 2004).

2.3. Apiculture extension service in Ethiopia

In Ethiopia beekeeping extension is initiated in 1965 and formally organized and started in 1978 in Holeta with the establishment of a bee research and training center, and other four training centers for production and distribution of equipment and development of marketing access (EBA, 2005). The extension package of the current government is towards gradually replacing traditional beehives with modern wooden frame type. Under the Federal Ministry, Holeta Bee Research Center, Asella and Agarfa Farmers Training Centers, Wondo Genet Forestry Colleges are responsible for research and training at national level. Technology introduction and adoption was focused on modern beehives and low cost beekeeping technologies.

The establishment of the Ethiopian Honey and Beeswax Producers and Exporters Association (EHBPEA) in 2005 has also positive effect in supporting the development efforts of the Ministry of Agriculture. The role of international and local Non-Governmental Organizations (NGOs) in support of government extension program in apiculture should also be mentioned as part of the development strategy at country level (*Shiferaw et al., 2010*).

According to *Shiferaw et al., 2010 et al.,* (2010), to improve knowledge, new methods of knowledge transfer included were: demonstration (on bee forage, apiary site establishment, wax printing), farmer to farmer knowledge exchange, leaflet distribution, and farmers' educational tour within and outside of the district. Moreover, to improve skills, the number of trainings provided for targeted farmers increased with diversified topics focusing on specific issues like bee forage, modern beehives and apiary site management, improvement of traditional beehives, bee-predator control. This increase in frequency of training was also followed by increased supervision and follow up of farmers. To improve the supply of inputs for beekeeping, the extension service also worked on bee colony development, forage development and marketing and linking with other actors. Support for modern apiculture, mainly beehives, was undertaken by safety net projects through WoLFRDO. Traditional beehives were made by the beekeepers themselves and/or purchased from local markets, while modern hives were supplied through the WoLFRDO, the various supporting organizations. Linkages were also made with credit institutions to provide credit for apiculture improvement intervention. Credit was disbursed for farmers to purchase modern hives after they received training; for instance in the study area, credit was provided by Oromia Credit and Saving Institution (OCSSC).

2.4. Honey and other bee products production and marketing

Honey has been highly prized for its flavor, as well as nutritional and medicinal values by the local communities. In areas deficient in other sugar sources, it is highly sought-after for its sweetness and energy-giving properties. The current annual honey production is estimated at approximately 53,970 tones, accounting for about 24 and 2% of the total Africa and world honey production, respectively (Demisew, 2016). In Ethiopia, around 95% of the

honey produced goes to domestic market with about 50% of the honey is used for making honey wine (locally called tej). In most parts of the country almost no wedding or other cultural, religious and social events can be imagined without the honey wine '*Tej*'. Even though honey satisfies the local demand, it is so crude that it cannot compete in the international market. It is useful primarily for honey comb, candle making, cosmetic industries, varnishes ointment and cream, and polishes, creating special forms and surfaces for artistic sculptures and for queen cups preparation to be used for queen rearing to develop and multiply bee colonies.

In Ethiopia, wax is largely collected from traditional hives rather than the modern beehives. The wax yield from traditional hives is estimated to be8–10% of the honey yield, compared to 0.5–2% from modern beehive. In the year 2014 Ethiopia produced 5,344 tons of beeswax, which is 32.65% of the total beeswax produced in Africa (16,366 tonnes), 8.08% of the total beeswax produced globally (66,173 tonnes) (FAOSTAT, 2016) and this makes Ethiopia 4th in the world of raw wax production next to China, Mexico and Turkey (Dayanandan, 2015). It is estimated that about 25% of the total beeswax production is 'lost' due to selling of honey with the wax (not extracted). This includes the loss of beeswax that is sold to consumers with the crude honey. Honey consumers chew the honey and spit out the remaining beeswax.

Honey is almost exclusively used for domestic market, mainly for making local brewery, also called t*ej and biyrth.* Even though the national honey production satisfies the local demand, it is so crude that it could not compete in the international market. To this effect, an average of 3000 tons of honey per annum has been exported to neighboring countries over the years 1984–94. Now this figure has increased to 4252.8 tons in the year 2011-2016 (Demisew, 2016). In beeswax exporting on the other hand an average of 270 tons of wax was exported per year over the period 1984–94, in the year 2011- 2016 it increased to 2255.4 tons. Export of honey is estimated to contribute an average of USD 2.718mill to the annual national export earnings. In the year 2013 the quantity of honey and beeswax exported amounted to 729 and 365 tons, respectively (Mamo, 2016). Although the annual production of both honey and wax is large compared to other African countries, the system

of production commonly exercised is traditional. Almost the entire production is achieved by using traditional beehives, comprising a wide range of sometimes very sophisticated models.

2.5. Cost benefit analysis

The modern economic theory is a structured approach based on the principle that economic agents have a common goal of maximizing profit or welfare. The Cost-Benefit analysis is founded on two main principles (i.e. benefit and cost). The benefits are considered as the gains in human wellbeing, whereas, the costs are the losses in utility or human welfare. According to Boardman *et al* (2017) the cost-benefit analysis involves a complete evaluation of all the gains acquired against the losses incurred and that provides a benchmark for measuring the performance of a project. It requires both valuation and forecasting of all parameters of efficiency using actual prices or shadow prices. The shadow price is the forgone cost to an individual or entire society, whereas the actual price is the prevailing market rate for goods and services.

The main contribution of cost-benefit analysis is derived from its efficiency in resource allocation against competing needs among economic agents (Hahn & Sunstein, 2002). Cost-benefit analysis (CBA) is an established economic analytic tool designed for comparing the benefits and costs of a given project or activity. The CBA procedure enumerates, measures, and evaluates net benefits and total costs. The policy makers and or individuals are able to make informed decisions on the basis of options appraisal outcome. Gittinger, (1982) identifies various measures of comparing costs and benefits in the context of agricultural development projects. The application of the cost theory relates to economic choices that individuals or firms decide upon in any given set of available options. However, if there were no scarcity of economic resources or no alternatives to choose between, then costs and choice would be irrelevant. Full economic evaluation is the comparative analysis of alternative courses of action in terms of both costs (resource use) and consequences according to, (Drummond *et al.,* 2005).

2.6. Profitability of improved technologies

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. As Abebe (2007) cited Gavaian and Gemechu (1996) high yields are not sufficient conditions to persuade farmers to adopt a technology. As is the case of any business, farming with technology application must be basically profitable, or at least more profitable than any other alternative. While standard agricultural budgets omit various hidden costs, such as long lines, inducements, favors etc., they do provide a simple accounting of the financial costs and benefits to farmers of alternative production strategies.

It is obvious that the necessary condition for adoption of any agricultural technology is that it is acceptable to the farmer. Not only should the proposed innovation result in worthwhile monetary benefits, 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.

2.7. Analytical framework of the study

The decision to adopt a technology or not is a binary decision. It can be represented as a qualitative variable whose range is actually limited. This variable is limited because it can only take on two values: 1 or 0 (adopt or not adopt). The main assumptions underlying these models are: 1) the economic agent is faced with a choice between two alternatives e.g. adopt or not adopt a technology (modern beehive in our case) and 2) the choice the agent makes will depend on his/her attributes or characteristics. Such models approximate the mathematical relationships between explanatory variables and the dependent variable that is

always assigned qualitative response variables. Three types of models have been proposed in the econometric literature for estimating binary choice models: the linear probability model (LPM), logit, and probit models represented by linear probability function, logistic distribution function and normal distribution function, respectively. They are applicable in a wide variety of fields (Gujarati, 2004).

The probability model, which expresses the dichotomous dependent variable (Y_i) as a linear function of the explanatory variables (X_i), is called linear probability model (LPM). LPM has some econometric drawbacks like non-normality of the disturbances (U_i), heteroscedastic variances of the disturbances and non-fulfillment of $0<E\ (Yi/Xi)<1$. Therefore, linear probability model is not appropriate to test the statistical significance of estimated coefficients (Gujarati, 2004). The logit and probit models will guarantee that the estimated probabilities will lie between logical limit 0 and 1.

Available evidence shows that the logistic function was the most frequently used function in adoption studies. According to Hosmer *et al* (2013), there are two primary reasons for choosing the logistic distributions: from mathematical point of view; it is an extremely flexible and easily used function; and it lends itself to a meaningful interpretation.

2.8. Empirical review of determinants for adoption of modern technologies

A number of studies have been conducted and documented that some demographic and socio economic factors determine the adoption of modern beehive in developing countries.

The study conducted by Bunde and Kibet (2015) in Kenya, by employing logistic regression model, showed that sex of household head, age of household head, family size and education level of household head significantly and positively determine the adoption of modern beekeeping technologies (Bundo &Kibet, 2015).

Study conducted in former Mwingi District of Kenya by using probit model to identify factors that affect modern beekeeping revealed that years of schooling, apiary visit, CIP participation, yield perception and honey quality perception significantly and positively

affect and household monthly income negatively affects adoption decision of modern beekeeping (Affognon *et al.,* 2015)

The study conducted on adoption and profitability of Kenya Top Bar beehive which may be the first study in Ethiopia by Melaku Gorfu evidenced that household farm experience, perception of timely supply of the technology, extension contact, and visit to apiaries are major adoption determinants (Gorfu, 2005). According to this author higher benefit was realized by institutional KTBH when compared to the home made KTBH and traditional hive; accordingly adopting both institutional provided KTBH and homemade KTBH was beneficiary and remunerative.

According to study conducted by Workeneh Abebe in Atsbi Wemberta in Tigray region using logistic regression; credit, knowledge, educational level of household head, perception and apiary visit were found to be positively and significantly influencing adoption of improved box hive. The net benefit driven from adopting modern beehive is twice as much as that of traditional beehive (Abebe, 2007).

Study conducted by Tamirat Gabiso, employing logistic regression model in Arsi zone Oromia, house type owned by the household, livestock possession, land holding, total bee colony possession, income generated from other non-farm activities, demonstration and training given relating to modern beehive use can significantly affect the adoption of modern beehive and also the financial benefit driven from it (Gebiso, 2015).

According to study conducted by Hailesselassi in Tigray region Saese Tsaeda district using logistic regression model revealed that access to credit, extension service, education level of house hold head, having own farm land, distance from all-weather road and distance from product market positively and significantly affect, age of house hold head and distance from input market negatively affect the adoption of modern beehive (Hailesselassi, 2016).

Using logit regression model Sheleme Refera also reported in his study conducted in East Wollega zone of Oromia that total land area, extension service and education level of household head significantly and positively affect the adoption of modern beehive (Sheleme, 2017).

Study conducted in Wag Himra North Wollo zone of Amhara region by using tobit model clearly shows that age, number of livestock owned, educational level, number of local hives beekeepers possessed, training provided, total annual income of beekeepers, credit service, distance to Kebele agricultural office, extension service, and participation in non-farm income sources are the main determinant factors of probability of adoption and intensity use of modern beehive (Abeje *et al.,* 2017).

Moreover study conducted by Tarekegn *et al., (2018)* in Kaffa, Sheka and Bech Maji zones by employing tobit model to identify the factors that affect adoption and intensity of modern beehive showed that total annual income, extension contact, perception of high price (low), perception of high price (medium) and participation in demonstration positively and significantly affect, and distance from FTC negatively affect the adoption decision of modern beehive (Tarekegn *et al.,* 2018).

Gorfu (2005) conducted his study in Ambasel woreda Amhara region using partial budgeting analysis that both the homemade and institutionally made KTBH were beneficial and remunerative as compared to traditional hives. As noted by the author, movable top bar hives results in higher net return per colony compared with traditional hives. Abebe (2007) also conducted similar analysis in Atsbi Wemberta district Eastern zone of Tigray regional State. He found that the net benefit of improved box hive was around three times higher than that of traditional beehives which makes significant difference in the net benefit of the two hives. In addition to these authors, Gebremichael (2012) also came with similar conclusion in his study using partial budgeting analysis that the net benefit earned from improved movable hive is more than twice that of traditional beehive.

The above reviewed empirical studies indicate that the factors in which adoption of new agricultural technologies influence differs from one area to the other, from one agricultural product to the other, as well as, from one type of technology to another. The net benefit earned from these improved movable hive was also higher than that of traditional hives. Therefore, conducting technology specific and area specific study helps to understand the influence of these expected factors.

2.9. Conceptual framework for the study

A conceptual frame work is a diagrammatic presentation of the relationship between dependent and independent variables which is one element of scientific research process in which a specific concept is defined as a measurable occurrence or in measurable terms that basically give clear meaning of the concept. Based on the above empirical reviews, adoption of a given technology is hypothesized to be influenced by demographic characteristics, socio cultural characteristics, institutional characteristics and economic characteristics of sample respondents. Factors influencing adoption are neither exclusively economic nor purely non-economic. Both economic and non-economic reasons are essential motives for shaping the farmers attitude towards the new technology and its final adoption. The conceptual framework for this study was presented on the figure below (Figure1).

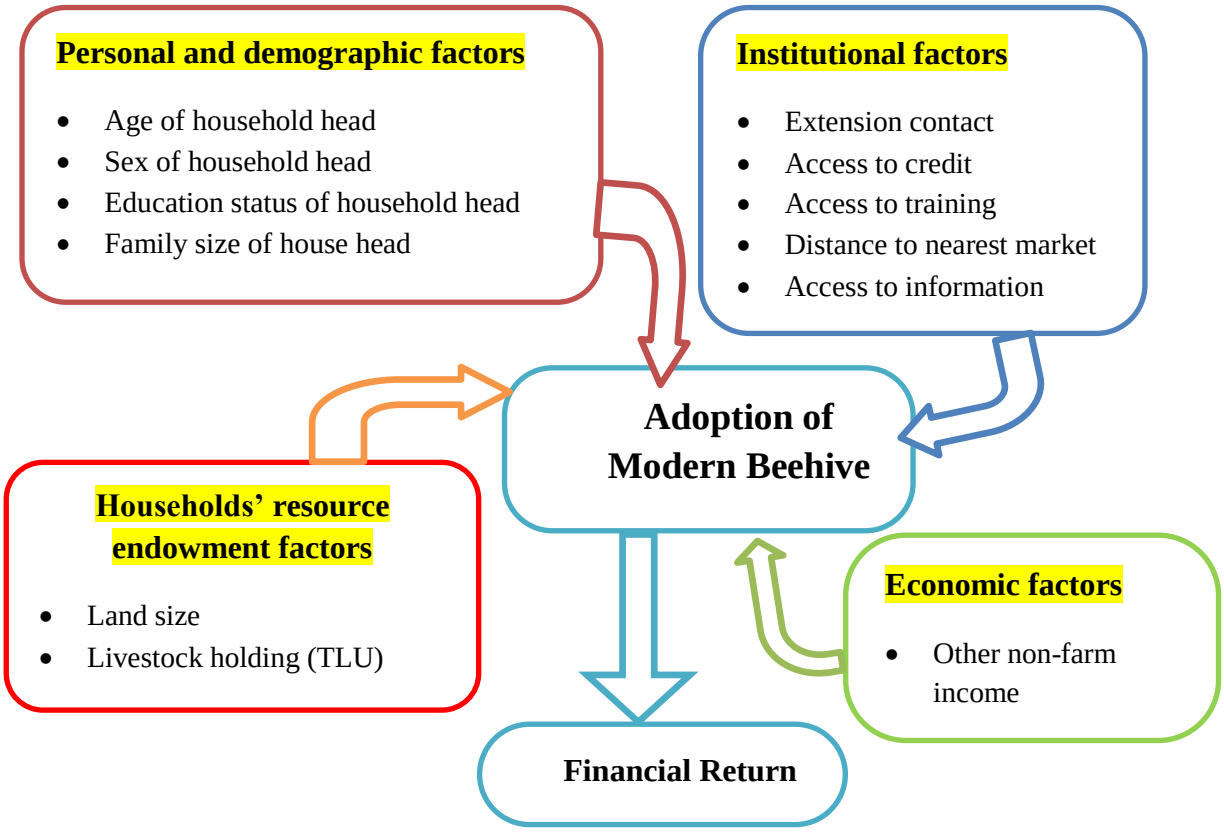

Fig. 1 Conceptual frame work of the study

Sources: Conceptualization from (Abebe, 2007)

3. RESEARCH METHODOLOGY

This section summarizes the overall methodology of the study. This section mainly focuses on description of the study area, data types, and source of data and method of data collection, sampling procedure and sample size. It also describes the methods of data analysis employed (i.e. descriptive and econometrics) in their order. Finally definition and measurements of variables used in the study will be presented.

3.1. Description of the study area

This study was conducted in Gera district which is found in the Jimma zone in Oromia Regional State. It is 465 km away from the capital city Addis Ababa and 98 km far from Jimma city, the capital city of the zone. It is found at Latitude: 7°9' 59.99" North and Longitude: 36° 14' 60.00" East. It is bordered by Goma to the east, Shebe, Seka Chekorsa and Ginbo districts to the south, by the Sigmo district to the west, and Gumay district to the north. According to the WoLFRDO, the district covers an area of 144,320 hectares comprising 31 kebeles, 29 rural and 2 urban kebeles. About 26.5% is arable or cultivable (23.4% was under annual crops), 7 % pasture, 56.6% forest, and the remaining 9.9% is considered degraded, built-up or otherwise unusable.

The total population of the district was 152,238 with a total of 18,816 male-headed households (MHHs) and 885 female-headed households (FHHs). Within the district there is a diversity of terrain—50.2% is considered to be highland (Badda), 46.1% of the area is mid-altitude (Badda Daree), while 3.7% is lowland (Gamoji). The altitude of the district is between 1,390 to 3,200 meters above sea level, giving the area ecologically distinct areas. The district is endowed with natural forests and animals. Rainfall is often in between 1,880 to 2,080 millimeters (mm) per annum. Gera district is known by different agricultural activities like animal fattening, honey production, organic coffee, cereal crop and spice production. Gera is endowed with livestock potential of the 252,438 cattle, 72,940 sheep, 20,594 goat, and 52,584 equine and 61,174 poultry. In the district 13,244 population and 8270 households involved in beekeeping. The total numbers of beehives that exist in the

district were 325,698 traditional, 12,142 transitional and 7851 modern beehives, respectively. (WoLFRDO, 2017).

Map of study area is shown under figure 2.

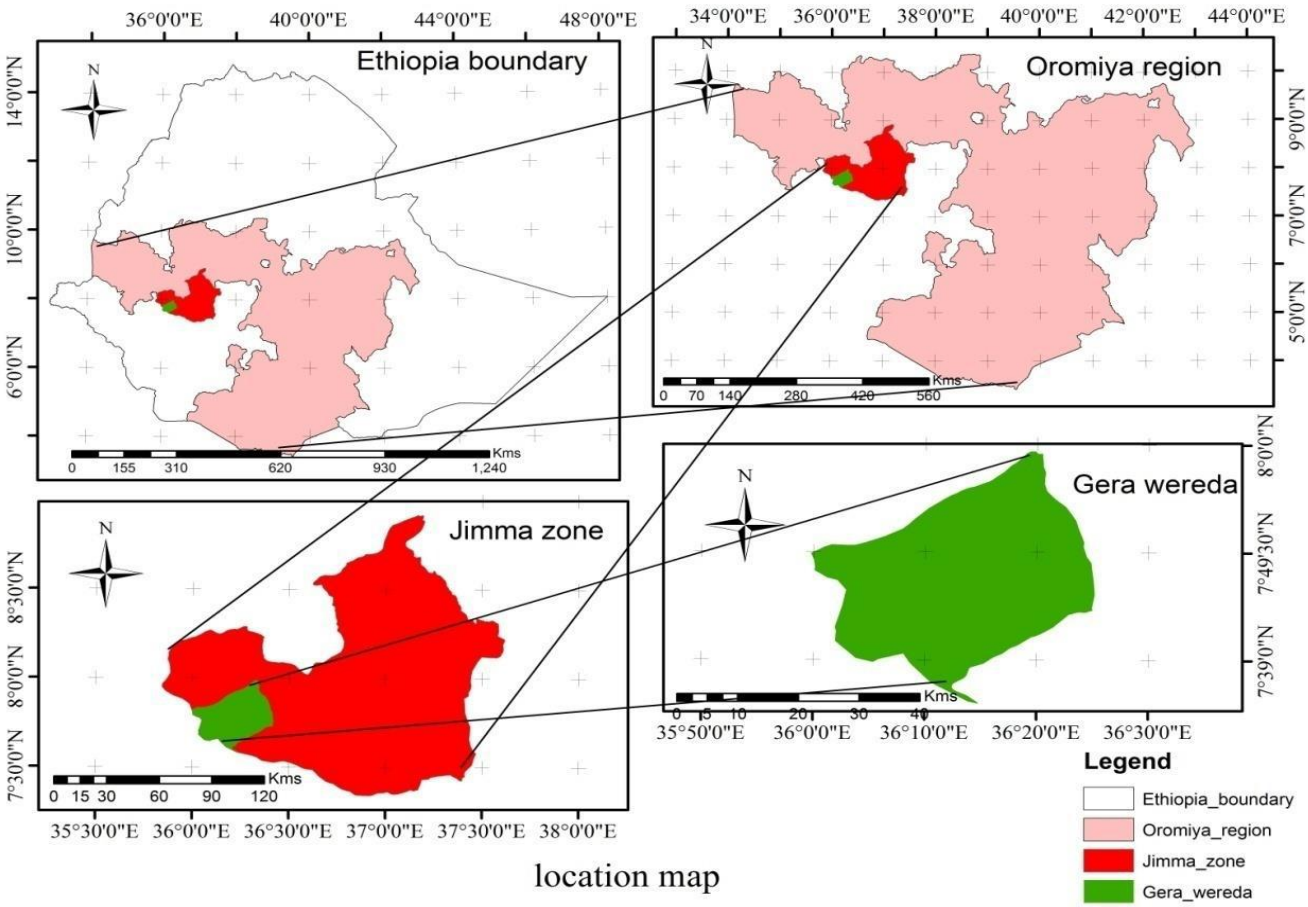

Figure 2: Location map of the study area

3.2. Data source, data type and method of data collection

Both qualitative and quantitative data were collected from both primary and secondary source of data. The data were collected from beekeepers and extension workers of the district. Semi-structured survey questioner was prepared and pre-tested to include all data relating to the proposed study. Based on the information obtained during pre-test modification were made on survey questionnaires. To obtain the relevant information,

observations and personal interviews were conducted with beekeepers and extension workers. Enumerators who know about beekeeping were assigned to collect the data using the interview method, under the supervision of the researcher. Training was given to enumerators regarding to data collection.

Secondary data was collected from different sources such as books, research publications, journals, office reports, CSA reports and Internet. For cost benefit analysis, the data such as price of modern beehive and accessories, honey yield, price, feed cost, labor cost and traditional hive cost were collected from the WoLFRDO as well as sample respondents.

3.3. Sampling procedure and sample size

3.1.1.Sampling procedures

A two stage sampling procedure was used to select the rural kebeles and sample households. There are 29 rural and 2 urban kebeles in the district. In the first stage, out of 29 rural kebeles four rural kebeles were selected randomly. In the second stage, from the list of adopters and non-adopters obtained from the four selected kebeles a total of 197 beekeeper households were randomly selected using probability proportional to size sampling (PPSS) techniques (Table 1)

3.1.2.Beekeepers sampling

The strategy used for sample size determination was Yamane (1967) formula which is convenient for sampling if the total population of the study is finite.

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

Where, n = sample size, N= Number of beekeepers in the district which is 8270 (8102 male and 168 female) (WoLFRDO, 2017) and e = level of precision which is assumed 7% for this study with 95% confidence level. According to this 197 sample respondents were selected from the four randomly selected kebeles.

$$n = \frac{8270}{1 + 8270(0.07)^2} = 197$$

Table 1: Sample size determination from selected kebeles

No	Name of selected kebeles	Total households in the kebele			Beekeeper households in the kebele			Proportion	Sample household from the Kebeles.		
		Male	female	Total	Male	female	Total		Male	female	Total
1	Wanja Kersa	567	43	610	346	24	370	0.29	42	15	57
2	Qacho Anderacha	296	24	320	189	19	208	0.16	24	8	32
3	Ganji Chala	492	43	535	398	27	425	0.33	51	14	65
4	Gara Naso	287	28	315	263	17	280	0.22	39	4	43
	Total	**1642**	**138**	**1780**	**1196**	**87**	**1283**	**1**	**156**	**41**	**197**

Source: Study kebeles profile

3.2. Methods of data analysis

The data collected from sample beekeepers was analyzed and presented using both descriptive statistics and econometric models.

3.2.1.Descriptive statistics

Descriptive statistics like mean, standard deviation, percentages, frequency, ranking and tabular analysis were used to examine and understand the demographic and socioeconomic, and institutional characteristics of sample respondents. Furthermore, it was also used to examine the smallholder farmer's challenges and opportunities of utilization of modern beehive technology compared to traditional bee hive. Chi-square test and an independent sample t-test were employed to know the statistical relationships of explanatory variables on the adopting and non-adopting farmers. Frequency analysis and index analysis was used to analyze the ranked data.

3.2.2.Partial budgeting

For assessing financial benefit of modern beehive partial budgeting was employed. Partial budgets were drawn up for those practices that had limited impacts on the costs and returns of an enterprise. A partial budget is a technique for assessing the benefits and costs of a practice relative to not using the practice. It thus takes into account only those changes in costs and returns that result directly from using a new practice (CIMMYT, 1988 and Roth and Hyde, 2002).

For the assessment of financial benefits of modern beehive comparison of the net return gained from traditional hive and modern beehive was made in per hive basis for the modern beehive adopters. Data for different cost items, their cash outlay, and their service period were collected for each individual respondent that are using the different types of hives to come up for the total cost for the activities. Based on the information obtained a partial budgeting was employed focusing only on the changes in income and expenses that would result from implementing the specific alternative, modern beehive. To get the net benefit of the alternative activities the total cost was subtracted from the total benefit. Finally if the net benefit is positive, the conclusion drawn can be that the activity has financial advantages. However, if the net benefit is negative, the recommendation was, it was better off to stay using the current situation.

3.2.3.Econometric analysis

The logistic function was used because it represents a close approximation to the cumulative normal and it was simpler to work with. Even though there exist statistical similarity between the results of logit and probit model, but logit model is easier to estimate and we use for this study since one advantage that logit has over probit is that it can provide an additional interpretation i.e. the factor change in the odds of an event occurring (Aldrich and Nelson, 1984). In many cases logistic regression is preferred to the probit due to its link to other models such as LPM and its simpler interpretability as the logarithm of the odds ratio and its eminence effort to retrospectively collect data analysis

Following Maddala (1983), Aldrich and Nelson (1984), and Gujarati (2004) the logistic distribution for the adoption decision of modern beehives can be specified as:

$$P_i=\frac{1}{1+e^{-z_i}} \text{ ---------- (1)}$$

where

- P_i is a probability of adoption of modern bee hive for the i^{th} farmer
- e- represents the base of natural logarithms
- Z_i - is the function of a vector of n explanatory variables which is expressed as

$$\mathbf{Z_i = \beta_0 + \beta_{1i}X_{1i} + \beta_{2i}X_{2i} + \beta_{3i}X_{3i} + \beta_{4i}X_{4i} + \beta_{5i}X_{5i} + \beta_{6i}X_{6i} + \beta_{7i}X_{7i} + \beta_{8i}X_{8i} + \beta_{9i}X_{9i} + \beta_{10i}X_{10i} + \beta_{11i}X_{11i} + \beta_{12i}X_{12i} + \varepsilon_i} \text{ ---------- (2)}$$

Where

- Z_i ---- is an underlying and unobserved stimulus index for the i^{th} farmer
- X_1--- is access to credit
- X_2----is access to information
- X_3---is attendance in training relating to beekeeping
- X_4---is distance to nearest market
- X_5---frequency of extension contact
- X_6---is household's farm size
- X_7---is household head age
- X_8--- is household's head education level
- X_9--- is household head sex
- X_{10}---is household's livestock holding

- X_{11} --- is income from other non-farm activities
- X_{12}---- is total family size
- β_0- is the constant term to be estimated
- β_i - are the unknown parameters to be estimated which measures the marginal impact of a unit change in the explanatory variables on the probability of technology adoption.
- ε_i- the disturbance term and n is the number of explanatory variables identified for the study
- If P_i is the probability of adopting modern bee hive then 1- P_i represents the probability of not adopting the technology and expressed as

$$1\text{-}P_i = 1\text{-}\frac{1}{1+e^{-z_i}} = \frac{1}{1+e^{z_i}} \text{ ---------- (3)}$$

Then, the odd ratio of the above two equations is expressed as

$$\frac{Pi}{1-Pi} = \frac{\frac{1}{1+e^{-z_i}}}{\frac{1}{1+e^{z_i}}} = \frac{1+e^{z_i}}{1+e^{-z_i}} = e^{z_i} \text{ ----------(4)}$$

and this equation defines the probability of adoption of modern beehive to non-adoption of the technology. Since we cannot use odds ratio directly in any modeling because they are asymmetric we can transform it using logarithm.

The marginal effect of an explanatory variable on the expected value of the dependent variable is: -

$$\frac{dPi}{dX_i} = \frac{e^{z_i}}{(1+e^{z_i})^2}\hat{\beta}_j = P_i\,(1\text{-}\,P_i)\hat{\beta}_j \text{ ---------- (5)}$$

Finally, the logistic model is expressed as follows by taking the natural logarithm of odd ratio

$$L_i = \ln\frac{Pi}{1-Pi} = \ln e^{z_i} = z_i \text{ ---------- (6)}$$

Where L_i= log of the odds ratio in favor of modern bee hive adoption, which is not only linear in X_i but also linear in the parameters.

This model can be estimated using the iterative maximum likelihood (ML) estimation procedure. In the case of random sample of n observations when the observations are sampled independently the likelihood function will simply be the product of individual contributions as:

$$L=\prod_{i=1}^{n} P_i^{Yi}(1-p_i)^{1-Yi} \quad \text{---------- (7)}$$

Where $\boldsymbol{\Pi}$ is the product operator; P_i is the probability to adopt modern beehive (that is Y_i=1) and 1-pi denotes the probability of the farmer I does not adopt the technology (that is Y_i=0).

By taking its natural logarithm and replacing P_i by $\frac{1}{1+e^{-z_i}}$ and 1-P_i by $\frac{1}{1+e^{z_i}}$ the log likelihood function will be:

$$LnL=\sum_{i=1}^{n} Y_i(\beta_0+\beta_i X_i)-\sum_{i=1}^{n} \ln[1+e^{(\beta_0+\beta_i X_i)}] \text{----------} \quad (8)$$

3.3. Operational definition and measurements of variables

3.3.1.Definition of dependent variable

The dependent variable of the model was $Y_{i,}$ which has a dichotomous nature measuring the adoption of modern beehive of small holder farmers. It was represented in the model by 1 for beekeepers who adopt and by 0 for non-adopting one.

3.3.2. Definition of independent variables

1. **Age of household head (AGE):** is a continuous variable that is measured in years. It is argued that older farmers have more experience and acquire indigenous knowledge than younger farmers, hence, have a higher probability of adopting the practice. It is hypothesized that with the expectation of risk aversion behavior of aged farmers with respect to fear of absconding of bees and other unexpected events, it is unlikely for these farmers to adopt and increase the proportion of modern beehive as age of the farmer's

increases. The risk of modern bee keeping arises from high cost of production, and bee products market price fluctuation. (Hailesselassi, 2016 and Bundo & Kibet, 2016)

2. **Sex of household head (SEX):** is dummy variable taking the value 1 if the sex of household head is male and 0 otherwise. According to different studies male household heads are more likely to adopt modern beehive than female household heads (Dibaba, 2016, Bundo & Kibet and 2016, Hailesselassi, 2016). In this study, it is hypothesized that sex (being male) of household heads has a positive influence on the adoption decision of use of modern beehive.

3. **Educational level of household head (EDUC):** is a categorical variable that takes a value of 0 if illiterate, 1 if the household education level is from 1-4 grade, 2 if the level is 5-8 grade and 3 if the level of education is greater grade 9 and above. It is expected that there is a positive relationship between educational status and adoption, that is, as educated farmers begin to have greater utilization of agricultural information, the tendency was for them to become more innovative than illiterate farmers (Gedefa 2010; Affognon *et al.,* 2015; Bundo & Kibet, 2016; Abeje *et al.,* 2017; Sheleme, 2017 and Tarekegn, *et al.,* 2018) also found that educational status of the household head positively influenced adoption of new technologies. Thus, education level is hypothesized to influence decision on using modern beehive positively

4. **Family size of household (FAMSIZ):** Is continuous variable measured in total number of household members. It can be an incentive for adoption of new technologies as more agricultural output is required to ensure the family livelihood or to satisfy the family need (Bundo & Kibet, 2016). Thus, it is expected that family size positively affect adoption of modern beehive technology.

5. **Frequency of extension contact (FREXCONT):** is continuous variable measured in number of contacts/frequency of yearly contacts with the extension agents. Farmers who have a frequent contact with extension agents are expected to accept and practice new ideas faster than those farmers who made few contacts. It is therefore, hypothesized that extension contact expected to affect decision to adopt modern beehive positively. Farmers who have frequent contact with extension agents adopt new technologies faster than those who have few contacts. (Abeje *et al.,* 2017; Sheleme, 2017 and Tarekegn, *et al.,* 2018) found that extension contact has a positive effect on adoption of new technologies by exposing farmers

to new information and technical skills. Therefore, frequent contact of beekeepers with extension agents was hypothesized to influence adoption of adoption of modern beehive positively.

6. **Training (TRNA):** is dummy variable taking the value 1 if the household head has an access to training in the area of modern beekeeping and 0 otherwise. Training is one of the means by which farmers acquire new knowledge and skill (Gebiso, 2015 and Abeje *et al.,* 2017). Therefore, it can be hypothesized that those farmers who got this opportunity are expected to acquire better knowledge about the subject matter and motivated to adopt the modern beehive technology.

7. **Access to information (INFOR)**: is dummy variable taking the value 1 if the household head has an access to information in relation to the technology and 0 otherwise. According to the results of (Tefera, 2008; Yehuala, *et al.,* 2013 and Dibaba, 2016) the availability of timely information on new technologies was found to have a positive and significant influence on the decision possibility of households' adoption of new technologies. Access to relevant agricultural information is usually supposed to make farmers to be aware of and get better understanding of that technology. Hence, access to information through different mechanism is expected to influence adoption of modern beehive positively.

8. **Land size (LANDSIZ):** is continuous variable measured in hectares that indicate the total area of land that a farmer owns. Beekeeping activity requires small land and beekeepers kept their bees at un-cultivated land. Beekeepers those who hold large sized farm may have more chance to adopt and intensify the new technology. Land size is often correlated with farm income and wealth, which may ease the liquidity constraint to invest in procuring new agricultural technologies (Sheleme, 2017). Therefore, those farmers with larger land size are expected to have cash to buy modern beehive for their beekeeping activity. Thus, it is hypothesized that land size positively influenced probability of adoption of modern beehive.

9. **Total livestock holding (TLU):** is continuous variable measured in number of live animals the household holds in terms of TLU. It is an indicator of wealth status. Tefera (2008); Gedefa (2010) and Abeje *et al., (*2017) confirmed that livestock holding has positive influence on adoption in their respective studies. However, bees are conflicting with other livestock due to sting behavior of bees that causes death of other livestock. So it is

hypothesized that total number of livestock holding may affect positively or negatively the adoption of modern beehive.

10. **Access to credit service (CRESER):** is dummy variable taking the value 1 if the beekeeper received credit service either in cash or kind and 0 otherwise. Lack of initial capital may restrict the beekeeper from adopting the new technology, particularly those poor beekeepers. (Tefera, 2008; Hailesselassi, 2016; Abeje *et al.,* 2017 and Tarekegn, *et al.,* 2018) revealed that accessibility of credit positively influences new technology adoption. So it is hypothesized that access to credit will positively influence adoption of modern beehive.

11. **Distance from the nearest product market (DISTMKT):** is continuous variable measured in kilometer. Existence of local markets offering output sales opportunities with lower transportation cost is important for the development of beekeeping in the area. (Tefera, 2008; Gebremichael, 2012 and Hailesselassi, 2016) revealed that household's distance from the nearest market negatively and significantly influenced adoption of new technologies. However result of (Hailesselassi, 2016) shows that the farther the market the more farmers adopt new technology by expecting higher price when they sell their product to farther market Therefore, household's residence distance from the nearest market is expected to influence adoption and financial benefit modern beehive either negatively or positively.

12. **Income from other non-farm activity (OFACT):** is a continuous variable which is measured in birr. Participating in other non-farm activities enables to earn more additional income, and more likely to purchase improved inputs. On the other hand, other non-farm activities can compete for resources that needed to the development of apiculture, for instance labor and capital resources. (Tefera, 2008) presented that other non-farm activities involvement negatively affected improved poultry intensification and (Yehuala *et al.,* (2013) also found the same result on fertilizer adoption. (Gebiso, 2015 and Abeje *et al.,* 2017) on the other hand identified participating in other non-farm activities has a positive impact on technology adoption. Thus, participation in other non-farm activities is expected to be affect modern beehive adoption positively or negatively.

Table 2. Summary of variables code, type and Expected sign

No.	Variable	Code	Type	Measurement	Expected sign
1	Household head sex	SEX	Dummy	Female=0, male=1	+
2	Household head age	AGE	Continuous	Years	+/-
3	Total family size	FAMSIZ	Continuous	Number	+
4	Household head educational level	EDUC	Categorical	0 = illiterate, 1=1-4 grade 2= 4-5 grade 3= >8 grade	+
5	Household land size	FARMSIZ	Continuous	Hectares	+
6	Households' livestock holding	TLU	Continuous	TLU	+/-
7	Income from other non-farm activity	NFACT	Continuous	Birr	+\-
8	Access to credit service	CRESER	Dummy	No=0, Yes=1	+
9	Frequency of extension contact	FREXCONT	Continuous	Number per year	+
10	Attendance in training	TRNA	Dummy	No=0, Yes=1	+
11	Access to information	INFORM	Dummy	No=0, Yes=1	+
12	Distance to nearest market	DISTMKT	Continuous	Kilometers	+/-

4. RESULTS AND DISCUSSION

This chapter presents the major findings of the study and discusses it in comparison with the results of other studies. In the first section it presents results of descriptive statistics employed to describe the general demographic, socio-economic and institutional characteristics of sample beekeepers. In the second section econometric analysis was also used to identify factors affecting adoption modern beehive in the study areas. In the third section partial benefit analysis was used to assess the profitability of modern beehive adopted in the study areas. Finally the major challenges and opportunities of modern beehive utilization were discussed.

4.1. Descriptive results

4.1.1. Demographic and socioeconomic characteristics of sample beekeepers for discrete variables

Table 3 shows the demographic and socio economic characteristics of sample respondents for discrete variables. From the table it is observed that there is a significant difference between the two categories in sex, training education level and access to information while there is no significant difference in access to credit service.

4.1.1.1. Sex and marital status of household head

About 57.8% (114) of the respondents were adopters of modern bee hive while the remaining 42.2% (83) were non-adopters. From the total of 197 respondents 40(20.3%) of them are female headed and the remaining 157 (79.7%) are male headed. Out of 114 adopters 98 of them are male headed and the reaming 16 are female headed. While out of 83 non-adopters 59 (71.08%) and 24 (28.92%) respondents are male and female headed households, respectively. The result shown in table 3 revealed that the percent of male-headed households using the modern beehive were significantly higher than that of female-headed households. This result confirms with the traditional thinking that farming particularly beekeeping to be men's job due to physical reasons it claims.

Most of the sample household heads (86%) are married while 2 percent, 7 percent and 5 percent are single, divorced and widowed, respectively. Most of the respondents follow Muslim religion and the remaining 12 % and 16 % of them follow Ortodocs and Protestant religion, respectively (appendix 7.2).

Table 3. Demographic and socioeconomic characteristics of sample beekeepers (discrete variables)

Characteristics		Adopters (N=114)		Non-adopters (N=83)		Total Sample (N=197)		χ^2 value
		N	%	N	%	N	%	
Education level	Illiterate	34	29.8	37	44.6	71	36.0	9.586**
	1-4 grade	32	28.1	28	33.7	60	30.5	
	5-8 grade	35	30.7	12	14.5	47	23.9	
	>grade 8	13	11.4	6	7.2	19	9.6	
Sex	Male	98	85.96	59	71.08	157	79.70	6.5725**
	Female	16	14.04	24	28.92	40	20.30	
Access to credit service	Yes	47	41.23	26	31.33	73	37.06	2.0194
	No	67	58.77	57	68.67	124	62.94	
Training	Yes	60	52.63	28	33.73	88	44.67	6.9392***
	No	54	47.37	55	66.27	109	55.33	
Access to information	Yes	89	78.07	52	62.65	141	71.57	5.612**
	No	25	21.93	31	37.35	56	28.43	

Source: Survey output, 2019 *** & ** represents 1% & 5% significance level, respectively

N – Number of observations % - percentage of observations

4.1.1.2. Education of household head

The survey result of this study revealed that 36.04% of the respondents did not attend any formal education. The remaining 30.46%, 23.86% and 9.64% of the respondents had the

education level of 1-4 grade, 5-8 grade and greater than 8 grade, respectively As shown on table 3 there is statistical significant percentage difference between adopters and non-adopters at 5%. This is consistent with findings of (Abebe, 2007; Yehuala, 2013; Taddele, 2016; Abeje *et al.,* 217 and Tarekegn *et al.,* 2018). Educated households with higher education level are expected to have better skills, better access to information and ability to process information in addition to these they can manage and interpret production instructions by themselves any time with what they had written and printed materials. Moreover, household heads that have better education level are more likely to adopt modern hive than those who are illiterate. Moreover they are more ready to understand new idea and concepts provided by extension workers and other informants. Gichora (2003) noted that for more advanced beekeeping, one should have a good grasp of bee biology and behavior of bees for better colony management. Moreover, for illiterate people there is a need of intensive training and persuading of beekeepers before distributing modern beehive.

4.1.1.3. *Access to credit services*

Credit is an important institutional service to finance poor farmers who could not afford to purchase input from own savings especially at early stage of adoption. It enables farmers to purchase inputs or acquire physical capital, needed for technology adoption. In other words, the availability of credit facilitates technology adoption. It is more essential for farm technologies like beekeeping, which the farmers perceive the technology to be costly to engage in the activity (Abebe, 2007). The chi-square test result revealed that there is no difference between adopters and non-adopters beekeepers in relation to access to credit services in the study area (Table 3)

It is only about 37.05 of the respondents are users of credit from different sources. About 79.4 % of the credit user respondents obtained the credit from a formal microfinance institution Oromia Credit and Saving Share Company (OCSSC), while the remaining 4.1 %, 10.9 % and 5.6 % of them gets credit from relatives, merchants and other sources. It was found that 62.95% of the respondents were not the beneficiaries of the existing credit opportunity. This was mainly to avoid risk of repaying the loan from other sources, if expected amount of honey from improved modern beehive is not obtained (25%) and religion case (42.8). The remaining 17%, 8% and 7.2% of the respondents have not used the

credit due to high interest rate, unavailability of credit and lack of interest to take credit, respectively.

4.1.1.4. Beekeeping training and Access to information

The training can bridge technical gaps and equip the beekeepers with basic knowledge on how to operate improved hives and bee equipment's, basic bee biology, manipulate honeybee colonies, record keeping, grow appropriate bee forage plants, new processing techniques for production of higher quality products and its marketing. About 44.5 % of respondents have got training in beekeeping activities on improved beekeeping practices, whereas as, 55.5 % of the sample beekeepers have no chance of getting training. About 60 (52.6%) of adopters and 28 (33.7 %) of non-adopters got training on beekeeping during the study period. While the remaining 47.4% of adopters and 66.3 % of non-adopters didn't have access to training and which is also statistically different at 1% (table 3). Even though the non-adopters got training on beekeeping which can also encompasses modern beekeeping, they didn't adopt modern beehive due to different reasons like expensiveness of modern beehive, un-availability of modern hive, and others. In the study area, livestock and fishery development office and Non- Governmental Organization organized beekeeping training. The trainings were offered on bee management, hive construction (transitional), in transferring bee colony, comb preparation and colony multiplication.

Access to relevant agricultural technologies information makes farmers to be aware of modern technologies like modern hive, which in turn, will facilitate change in the behavior of farmers and may ultimately lead to decision to take risk for modern beehive adoption. Farmers could get access to agricultural information in different ways. These include participation on events like training, demonstration, through radio/TV, mobile phone, farmer-to-farmer information sharing, etc. The survey result revealed that on average about 78.07 % adopters had chance to access available agricultural information while 62.6 % non-adopters had access to agricultural information. The chi-square test results show that access to information related to modern beehive between adopters and non-adopters was statistically significant at 5 % significance level (table 3). This shows that the adopters have got more opportunity of information on improved technologies like modern beehive than non-adopters.

4.1.2. Demographic and socioeconomic characteristics of sample beekeepers of continuous variables

Table 4 shows the demographic and socio economic characteristics of sample respondents for continuous variables. From the table it is observed that there is a significant difference between the two categories in age, family size, land size, livestock holding, extension contact, income from other non-farm activities and distance to nearest market.

Table 4. Demographic and socioeconomic characteristics of sample beekeepers (continuous variables)

Variable	**Adopters (N=114)**		**Non-adopters (N=83)**		**Total sample (N=197)**				**t value**	**p value**
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Min**	**Max**		
Age	45.92	11.14	39.08	7.608	43.04	10.35	24	67	-4.827***	0.0000
Family Size	7.61	2.522	6.698	2.443	7.228	2.524	3	14	-2.547**	0.0096
Land size	2.623	1.682	2.14	1.146	2.42	1.614	0	9	-2.0927**	0.0377
Livestock holding	4.496	2.600	3.748	2.231	4.181	2.474	0	12	-2.1146**	0.0357
Other non-farm income	5849.1	8225.73	1840.96	4778.99	4160.4	7245.79	0	30000	-3.9560***	0.0001
Extension contact	2.719	1.721	1.566	1.363	2.233	1.677	0	8	-5.054***	0.0000
Distance to nearest mkt	4.152	2.336	4.754	2.30	4.406	2.334	0.25	12	1.7993*	0.0735

*** & ** represents 1% & 5% significance level, respectively

4.1.2.1. Age of household head and family size

The mean age of household head for adopters and non-adopters is 45.92 and 39.08 years with standard deviation of 11.04 and 7.60, respectively. For the whole sample respondents the mean age is 43.04 with standard deviation 10.35, the age ranges between 24 to 67 years

old. It has significant mean difference at less than 1%confidence level and the result is provided in Table 4. The result shows that the non-adopters' mean age is younger than that of adopters. This implies that the older the beekeeper the more he/she become experienced in beekeeping to understand the benefit of modern beekeeping so as to adopt new technologies that results in high yield and better benefit. Similarly it was found that 4 % and 36 % of the adopters' age ranges from 25-30 and 31-40 years. The remaining 30 %, 14 % and 15 % of the adopters were found in the age category of 41-50, 51-60 and 61-67, respectively. For the non-adopters 23 % and 40 % of them were found in the age category of 24-30 and 31-40 years. The remaining 31 % and 6 % of them found in the age category of 41-50 and 51-60 years. Appendix 7.1 shows that as the age of respondents increase, adoption of improved modern beehive increases. The result agrees with Gebiso, (2015) and Bunde and Kibets (2016) who also indicated that age of the household head positively influenced technology adoption.

The respondents mean family size was 7.61 and 6.69 for adopters and non-adopters, respectively. It ranges from 3 to 14 members in a family. The finding on the mean difference of both categories is provided in table 4. The result showed that the mean family sizes of adopters are greater than non-adopters. There is also significant mean difference between adopters and non-adopters at 5%. This indicates that beekeepers with large family size decide more for technology adoption. This in turn implies technology adoption increases hive products which contribute to satisfy the need of their family. This finding was consistent with the findings of (Abebe, 2007; Bunde and Kibet, 2016 and *Abeje et al.*, (2017).

4.1.2.2. *Farm size, Livestock holding and income from other non-farm activities*

Farm size was thought to be a good alternative indicator of wealth. The size of land distribution between adopters and non-adopters is on average 2.623 ha and 2.140 ha for adopters and non-adopters, respectively (appendixes 6.3). The respondents have the land size which ranges from zero to 9 hectare with the mean of 2.12 ha. As shown in table 4 there is a significant mean difference between the two categories at 5 %. This implies that beekeepers that hold large sized farm may have more chance to adopt the new technology. Farm size is often correlated with farm income and wealth, which may ease the liquidity

constraint to invest in procuring new agricultural technologies. This is consistent with the finding of (Dibaba, 2016, Jebesa, 2017 and Gebiso, 2015).

The result in table 4 shows that the average land holding of adopters is higher than that of non-adopters and hence it can affect adoption of improved modern beehive in the study area. Moreover, with regard to land use patterns, from the total farm size (379.075 ha) farmers allocated on average 87.75(21.01%), 30.235(7.24%), 264(63.92%), 24.875(5.95%), and 7.875(1.89%) hectares of their land for annual crops cultivation, homestead, coffee plantation, grazing and irrigation, respectively. According to this study most respondents hold a land size between 1-2 hectares (39.59%) and 2-3 hectares (23.86 %) while the remaining 12.18% , 14.72%, 5.58 % and 4.06 % hold a land size less than one, 3-4, 4-5 and greater than 5 hectares, respectively (appendix 7.3).

Livestock holding was thought to be a good proxy indicator for wealth. The major livestock reared in the area are cattle (ox, cow, calf and heifer), sheep, goat, poultry, horse, mule and donkey. Mean comparison was made between adopters and non-adopters using t-test and the result is provided in table 4. The total livestock holding of the respondents was 823.7 TLU ranging from 0 to 12 with mean TLU of 4.18. The mean livestock holding for adopters and non-adopters is 4.496 and 3.748, respectively. It has significant mean difference at 5%. It reveals that there is significant difference in the wealth status of both categories measured by livestock holding. This finding was in line with the findings of (Abeje *et al.*, 2017 and Dibaba, 2016).

Involvement in other non-farm activities will provide additional income for beekeepers to acquire new modern technologies like modern beehive. According to the survey result only 73 (37.05%) respondents were involved in other non-farm activities and earn additional income. The mean earnings from other non-farm income were 5849.12 birr and 1840.96 birr for adopters and non-adopters, respectively. As shown in table 4 there is a significant mean difference between the two categories at less than 1%. The result is in line with the findings of (Gebremichael, 2012; Gebiso, 2015 and Abeje *et al.*, (2017).

About 47 (64.4%) of the adopters were involved in other non-farm activities, while the remaining 26 (35.6%) are non-adopters. The minimum and maximum amount of money

gained from non- farm activities is 600 and 30,000 Birr per annum, respectively. The percent involvement and type of other non-farm activities were trade 36 (51.4%), laborer 14 (20%), carpenter 17 (24.3%), and civil servants 3 (4.3%). This indicates beekeeping can be performed side by side along with other Non- farm activities.

4.1.1.1. Extension contact and Distance to nearest market

Extension plays a great role in promoting improved beekeeping technologies. In beekeeping to offer effective extension service, the extension workers themselves need to be well equipped in skill in the technology. The study result revealed that about 83.3 % of the respondents had contact with extension agents. Among the adopters, 88.6% of them had contact with extension agents whereas 73.5% of the non-adopters had the same. The mean extension contact of adopters is 2.72 per year and that of non-adopters is 1.56, and as shown in table 4 the difference is statistically significant at less than one percent. Therefore, adopters more frequently contact with extension agents than non-adopters at less than 1% level of significance. This finding was in line with the findings of (Hailesselassi, 2016; Abeje *et al.,* 2017; Jebesa, 2017 and Tarekegn *et al.,* 2018). This assists the beekeepers to know more about the technology, which in turn help them to utilize the technology effectively. This shows that the beekeepers who frequently visit extension agent get more acquaintance with technology and tends to decide adoption of the technology.

Farmers sold part of their agricultural products immediately after harvest to cover their costs of production, social obligation and urgent family expenses in the nearby market. The survey result indicates that the average distance of the farmers' home from nearest market was 4.406 km. The minimum and maximum distance the beekeepers far from the nearest market were 0.25 km and 12 km, respectively. As shown on table 4 the difference between average distance of adopters' (4.152km) and non-adopters' home (4.754km) from nearest market was found to be significant at 10%. This implies that farmers who are far away from market centers might face greater transaction and transport costs and lack of information on the availability of the latest released technology provided by extension system. But those who are near the available nearest market can get access to the technologies. This finding was consistent with the finding of (Gebremichael, 2012 and Gelmesa, 2016) but contradicts the finding of (Taddele, 2016).

4.1.2. Beekeeping practice in Gera district

4.1.2.1. Means of engaging in beekeeping and placement of hive

With regard to the initial base to start beekeeping; farmers can start beekeeping using different methods. The majority of the beekeepers, about 134 (68%), started beekeeping activities by catching the swarm and the remaining 63 (32%) through inheritance. About 66.67% of adopters and 69.9 % of non-adopters started by catching swarm while the remaining 33.33% of adopters and 30.1% of non-adopters started through inheritance from their parents (appendixes 6.4). The result indicates that both adopters and non-adopters engaged in beekeeping activity with similar situation in all ways of starting beekeeping, which is by catching swarm. They catch the swarm by hanging traditional hive on tall trees to catch swarm then transfer it to modern and transitional hive.

As to the choice of the place to install the hive, 121 (61.4%) of the respondents put their hives at the backyard of their house plus hanging on big trees in forest. The remaining 50 (25.4%) and 26 (13.2%) put their hives by hanging only on tall trees in the forest and hanging on trees near their home, respectively.

4.1.2.2. Adoption of modern beehive, bee hive holding, honey production and use of honey

Beekeeping in Gera district is practiced as a sideline to other agricultural activities. Based on the results of this study, there were no farmers that base their livelihood only on beekeeping. Based on their level of technological advancement, three distinct types of beehives were used by the sample beekeeper farmers in the area. These were local (traditional), intermediate or transitional and modern beehive.

The mean traditional hive holding of adopters and non-adopters is 35.05 and 30.92, respectively. However there is no statistical mean different between the two categories in traditional bee hive holding. As shown in appendix 7.5 the mean distributions of traditional hive with bee and without bee were 16.26 and 17.82, respectively. As we can see here most traditional beehives do not have bee colony, this is because of less follow up done to

traditional hives and most beekeepers use traditional hives to catch a swarm and transfer to modern and transitional hives. The mean transitional hive holding of adopters and non-adopters is 2.04 and 1.73, respectively. The mean difference of transitional beehive holding was found to be statistically significant between the two categories at less than 1% significance level. The mean modern bee hive holding of adopters with bee and without bee were 3.73 and 3.41, respectively. As shown on appendix 7.5 more than half of modern beehives had bee colony, which indicates that the management given to modern beehive is better than that of traditional and transitional hives and hence the benefit drawn from it is higher as compared to the remaining types of hives.

The productivity of beehive per year varies from location to location, which in most case is determined by the availability of bee flora, the level of management and harvesting system, and input technology used. The frequency of harvesting honey per hive in the same area and year is also different among beekeepers. Honey is harvested in the study area from end of April to beginning of May each year (the peak period) which is named “Buto” and rarely harvested in February (Girawa/Ibbicha) and end of June (Bisana/Mekenisa). About 77.7 % of the sample beekeepers harvest once a year and 20.3% of them harvest twice while the remaining 2 % of them harvest three times in a year during the study year. However it was reported that most yields obtained during the second and third round harvest would be left as a food for the colony to strengthen it for the coming harvest, which is the peak period of harvest. About 167 (84.77%) respondents produce only honey whiles the remaining 30 (15.23%) of them produce honey as well as wax.

Honey productivity of traditional, transitional and improved hives is markedly different in the study area. It was found that the average honey productivity of traditional beehive per hive per year was 5.76 kg with the minimum and maximum productivity of 2.2 kg and 25 kg. The average productivity of transitional beehive was 17.79 kg with minimum and maximum of 5 kg and 35 kg. It was also figured out that the average productivity of modern beehive per hive per year was 22.36 kg with minimum and maximum productivity of 5 kg and 45 kg. Accordingly, the average annual productivity of modern beehive was more than three times of the average annual productivity of traditional beehive.

Honey harvested by the sample farmers in the study area was expected to be used for multipurpose. Except for the inconsiderable amount that was extended as a gift, much of the collected honey was consumed and sold during harvesting period. However, the amount of honey sold was much more than the amount of honey consumed by the households. Thus, the total amount of honey produced by the sample beekeepers were around 29,843 kg, of which, 3529 kg (11.8%), 24,898 kg (83.23%) and 1486 kg (4.97%) was consumed, sold and given as a gift by the sample respondents, respectively. Out of the total 197 sample respondents 102 adopters and 45 non-adopters sold their produce at their nearby market, while 12 adopters and 30 non adopters sold to collectors found around their farm gate the remaining 8 non adopter respondents didn't sold their produce since their production is not enough/not surplus to be marketed. Moreover, sample farmers earned annual gross income from beekeeping activities by selling honey or both honey and beeswax. As the result presents, adopters sold significantly larger amount of honey (164 kg) than non-adopters (80.73 kg) (appendix 7.5). As a result, adopters obtained significantly higher beekeeping income (12,300 Birr) than non-adopters (6054.75 Birr).

4.1.2.3. Honeybee feeding and hive shade construction

Honeybees store honey for their own consumption during dearth period. Beekeepers are harvesting honey, which the honeybees stored for themselves. As a result, honeybees face starvation due to lack of feed. To overcome the problem, supplementary feed is required for the honeybees. In this study, it was found that 38 (96.39%) and 3 (3.61%) of the respondent provided supplementary feed from adopter and non-adopter categories respectively. The supplementary feed includes sugar, syrup, honey, and "Shuro" (pea's flour and beans flour).

Hive shading is one of the practices which is recommended to protect the honeybees from high temperature, wind and rain. Among the adopters of modern beehive only 33 (28.95%) beekeepers were adopting the practice whereas 4 (4.82%) of non-adopters were constructed hive shade over their transitional hive (appendix 7.4).

4.2. Econometric analysis of determinants of adoption of modern beehive

The selection of the variables for the study was done on the basis of theoretical explanations, findings of empirical studies and a priori knowledge. Based on these 7 continuous and 5 discrete variables were selected. Before estimating the model parameters, the presence of multicollinearity among the hypothesized explanatory variables was checked. For continuous variables the Variance Inflating Factor (VIF) was used to check for the presence of multicollinearity and for discrete variables the Contingency Coefficient (CC) method was used. The test shows that there is no sever collinearity among the explanatory variables (Appendixes 6.1.7 and appendixes 6.1.8). In addition to this heteroscedasticity test was also conducted using Breusch-Pagan test and showed the absence of the problem.

The overall significance of the model is measured by the Wald statistics which follows a chi-squared distribution with 12 degree of freedom. The hypothesis that all the coefficients except the constant are zero (0.0000) is rejected as equation is significant at 1 percent significance. This implies that significant proportion of the dependent variable is explained by independent variables. The likelihood-ratio chi-squared had a value of 74.29 with Pseudo-R^2 of about 27.7 percent which implies that about 27.7 percent of the variation in the adoption of the modern beehives in the district is explained by the variables considered (Table 5).

In the Logit model, a household head is considered as an adopter if he/she was using modern beehive during the study period. Among the explanatory variables, age of the household head, educational status of household head, income from other non-farm activities, total livestock holding(TLU), extension contact, access to training and distance to nearest market were found to be significant factors in the decision of households to adopt modern beehive. The explanatory variables that were significantly influencing the adoption of modern beehive are discussed as follows:

Table 5 Logistic regression output for adoption of modern beehive

ADOPTION	Coef.	Std. Err.	Z	P>z	Mean values	Dy/dx
Sex	0.639661	0.44624	1.43	0.152	-	0.10424
Age	0.057898***	0.021487	2.69	0.007	43.04	0.00944
Education level	0.414865**	0.19679	2.11	0.035	-	0.06761
Total family size	0.086118	0.082541	1.04	0.297	7.23	0.01403
Non-farm income	0.0000556*	0.0000296	1.88	0.06	4160.4	0.0000091
Land size	0.061951	0.115454	0.54	0.592	2.42	0.01010
Livestock holding	0.123443*	0.073025	1.69	0.091	4.181	0.02012
Extension service	0.401612***	0.130706	3.07	0.002	2.23	0.06545
Training	0.844776**	0.377684	2.24	0.025	-	0.13767
Information	0.40425	0.410237	0.99	0.324	-	0.06588
Credit	0.382028	0.386123	0.99	0.322	-	0.06226
Distance to nearest mkt	-0.16253**	0.080578	-2.02	0.044	4.406	-0.02649
_cons	-5.45497	1.212355	-4.5	0.0000	-	0.10424
Number of obs = 197	LR chi2 (13) = 74.29		Prob > chi2		=0.0000	
Log likelihood = -96.9542	Pseudo R^2 = 0.2770					

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

(#) Dummy variable; marginal effect (dy/dx) is for discrete change of dummy variable from 0 to 1

Age of household

Depending on the nature of the technology, age of farmer is likely to play different roles in technology adoption. Age has a positive and significance influence on the probability adoption of modern hive technology at 1 percent level of significance. From the logit model result in table 5**,** it is revealed that for every increase in age of household head by one year above the age of 43.04 the probability of adopting modern beehive increases on average by 0.944%. The implication is that the increase in farmer's age increases farmers' experience in beekeeping and understanding more the benefits of the technology. This result is in line with

(Gebiso 2015; Bunde and Kibet 2016; Gelmesa 2016 and Miruts 2016). However, it is in contrast with (Tedele 2016; Sheleme 2017 and Abeje *et al., 2017)*

Education

Educational level of the household head is important to note as determinant of adoption to farm technologies. The possible reasons for more adoption of modern hives by beekeepers educational backgrounds could be that education may increases access to information and their knowledge to understand the technology. Beekeeper, who had higher education level, can have simple and diversified communication ways to extension services. As the logit estimation result indicates (table 5), education level of house hold head positively and significantly affect adoption of modern beehive at 5 percent level of significance. Farmers, who had higher education level, keeping other things constant, have 6.761% higher probability of adoption of modern beehive, than illiterate farmers. This result is consistent with the research results of (Bundo and Kibet 2016; Tedele, 2016 and Tarekegn *et al* 2018) who stated that education affect adoption of modern beehive positively.

Other non-farm activities income

Involvement in and income earned from other non-farm activities passes significant and positive effect on adoption decision of modern beehive at 10% significant level. According to the logit model output for a one birr increase in income earned from other non-farm activities from the mean value of 4160.4, the probability of adopting modern beehive will increase by 0.00091%. This is because when farmers participate in other non-farm activities and earn an additional income they would tend to have more cash on hand which made them buy different agricultural technologies easily. This finding is in line with (Gebremichael 2012; Gebiso, 2015 and Abeje *et al., 2017)* but contradicts the finding of (Yehuala *et al.,* 2013).

Livestock holding (TLU)

Livestock holding unit is also the other important factor found to have significant influence on the household decision to adopt modern beehive. Livestock are considered as an asset that could be used either in the production process or be exchanged for cash for the purchase

of agricultural inputs and technologies like modern beehive whenever the need arises. The model output also indicates that the number of livestock owned by a household in TLU affects positively and significantly the level of adoption of modern beehive at 10 % level of significance. On average a unit increase in the number of livestock owned beyond the mean value of 4.181 increases the probability of adopting modern beehive by 2.012% (Table 5). This is because farmers with relatively more livestock unit make use of their income obtained from sale of livestock and their byproducts for the purchase modern technologies like modern beehive. The finding was in consistent with the finding of (Abeje *et al.,* 2017 and Dibaba, 2016).

Extension contact

As expected the number of extension contact was significantly and positively influenced the adoption of modern beehive at 1% significance level. The marginal effect result also shows that the estimated increase in the probability of adoption of modern beehive technologies due to an increase in extension contact by one beyond the mean value of 2.23 was 6.545%. From this result it is possible to state that those household who have access to extension service are more likely to adopt modern hive than those who have not. This shows that extension service plays a significant role in providing information and persuading farmers to use new technology. Henceforth, frequency of extension contacts by development agents with farmers is assumed to be the potential force which accelerates the effective dissemination of adequate agricultural information to the farmers, thereby enhancing farmers' decision to adopt modern beehive. The reason is that farmers can learn more about the technology and familiarized using of modern box hive. This finding is in line with (Gorf, 2005, Gebremichael, 2012; Tedele, 2016; Sheleme, 2017 and Tarekegn *et al.,* 2018).

Training

Training was positively related to adoption of modern beehive at 5% level of significance. The result of logit regression indicate that as compared to farmers who didn't participated on modern beehive training, those farmers who participated on modern beekeeping their probability of adopting modern beehive increases on average by 13.767%. This finding is in line with (Gebiso, 2015; Gelmesa, 2016 and Abeje *et al.,* 2017) who found that

participation in training in relation to the given technology would positively and significantly affect the adoption aof that technology.

Distance to nearest market

Distance from farmers' house to nearest market was negatively related to the adoption of modern beehive technology. For every one kilometer increase in the distance from the mean value of 4.406 km from nearest market the probability of adopting modern beehive decreases by 2.649%. This is due to the fact that as the farmers resides far from the nearest market might face greater transaction and transport costs which in turns to reduce farmers' decision to adopt modern beehive. The finding was consistent with the research results of (Gebremichael, 2012 and Gelmesa, 2016) in which they found that distance to nearest market has a negative influence on adoption of modern technologies but, contradicts with (Hailesselassi, 2016) this is because the market gain of honey sale is positively increased as farmers were sale their product at reasonable market price if they are travel far away from their local market.

4.3. Results of partial budgeting

Table 6 shows a partial budget for both traditional and modern beehives. The partial budget excludes the fixed costs like land because it is unchanging across practices. The costs that vary across the two practices include labor cost during preparation and harvesting, cost of beeswax used for preparation of foundation sheet, cost charged to accessories like honey extractor and the like, depreciation on fixed inputs, feed cost, transport cost, interest on fixed and variable costs. All benefits and costs were calculated using the nearest market average prices and input costs. That is, the average of actual price which the farmer pays for the inputs or receives for the products in 2018 at the nearby market place. Hence, the average honey yield and average selling prices were taken for the partial budget in this study.

The same was done for inputs costs and requirements. For this study interest rate was assumed to be 10% for all variables and fixed costs. Depreciation for the fixed inputs was estimated using the straight-line method in addition to this depreciation of traditional beehive was calculated by considering the salvage value is 10% of its original price at 4

years' service life while the price of modern beehive was 1200 at 12 years' service life and its salvage value would be 10% of its purchase price.

Table 6 Partial budgeting for traditional and modern beehives (Per annum)

Activity	Traditional beehive	Improved/modern bee hive
Labor cost (Birr/hive)	15	0
Beeswax cost (Birr/hive)	0	48.45
Feed cost (Birr/hive)	0	16.1
Accessories service charge (Birr/hive)	0	1.01
Transport cost (Birr/hive)	4.92	12.09
Bamboo leaf cost for hive wrapping	18	0
Interest on variable costs (Birr/hive)	6.24	148.84
Interest on fixed costs (Birr/hive)	2.45	120
Depreciation of beehive	5.513	90
Total costs that vary (Birr/hive) (A)	52.125	436.49
Average honey yield (kg/hive) (B)	7.275	21.403
Average honey selling price (Birr/kg)	62.34	77.67
Gross benefit (Birr/hive) (C)	453.52	1662.37
Net benefit (Birr/hive) (C-A)	401.40	1225.88
Reduced cost		0
Gained benefit (1662.37-453.52)		1208.90
Lost income		0
Increased cost (436.49-52.125)		384.4
Increment on net benefit as a result of modern beehive (Birr)		824.48

Source: Survey output, 2018

The result shows that the traditional beehive yields on average 7.275 kg/hive/year at its average selling price of 62.34 Birr/kg, while modern beehive yields on average 21.403 kg/hive/year at its average selling price of 77.67 Birr/kg. From this we can see that average yield and average price of modern beehive higher than traditional hive. However the input

requirement of modern beehive is higher than that of traditional hive. According to the results of partial budget shown in table 7 the total cost that vary for both traditional and modern beehives were estimated to be 52.12 Birr/hive and 436.49 Birr/hive, respectively. The gross benefits were 453.52 birr/hive and 1662.37 Birr/year while the net benefits were 401.40 Birr/hive and 1225.88 Birr/hive for traditional and modern beehive, respectively. That is the net benefit of modern beehive is more than three times higher than the net benefit of traditional beehive. This finding was in line with the finding of Gorfu (2005) who found movable top bar hives results in higher net return per colony compared with traditional hives. Abebe (2007) also found that the net benefit of improved box hive was around three times higher than that of traditional beehives. In addition to these authors, Gebremichael (2012) also came with similar conclusion in his study using partial budgeting analysis that the net benefit earned from improved movable hive is more than twice that of traditional beehive.

It can be concluded from this that smallholder farmers would choose to adopt modern beehive, but the choice is not understandable, because smallholder farmers will also want to consider the increase in costs. Hence, in this case, smallholder farmers will obtain extra benefit of 824.48 Birr/hive by investing extra cost of 384.36 Birr/hive to adopt modern beehive. This implies that adoption of modern beehive makes higher net benefit than traditional beehive.

4.4. Challenges and opportunities of modern beehive utilization in the study area

The total numbers of modern beehives owned by adopters included for this study were 728. Out of this only 426 (59.33%) of it had bee colony. In addition to this in the study area most beekeepers buy the modern beehive and start using it for its ease of management and high yields as compared to that of traditional one, but cease to use modern beehive year to year due to different reasons. So identifying the existing challenges for modern beekeeping and opportunities of utilizing this modern beehive are of paramount importance. The ranking

was done by calculating weight and indices for each challenge and opportunities finally ranking was done by looking at the indices of each constraints/opportunities.

Weight: - is obtained by summing up the product of the number of respondents of 1rst rank by the number on constraints/opportunities list (K) then the number of respondents of 2^{nd} rank by k-1 and continuing to the last rank.

Indices: - is obtained by dividing the weight of each constraints/opportunities by the total weight which is obtained by summing up the weight of each constraints/opportunities.
Finally the rank is given by comparing the resulting indices.

4.4.1. Challenges

As shown on table 7 pest and predators were the primary challenges that hinder the modern beehive utilization and expansion of the number of modern beehive followed by absconding and inaccessibility of modern beehive and accessories. The existence of honeybees' pests and predators affect the honeybees' life, which leads them to absconding (Abebe, 2007). Absconding (the total movement of honeybee colony by leaving the hive) can happen due to different reasons. Ants and mites cause a significant effect on honey yield since they highly hinders or limits the activity of bees or causes absconding. According to the respondent's ants, honey badgers and monkeys are the major predators that harm bees and the modern beehive as well which are also the reasons for absconding of bee colony from modern beehive.

Financial limitation (10.2%), high cost of modern beehive and accessories (9.5%), poor quality of training regarding to modern beekeeping (8.5%), poor extension support (8.2%), lack of appropriate management knowledge (6.6%), lack of attention (5.6%), lack of business support (4.6%), lack of market information and market linkage (2.5%) and lack of credit access which can help in solving financial problem thereby to expand the number of modern beehives (3.7%) are the remaining challenges of modern beehive utilization in their order of importance.

Table 7 Challenges that hinder modern beehive utilization

No.	Challenges	Rank and number of respondents (Percentage)												Weight	Index	Overall rank
		1rst	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th			
1	Honeybee pests and predators	84 (73.7)	14 (12.3)	10 (8.8)	6 (5.3)									1316	0.148	1rst
2	Absconding	8 (7)	55 (48.2)	20 (17.5)	17 (14.9)	7 (6.1)	4 (3.5)	3 (2.)						1156	0.130	2nd
3	Inaccessibility of modern beehive and accessories	5 (4.4)	16 (14)	54 (47.7)	12 (10.5)	6 (5.3)	7 (6.1)	14 (12.3)						1065	0.120	3rd
4	Financial limitation	9 (7.9)	12 (10.5)	7 (6.1)	45 (39.5)	10 (8.8)	8 (7.0)	6 (5.3)	6 (5.3)	6 (5.3)				941	0.106	4th
5	High cost of modern hive and its accessories	8 (7)	9 (7.9)	6 (5.3)	10 (8.8)	45 (39.5)	8 (7.0)	8 (7.0)	7 (6.1)	3 (2.)	4 (3.5)	6 (5.3)		880	0.099	5th
6	Poor quality of training		8 (7)	7 (6.1)	7 (6.1)	13 (11.4)	45 (39.5)	4 (3.5)	8 (7)	5 (4.4)	7 (6.1)	10 (8.8)		765	0.086	6th
7	Poor of extension support			10 (8.8)	10 (8.8)	9 (7.9)	17 (14.9)	46 (40.4)	5 (4.4)	12 (10.5)	5 (4.4)			745	0.084	7th
8	Lack of appropriate management knowledge				2 (1.8)	7 (6.1)	10 (8.8)	5 (4.4)	60 (52.6)	9 (7.9)	11 (9.6)	10 (8.8)		563	0.064	8th
9	Lack of attention					8 (7)	9 (7.9)	5 (4.4)	10 (8.8)	58 (50.9)	15 (13.2)	8 (7)	1 (0.9)	501	0.057	9th
10	Lack of business support services						6 (5.3)	10 (8.8)	5 (4.4)	10 (8.8)	56 (49.1)	15 (13.2)	12 (10.5)	377	0.043	10th
11	Lack of access to credit				5 (4.4)	6 (5.3)		9 (7.9)	8 (7)	5 (4.4)	11 (9.6)	8 (7)	58 (50.9)	239	0.035	11th
12	Lack of Market information and market linkage							4 (3.5)	5 (4.4)	6 (5.3)	5 (4.4)	57 (50)	37 (32.5)	314	0.027	12th
	Total	114	114	114	114	114	114	114	114	114	114	114	114	8862	1.00	

Source: Survey output, 2018

Index = Sum [(number of respondents of the 1 rst rank * 9) + (number of respondents of the 2nd rank *8) + (number of respondents of the 3rd rank * 7) + (number of respondents of the 4th rank * 6) + (number of respondents of the 5th rank * 5) + (number of respondents of the 6th rank * 4) + (number of respondents of the 7th rank * 3)+ (number of respondents of the 8th rank * 2) + (number of respondents of the 9th rank * 1) +]/Total weight (Endalew *et al.*, 2016).

4.4.2. Opportunities

According to the respondents the major opportunities that make utilize modern beehive better were listed in table 8. Accordingly, its ease of management as compared to the traditional one ranked first taking 18.2%. In the study area traditional beehive is kept in the forest on tall trees which might have high risk which may leads to death to beekeepers when they climb on the tree for hanging hive and harvesting honey. Modern beehive is kept near to home at backyard on constructed beds which is simple to inspect as well as harvest. Availability of bee forage, high in productivity and overall production, existence of high demand of the produce ranked 2nd, 3rd and 4th. The indigenous knowledge for beekeeping beekeepers got through experience also ranked 5th this is because this experience helps beekeepers in managing well their apiary especially in inspecting and follow-up. High quality of the produce, existence of abundant bee colony, existence of extension support and easy access to market information were ranked 6th, 7th, 8th and 9th, respectively.

Table 8 Opportunities for modern beehive utilization

	Opportunities	Rank and number of respondents (Percentage)									Weight	Index	Overall rank
		1rst	2nd	3rd	4th	5th	6th	7th	8th	9th			
1	Eases of management	70 (61.4)	15 (13.2)	9 (7.9)	10 (8.8)	7 (6.1)		3 (2.6)			917.0	0.182	1rst
2	Availability of bee forage	18 (15.8)	65 (57)	8 (7)	8 (7)	8 (7)					826.0	0.164	2nd
3	High in productivity and overall production	10 (8.8)	15 (13.2)	54 (47.4)	6 (5.3)	6 (5.3)	4 (3.5)	10 (8.8)			700.0	0.139	3rd
4	Existence of High demand of the product	8 (7)	9 (7.9)	10 (8.8)	50 (43.6)	14 (12.3)	5 (4.4)	6 (5.3)			622.0	0.123	4th
5	Indigenous knowledge for beekeeping	5 (4.4)	4 (3.5)	10 (8.8)	10 (8.8)	60 (52.6)	12 (10.5)	8 (7)			579.0	0.115	5th
6	High quality of produce/honey	3 (2.6)	2 (1.8)	7 (6.1)	14 (12.3)	8 (7)	58 (50.9)	4 (3.5)	8 (7)		476.0	0.095	6th
7	Existence of abundant honeybee colony		4 (3.5)	12 (10.5)	12 (10.5)	7 (6.1)	17 (14.9)	46 (40.4)	5 (4.4)	2 (1.8)	441.0	0.088	7th
8	Existence of extension support			4 (3.5)	4 (3.5)	3 (2.6)	9 (7.9)	20 (17.5)	51 (44.7)	18 (15.8)	283.0	0.056	8th
9	Easy access to market information and market linkage						8 (7)	17 (14.9)	26 (22.8)	58 (50.9)	193.0	0.038	9th
	Total	114	114	114	114	114	114	114	90	78	5037	1.00	

Source: Own survey output 2018

Index = Sum [(number of respondents of the 1 rst rank * 12) + (number of respondents of the 2nd rank *11) + (number of respondents of the 3rd rank * 10) + (number of respondents of the 4th rank * 9) + (number of respondents of the 5th rank * 8) + (number of respondents of the 6th rank * 7) + (number of respondents of the 7th rank * 6)+ (number of respondents of the 8th rank * 5) + (number of respondents of the 9th rank * 4) + (number of respondents of the 10th rank * 3) + (number of respondents of the 11th rank * 2)+ (number of respondents of the 12th rank * 1)]/Total weight (Endalew *et al.*, 2016).

5. SUMMARY, CONCLUSION AND RECOMMENDATIONS

In this section, the summary of the major results and conclusions drawn from the major findings of the study are presented. Recommendations for policy makers and further research work are also presented.

5.1. Summary

The study aimed at analyzing the adoption and financial returns of modern beehives in Gera district Jimma zone Oromia Ethiopia with the specific objectives of analyzing the determinants of modern beehive adoption, analyzing the financial returns of modern beehive with traditional hive and analyzing the challenges and opportunities of modern beehive utilizations.

The data were generated both from primary and secondary sources. The primary data were generated from interview schedule using semi-structured quaternaries from 197 randomly selected beekeeper households from 4 kebeles.

The analysis was made using descriptive statistics and econometric model. Different analytical techniques were applied to analyze the collected data. Percentage, frequency, means, standard deviation, ranking, chi-square and t-tests were used. Logistic model was applied to analyze factors affecting adoption modern beehive. Cost and benefit analysis was used to compare cost and benefits of modern beehive adopted with the traditional beehive in the study areas.

The result indicates out of the total interviewed 197 respondents 114 (57.8 %) were adopters while 83 (42.2%) of them were non-adopters of modern beehive and also 79.3 % and 20.3 % were male headed and female headed households, respectively. From the total sample respondents 36% were illiterate while 30.5%, 23,9% and 9.6% of them had an education level of 1-4 grade, 5-8 grade and grade 9 and above, respectively. The result also depicted that there was a statistical mean difference between the two categories. Age of household head of the sample respondents ranged from 24 to 67 years with an average age of 43.04 years. The average age of adopters and non-adopters was found to be 45.92 and 39.08 years,

respectively. The survey result indicated that the average number of contacts the development agents made with adopter and non-adopter households per year was 2.72 and 1.56, respectively with a minimum of zero and maximum of 8 contacts per year. Results show that there was a statistically significant difference in extension contact between adopters and non-adopters. Among the total sample respondents 44.67 % were participated in the training about modern beekeeping technology. Among these, 52.6% adopters and 33.7 % non-adopters received the training related to the technology.

5.2. Conclusions

The most important explanatory variables affecting the adoption of modern beehive were analyzed using logit model. The model results show that among 12 explanatory variables, which were hypothesized to influence the adoption of modern beehive, seven were statistically significant; the remaining variables were found to have statistically insignificant contribution towards adoption of modern beehive technology at conventional probability level. Accordingly, age of household head, education status of household head, income earned from other non-farm activities, number of extension contact, total number of livestock the household head own and participation in training regarding to modern beehive significantly and positively affect the probability of adoption of modern beehive, while distance to nearest market affect significantly and negatively the probability of adopting modern beehive.

According to the results of partial budgeting the average honey yield of traditional and modern beehives were 7.275 and 21.403 kg/hive/year with selling price of 62.34 birr/kg and 77.67 birr/kg, respectively. The gross income earned on per hive basis was 453.52 birr and 1662.37 birr by spending 52.12 birr and 436.49 birr for traditional and modern hives, respectively. From this we can conclude that the net return of modern beehive was 1225.88 birr/hive which is by three times higher than that of traditional hive which was 401.40 birr/hive. We can conclude from this smallholder farmers would choose to adopt modern beehive than practicing with the traditional hives.

In the study area near to half (48%) of modern beehive didn't have bee colony in it and most beekeepers face different challenges in increasing their number of modern beehive.

According to the survey result among the major constraints that hinder modern beehive utilization honeybee pest and predators, absconding, inaccessibility of modern beehive and its accessories, financial limitation, high cost of modern beehive and accessories, poor quality of training and poor extension support are listed first to 7th rank. Yet, despite all the challenges currently facing the modern beehive utilization, there are still enormous opportunities and potentials to boost the production and quality of honey products using modern beehive in Gera district. Among these its ease of management, high in productivity and overall production, availability of bee forage in the area, existence of high demand for the produce, indigenous knowledge for beekeeping obtained from beekeeping experience and high quality of the product as compared to that of traditional hives were the major opportunities that will make utilize the modern beehive better.

5.3. Recommendations

Based on the above conclusion, the following recommendations were forwarded. Government is advised to supply modern beehive and accessories with discounted/acceptable price and it is strongly advised to draw an effort to alleviate the challenges with regard to modern beehive utilization faced by beekeepers.

1. Education has a significant positive impact on adoption of modern beehive. Hence, strengthening adequate and effective basic educational opportunities to the rural farming households in general and to the study areas in particular is required. In this regard, the regional and local governments need to strengthen the existing provision of formal and informal education through facilitating all necessary materials. This result also suggests that placing much emphasis on expanding and strengthening basic agricultural education at farmer training centers (FTC) currently situated almost in all peasant associations (PAs) and increasing the enrolment rate increases the probability of adopting agricultural technologies, such as modern beehive. It is also advised to give special attention to the female headed farm households to increase their participation in this educational program. Because survey results show that female-headed households were less likely to use modern beehive technology. 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.

2. The number of extension contact made was found to influence adoption of modern beehive technology positively and significantly. Therefore, emphasis should be given to assign sufficient number of development agents that are equipped with knowledge and skills so that farmers can access support that help them to scale up their knowledge. Extension contact between beekeepers and extension agents should be further strengthened by increasing frequency of contact to promote modern beekeeping technology that focuses on a practical approach.
3. Age of household head influences the adoption of modern beehive positively and significantly. The fact that age influences adoption of modern beehive could suggest that older farmers are more likely to adopt modern beehive than younger farmers. The difference may be that younger farmers have less experience in beekeeping than older farmers and therefore older farmers have better understanding or knowledge and skills which enable them to perceive risks and constraints related to transfer of new technologies. Hence, extension organizations, research and other stockholders are advised to include younger farmers in different extension activities and arrange periodic experience sharing sessions among young and old age group farmers so that they can have much more understanding of the knowledge and benefits of recommended beekeeping technologies.
4. Other non-farm income activities are important through which rural households get additional income and exposure to informal ways of acquiring information. The income obtained from such activities helps farmers to purchase farm inputs including modern beehives. Thus, it is recommended that encouraging households' participation on other non-farming activities, which helps to increase the purchasing power of farmers to various agricultural inputs, by creating favorable conditions and better opportunities for smallholders during their off-seasons to have some other non-farm income source in addition to their regular farm activities
5. Training on modern beekeeping was found to be positively and significantly influenced adoption of modern beehive. Hence, the WoLFDRO and other concerned bodies are advised to provide adequate and effective training on modern beekeeping

to the rural farming households in general and to the study areas in particular. Thus, timely awareness training supported by practical demonstration must be arranged for beekeepers before any technological intervention is taken place, either by government or non-governmental organizations.

6. The size of livestock owned has a significant positive impact on adoption of modern beehive. Therefore the WoLFDRO is advised to strengthen the existing livestock production system through providing improved health services, better livestock feed (forage) and adopting agro-ecologically based high-yielding breeds and disseminating artificial insemination in the areas improve adoption of modern beehive.
7. Distance to nearest market was statistically significant and negatively affected adoption of modern beehive. Hence, concerned government offices is advised to establish market center for the farmers around their home which increase the probability of adoption of improved modern beehive thereby sell their produce at good price is recommended.

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6. APPENDICES

6.1. Appendixes tables

Appendixes 6.1.1. Age categories of respondents

Age	<30		31-40		41-50		51-60		>60		Total	Min	Max
	No.	%	No.	%	No.	%	No.	%	No.	%			
Adopters	6	0.05	41	0.36	34	0.30	16	0.14	17	0.15	114	25	67
Non adopters	19	0.23	33	0.40	26	0.31	5	0.06	0	0.00	83	24	55
Total	25	0.13	74	0.38	60	0.30	21	0.11	17	0.09	197	24	67

Appendixes 6.1.2. Marital status and religion of respondents

No.	Marital status	Adopters		Non-Adopters		Total	
		No.	%	No.	%	No.	%
1	Single	1	0.88	3	3.61	4	0.02
2	Married	102	89.47	68	81.93	170	0.86
3	Widowed	4	3.51	5	6.02	9	0.05
4	Divorced	7	6.14	7	8.43	14	0.07
	Total	114	100	83	100.00	197	1.00
Religion							
1	Muslim	75	65.79	68	81.93	143	0.73
2	Orthodox	18	15.79	5	6.02	23	0.12
3	Protestant	21	18.42	10	12.05	31	0.16
	Total	114	100	83	100.00	197	1.00

Appendixes 6.1.3. Land holding of respondents

Land holding	Adopters		Non-adopters		Total sample	
	No.	%	No.	%	No.	%
< 1	11	9.65	13	15.66	24	12.18
1-2	46	40.35	32	38.55	78	39.59
2-3	25	21.93	22	26.51	47	23.86
3-4	20	17.54	9	10.84	29	14.72
4-5	10	8.77	1	1.20	11	5.58
>5	2	1.75	6	7.23	8	4.06
Total	114	100.00	83	100.00	197	100.00

Appendixes 6.1.4. Beekeeping engagement, production per year and different practices

How beekeeping started	**Adopters**		**Non-adopters**		**Total sample**		X^2	P value
	No	**%**	**No**	**%**	**No**	**%**		
Catching bee colony	76	66.667	58	69.9	134	68.0	0.226	0.634
Inheritance	38	33.333	25	30.1	63	32.0		
Total	114		83		197			
Production per year								
One time	84	73.7	69	83.1	153	77.7	5.837*	0.054
Two times	29	25.4	11	13.3	40	20.3		
Three times	1	0.9	3	3.6	4	2.0		
Where they keep								
Hanging on trees near to home	17	14.91	9	11	26	13.2	93.51***	0.00001
Hanging on trees in forest	0	0.00	50	60	50	25.4		
Back yard + Hanging trees forest	97	85.09	24	29	121	61.4		
What they produce								
Honey only	89	78.07	78	93.98	167	84.77	9.412***	0.0002
Honey + Wax	25	21.93	5	6.02	30	15.23		
Hive shade construction								
No	81	71.05	79	95.18	160	81.22	18.33	0.0000
Yes	33	28.95	4	4.82	37	18.78		
Supplementary feed								
No	76	66.67	80	96.39	156	79.19	25.73	0.0000
Yes	38	33.33	3	3.61	41	20.81		

Appendixes 6.1.5. Beehive holding, honey production, and its use

Description	Adopters		Non-adopters		Total sample		t value	p value
	Mean	SD	Mean	SD	Mean	SD		
Beehive possession								
Traditional hive	**34.08**	**31.91**	**30.92**	**27.74**	**32.75**	**30.19**	**-0.725**	**0.2696**
With bee colony	16.263	16.14	15.277	15.101	15.847	15.679	-0.4349	0.6641
Without bee colony	17.82	18.089	15.65	18.29	16.694	18.163	-0.828	0.408
Transitional hive	**2.04**	**2.721**	**0.807**	**1.735**	**1.522**	**2.429**	**-3.635*** **	**0.0004**
With bee colony	0.868	1.436	0.397	0.81	0.67	1.232	-2.691***	0.0078
Without bee colony	1.754	1.781	0.409	0.963	0.852	1.536	-3.555***	0.0005
Modern hive	**7.149**	**5.93**	**0**	**0**	**0**	**0**	**-10.97*** **	**0.0000**
With bee colony	3.736	2.85	0	0	0	0	-11.93***	0.0000
Without bee colony	3.412	3.691	0	0	0	0	-8.416***	0.0000
Total honey produced	195.44	147.3	91.951	87.509	151.842	135.46	-5.707***	0.0000
Traditional hive production	7.275	4.413	6.185	3.998	6.816	4.267	-1.779*	0.0767
Transitional hive production	6.757	9.347	3.634	6.564	5.441	8.413	-2.61***	0.0097
Modern hive production	21.403	9.238	0	0	0	0	-21.12***	0.0000
Honey uses								
Honey home consumed	21.868	16.465	12.481	13.374	17.913	15.897	-4.267***	0.0000
Honey Gifted	9.578	7.523	4.746	5.332	7.543	7.088	-5.005***	0.0000
Honey Sold	164	137.09	74	80.73	126.38	124.55	-5.299***	0.0000

Appendix Tables 6.1.6 Conversion factor of tropical livestock unit (TLU)

Livestock Category	TLU
Ox and Cow	1
Heifer	0.75
Young Bull (*Woyefen*)	0.34
Calf	0.25
Sheep and Goat (Young)	0.06
Sheep and Goat (Adult)	0.13
Hen	0.013
Donkey (Young)	0.35
Donkey(Adult)	0.70
Horse and Mule	1.1

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

Appendixes 6.1.7. Result of variance inflation factor for continuous explanatory variables

Variable	VIF	1/VIF
AGE	1.22	0.818164
TOTALFAMILSIZEE	1.2	0.832923
EXTESERV	1.1	0.907637
AMOUNTOFFAR	1.1	0.908527
LANDSIZE	1.06	0.939266
DISTNEARES~T	1.05	0.9553
LIVESTOCKHOLDING	1.05	0.955442
Mean VIF	1.11	

Appendixes 6.1.8. Result of contingency coefficient for dummy explanatory variables

Variables	SEX	EDUCAT~N	INFORM	CREDIT	TRAINING
SEX	1				
EDUCATION	0.0416	1			
INFORM	0.0736	0.0192	1		
CREDIT	0.0737	0.1381	-0.0757	1	
TRAINING	0.0728	-0.1549	0.2041	-0.1609	1

6.2. Appendixes survey questionnaire

Name of enumerator_____, Kebele _____Date _____, Code ____.

Dear Sir/Madam,

This beekeeper's Survey, on Adoption of modern beehive, is being conducted by Jimma University College of Agriculture and Veterinary Medicine (JUCAVM). The survey is carried out in Gera district Jimma Zone, Oromia Ethiopia. The purpose of the survey is to gather information about the honey production systems, factors that affect adoption of modern beehive and challenges and opportunities that beekeepers face to use modern beehive after using it in the area of study.

The obtained information will be used to produce knowledge on the determinants of modern beehive adoption of smallholder beekeepers in the study area. The information will be entered into a statistical package and inferences will be made from the pool of the information collected from all respondents. There is no situation in which your name or any information related to your privacy will appear in the results of the study. If there is a felt need for that, the result of the study will be communicated to you. Hence, please answer as many questions as you can so long as they apply to your situation.

All information will be treated as strictly confidential.

Thank you for your cooperation.

Instructions

A. Make brief introduction about objective and importance of the study
B. Do not put your own feeling rather put what they told to you.
C. Please ask each question clearly and patiently until the farmer gets your idea.
D. Please do not use technical terms and use local units
E. Prove that all questions are asked finally thanks the farmer for his/her responses.

1. Household characteristics

1.1. Name of the household head_____ Village_____

1.2. Sex of the household head: 1. Male ☐ 2. Female ☐

1.3. Age of the household head _____ years.

1.4. Religion of the household head: 1. Muslim 2. Orthodox 3. Protestant 4. Others

1.5. Marital status of the household head: 1. Single 2. Married 3.Widowed 4. Divorced

1.6. Educational level of the household head: 1. Illiterate 2._____ grade.

1.7. For how long have you been in Beekeeping? _____years.

1.8. Total family size: M._____F._____Total._____

1.8.1. Number of family member of age less than 14: Male ____Female ___ Total _____

1.8.2. Number of family member of age 15< x > 65: Male ____Female ____ Total _____

1.8.3. Number of family member of age greater than 64: Male ____Female __ Total ____

1.9. Have you involved in farming activities. 1. Yes 2. No

1.9.1. If yes which one 1. Livestock rearing 2. Crop production 3. Poultry keeping 4. Others

1.9.2. If yes what is your annual total income from farming activities? _____ Birr

1.10. Have you involved in off/other non-farm activities in 2010 E.C? 1. Yes 2. No

1.10.1. If yes, what is the type of other non-farrm activity you involved in? 1. Trade 2. Handcraft 3.Daily labor 4. Others

1.10.2. If yes, who participated in the off/other non-farm activities? _____.

1.10.3. If yes, how many persons of the household members participate on it? _____.

1.10.4. If yes, what is the total estimated income obtained from the activities? ____Birr.

2. Farm characteristics

2.1. Do you own land? 1. Yes 2. No

2.1.1. If yes, how did you acquire it? 1. Kebele given land ('Mirit') 2. Inherited from parent 3. Rented

2.1.2. Total Farm Size_____ in Hectare and number of plots _____

1. Cultivated area_____ Hectare _____ plots.

a. Area allotted to annual crops_____ Hectare, _____plots.

b. Area allotted to tree crops (Coffee) _____ Hectare, _____plots.

2. Uncultivated (Hilly, Rocky) land_____ Hectare, _____plots.

3. Homestead_____ Hectare, _____plots.

4. Grazing land _____ Hectare, _____ plots.

5. Irrigated land _____ Hectare, _____plots

6. Planting "bahirzaf" tree _____ hectare _____ plots

2.2. Did you grown crops? 1. Yes 2. No

2.2.1. If yes, what are the crops you grown in Meher and Belg in 2010 E.C.?

Table 1.Types of crops you grown in 2010 E.C.

Crop type	Area planted (Hectare)	Total production (Qt)
Teff		
Sorghum		
Maize		
Barley		
Cooffee		
Vegetables		
"Enset"(Kocho)		
Chat		
Total		

2.3. Did you own livestock? 1. Yes 2. No

2.3.1. If yes, what is the total number of livestock you own in 2010 E.C.?

Table 2. Total number of livestock owned in terms of TLU, their main purpose and annual income including their products in 2010 E.C.

No.	Livestock type	Total number	Total number sold	Total income (Birr)	Purpose*
1	Oxen				
2	Cows				
3	Calves				
4	Heifers				
5	Goats				
6	Sheep				
7	Horse				
8	Mule				

9	Donkey				
10	Poultry				
	Grand total				

2.4. Do you keep bees? 1. Yes 2. No

2.4.1. If yes, how did you start beekeeping?

1. By catching swarm 2. By buying bee colony 3.Through inheritance 4. If other specify_____

2.4.2. If yes, where do you keep your honeybees?

1. Homestead 2. In forest 3. In the house 4. If others specify _____

2.4.3. If yes, how many beehives do you own in 2010 E.C.?

1. Traditional hive _____ 2. Transitional hive _____ 3. Modern hive _____ 4. Total _____

2.4.3.1. Beehives with bee colonies 1. Traditional __ 2. Transitional___ 3. Improved __

2.4.3.2. Beehives without bee colonies 1. Traditional __ 2. Transitional __ 3. Improved

2.4.3.3. If there is beehive without bee colony, what is the reason? _____

2.4.4. If yes, among your families, who does predominantly take care of beekeeping?

1. Husband 2. Wife 3.Children 4.Hired labor 5. If others specify ____

3. Use of modern beehive technology

3.1. Are you aware of modern beehive? 1. Yes 2. No

3.1.1. If yes, from whom did you hear about it?

1. Extension agent 2. Radio/TV 3.Field day 4.Neighbor 5. Printing materials

6. Workshop 7. If others specify _____

3.2. Have you ever used modern beehive? 1. Yes 2. No

3.2.1. If yes, when did you start utilizing modern beehive? _____ E.C. with ____ number of hives.

3.2.2. If yes, for how long did you used modern beehive? _____ years.

3.2.3. If yes, are you using modern beehive in 2010 E.C.? 1. Yes 2. No

3.2.4. If yes, from where do you usually get the modern beehive?

1. WoLFDRO 2. Own making 3. Market 4.NGO 5. If others specify

3.2.5. If you are **using modern beehive**, why did you use it?

1. Easily available 2. Ease of management 3. Locally prepared 4. Too Cheap 5.Convinced of benefits 6. Higher productivity 7. If other specify

3.2.6. If you are **not using** modern beehive, why you did not use it?

1. It is expensive 2. It is not available 3. It needs skill 4. Lack of awareness

5. Not convinced of benefit 6. Never heard 7. Any other specify_____

3.2.7. If yes, do you want to increase the number of modern beehive? 1. Yes 2. No

3.2.9.1. If not, why?

1. Too expensive 2. Not available 3. Needs skill 4. No bee forage 5. Lack of land

6. Satisfaction with the existing number 7. Not sure of benefit 8. Cash shortage

9. Not better than local 10. Others (like labor shortage), specify_____

3.3. Can you buy modern beehive whenever you want to buy? Yes ☐ No ☐

4. Access to institutional services

4.1. Have you ever received extension service on beekeeping? 1. Yes 2. No

4.1.1. If yes, who assisted you for utilizing modern beehive?

1. WoLFDRO 2. NGOs 3. Research centers 4. Neighbors 5. Relatives

4.1.2. If yes, how many times did you have contacted extension agent per year? ____-

4.1.3. If yes did you find the extension contact useful? _____

4.1.4. Which extension agent helped you most learn about box hive?

1. Extension agent 2. Radio/TV 3. Field day 4. Printed materials

4.2. Did you attend beekeeping training? 1. Yes 2. No

4.2.1. If yes, from where did you got training?

1. WoLFDRO 2. NGOs 3. Research centers 4. Any others

4.2.2. If yes, on what area did you attend training?

1. Colony multiplication 2. Bee management 3. Hive products 4. Marketing

5. In transferring bee colony 6. Comb preparation 7.Harvesting 8. Others

4.2.3. If yes, what methods were employed during training?

1. Lecture 2. Demonstration 3. Group discussion 4. Combination of all

4.2.4. If yes, did you find the training useful?

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

1. Understanding effective way of using modern hive 2. Understanding improved beekeeping management 3. Any other specify _____

4.2.6. If No, what was wrong with training?

1. It focus only on theory 2. The training duration is too short 3. Lack of experienced trainer 4. It was not based on my need 5. Any other specify ___

4.4. Did have an access to information related to beekeeping technologies?

1. Yes ☐ 2. No ☐

4.4.1. If yes through what mechanism did you get the information?

1. Mobile 2. TV/Radio 3. Neighbors 4. Development agents 5. Others

4.4.2. Do you think that the information you got is useful for adopting new technologies like modern beehive? 1. Y☐ 2. No☐

4.4.3. If yes, have you adopted such technologies? **Yes ☐ 2. No ☐**

4.5. Did you have an access to credit? 1. Yes ☐ 2. No ☐

4.5.1. If yes did you borrow money for beekeeping inputs? 1. Yes ☐ 2. No ☐

4.5.1.1. If yes, what was your source of credit?

1. OCSSC (WLQO) 2. Bank 3.Service cooperative 4. Relatives 5.Merchant 7. Others 4.5.1.2. If yes, what is the type of credit? 1. Cash 2. Kind, with the interest rate of _____%.

4.5.1.3. If yes, have you repaid all the credit? If not, why? _____

4.5.1.4. How did you repay your credit?

1. By selling the hive product 2. From other sources 3.If others specify ___

4.5.2. Did you use the credit offered for beekeeping to other purposes? 1. Yes☐ 2. No ☐

4.5.2.1. If yes, for what purpose did you use? 1. for educating children2. For purchasing cloth 3. For purchasing seed, fertilizer 5. For purchasing goat or sheep 6. Any other ____

4.5.3. Was there any time you could not use improved beekeeping practice due to lack of access to credit in 2010? 1. Yes ☐ 2.No ☐

4.5.4. Did you think that credit will help to improve beekeeping practice? 1. Yes☐ 2.No ☐

4.5.5. If you have not used credit even you need credit access for beekeeping so far, what are the main reason 1. High interest rate 2. Unfavorable terms of repayment 3. Lack of collateral 4. Unavailability of credit 5. If others specify _____

6. Hive produces and bee forage

6.1. What are the produces you get from your hive?

1. Honey 2. Beeswax 3.Bee colony 4. Others _____

6.2. When is the harvest period? 1. 1rst round _____ 2nd round _____ 3rd round (if there is)_____ _____

6.3. How many times do you harvest per annum? _____.

Table 4. Amount of hive products from each hive type you got at different seasons in 2010 E.C.

Source	No. hives	Total yield (Kg/year)	Average honey yield/harvest/hive in kg			Average beeswax yield/harvest/hive in kg			Bee colony
			1rst round	2nd round	3rd if there is	1rst round	2nd round	3rd if there is	
Traditional hive									
Transitional									
Modern beehive									

6.4. Honey produced uses per household.

Table 5. Honey uses per household in 2010 E.C.

Honey uses	Unit	Traditional	Transitional	Improved	Total
Consumed	Kg				
Sold	Kg				
Gifted	Kg				
Total	Kg				

6.5. Have you constructed hive shading? 1. Yes 2. No

6.6. Did you provide supplementary feed to your honeybee during shortage period? 1. Yes 2. No

6.6.1. If yes, what do you feed your honeybees?

Table 6.Supplementary feeds that are offered to bees by the beekeepers in 2002 E.C.

Types of feed	Amount offered per day per colony(kg)	Period of the year (month)	Costs per kg (Birr)
"Shiro"			
"Besso"			
Sugar syrup			
Honey + water			
If other specify			

6.7. What are the common bees forages/trees in your area

_____

7. Access to market

7.1. Did you have an access to market? 1. Yes 2. No

7.2. Did you sold hive products during 2010 E.C.? 1. Yes 2. No

7.2.1. If yes, what were the produces you sold?

1. Honey 2. Beeswax 3.Bee colony 4. Others _____

7.2.2. At what season do you sell your farm produces? _____

7.2.3. . If yes, where do you sale your hive produce?

1. At market found in nearby town 2. At farm gate 3. Cooperative 4. Tej house 5.Any other (specify) _____

7.3. If you did not sale, what were the reasons?

1. Price too low 2. No surplus to be marketed 3. Marketing places too far 4. If others specify

7.4. What is the distance to the nearest market? _____ Km, _____ minutes.

7.5. What are the major bee product marketing constraints you have observed in your area?

_____

8. Income and expenses from beekeeping

Table 7.Annual income from hives products in 2010 E.C.

Type	Total production (kg)			Total sold (kg)			Selling price			Total income ETB		
	Tradit.	Trans.	Moder.	Tradit.	Trans.	Moder.	Tradit.	Trans.	Moder.	Tradit.	Trans.	Moder.
Honey												
Beeswax												
Bee colony												
Others												

8.2. What are the expenses of beekeeping?

Table 8. Beekeeping expenses per hive per annum in 2010 E.C.

No.	Items	Traditional		Transitional		Improved		Total cost
		Amount	Price	Amount	Price	Amount	Price	
1	Beehive							
2	Transport cost per hive							
4	Beeswax cost per hive							
5	Labor cost per hive							
6	Bamboo leaf cost							
7	Service charge for accessories (casting mold, honey extractor etc)							
8	Feed cost							
9	Hive shading cost							
10	Interest on variable inputs							
11	Interest on fixed inputs							
12	Depreciation on fixed inputs							
	Others							

8. Challenges and Opportunities of modern beehive utilization

8.1. Challenges

No.	Challenges	Rank	What measures will be taken
1	Honeybee pests and predators		
2	Absconding		
3	Inaccessibility of modern beehive and accessories		
4	Financial limitation		
5	High cost of modern hive and its accessories		
6	Poor quality of training		
7	Poor of extension support		
8	Lack of appropriate management knowledge		
9	Lack of attention		
10	Lack of business support services		
11	Lack of Market information and market linkage		
12	Lack of access to credit		
13	Others		

8.2. Opportunities

No.	Opportunities	Rank
1	Eases of management	
2	High in productivity and overall production	
3	Availability of bee forage	
4	Existance of High demand of the produce	
5	Indigenous knowledge for beekeeping	
6	High quality of produce/honey	
7	Existence of abundant honeybee colony	
8	Existence of extension support	
9	Easy access to market information and market linkage	
10	Others	