ASSESSING THE INFLUENCE OF ADOPTION AND USE OF MODERN HONEY EXTRACTING TECHNOLOGIES ON HOUSEHOLD INCOME OF SMALLHOLDER BEEKEEPING FARMERS IN BARINGO COUNTY, KENYA

CHELAGAT JEMUTAI JANE

REG NO: A56/7822/2017

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE MASTERS DEGREE IN AGRICULTURAL AND APPLIED ECONOMICS, DEPARTMENT OF AGRICULTURAL ECONOMICS FACULTY OF AGRICULTURE

UNIVERSITY OF NAIROBI

NOV 2021

DECLARATION

I declare that this is my original work and has not been presented for any degree at any other University

Signed 07.2022

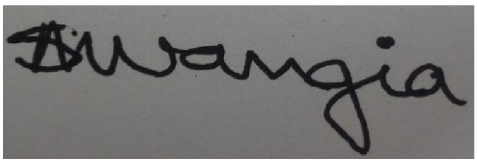
CHELAGAT JEMUTAI JANE

This thesis has been submitted for examination with our approval as the University supervisors

Signed **Date**-16.07.2022

DR. JOHN R.BUSIENEI, PHD

Lecturer, Department of Agricultural Economics

Signed.  Date—08 October, 2021

DR. SABINA M.WANGIA, PHD

Senior Lecturer, Department of Agricultural Economics

ACKNOWLEDGEMENT

First, I take this opportunity to thank the almighty God for the strength to overcome various challenges in the course of writing this thesis. Secondly, I wish to express my deep and sincere gratitude to Dr. John R. Busienei and Dr. Sabina M. Wangia for their guidance and invaluable technical advice in supervision of this work. Thanks for the University of Nairobi, particularly the Department of Agricultural Economics for putting in place Collaborative Masters in Agricultural and Applied Economics (CMAAE), which has enabled me to learn a lot both in theory and practice. Much appreciation also goes to the entire staff of the department of agricultural economics for their guidance, computer services, materials and other support in this thesis development. Last but not least, I thank all my classmates for their advice, encouragement and team work they showed over the entire course. To all and sundry, I wish you God's blessings now and in the future.

DEDICATION

I would like to dedicate this work to my dear mum, Mrs. Andrew Chelagat and dad Mr. Andrew Chelagat, brothers and sisters and friends for their great love and words of wisdom to me.

May God bless you

TABLE OF CONTENTS

LIST OF TABLES

LIST FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

AMI	Agricultural management institute (Canada)
ANOVA	Analysis of variance
ASALs	Arid and semiarid lands
ASDS	Agricultural sector development strategy
BCE	Before the Christian era
CMAAE	Collaborative masters in agricultural and applied economics
FAO	Food and agricultural organization (United Nations)
FAOSTAT	Food and agriculture organization corporate and statistical database
GoK	Government of Kenya
HMF	Heavy metal free (resins)
KNBS	Kenya national bureau of statistics
Kshs	Kenya shillings
MoLFD	Ministry of livestock and fisheries development
MTS	Meter tonne second
NPV	Net present value
PGR	Procuraduría General de la Repúlica (Mexico)
PH	Potential hydrogen (measure of acidity)
SNV	Stitching nederlandsevrjwilligers (Netherlands development organization)
SPSS	Statistical package for social scientist
UN	United Nations
US	Unite States

USAID	United states agency for international development
USDA	United states department of agriculture

ABSTRACT

Beekeeping has remained traditional with honey the major commodity being harvested from log hives and the wild. Previous empirical work, have paid attention on pre-harvest technologies, little information is known on post-harvest technologies. The research sought to, characterize small-holder beekeeping farmers in to adopters and non-adopters, and establish the effect of adoption and use of modern honey extracting technologies on the household income and to analyze the determinants of adoption and use of modern honey extracting technologies. Primary data was collected using semi-structured questionnaires. Cross sectional data was used. Descriptive and correlation research design was used. Multi-stage sampling method was used to arrive at the respondents for interviewing. 134 small-holder beekeeping farmers were interviewed. T-test demonstrated that there was significant statistical difference between the two groups in terms of age, level of education, membership to groups, access to information, experience and access to credit. OLS results pointed out that modern technologies had positive influence on household income, while traditional technologies had a negative influence on the same. Results from logistic regression model asserted that, kilograms of honey extracted, level of education, access to information, household size, age, cost of honey extractor, group membership, credit availability and off-farm income were important significant explanatory variables in influence the adoption decision. The survey recommended farmers to frequently attend trainings, seminars, workshops, shows and exhibitions in order to access information and get educated on how to make use of modern honey extracting technologies. Moreover, it is necessary for farmers to diversify income in order to eliminate the risk averse behavior common with low-income farmers. This will enable them to purchase modern extracting technologies.

Key words: Adoption, extraction, modern, smallholder, technologies, household income

CHAPTER ONE: INTRODUCTION

1.1Background information

In Kenya, apiculture tends to be treated as a hobby or sideline activity, but it is an important occupation that is part of rural life worldwide (Oladimeji,2017). It provides income to 90,040 farmers and the national dependency ratio is 1:6 (KNBS). Apiculture has acted as source of formal employment to 900 farmers working in beekeeping industries. 547,440 have benefited from beekeeping (FAOSTAT)g. At the farm level, estimated honey yield is about 20% of the estimated production of a beehive (Mburu et.al, 2015). In rural areas in Africa, Kenya included, income sources are limited. Small-scale apiculture could be a major contributor to securing livelihood if measures are put in place to add value to the products from the trade (Abdullahi, 2014).

The Ministry of Livestock estimates that beekeeping can be sustained in 80% of the nation (MoALF, 2019). The apiculture industry, according to KNBS has a potential to produce more than 100,000 Metric tonnes (MTS) of honey and about 10,000 MTS of beeswax per annum, only a fifth of the capacity has been achieved so far (Mburu et.al, 2015). The potential in honey production has not been obtained, though it is a major occupation of the people in Arid and semi-arid lands (ASALs) (Heckle et al, 2018).This might be attributed to the fact that, over 90% of beekeepers in Kenya use traditional hives that lead to honey of low quality (Chemwok et.al, 2019). The living standards have been low despite most of them venturing in the activity which might be attributed to farmer's lack knowledge on health benefits associated with the use of honey e.g in diabetes management (Chege et.al, 2016) among other factors.

There are two broad methods of extraction honey in Baringo County, namely: traditional and modern.Studies have shown that, modern extraction methods produce high quality, well priced honey while traditional methods produce poor quality and low value honey (Oladimeji, 2017). The modern extraction methods employ the use of honey extractors generated manually or by use of electricity, radial and tangential.Currently, there are many types of manual and electric honey extractors available in the market. Regardless of the type of extracted used, the process of separating honey from the combs is the same (Adaman, 2019) as shown in figure 1 below:

Figure 1: How to use a honey extractor

Source: Adaman, 2019

The first classification of honey extractors is based on the means of operation (Abecassis et.al, 2015). This classification gives two types of extractors; manual and electric. Electric honey extractor (VIVO BEE-Voo4E 4 frame electric honey extractor) is the commonly used electric honey extractor by commercial beekeepers in the County. This type of honey extractor is as Shown in figure 2 below:

FIGURE2: Electric honey extractor

Source: (Mendeley, 2021)

Manual honey extractor (VIVO BEE-Voo4B 2 frame manual honey extractor) is type of manual honey extractor is light weight and spacious. It best fits small-scale beekeepers who have just started the business of beekeeping. It is described as the best manual extractor (MoALFD, Kabarnet, 2019). This type of honey extractor is as shown in figure 3 below:

Figure 3: Manual honey extractor

Source: Kiingwa 2020

Another classification of honey extractor is based on how the frames are arranged in the basket: ones with tangential baskets and ones with radial baskets. These two types of honey extractors can either be manually or electrically operated.

Tangential honey extractor on the other hand, is the mostly utilized type of extractors mostly by small-holders. The honey comb in the frames faces outwards. The machine only separates honey from comb from only the outside the frame. For this reason, there is need to flip the frame and repeat the process (Wikipedia). Figure 5 below illustrates tangential honey extractor.

Figure 4**: Tangential honey extractor**

Source: Peter, 2019

Traditional methods of honey extraction include: Crushing and straining, heat method and melting method. Crushing and straining involves the following steps;the honey containing combs is crushed with a spoon. The honey is strained using a kitchen strainer. It is then collected in a basin underneath the strainer. The honey is poured in to jars and stored. The process is as presented in appendix 2

Heat methodinvolves, heating water in a sufuria, putting honey comb in an enamel basin or any other container which is not made of iron, putting the container with honey combs on the boiling water, Heating the honey until most of the honey melts, separating the melted honey from the combs by straining through a muslin cloth, keeping the honey in a container to cool down,

removing the wax layer that forms on the surface of the honey (Wikipedia). Melting method involves putting the honey in a bucket and leaving it on the sun to melt, separating the melted honey from the combs by simply removing the comb layer that forms on the surface. This method mostly attributed to result to production of semi-processed honey (Wikipedia).

Baringo County is the second largest honey producer in Kenya after Kitui County (FAOSTAT). It is also one of the arid and semi-arid lands (ASALs) areas in the nation and is therefore experiencing frequent climatic variations (KNBS).Beekeeping acts as source of livelihood through the sale of hive products (Ominde, 2014). Baringo County is one of the favorable areas for beekeeping because beekeeping does not require fertile land, large pieces of land, is not resource intensive (Heckeet,al, 2018). The researcher further pointed out that, climatic variations have minimal effect on the practice compared to other farm activities. Most beekeepers in Baringo County sell their honey in raw form; others use traditional method to extract their honey while a few utilize the modern method(Chemwok et.al, 2019). The use of traditional method has resulted to low honey prices due to low quality honey (Berem, 2015). In addition, the method is slow and requires a lot of energy.

1.2 Statement of the research problem

Baringo County is one of the counties designated as Arid and Semi-Arid Lands (ASALs).

Bee keeping is one of the sub-sectors supporting the livelihood of many households, given that two thirds of Kenya's total land area is arid and semi-arid where beekeeping can be an option to diversify the livelihoods of people. Most small-holder beekeepers in the county sell their honey in raw form (Suraj, 2018); therefore, they sell low quality honey which has led to denial of

access to international markets. According to Bichange, (2010) honey requires improved extraction and quality assurance to enhance its market competitiveness. Low quality honey fetches low prices in comparison with honey of high quality (Berem, 2015). Advanced value adders sell their honey at higher prices; generate more income hence better savings (Ondite, 2014). Traditional methods are mainly used to harvest and process honey in the area which leads to impurities in the extract resulting to low quality honey. Development and validation of an extractor improves the processing of quality honey harvested from indigenous hives and natural colonies (Mercyline, 2021)

Otieno (2019) did a study on the socio-economic factors influencing adoption of modern beekeeping technologies; he found out that, the modern beekeeping contributes significantly to household's income. The results of this study go in line with the findings by Muya B.I (2014) who found out that, economically new technology (movable comb hives) produces higher net returns than old technology (logs, pots and baskets). Furthermore, Affognon (2015) from his study on adoption of modern beekeeping and its impact on honey production revealed that there is a positive and significant relationship between the adoption of modern hives and the quantity of honey produced. A study done by Gebiso (2015) concur with a study carried by Adgaba et.al (2014) who aimed at finding out the determinants of box hive technology adoption. The analyst foundout that, education, trainings and access to information, access to market positively influences adoption of box hive. Further, the researchers recommended adoption of modern beekeeping technologies e.g modern hives and it's accessories especially honey extractor as a very important factor in enhancing the development of the sub-sector by increasing beehives productivity. The results from the two studies are in line with the findings of Heckle, R. et.al

(2018) who concluded that access to information, land and beehives, availability of alternative income generating activities and access to market, positively influences modern beekeeping. Nevertheless, Chemwok et.al (2019) did a more generalized study on factors influencing honey production. The researcherfoundout that over 90% of the beekeepers in Kenya use traditional methods that lead to honey of low quality. He also pointed out that indigenous hives have a lower bee population and produce lower yield compared to modern hives.

From the findings of the studies/previous empirical reviews, there is a clear indication that information on economic and institutional and socio-cultural factors influencing adoption and use of modern honey extracting technologies is not well documented which is the focus of this study. Information on the relationship between the use of modern honey extraction technologies and the income of the smallholder beekeeping farmers is lacking. The current information also confirms that most of the research focus on honey production and factors that influence adoption of the technologies involved (Pre harvest technologies). These pre harvest technologies include: sitting an apiary, use of modern hives such as box hive, methods of honey harvesting, maintenance of colony size and general management of the bees in the hive.

Little or no information is known about the post-harvest technologies which include honey extraction technologies. It is therefore clear that there is inadequate research information on adoption and use of modern honey extracting technologies. This current study therefore seeks to establish the factors influencing the adoption and use of modern honey extracting technologies and the influence of these technologies on household income of a smallholder beekeeping farmer.

1.3 Objectives of the study

1.3.1 Overall objective

To analyze the effect of adoption of honey extracting technologieson household income and the determinants of its adoption among smallholder beekeeping farmer's in Baringo County, Kenya

1.3.2 Specific objectives

1. To characterize smallholder beekeeping farmers in to adopters of use and non-adopters of use
2. To establish the effect of adopting honey extracting technologies on household income among smallholder beekeeping farmers in Baringo County, Kenya
3. To analyze the determinants of adoption of honey extracting technologies among small-holder beekeeping farmers in Baringo County, Kenya

1.4 Hypotheses

Hypothesis 1: Adoption of honey extracting technologies do not influence beekeeper's household income in Baringo County, Kenya

Hypothesis 2: Socio-economic, cultural and institutional factors do not influence farmer's decision to adopt modern honey extracting technologies in Baringo County, Kenya

1.5 Justification of the study

This current study will help contribute to the existing body of knowledge on processing technologies available in the market. It will likewise inform policy makers who are involved in implementing new ideas to farmers on the areas of focus. It will contribute to achieving the processing strategy as one of the objectives in Kenyan agribusiness strategy that missed on GI as a possible market targeting intervention. It will also contribute to achieving the nation's strategic

plan and vision 2030 objectives that is: eradicating hunger, employment creation, increased household income, conservation of the environment an increased access to markets.

In addition, the research will contribute to improved livelihoods of the people living in arid and semi-arid lands, improved marketing of agricultural produce, and processing of farm produce which are outlined in the agricultural sector development strategy (2010-2020). The knowledge will be important in contributing to employment creation among the youth, individuals and groups hence contributing to one of the goals of Kenya youth agribusiness strategy. This will help increase their income, therefore uplifting their living standards and the overall country's economy. Therefore, the study will attempt to achieve Sustainable Development Goals 1, 2, and 3, and one of the Big Four Agenda of the Kenya Government. The findings will also be relevant to smallholder beekeepers in choosing the honey extracting method which will increase the quality and quantity of honey produced, their income and therefore improving their living standards and the overall country's economy.

1.6 Basic assumptions

The researcher will assume that the interviewee understands the questions asked and would give accurate information on the questions asked to facilitate the success of data collection exercise, interpretation and analysis. The researcher will also appreciate the beliefs, norms, taboos and gender issues in influencing the decision of a beekeeper to adopt an innovation. However, the researcher assumed that this would not affect the success of the research.

1.7 Summary

This opening chapter bestows concise context of the research which predetermines the platform of this research work, positions the subject matter in context and encompasses broad accounts about the obligation of the research. The chapter also gives an account of the research problem which exemplifies the core problem and clarifies why the problem is meaningful to the research. It gives the general objectives of the study, hypotheses to be tested, justification of the study, delimitations of the study, limitations of the study, premise of the study and provides simplified clarification of momentous terms

1.8 Delimitations of the study

The study aims at analyzing the effect of different modern honey processing methods on the income of small-holder beekeeping farmers in Baringo County. This will employ the use binary logit model in determining the effect of the use of modern honey processing technologies on the income of the small-holder beekeeping farmers in the County. The study will be limited to two central divisions in the county. The choice of these two divisions was based on the fact that, it is one of the favorable areas in honey production, it is composed of small and medium scale farmers which is the focus of the study and has the largest number of beekeepers (3,000) (MoLFDMarigat, 2019).

1.9 Limitations of the study

The research was confronted with diverse constraints that contributed to holding up data that the study was searching. The major constraint of the research is its incompetence to cover a considerable figure of apiculture farmers due to limited time. The constraint was averted by paying attention to factors influencing farmer's decision to adopt advanced technologies inn apiculture enterprises with special focus on smallholder beekeeping farmers and key informant

interviewees. The research would have embodied smallholder beekeeping farmers beyond this area of study to cater for more extensive study but this was not possible due to time and resource constraint.

In addition, the study was also confronted with other limitations such as negligence by smallholder beekeeping farmers: as most of them were ignorant and was hard to persuade them to answer the queries provided in the questionnaires. Communication was also a constraint due to the fact that most of the interviewees were ignorant as mentioned earlier. Nevertheless, the analyst educated and appointed community translators who were in a position to translate English in to native language and was then in a position to persuade interviewees to respond. Additionally, interviewees perceived that the report they gave could be used to depict pessimistic representation of their approach or to be used for emulation purposes. The analyst however assured the interviewees of confidentiality standards that the results would be presented and that it will be applied only to scholarly work.

1.10 Definition of significant terms

Apiculture: It is the practice of maintaining bee colonies in man-made hives by humans

Honey:This is a sweet fruit, which is sticky and yellowish-brown in color made from nectar collected by bees and other insects from flowers.

Honey extractor: This is a mechanical device used for extracting honey from honey combs

Small-holder: A person who owns an area of land that is used for farming but is much smaller than a typical farm

Income: Money received on a regular basis for work or through investments

Technology: Machinery and equipment developed from application of scientific knowledge

Livelihood: A means of securing the necessities of life

Adoption: An action or fact of choosing to take up, follow or use something

Processing: It is the act of performing a series of mechanical or chemical operations on something in order to change or preserve it

1.11 Organization of the thesis

This thesis is organized in to five chapters. Chapter one covers the background of beekeeping (apiculture in general), modern honey extracting methods available in the market, factors determining adoption of new extracting technologies, Baringo county and beekeeping, statement of the research problem, objectives and hypotheses to be tested, justification for the study and organization of the proposal. Chapter two reviews honey production and extractionin Kenya, marketing of extracted honey, honey extraction and household income in Baringo county, factors determining adoption of modern technologies in beekeeping and review of past studies. Chapter gives an account of the methodology used to effect this study. It also illustrates the types and sources of information used to perform this study, the targeted population, methods and techniques of sampling that were used to select the sample size. The chapter also illustrates how the information used to carry out this study was collected and figured out. The techniques in the study gave guidance for data collection and handling. Chapter four presents the data analysis presentation and explanation. Furthermore, it reviews results from the hypotheses that were being tested, to ascertain if socio-cultural, institutional and cultural factors influence farmer's decision to adopt current honey extracting technologies in apiculture enterprises. Lastly, chapter five demonstrates short statements of the main points

(summary), discussions, outcome of the research (conclusions) and the judgments drawn from the study (recommendations). The chapter also presents the results from the queries in the questionnaire and interview advisor which were together executed to the smallholder farmers together with those farmers who were members of women groups. It finally deliberates the results in connection to the review of literature and the aims of the study.

CHAPTER TWO
REVIEW OF LITERATURE

2.1 Introduction

This chapter provides extensive literature and research information to honey production and processing in Kenya,and the determinants of adoption of modern processing technologies. The literature summarizes a diverse spectrum of views about new technology adoption and the influence of the technologies on small-holder household income.

2.2 Current status of honey productionin Kenya

Honey production is an important economic activity in the ASALs in Kenya. ASALs contribute 80% of the total honey produced in the Country. Honey production is also carried out in non-ASAL areas. Only (25,000 metric tonnes) is achieved leaving the full potential of 100,000 metric tonnes (KNBS). Kenya, the potential of honey production has not been achieved. Only about 20% of annual honey production potential has been exploited. Kenya is the third important producer of honey after Ethiopia and Tanzania (Muma, 2019). According to Mesele (2021), quality of honey is the most predetermining issue in price determination. A study by Chemwok et.al (2019) on the factors influencing honey production, pointed out that in traditional methods of honey production are used by over 90% of the beekeepers in Kenya which results to production of low quality honry.According to Kenya's news agency, the main honey producing areas; Baringo, West Pokot, MwingiKitui, Tharaka, Western and Coastal Regions. The average honey production in Kenya is 25,000 MTs/Annum (Directorate of Livestock Production, 2014). The world;s richest honey market is the United Arab Emirates which sells honey at the highest price per kilogram (ksh2,000) in comparison with the locally sold honey at Sh. 500-800 per

kilogram (United Nations commodity trade data base, 2019). Ethiopia which is the largest honey producer in Africa produces 43,000 metric tonnes (FAOSTAT, 2014).

Honey producers in Kenya have employed traditional methods of beekeeping for many years (Chemwok et.al, 2019). 100,000 MTS of honey in Kenya has been attained which is only 20% of the country's potential. Apiculture has a huge untapped potential and if fully exploited, can greatly improve the living standards of smallholder farmers. The practice is simple, easy to begin with biodiversity benefits. Affognon (2015) did a study use of modern technologies in beekeepingon adoption of modern beekeeping and its impact on honey production in the former Mwingi district of Kenya, using theory-based impact assessment. The researcher noted that the use of modern technologies in beekeeping ha significant and positive influence in the quantity of honey produced. The use of pre-harvest technologies in Kenya began in 1960's. Since then, there has been low technology adoption by farmers. Traditional log hive produces the highest percentage of honey (60%) compared to other types of beehives (Al-Ghamdi*et.al* 2017). It provides considerable percentage of bee products. These results go in line with the results by Chemwok et.al (2019), who in addition, pointed noted that indigenous hives have a bee population of 70% and a yield of 16kg of honey per hive in a year.

The potential in beekeeping in Kenya has not been obtained despite the efforts of researchers of finding the most profitable technologies. This is attributed to lack of beekeeping equipment, ignorance by bee farmers, lack of knowledge and skills and low technology adoption (Abebe, 2009). Bee farmers are often exploited by middlemen ending up selling their honey at a 'throw away price' (Suraj, 2018). This has been attributed to lack of knowledge and market outlets to

the sell their honey. The most available beehives in Kenya include: traditional hive (logs, pots, baskets) and modern hive (Kenya top bar hive, langstroth hive and box hive) (MoALFD, 2009). Kiptarus et.al (2011), in his study on the current situation of beekeeping in Kenya found out that, technology adoption enhances production. Adoption of honey production technologies is determined by socio-economic characteristics of an individual and the attractiveness of the technology. Socio-cultural factors negatively and positively determine the use of modern apiculture equipment (Irungu, 2016). Lack of skills, lack of credit, information asymmetry, cost of equipment, high input cost and lack of trainings are the major challenges faced by the small-holder beekeeping farmers in technology adoption (Jagiso, 2018; Suraj, 2018; Kalanzi, 2015; Masuku, 2013, Natukunda, 2012)

2.3 Honey processing in Kenya

Agro-processing is a term that refers to changing the form of agricultural products in order to add value to the product or o preserve it.Processing of agricultural products majorly serves to of agricultural products majorly serves to yield high economic returns to farmers.Ngomo, (2021), carried out a study in Kitui County on the determinants of production and performance of honey processing projects. The researcher discovered that production determinants such as market demand, loan access, technology adoption, financial access and farmer training had positive and significant influence on the performance of processing projects in the County.Muli, (2019) on the other hand, did a study in the same County on the determinants of financial performance of processing small and medium enterprises. The analyst pointed out that access to finance, corporate governance, product costing and risk management practices had a positive and significant relationship with financial performance. The findings of the two studies conducted on the two

Counties were supported by literature reviewed by the two studies. Various recommendations were made concerning processing projects including all agricultural products with reference to the findings of the studies.

Processing is part of value chain in all agricultural products. According to Jagiso, (2018), shortage of input supply, lack of skills, lack of credit, reduced land sizes, and shortage of bee forage are the major problems faced by small-holder beekeepers in the value chain. Omari, (2010), carried out a more intensive study on analysis of value chain for traditionally processed honey and identifying the most profitable value-adding activity practiced by traditional beekeepers using gross margins. The analyst found out that there is significant difference in revenue accrued from unprocessed honey and value-added through filtering, packaging and quality testing. He therefore suggested further research technologies used in honey processing and their relationship with small-holder farmer's choice. On the other hand, Abebe, (2009), discovered that drought, pests, predators, lack of training, inadequate credit facilities, water scarcity, poor infrastructure, information asymmetry and illiteracy are the major challenges to production and marketing of honey as part honey value chain.

Honey processing involves changing the physical and chemical form of honey in order to preserve it or to add value to it. Honey extraction means separation of honey from combs or simply squeezing honey out of combs. Therefore, this current study focuses on extraction as part of processing. Therefore, processing here can also be used to refer to extraction having in mind that processing is a wider term. Berem, (2015), carried out a study on characterization of various honey processing methods and Markets in Baringo County, employing Heckmann two stage

probitmodels. The analyst pointed out that most honey producers in the County of interest sell their honey at throw away prices due to lack of processing. This may be attributed to the fact that most of the honey extractors in the area of study employ traditional methods which results to incomplete extraction leading to impurities in the extract (Oladimeji, 2017). Kiplimo, (2015), ruled out that, modern hives generate more income compared to traditional hives. This may be attributed to the fact that, modern hives makes it possible to use modern technologies in extraction which leads to completely processed honey, hence honey of higher quality and therefore higher prices. This is in line with the findings of Ondite, (2014) who from his study, concluded that advanced value adders generate more income hence better savings. In addition, Kalanzi, (2015), from his study on socio-economic analysis of beekeeping, using logistic regression model, discovered that, honey adulteration, cost of the equipment, and unreliable honey supply are the major challenges faced by large scale processers. Out of observation, cost of the equipment was found to be a major challenge to small-scale processors in the area of study.

2.4Honey extracting technologies in Kenya

According to (Khakina, 2015), international market for honey is expected to reach 1.9M tonnes. This has not been made possible due to lack of proper honey extraction. The major problem facing honey extractors is the fact that most of them are unable to access markets in an easy way and therefore they are forced to spent a lot of money in travelling to access far away centralized markets or sell their products to middlemen at a throw away price (Berem, 2015). Mercyline, (2021), did a study on development of an extractor improve the processing and quality honey harvested from indigenous hives and natural colonies. The analyst discovered that, development

and validation of an extractor improves the processing of honey harvested from indigenous hives such as pots, logs and buckets. This would improve on their quality hence fetching higher prices.

Honey extraction is related to quality in the sense that the use of tradition al technologies in honey extraction produces semi-processed honey while the use of modern technologies yields fully processed honey without impurities. Technology adoption in the area of study has remained low. Natukunda, (2012) from his study on determinants of farmers choice of apiculture production attributed this to lack of credit services, pests and predators, unaffordable and inappropriate extension services, inadequate water supply and shortage of bee forages, high input cost.

Honey requires improved extraction and quality assurance to enhance its market competitiveness (Bichange, 2010). For this reason, there is need to find out the available technologies that can be used for honey extracting in order to improve its quality and therefore gain access to international markets. Renaud (2017), in his study pointed out that one of the main factors preventing beekeeping adoption is farmer's putting priority to activity with higher and regional incomes. This leads to farmer's neglecting those activities that may take long for them to realize the economic returns. For this reason, farmers embark of selling raw honey in order to get their returns at a faster rate. Honey extraction has been found to improve the living standards of farmers in general, through reduction of poverty levels in the rural areas.

The use of modern technologies in beekeeping generally improves productivity. Hippolyte, (2015), in his study on choice of honey processing technologies and its effect on beekeeping

productivity using probit and logit models pointed out that there is significant relationship between the use of modern honey production technologies and beekeeping productivity. These results are in line with the results by Abdullahi, (2014) who found out that modern beekeeping is more profitable and most beekeepers derive their livelihood from this activity. For this reason, farmers should be supplied with affordable and appropriate extension services, cheap beekeeping inputs and capacity building on how to control bee pests and predators.This current study will specifically focus on the rural small smallholder farmers of the County.

Trainings have been found to be one of the major factors influencing farmer's decision to adopt modern extracting technologies. Masuku, (2013) did a study of factors influencing honey production in Swaziland and pointed out that, trainings to small-holder beekeepers are helpful in creating awareness to farmers on how adoption of new technologies in processing and extraction would boost their productivity. He therefore recommended factors that can influence increase in colony size and use Langstroth hives be made known by small-holder beekeeping farmers.Gatimbu, (2020) in his study in Kitui County also recommended the County government to help with training programs by providing free beekeeping training or cooperating with other instructors. According to Heckle R. et.al (2018), in his study on beekeeping adoption, the case of small-holder farming community, the main factors affecting the decision of small-holder beekeeping farmers to take up beekeeping were access to information, land and beehives, availability of alternative income generating activities and access to market.

On the other hand, Adgaba et.al, (2014), did a study socio-economic analysis of beekeeping and determinants of box hivetechnology adoption in the kingdom of Saudi Arabia. The researcher

found out that, education level positively influences the adoption of box hive. The analyst attributed this to the fact that education level increases the knowledge and equips farmers with skills on how to make use of new technologies. The findings of these two studies are in line with the findings of Bekuma, (2018) who discovered that personal factors such as age, economic factors e.g land, availability of credit, institutional factors e.g attendance in extension events and psychological factors e.gknowledge and perception of the beekeepers are majorly the factor influencing adoption of beekeeping technologies. The honey extracting technologies in the County are categorized in to two; Traditional and modern technologies. Traditional technologies include; crushing and straining, heating and melting methods. Modern technologies involve the use of machines; this includes; electrical, manual, tangential and radial machines. The method methods are as illustrated in chapter one of this thesis. According to Chemwok et.al (2019) most beekeepers in the County use traditional methods in extracting their honey.

2.5Apiculture and household welfare

Income is the profits and losses incurred through the operation of a farm. It is a measure of the economic viability for the operation of a farm. Consumption is the use of goods and services by a household. It is a measure of purchasing power of an individual. Consumption can therefore be considered as a measure of income. According to Moratti et.al, (2012), household welfare can be measured in terms of consumption and income. Consumption here includes food consumption, non-food items including health, education, and non-food expenditures; it also includes household expenditures and consumer durables. Lekobane et.al, (2016), in his study on determinants of household welfare and poverty in Botswana also noted that consumption and

income are justified as the measures of household welfare. Income is likely to be a more sensitive issue for respondents than consumption (Deaton, 1997). This justifies the focus on income in this study. This is also due to the fact that income can be easily measured compared to consumption and the respondents can easily respond to issues related to income and provide appropriate data for analysis.

Adoption of modern beekeeping/apiculture is closely linked to the income generated. Muya, (2014), pointed out that, economically, movable comb hives (new technology) produced higher net returns per colony compared to the use of traditional hives (old technology). Otieno, (2019), on the socio-economic factors influencing adoption of modern beekeeping technologies noted that, modern beekeeping farming contributes significantly to household income. On the other hand, Joshua et.al (2018), in his study pointed out that, conserving biodiversity has positive effect on income from beekeeping. The researcher attributed this to the fact that conserving biodiversity provides flowers for bees to forage on. Caleb (2017), in his study also noted that, modern hives generate more income than traditional hives with Langstroth hives producing highest followed by Kenya top bar hive with log hive producing the lowest. Most adoption studies have discovered that there is a positive relationship between adoption of modern beekeeping technologies and household income (Al-Ghamdi et.al, 2017; Kiplimo, 2015; Ondite, 2014; Omari, 2010). The current study therefore seeks to investigate the influence of modern honey extracting technologies on household income.

2.6 Review of empirical studies

Socio-cultural factors include age, gender, and marital status, level of education, culture and household size these are attributed to positively influence adoption of traditional extracting technologies in this study. These factors may influence adoption either positively or negatively (Irungu, 2014). Institutional factors on the other hand, include availability of credit, group membership, market access, extension services and information search costs. These factors also influence the adoption of modern extracting technologies either negatively or positively. Psychological, personal, institutional and economic factors have been known to influence adoption of modern beekeeping technologies (Bekuma, 2018)the research focuses on identifying the specific economic, institutional and socio-cultural factors institutional factors that determine adoption of modern honey extracting technologies among small-holder beekeeping farmers.

Finally, economic factors to be analyzed in the current study include: experience, cost of labor, equipment, transport, price and quality of honey produced. Land size is an important economic factor that has been found to determine positively the adoption of use of modern technologies. (Taha,2009). On the other hand, availability of credit to purchase agricultural technologies is another factor. The small-holder beekeeping farmers who have access to credit services have the ability to purchase improved beekeeping technologies. Access to credit has been identified by many reserachers to influence adoption of modern beekeeping technologies (Abebe, 2009; Natukunda, 2012; Sakijo, 2018; Suraj 2018; Gebiso, 2015). Hence access to credit influences adoption of use beehive technology both positively and negatively. (Sisayet.al, 2013).

2.6.1 Determinants of adoption of modern honey extracting technologies

Mercyline (2021) carried out a research intending to develop and improve the standard of honey harvested from traditional hives and native colonies through processing. Using Analysis of variance, the analyst found out that, development and validation of an extractor improves the processing of quality honey harvested from indigenous hives and natural colonies. Another study on determinants of production and performance of honey processing projects; the case of Kitui County was conducted by Ngomo (2021). Using descriptives and linear regression model, the researcher revealed that production determinants had favorable and significant impact on honey processing performance

Chemwoket.al(2019), used descriptives and ordinary least squares to analyze the factors influencing honey production in Marigat, Baringo County, Kenya. He pointed out that, over 90% of beekeepers in Kenya use traditional hives that lead to honey of low quality. On the other hand, Otieno et.al (2019) did another study on socio-economic factors influencing adoption of modern beekeeping technologies in Baringo County, Kenya. Using binary logistic model, the analyst noted that modern farming significantly contributes to household income. In addition,

Amanuelet.al (2018),conducteda study on determinants of adoption of modern honey production technologies using descriptive research design. He found out that adoption of use of, modern hives has significant influence on productivity of beehives. Invention of new technology, sufficient and relevant extension services provided by agricultural officers, capacity building, credit services, modern beehive accessories and special adult education would promote adoption

of beehive technology. He therefore recommended these factors to be put in place by extension agents or policy makers who are in process of promoting a given idea or innovation to small scale farmers.

Bekuma (2018), sought to review adoption of modern beehive technology and determinant factors in Ethiopia. The researcher used logistic regression and discovered that psychological, institutional, economic and personal factors influence adoption of beekeeping technology. In addition, Heckle (2018), did a case study on beekeeping adoption; a case of three small holder farming communities in Kenya. The analyst employed descriptive statistics in data analysis and stated that the main factors affecting small-holder farmers to take up beekeeping are access to information, land and beehives, availability of alternative income generating activities and access to market.

Jagiso (2018), focused on analysis of Value Chain in honey and Producers Financing in Southern Ethiopia. The study focused on identifying the functions of different actors in the value chain. The findings of the study revealed that factors such as lack of skills and experience, lack of inputs are the major constraints in adoption of modern pre-harvesting beekeeping technologies. The study further recommended policies that focus on these issues to be put in place by policy makers.

Suraj*et.al.* (2018) used direct and indirect observation with probit model to study factors determining adoption of beekeeping technologies. The researcher found out that, most

smallholder bee farmers sell their honey in raw form; therefore, they sell low quality honey. The researcher further found out the major constraints in beekeeping to be lack of equipment, attack by pests and diseases, poor weather conditions, inadequate knowledge and skills, bee phobia, inadequate capital, information asymmetry and low levels of income. Using binary logistic model and likert-type of analysis, Oladimeji (2017) conducted a study on use of modern equipments and organizational practices amidst honey producers in North central and North Western Nigeria towards sustainable development goals. From the results, the analyst observed that,traditional hives have a lower population of bees (70%) and a give a total produce of yield of 16kg per hive annually.

Irungu (2016) did another research which focused on socio-cultural factors determinants of farmer's choice of modernized machinery in beekeeping industries. Data was collected using semi-structured questionnaires, personal interviews, observation of point respondents. The findings of the study revealed that: age, gender, marital status, level of education and household size these are attributed to positively influence adoption of traditional extraction technologies in this study. These findings attest the findings of a study by Kenya beekeepers association (K.B.A, 2005) which recommended sex of the household head, marital status and the size of the household, as the major socio-cultural factors determining choice of modernized technology in beekeeping projects.

Berem (2015) analyzed beekeeping and activities of diverse bee product outlet in Baringo County. The study employed the use of institutional analysis and development framework. The findings of the study revealed that there was generally low technology adoption in the region

which led to the sale of raw honey which is low priced. This has led to negative effect on household income of beekeepers in the region. The study suggested further study on factors that determine adoption of modernized machineries to use in beekeeping projects. The findings further recommended state contribution in the form of developing basic underlying framework of the beekeeping system, exploring and developing the sector within the county.

Hippolyteet.al. (2015) did another research on farmer's choice of modernized machinery in honey production and its effect on honey production in the former Mwingi district, Kenya. The study employed the use of probit and logit models. Data entry was done using statistical package for social scientist (S.P.S.S). The findings of the study revealed that there is a significant relationship between adoption of modern hives and the quality and amount of honey produced. The study recommended research on socio-economic and technical know-how attributes influencing farmer's choice of modernized beehives.

Kalanzi, (2015) focused on Socio-economic investigation of honey production operations in Western Uganda. The results of the study indicated that capacity building and level of education in beekeeping were the major factors influencing farmer's decision to use advanced beehives. The study recommended commercialization efforts to major on special trainings that solve the challenges faced by beekeeping farmers in the area. Affognon, on the other hand, did a similar study on adoption of modern beekeeping and its impact on honey production in the former Mwingi district of Kenya; Assessment using theory-based impact evaluation. The researcher employed probit model, and pointed out from the analysis that, positive and significant influence exists between the adoption of modern hives and the quantity of honey produced.

Yusuf, (2014) analyzed the effect of educating youths on beekeeping in the Moro local government of Nigeria. The study employed the use of structured questionnaires. The sample size was 116 bee farmers randomly selected. The findings of the study revealed that there are high levels (93%) of choice of modernized technologies by males compared to their female equivalent. The study suggested policies to be put in place to deal with stealing which is prevalent in the place. It further recommended youth trainings to target areas of objection and also studies on less threatening bee breeds for introduction

Masuku, (2013) did a case study on socio-economic analysis of beekeeping in Swaziland using observation and descriptives.The study showed that there is room for enhancing the living standards of smallholder bee farmers as it is a profitable enterprise. The study recommended that there is need for these farmers to make use of modernized pre-harvest equipments and also to introduce practices that encourage colony size multiplication so as to be able to increase the quantity and quality of honey produced.Adgaba (2014) proposed to conduct a more similar study on socio-economic analysis of beekeeping and determinants of beehive technology adoption in the kingdom of Saudi Arabia. Using logistic regression model and descriptives, the researcher found out that, education level, positively influences the adoption of box hive which might be attributed to the fact that education level increases farmer's knowledge and level; of awareness.

Natukunda (2012) sought to establish factors influencing adoption of bee farming and associated equipmentsinBushenyi district Western Uganda. Analysis of the data was done using descriptive statistics and Musa et al rank index to come up with challenges and opportunities. In spite of the

challenges in beekeeping, opportunities are also present in the study area: availability of beehives, honey market sustainable prices, healthy bee colonies and appropriate infrastructure. For beekeeping activities to be sustained in the study area, it is suggested that extension services should be affordable and appropriate, beekeeping inputs should be affordable, trainings to beekeepers on pests and predator's control mechanisms should be provided to bee farmers.

Kiptarus*et.al* (2011) did a study on beekeeping in Kenya: The current situation, using descriptive statistics. He found out that there is need for technology adoption to forge ahead with transformation measures for enhanced production. Policies, lack of a functional monitoring plan, inadequate research, low technology adoption, lack of market information, Defensive honey bee, Technology development an improvement, High cost of production and extracting equipment, pests and diseases, climate variability, low honey production, Poor quality honey and inadequate skills are constraints to honey production.

Bichang'a, (2010) carried out a study on characterization of Kenyan honey and design model for processing equipment. The moisture content of Kenyan honey was found to be below the maximum permitted limit of (21%) and therefore stands no risk of fermenting. Most of the Kenyan honey had matured with acceptable levels of proline and diastase number. The study recommended that the physicochemical parameters of Kenyan honey can successfully be used to design honey extraction and processing equipment which can be used to process honey in any part of the country.

Abebe, (2009) proposed to study marketing chains of honey in AtsbiWemberta District, Eastern Zone of Tigray Region. The researcher used Robust OLS regression econometric model to figure out factors determining marketing supply of honey. The findings from this study stated that level of education of the household head, honey price, amount of honey produced, were the major positively significant factors determining marketable supply honey of the county. Further, a significant quantity of honey produced is marketed directly to consumers from producers (43.4%). The performance of honey marketing indicated by marketing margins accomplished with analysis of costs and gross profits obtained by characters from different marketing channels. From the results of this research, interrogated interventions to improve marketable supply of honey produced are recommended

2.6.2 Effect of adoption of modern honey extracting technologies on household income

Muli (2019) conducted a study on determinants of financial performance of processing small and medium enterprises in Kitui County. Then analyst employed descriptive statistics and linear regression model in the analysis of the results. The researcher found out that, access to finance, financial corporate governance, production costs and risk management practices were positively related with financial performance of the processing small and medium enterprises in Kitui County. Suraj*et.al.* (2018) carried out another study using direct and indirect observation with probit model to study factors determining adoption of beekeeping technologies. The researcher found out that, most smallholder bee farmers sell their honey in raw form; therefore, they sell low quality honey. The researcher further found out the major constraints in beekeeping to be lack of equipment, attack by pests and diseases, poor weather conditions, inadequate knowledge and skills, bee phobia, inadequate capital, information asymmetry and low levels of income.

Kiplimo (2017) did a study on the factors influencing the quality of honey produced using descriptive research design. He found out that modern hives generate more income than traditional hives. The study recommended research to be carried out on how to improve beekeeping and the quality and quantity of honey production. Nabwire, (2016) did another study on consumer's readiness to pay for standard aspects of honey in Kenya. Primary data was collected using structured questionnaires. Data was entered in to statistical package for social scientist and analyzed using choice experiment, D-optimal design. The nature of the research was quantitative experimental research design. The findings revealed that consumer's knowledge on quality standards of honey enhances their willingness to pay. The findings further recommended that there is need to spread knowledge and awareness to consumers on quality characteristics of honey.

Lekobane (2016) carried out a more specific study on determinants of household welfare and poverty in Botswana. The researcher employed regression analysis to investigate determinants of household welfare and poverty in Botswanausing the 2002/2003 Household Income and Expenditure Survey and the 2009/2010 Botswana Core Welfare Indicator Survey data. The researcher found out that education level and employment status of the household head are the major factors determining household welfare and poverty in Botswana. In addition, living in rural areas increases the possibility of being poor and has negative influence with welfare. The researcher therefore recommended public policy to continue putting more emphasis on education and creation of jobs which are among the strategies of alleviating poverty in Botswana. The

researcher finally recommended rural development as a critical factor in reduction of poverty levels in the area of study.

Gebiso (2015) did a study on adoption of modern bee hive in Arsi zone of Oromia region. The researcher focused on the determinants of adoption and financial benefits using binary logistic regression model. The researcher discovered that the main determinants of beekeeping adoption are farmyard size, number of local beehives possessed, trainings provided, and access to information, provision of credit services, participation of beekeepers and availability of non-farm income.

Abdullahi (2014) did a study on correlative economic investigation of modernize old honey production technologies in Nigeria. The study employed the use of regression analysis and farm budgeting in analyzing the data. The nature of the research was descriptive research design. The sample size was 80 interviewers interviewed through purposive random sampling technique. The findings of the study suggested that beekeeping is a profitable enterprise in the area and can act as another source of income. This enterprise can greatly increase the income of smallholder beekeeping in the region hence improving the living standards. The results of the study suggested state contribution in providing appropriate infrastructure, financial services, good market outlets, capacity building by extension officers to increase yields and earnings to meet family requirements.

Ondite (2014), sought to establish whether or not value addition on hive products would increase income and hence improve the livelihoods of bee farmers. The nature of the research was

descriptive research design. The sample size was 127 bee farmers randomly selected using sampling tables. The findings of the study revealed that exceptional value adders received higher returns hence had more improved living standards. The study recommended that farmers be trained on the importance of value addition and how to identify hive products and their uses.

Omari (2010) focused at establishing the value chain for naturally produced honey and coming up with the activity by beekeepers with the highest returns. The analyst used gross margins and discovered that beekeeping contributed to about 44% to the income of the sampled households. The study suggested that associations regarding marketing, use of improved technologies, educating farmers on beekeeping knowledge and skills, producing of locally cheap packing materials and post-harvest honey production technologies to encourage value addition along the value chain should be the focus of any intervention that needs to be carried out

Table 1: Summary of empirical studies

Author	Focus	Method	Findings	Knowledge gap
Mercyline(2021)	Development of an extractor to improve the processing of quality honey harvested from indigenous hives and natural colonies	ANOVA	Development and validation of an extractor improves the processing of quality honey harvested from indigenous hives and natural colonies	The study sought to find out the physical properties of honey significant in; characterizing honey from different sites of Marigat. There was also need to develop and validate an extractor to improve the processing of quality honey harvested from indigenous hives and natural colonies
Ngomo (2021)	Determinants of production and performance of	Descriptives Linear regression	Production determinants had a favorable and	The study sought to find solutions to the obstacles that restrict

	honey processing projects; the case of Kitui County	analysis	significant impact on honey processing performance	production and performance of honey processing projects in Kitui County
Chemwok et.al (2019)	Factors influencing honey production in Marigat, Baringo County	Descriptives Ordinary least squares	Over 90% of beekeepers in Kenya use traditional hives that lead to honey of low quality	There was need for the study to document relevant specific information on the influence of institutional, economic, social and technological factors on honey production in Marigat Sub-County, Kenya
Muli (2019)	Determinants of financial performance of processing small and medium enterprises in Kitui County	Descriptives Linear regression analysis	Access to finance, financial corporate governance, product costs and risk management practices were positively related to financial performance of the processing SME'S In Kitui County	There was need to find out the reasons lying behind the high mortality rate of processing SME'S in Kitui County
Otieno (2019)	Socio-economic factors influencing adoption of modern beekeeping technologies in Baringo County, Kenya	Binary logistic regression	Modern farming positively and significantly contributes to household income	The study saw the need for documentation of knowledge on levels of modern beekeeping technologies within the country, challenges facing modern beekeeping farmers, level of household income from beekeepers in comparison with other sources, and factors influencing adoption of modern

				beekeeping technologies in Baringo County, Kenya
Amanuel (2018)	Adoption of modern beehives and cultural factors influencing	Descriptive	Adoption of modern beehives technology has significant influence on productivity of beehives	Insufficient information on economic and institutional factors determining adoption of advanced beehives e.g., extension, credit, trainings e.t.c
Bekuma (2018)	Review of adoption of modern beehive technology and determinant factors in Ethiopia	Logistic regression	Psychological, institutional, economic and personal factors influence adoption of beekeeping technologies	Lack of research on determinant factors that affect adoption of beehive technology and highlights on policy implication for further extension of modern beehives
Heckle et al (2018)	Beekeeping adoption; A case of three smallholder farming communities in Kenya; Just to mention a few	Descriptives	The main factors affecting adoption of small-holder farmer's decision to take up beekeeping are; access to information, land and beehives, availability of alternative income generating projects and access to market	Information on pathways to adoption of beekeeping with those that have recently entered, factors leading smallholder to incorporate beekeeping in their household's livelihood strategy and factors preventing smallholder from taking up beekeeping was lacking
Jagiso (2018)	Honey value chain analysis and producer financing	Descriptive statistics	Shortage of input supply, lack of skills, lack of credit, reduced land sizes and shortage of bee forage are the major problems faced by small-	Little information on the role of processing as part of the value chain in increasing the producer income

			holder beekeepers in the value chain	
Suraj (2018)	Determinants of use of modern apiculture production equipments	Direct and indirect observation Descriptive statistics	Lack of credit, inadequate skill, lack of equipment, ignorance, poor extension services, information asymmetry, poor infrastructure are some of the determinants of poor adoption of beekeeping technologies	No information documented on the factors influencing adoption of modern honey processing (post-harvest) equipments
Al-Ghamdi*et.al* (2017)	Relative advantage of using modern bee hives	Descriptive statistics ANOVA, CD production function Partial budgeting	The use of modern bee hives generates more income compared to traditional hives	Information on the factors that motivate beekeepers to use modern bee hives (box hive)
Oladimeji (2017)	Adoption of improved technologies and management practices among the farmers in North central and North Western Nigeria towards sustainable development goals	Binary logisti regression Likert-type of analysis	Indigenous hives have a bee population of 70% and a yield of 16kg of honey per hive in a year	There was need for the study to find out the level of awareness of bee farmers on improved technologies and management practices
Irungu (2016)	Socio-cultural factors in influencing the adoption of modern technology in beekeeping projects	Descriptive statistics Observation	Socio-cultural factors positively and negatively determine the use of modern apiculture equipment	No documentation on economic and institutional factors that determine adoption of modern equipments in beekeeping

Lekobane (2016)	Determinants of household welfare and poverty in Botswana	Linear regression analysis	Education level and employment status of household head are the major determinants of welfare and poverty in Botswana	The study focused in finding out the determinants of welfare and poverty in Botswana
Affognon (2015)	Adoption of modern beekeeping and its impact on honey production in the former Mwingi district of Kenya; Assessment using theory-based impact evaluation	Probit model	Positive and significant relationship exists between the adoption of modern hives and the quantity of honey produced	The study focused at documenting relevant information on the influence of commercial insects' program on farmers adoption of modern hives and impacts on honey production
Berem (2015)	Characterization of various honey processing methods and markets in Baringo County	Descriptive statistics Heckmann two stage Probit model	Most honey producers sell their honey at throw away prices due to lack of processing	Lack of research on existing honey processing methods and honey markets in Baringo County
Gebiso (2015)	Adoption of modern beehive in Arsi zone of Oromia region; Determinants and financial benefits	Binary logit model	The main determinants of beekeeping adoption are farmyard size, number of local beehives possessed, training provided, access to information, provision of credit services participation of beekeepers, non-farm income	The study justified the need for providing knowledge on adoption rate of modern hives and its determinant factors in Arsi zone of Oromia region
Kiplimo (2015)	Factors influencing the quality of honey	Descriptive research design	Modern hives generate more income than	The study sought to find out the factors the quality and

	produced		traditional hives	quantity of honey produced by various farmers in beekeeping projects
Hippolyte (2015)	Choice of honey processing technologies and its effect on beekeeping productivity	Probit Logit Propensity score matching	There is a significant relationship between the use of modern honey production technologies and beekeeping productivity	The study aimed at documenting factors that influencing the choice of various honey production technologies
Kalanzi (2015)	Socio-economic analysis of beekeeping enterprise	Descriptive statistics Logistic regression model	Honey adulteration, cost of equipment and unreliable honey supply are the major challenges faced by large scale processors	The study saw the need for finding out the role of commercialization in overcoming constraints identified in honey production
Abdullahi (2014)	Comparative analysis of modern and traditional beekeeping	Descriptive statistics Farm budgeting model and regression analysis	Modern beekeeping is more profitable and most beekeepers derive their livelihood from this activity	Lack of enough information on the role of policy makers in increasing productivity in beekeeping.
Adgaba (2014)	Socio-economic analysis of beekeeping and determinants of box hive technology adoption in the Kingdom of Saudi Arabia	Logistic regression model Descriptives	Education level, positively influences the adoption of box hive which might be due to the fact that education increases the farmer's knowledge and level of awareness	The study aimed at providing relevant information on socio-economic profile of beekeepers and factors affecting adoption of improved beekeeping technologies
Ondite (2014)	Effect of processed hive products on the income of smallholder	Descriptive statistics Heckman two stage	Advanced value adders generate more income hence better savings	The study aimed at finding out the role of farmer's training in promoting adoption of modern

	beekeepers in Baringo			honey processing technologies in beekeeping projects.
Yusuf (2014)	Impact of training on beekeeping to youth in Nigeria	Descriptive statistics	There are high rates of adoption among males relative to female	Lack of research on less aggressive bee species
Masuku (2013)	Assessment of factors influencing honey production in Swaziland	Descriptive statistics	Trainings to small-holder beekeepers will create awareness to them on how this activity can boost their productivity	The study sought to discover factors that can influence increase in colony size and use langstroth hives because by smallholder beekeeping farmers
Natukunda (2012)	Determinants of farmers choice of apiculture production technologies	Descriptive statistics	Lack of credit services, pests and predators, unaffordable and inappropriate extension services, inadequate water supply, shortage of bee forages, high input cost are the major factors influencing choice of apiculture technologies	Insufficient information on factors influencing farmer's choice of post-harvest technologies
Bichange (2010)	Characterization of Kenyan honey and design model for processing equipment	Descriptive statistics	The moisture content of Kenyan honey was found to be below the permitted limit	The study aimed at filling the knowledge gap on physiochemical parameters that can be used successfully to design honey extraction a processing equipment which can be used to process honey in any part of the country

Kiptarus*et.al* (2011)	Beekeeping in Kenya: The current situation	Descriptive statistics	Technology adoption enhances production	The study aimed at analyzing and documenting technologies that influence honey processing
Omari (2010)	Analysis of value chain for traditionally processed honey and identifying the most profitable value-adding activity practiced by traditional beekeepers	Gross margin	There is a significant difference in revenue accrued from unprocessed honey and value-added through filtering, packaging and quality testing	Insufficient analysis of the technologies used in honey processing and their relationship with smallholder farmer's income
Abebe (2009)	Analysis of honey marketing chains	Robust OLS Regression	Drought, pests, predators, lack of training, inadequate credit facilities, water scarcity, poor infrastructure, information asymmetry, illiteracy are the major challenges to production and marketing of honey	Factors influencing marketable supply of honey are not clearly documented

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter provides the theory in which the study will be anchored on, conceptual framework, the models which will be used to analyze the data and the study area. It also provides research design, target population sampling procedure, sample size, data collection procedures and data analysis and presentation techniques.

3.2 Random utility theory

Random utility approach, was developed by Daniel McFadden (1974), and is used to link deterministic model with a statistical model of human behavior. The theory posts that people generally chose what they prefer, and where they do not, is determined by random factors. Categorical factors can be either fixed or random. The theory states that, given alternatives, an individual will choose an alternative depending on the individual's socio-economic characteristics and the attractiveness of the alternative.

Therefore, the present research is consequently based on the theory of random utility model (RUM). It makes the assumptions that choice makers are logical which means they select a method that maximizes utility (Wooldridge, 2012). This present research makes an assumption that, the small-scale farmers will select the method of extraction that provides the highest satisfaction (Mendola, 2005). In relation to the current study, a small-holder producer is assumed to select honey extracting method in a waythat gives the highest utility/satisfaction compared to other methods. The utility/satisfaction that farmers obtain in selecting an extracting technique is specified as shown in equation 3.1:

$$U_{i(j=k)} = \beta_{j=k}X_{ij} + \varepsilon_{ij} \forall j \in N \qquad (3.1)$$

The small-holder bee farmers will select an extracting technique if the anticipated satisfaction from this technique is greater than that of all the other methods. The likelihood of selecting a particular technique is the same as the likelihood that the satisfaction of that given method is higher than the satisfaction derived from all the other methods in the choice set (Greene, 2002). The small-holder farmer selectsthe extracting method j=k if:

$$U_{i(j=k)} > U_{i(j\neq k)} \quad \text{for all other } k \neq j \qquad (3.2)$$

Where:

U_{ij}denotes a random utility associated with thehoneyextracting technique j = k

$\beta_{j=k}X_{ij}$ is an index function indicating the processor's average satisfaction associated with this method

ε_{ij} denotes the error term

3.3 Conceptual framework

The independent variables in this case are socio-economic factors; age, level of education, gender and household size, institutional factors; credit availability, extension services, group membership, market access and economic factors; land size, cost of the honey extractor, cost of labor and cost of transport.

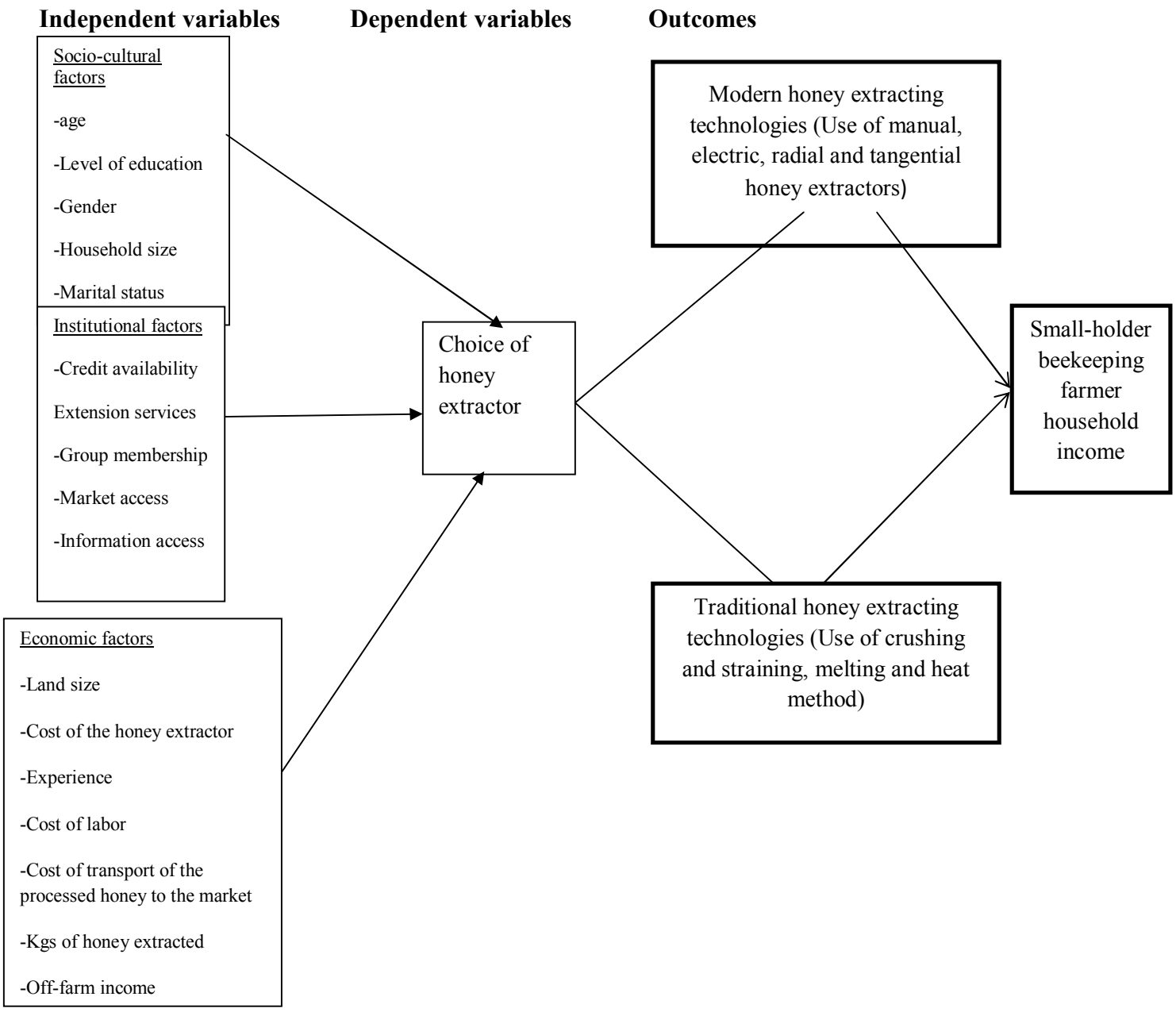


Figure 5: Conceptual framework of the determinants of the choice of honey extracting Methods and its outcomes

Source: Author's own conceptualization

3.4 Study area

Baringo County is situated in Rift valley, Kenya; its geographical coordinates are 0° 30' 0" North,35° 45' 0" East. The map below shows the study area (Marigat sub-county, located in

Baringo South).Baringo and Kitui County have proved to be the best Counties in bee production because most of the honey that is being sold in the Kenyan market is coming from these two counties.

The study was carried out in Baringo county one of the ASAL areas in Kenya.Thiscounty was chosen over the other county because only Baringo district has the organized beekeeping system and deals with small and medium scale farmers who are the focus of this study. The county was chosen over Kitui since the latter deals only with large scale and medium scale farmers.

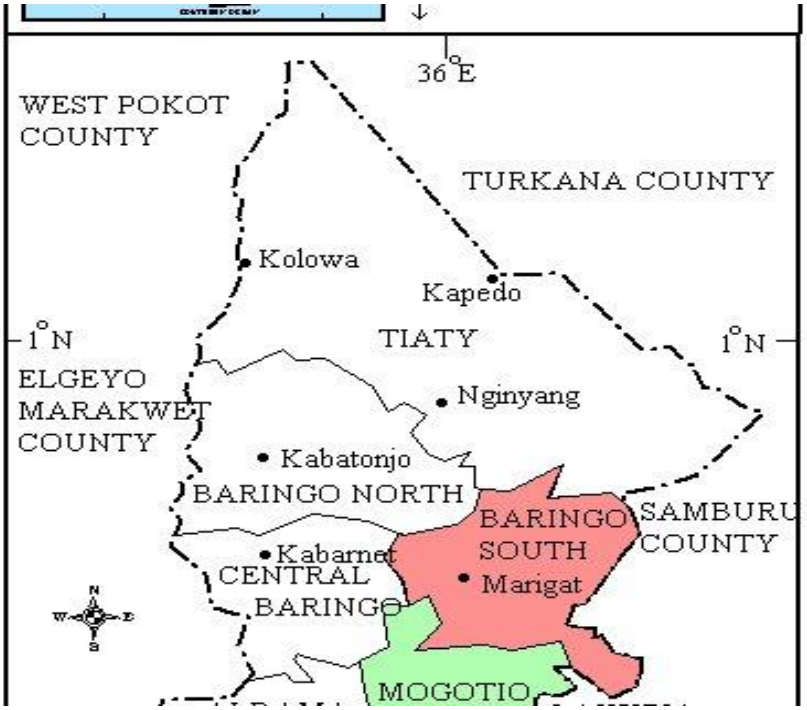


Figure 6**: Map showing Baringo County**

Source: Google

3.5 Empirical framework

Ordinary Least Square (OLS) - Multiple regression analysis was executed to establish the factors that have considerable significant influence on household income of the small-holder bee

farmers. Ordinary least squares method of analysis was developed by Gauss-Markov and is a type of linear least squares method of estimating the unknown parameters in a linear regression model. The model works by minimizing the sum of squares of the differences between the observed dependent variables and those predicted by the linear functions of the independent variable. The model is clearly specified as shown below:

$$Y=\beta_{O+}\beta_1x_1+\beta_2x_2+\beta_3x_3+\beta_4x_4+\beta_5x_5+\beta_6x_6+\beta_7x_7+\beta_8x_8+\beta_9x_9+\beta_{10}x_{10}+\beta_{11}x_{11}+\beta_{12}x_{12}+\beta_{13}x_{13}+\beta_{14}x_{14}+\beta_{15}x_{15}+\varepsilon\ldots\ldots\ldots \text{ Equation 3.1}$$

Where:

Y – Is the dependent variable; small-holder beekeeping farmer household income in this case

X_{1-15-} Are independent variables, in this case; Share of income from beekeeping, off-farm income, cost of honey extractor, tangential honey extractor, Kgs of honey extracted, radial honey extractor, access to information, credit availability, household size and market access, manual honey extractor, electric honey extractor, crushing and straining, heat method and melting method

β_{O-} Is the intercept (constant)

$\beta_{1\text{-}11}$ – Is the slope (unknown constant). It is the coefficient that allows interpretation of the results

ε – Random error component

The multinomial Logit Model

Given that there were more than two categories of the dependent variable, out of which only one alternative can be selected, multinomial logistic regression was used to establish the

determinants of adoption of use of modern honey extracting technologies. The dependent variable (adoption and use of modern honey extracting technologies) is a dummy variable taking a value of 0 to 6. 6represents electric honey extractor 5 represents manual honey extractor, 4 represents radial honey extractor 3 represents tangential honey extractor 2 represents crushing and straining, 1 represents heating method and 0 represents melting method

To identify the factors that influence the respondents' choice of honey extractor, multinomial logit model as used by (Pundo& Fraser 2006) was fitted. Given the alternatives before a respondent, the probability that an individual *i* choose alternative *j*, therefore, can be expressed as follows:

$$\mathbf{Pr}[Yi = j] = \frac{\exp(\beta' jXi)}{\Sigma \exp(\beta' jXj)}, \quad \text{.....Equation 3.2}$$

Where:

Pr[*Yi*□=□*j*]□=□Probability that an individual *i* uses either electric, manual, radial or tangential honey extractor.

j□=□1, 2, 3, 4, 5, 6, 7

i□=□1, 2, 3… 134

Xi□=□Vector of the predictor variables and

βj□=□Vector of the estimated parameters

The multinomial logit model ascertains the influence of explanatory factor on the likelihood that a beekeeping farmer will select one of the seven categories (heat, melting, crushing and

straining, electric, manual, radial and tangential honey extracting machine). The model was approximated by keeping the electric honey extractor 0; as the reference category. The e^{β} was estimated which displayed the odds ratio (OR) corresponding to changes in the explanatory variables. The odds are indicated as a single number to the ratio of one which means the likelihood of an occurrence of an event to the likelihood of an event not occurring.Correlation matrix was acquired to ensure that the multi-collinearity problem did not exist between the independent variables. Variables with higher multi-collinearity were eliminated in the last model to build on the values of the factors.

Model specification

The dependent variable

The dependent variable for the logit analysis is adoption and use of modern honey extracting technologies. The dependent variable here was modelled against a set of explanatory variables such as kilograms of honey extracted, level of education, land size, access to information, household size, age, gender, cost of honey extractor, group membership, credit availability, off-farm income, cost of labor, cost of transport, market access, access to extension services and experience

The independent variables to be included in the model

Kilograms of honey extracted: Kilograms of honey processed were expected to increase the farmer's likelihood of a farmer adopting the use of modern honey extracting technology. This is because an increase in the amount of honey processed increases the revenue accruing from honey production hence increased probability of a farmer adopting modern extracting technologies. Similarly, Omari (2010) revealed that there is a significant difference in revenue accrued from unprocessed honey and value-added through filtering, packaging and quality testing.

Level of education: The level of education was expected to increase the farmer's likelihood to adopt modern honey extracting technologies. This is because educating farmers eliminates reduces ignorance and illiteracy increasing adoption of modern technologies which increases the revenues from beekeeping. Similarly, Abebe (2009) mentioned illiteracy as one of the major challenges to beekeeping technology adoption.

Land size: Size of land was expected to increase the likelihood of a farmer adopting modern honey extracting technologies. This is because increased land sizes mean expansion of the enterprise, more production, and more kilograms of honey extracted hence the need for more efficient extracting machine. This leads to increased incomes and better savings in the long run. In the same way, Jagiso, (2018) mentioned reduced land sizes as one of the major challenges to small-holder beekeeping farmer in any study area.

Access to information: Access to information was assumed to have a positive influence on the likelihood of a farmer adopting the use modern honey extracting technologies. Access to information reduces transaction cost to continue or start beekeeping enterprise. This also

encourages the small-holder farmers to adopt new honey extraction. Access to information is one of the major determinants of adoption of modern beekeeping technologies (Heckle et.al, 2018).Suraj (2018) observed information asymmetry as one of the determinants of poor technology adoption among small-holder beekeeping farmers.

Household size: Size of the household was assumed to have positive influence on adoption of use of modern honey extracting technologies. Increase in the household size means increased participants in beekeeping projects hence increased production of hive products. Participation can also be increased through trainings to reduce literacy levels. Similarly, Masuku (2013) argued that trainings to small-holder beekeepers will create awareness to them on how this activity can boost their productivity.

Age: Age was expected to decrease the likelihood of adoption of use of modern honey extracting technologies. Increase in age means reduced energy levels to participate in beekeeping as an income generating activity. Younger generation is likely to adopt new extracting technologies faster compared to older generation. Amanuel (2018) argued that Adoption of modern beehives technology has significant effect on hives productivity.

Gender: Thisvariable is represented in relation to interviewee's sex. It has been found out by various authors as a significant variable describing the economic role of rural people in Africa (Mcsweeney, 1979 and Dey, 1980). Various authors such as Mayada et al (1994) reported thatwomen are in particular despised against credit service provision, while others such as Zeller (1994) argued that gender appeared to have no influence on adoption of advanced

techniques.Inrelation to Buvinic et al. (1979), factors connected to woman's lack of control over the economic resources and the nature of their economic activity are two categories of major factors that limit woman's access to financial services in comparison to men. This can either be farm off-farm or non-farm income. Consequently, in this current research, it was expected that female small-scale bee farmers were less likely to adopt the use of modern methods of honey extraction.

Cost of honey extractor: Cost of the honey extractor was assumed to decrease the likelihood of a farmer adopting modern honey extracting technologies. Increased cost of honey extracting technologies means increase in the total cost of production. This will ultimately decrease the revenues and profits arguing from beekeeping enterprises. High cost of honey extracting technologies also discourages farmers from adopting modern beekeeping technologies as most of the smallholder beekeeping farmers in the study area are poor. Natukunda (2012) mentioned financial problems as one of the factors affecting choice of apiculture technologies. Similarly, Kalanzi (2015) argued that Commercial processors are faced with honey adulteration, expensive equipment and unreliable honey supply.

Group membership: Membership to groups was expected to positively influence on adoption of use of modern honey extracting technologies. Membership to group means collective action in all activities concerning beekeeping. This reduces transaction costs of carrying business. It also makes it easy for farmers to access Institutional services such as trainings, extension services, credit, market and information which are the major hindrances to adoption of modern beekeeping

technologies. Natukunda (2012) observed these factors to be among the factors affecting choice of modern apiculture technologies.

Credit availability: Availability of credit was assumed to increase the likelihood of an adoption of use of modern honey extracting technologies. Access to credit eliminates the risk averse behavior of the farmers by enabling the access capital to engage in beekeeping enterprises. This will also improve adoption of modern beekeeping technologies. Suraj (2018) observed lack of credit as one of the determinants of poor adoption of beekeeping technologies.

Experience: Experience was expected to increase the likelihood of adoption of use of modern honey extracting technologies. Experience means a farmer has knowledge and skills to engage in the enterprise. This will reduce transaction cost that a farmer would incur in search of markets, inputs and other related factors. Experience would help overcome the challenge of lack of skills and knowledge experienced by most small-holder farmers. Jagiso (2018), Suraj (2018) and Abebe (2009) observed lack of skills as one of the major problems faced by small-holder beekeeping farmers in any study area.

Off-farm income: Off-farm income was assumed to have a positive relationship with adoption of use of modern honey extracting technologies. Availability of off-farm income helps to eliminate the cash constraint faced by most small-holder beekeeping farmers. This enables them to purchase modern equipment used in beekeeping. Off-farm income also may also act as source of informal credit to family members. This promotes adoption of modern beekeeping equipment by the small and medium scale farmers. Natukunda (2012) in his study pointed out financial

problems as among the factors affecting choice of apiculture technologies. Off-farm income acts as an alternative source of finances to the small and medium scale farmers.

Access to market: Access to market was expected to increase the likelihood of a farmer adopting the use of modern honey extracting technologies. Access to market encourages production due to availability of market to sell the product. It also encourages value addition as farmers are assured of where to sell the product. This will also enable the farmers to market their products at high prices as opposed to selling unprocessed products to middlemen at "throw away" prices. Ondite (2014) in his study found out that advanced value adders generate more income hence better savings. Value addition also enables farmers to access international markets.

Access to extension services: Access to extension services is expected to increase the likelihood of a farmer adopting the use of modern honey extracting technologies. Extension services equip the farmer with knowledge and skills on how to carry out beekeeping enterprises. It also makes the farmer to be aware of modern technologies available and hence promotes their adoption. Suraj (2018) and Natukunda (2012) pointed out poor extension services as among the major determinants of poor adoption of beekeeping technologies.

Econometric models diagnostic analysis

Green (1993) stated that it is unusual for the information in hand for a researcher to confront entirely to the theory lying beneath the model. Hence, before proceeding with the approximation of the multiple linear regression equation, the use of econometric theories, reasonable understanding of small-holder beekeeping farmer and stress econometric realization in modeling

has been of vital importance in analyzing variables that determine annual income from bee farming businesses. The process began with testing the degree of dependence among independent variables (multicollinearity), their association with the random term (heteroscedasticity) and viability of expressed model itself (fitness of the model).

Heteroscedasticity test

According to Kennedy (1985) heteroscedasticity is the probability of the error term to vary with some or all the independent variables. Due to the misdemeanor assumption of constatant variance of the error term, the probability makes the variable approximation incompetent in in prediction of independent factors. (Green, 1993).

Table 2: Variables to be included in the logit regression model

Dependent variable

Variable	**Measurement**
Adoption of use of modern honey extracting technologies	6 = Electric honey extractor 0= Others

Independent variables

Variables	**Measurement**	**Expected sign**
Kilograms of honey extracted	Kilograms/ month	+
Level of education	Dummy variable 1 = none, 0=Otherwise	+
Land size	Acres	

Access to information	Dummy variable 1 = Yes 0=Otherwise	+
Household size	Number	+
Age	Number	+
Gender	Dummy variable Male=0 Female=1	- -
Cost of honey extractor	Ksh	-
Group membership	Dummy variable 1 = Yes 0=Otherwise	+
Credit availability	Dummy variable 1 = Yes 0=Otherwise	+
Experience	Dummy variable 1 = Yes 0=Otherwise	+
Off-farm income	Ksh	+
Access to market	Dummy variable 1 = Yes 0=Otherwise	+
Access to extension services	Dummy variable 1 = Yes 0=Otherwise	+
Cost of labor	Ksh	-
Cost of transport	Ksh	-

Source: survey 2019

3.6 Sampling procedure and data collection

3.6.1 Data collection, sources and types

The study used primary data. The primary data was collected from households involved in beekeeping in Baringo central. Their reasons for the use of different honey extracting methods the costs incurred during honey extracting and the returns from extraction were collected through filling of questionnaires with both open-ended and fixed choice questions. Cross-sectional survey and multi-stage sampling were used

during the process. The questionnaires used which had both open-ended and fixed choice questions consigned both quantitative and qualitative features of the facts in the research. Secondary information obtained from the ministry of agriculture and livestock development, Marigat supported the results obtained from the four basic participants in Baringo County which included deliberately choosing one individual; from the stakeholders of Kerio valley development authority ministry of agriculture livestock and fisheries, Koriema honey processing Centre and Koriema stage women group.

3.6.2 Sampling procedures

Slavin (1984) examined that due to time, resources and energy constraint, research can be done from deliberately chosen sample of the population. The sample was obtained using multi-stage sampling whereby one central division (Marigat) was purposively selected. On the second stage, locations with the highest population of honey producers and extractors were purposively selected from the division. On the third stage, a random sample was drawn from the population consisting of adopters and non-adopters

3.6.3Sample size

This was arrived at employing Kothari (1990) formula. This formula was built on exactness and self-confidence level. Kothari formulae used are as presented below:

$n = ZpqN / D$

Where:

n: is the sample size

Z: is the standard normal value of 1.96 for 95% confidence interval

q=1-P: is proportion of population who have adopted modern honey extracting technologies

D: is statistical 5% level of significance = 0.05 ~ estimated error term for p in the sample

However, the population of the

= 133.976≈ 134

The sample was 134

3.7 Research design

Research design is the course of action framework or plan that is employed to develop solutions to research questions (Orodho, 2003). Research design can be anticipated of as the organization of the research (Kombo et.al, 2003). The research hypothesis in this study was tested through the use of descriptive research and correlation research design. In consonance with Cooper and Schindler (2003), an explanatory (descriptive) study is interested with determining the what, where and how of an occurrence. This study consequently was in a position to hypothesize the research as the factors influencing the small-holder farmer's decision on adoption of current technologies in apiculture enterprises in Kenya.

The major target of the research was quantitative nevertheless; a bit of quantitative technique was applied with a purpose of achieving exceptional understanding and probably permit an exceptional and greater perceptive investigation of the findings from the quantitative study. This approach handles the intensified analysis of problem resolving position in wherever problems are important to the study problem.The researcher tries to interpret and describe an issue frequently by establishing a description of collection of problems (Cooper and Schindler, 2003).

3.8 Target population

In accordance to Ngechu (2004), a population is clear-cut group of human beings, services, components and occurrences, collection of gods or households which are actually examined. In accordance to Mugenda and Mugenda (2003) a population is described as a group of personalities, cases or items with a few accepted discernable attributes in the smallholder beekeeping farmers in Baringo County is that they happen to be entirely apiculture farmers. Target population as defined by (Borg and Grall, 2009) is an entire set of investigation of entire representatives of legitimate or imaginary group of personalities, occurrences or items to which the analyst desire to conclude the findings. The target population in the current study was 3,000 farmers (MoALD), Marigat.

3.8.1 Oral interviews/questionnaires

An interview can be defined as determined conversation amidst two or more individuals. The application of oral interviews in research is of importance in collecting accurate and realistic information that is significant to the hypotheses testing and aims of the study. Oral interviews were administered on 134 smallholder beekeeping farmers.

3.8.2 Key informant interviews

The researcher also used key informant respondents who were deliberately chosen. The aim of using key informant interviewees was to obtain unrestricted comprehensive interviews with basic informants from community level participants with regard to their perspectives on the use of modern machinery in beekeeping enterprises. This resulted in developing an evaluation guide

with an order of unrestricted evaluation questions under the aims of the study that were to be assigned to chosen individuals for their know-how understanding.

3.8.3 Observations

Observation can be defined as an orderly account of occurrences actions and inventions in the community setting selected from the research (Patton, 1990). Observation allows the analyst to characterize the actual settings applying the five senses under investigation. The analyst used observation to obtain a few of the analytical information on the apiculture technological techniques amidst the apiculture farmers in Baringo County.

3.8.4 Review of secondary data

A summary of present information on entire significant articles connected to factors the research topic had been perfected. Data collected from these records permitted the analyst to triangulate and confirm the information collected form the ground. This was perfected as a section of the review of past studies. Chosen literature from Baringo County government basic participant officers (stakeholders) was analyzed so as to lay clear-cut information on apiculture technologies adoption.

3.9 Validity of the instruments

Validity can be described as the correctness and quality of interpretations based on the study findings (Mugenda and Mugenda, 2003). It is therefore the capability of instruments to measure

what is designed to measure. To improve content effectiveness, the study instruments in this research were estimated. A pilot study was done with a few smallholder beekeeping farmers in Marigat sub-County, Baringo County. Unclear queries were adjusted or eliminated after the interviewees had presented their complete questionnaires.

3.10 Reliability of the instruments

Concerning the accuracy of the study instruments, then questionnaires were first approved. Split half procedure was applied in proving the accuracy of the instruments in the course of pilot testing. This process was preferred over the other procedure due to its modesty. The unrestricted and analytical instruments were tailed by providing a mark for significant feedback and a zero for insignificant and empty feedback. The chosen instruments were classified in to two divisions. The marks of the divisions were consequently assessed, figured out and then compared. The coefficient was estimated employing the spearman brown prophecy formula as pointed out below:

3.11 Method of data analysis

This part describes the methods that were employed to interpret the information and analyze the variables. Before processing the feedback, information arrangement was perfected on the filled questionnaires by cleaning, correcting tabulating and recording the data. Data gathered was again analyzed with the use of descriptive and inferential statistics. The descriptive and inferential statistical techniques aided in interpreting the data and concluding the interviewee scope of compliance with the diverse comments under each determinant. Data analysis was perfected

employing S.P.S.S, and Microsoft excels to develop quantitative information that was bestowed in form of tables, percentages, means and standard deviation. The specific objectives of the study were achieved as shown in 3.12.1 and 3.12.2 and 3.12.3 below

3.11.1 Characterization of the smallholder beekeeping farmers

To achieve objective one, descriptive statistics such as mean and percentages were used

T-tests were also carried out to find out if there was significant statistical difference between the means of the two groups; that is adopters (those farmers using modern technologies) and non-adopters (those famers using traditional technologies

3.11.2 Establishing the effect of adopting honey extracting technologies on household income among smallholder beekeeping farmers

To achieve the second objective of this study, ordinary least squares was used as illustrated in equation 3.1

3.11.3 Analyzing determinants of adoption of honey extracting technologies among small-holder beekeeping farmers

Multinomial logit model was chosen due to existence of more than two categories of the dependent variable; unlike binary logit model where the dependent variable is limited to a maximum of two choice categories (Greene, 2002). Multinomial logit model is limited to computation of situations where there are more than two alternatives or where the outcome variable has more than two categories. In the current study farmers have more than two categories of technologies to choose from. These are manual, electric, tangential and radial,

crushing and straining, melting and heat methods of honey extraction. The probability of selecting any one of these techniques depends on the predictor variables involved in the model.

3.12 Model diagnostics

Prior to the binary logit model, some diagnostics tests were done to assess if the independent variables were suitable for the inclusion in the model

3.12.1 Tests for Multicollinearity

This occurs when there is linearity among the explanatory variables. This usually results to inflated variance, standard errors, and coefficients which end up displaying untrustworthy conclusions due to the fact that the likelihood of committing type one error is higher (Woolridge, 2012). Pearson correlation matrix and variance inflation factor was used to investigate the presence of multicollinearity among independent variables.

3.12.2 Tests for heteroscedasticity

This was done in order to check the efficiency of the independent variables. It was carried out to check the tendency of the disturbance term to vary with some or all explanatory variables. Breusch-pagan/cook/Weisberg test was used.

3.12.2 Test for model viability/fitness of the model

This involves testing the fitness of the model. Several models were compared and the one with the minimum likelihood ratio was chosen.

3.13 Ethical issues

Ethics can be defined as an arm of philosophy that is concerned with individual's behavior and acts as a guide to individual actions. For as much as analysts are individuals absolutely concerned about peoples' value of life, they ought to be honest people who will not carry out a study for self-benefit or a study that will adversely influence other peoples' life. In order to acquire the necessary information, it was the paramount to assure interviewees inconspicuousness. The interviewee's names were not written down in the concluding project reports. The analysts devoted himself to publish precise study results regardless of the results from the study.

CHAPTER FOUR
RESULTS

4.1 Introduction

The chapter displays how data collected was analyzed, presented and interpreted. Additionally, the section debates the results from the study queries that were being scrutinized to find out whether socio/cultural factors, managerial skills and institutional factors determine the use of improved equipments in honey production amidst the smallholder beekeeping farmers. The results were bestowed with the use of tables to ease review and clarifications. Statistical investigation of the results was carried out using descriptive and regression analysis.

4.2 The response rate

Out of the 134 questionnaires 109 were completed and returned. This represented 81% of the sample size while 19% were not returned. These were because of the shifts and therefore were not reachable at the time of the collection of the questionnaires. Completed and received questionnaires were more than half;therefore, the researcher proceeded with the analysis. The table below shows the sample size and the areas of data collection:

Table 3: Sample size distribution for the small-holder beekeeping farmers in Baringo County (n=134)

	Questionnaires issued	**Returned**	**Not returned**
Baringo South			
Kimalel	22	20	2
Loboi	22	22	0
Marigat	24	20	4
Baringo central			
KabarnetSoi	22	15	7
Chebano	22	18	4
Arabal	22	14	8
Total	**134(100%)**	**109 (81%)**	**25 (19%)**

Source: survey data 2019

4.3 Characterization of the honey extracting methods

Majority of the honey processors in the County 32% employed the use of crushing and straining in extracting their honey. This was followed by melting method, which contributed to 27% of the respondents. The farmers who used manual honey extractor were represented by 12% and the least being those who employed electric honey extractor who were represented at 4%. Generally, there was poor adoption of modern honey extracting technologies. Suraj (2018) attributed this to Lack of credit, inadequate skill, lack of equipment, ignorance, poor infrastructure, information asymmetry and poor extension services as some of the determinants of poor adoption of beekeeping technologies

Information on table 4 indicates that adopters were 29% that is farmers using electric, manual, radial and tangential honey extractors. On the other hand, non-adopters were 72% and include those farmers using crushing and straining, heat and melting method. The honey extraction methods employed by small-holder beekeeping farmers in the study area are as shown in table 4 below:

Table 4: Characterization of honey processing methods

Variable	Frequency	Percentage
Methods of extraction		
Electric honey extractor	4	4
Manual honey extractor	13	12
Radial honey extractor	8	7
Tangential honey extractor	6	6
Crushing and straining	35	32
Heat method	14	13
Melting	29	27

Source: Survey Data (2019)

4.4 Characterization of the small-holder beekeeping farmers in to adopters and non-adopters

This included smallholder beekeeping farmers in Baringo County, Kenya. The section involves the demographic, institutional, socio-cultural and economic characteristics of individuals of the smallholder beekeeping farmers in the County. To characterize the small-holder beekeepers in the research area in to users of modern technologies and non-users of modern technologies, study area in to adopters and non-adopters, data on demographic characteristics of the respondents, group membership, access to information,creditavailability,and experience were gathered and examined using descriptives and t-tests to indicate whether there was statistical difference between the groups.

Age was statistically significant. Table 5 results show that the variable was significant at 10% and that there was significant difference in age between the adopters and non-adopters.Most of the interviewees, were using modern honey extracting technologies were persons below 35 years of age (58%), while majority of those using traditional technologies were persons above 46 years of age (46%). These findings reflect the findings of Abebe (2009) who argued that ignorance is one of the major challenges to production and marketing of honey.

Level of education was significant at 5%. Results from table 5 indicate that there is significant difference in the level of education between the two groups of adopters and non-adopters. Majority of the adopters (58%) had attained tertiary level of education, while majority of the non-adopters had no formal education (54%). This indicates that education is a crucial factor in

adoption of modern honey extracting technologies. This goes in line with the findings of Adgaba (2014), who noted that education is one of the major determinants of modern beekeeping among smallholder beekeeping farmers.

Membership to groups was highly significant at 1%. Results from table 5 indicate that there is significant statistical difference in membership to groups between adopters and non-adopters. Majority of the adopters were members of groups (81%), while majority of non-adopters were not members of groups (63%). This show that membership to groups is one of the important factors determining adoption of modern honey extracting technologies. This goes in line with the findings of Gebiso (2015), who mentioned group membership as one of the factors determining modern apiculture technologies.

Access to information was similarly, highly significant at 1%. Results from table 5 indicate there is significant statistical difference in access to information between the two groups. Majority of the adopters indicated that they had access to information (74%), while majority of the non-adopters indicated that they had no access to information represented by (89%). This point out that availability of information concerning the various honey extracting technologies available, their prices, markets where they are being sold, means of operation e.t.c is relevant in determining small-holder beekeeping farmer decision to adopt and use these technologies. Many researchers have made discovery on this (Gebiso, 2015; Suraj, 2018; Heckle et.al, 2018).

Experience was significant at 5%. Table 5 indicates that there is significant statistical difference in experience between the two groups. Majority of the adopters pointed out that they had

previous experience in beekeeping (68%), while majority of non-adopters pointed out that the did not have much experience in beekeeping (64%). This result indicates that experience is a very important factor in adoption of modern honey extracting technologies (Jagiso, 2018).

Credit availability was significant at 10%. Result from table 5 indicates that there is significant statistical difference in availability of credit between the two groups. Majority of the adopters had access to credit (84%), while majority of the non-adopters did not have access to credit (59%). The results from the table indicate that availability of credit is an important factor in adoption of modern honey extracting technologies. This has been pointed out by Natukunda (2012), in his study on determinants of farmer's choice of apiculture production technologies.

Table 5: Characterization of the small-holder beekeeping farmers in to adopters and non-adopters (n = 109)

Variable	Adopters-n_1=31(29%)	Non-adopters-n_2=78(72%)	Total N=109	p-value
Age				
35yrs and below	18(58%)	15(19%)	33(30%)	
36-45yrs	8(26%)	27(35%)	35(32%)	0.0699*
46yrs and above	5(16%)	36(46%)	41(38%)	
Gender				
Male	17(55%)	37(49%)	54(50%)	1.80318
Female	14(45%)	41(53%)	55(50%)	
Level of education				
None	0(0%)	42(54%)	42(39%)	
Primary	2(6%)	21(27%)	23(21%)	0.0459**
Secondary	11(35%)	13(16%)	24(22%)	
University/college	18(58%)	2(3%)	20(18%)	
Marital status				
Single	17(55%)	34(44%)	51(47%)	1.0236
Married	14(45%)	44(56%)	58(53%)	
Group membership				
Yes	25(81%)	49(63%)	74(68%)	0.0019***
Otherwise	6(19%)	29(37%)	35(32%)	

Information access				
Yes	23(74%)	11(14%)	34(31%)	0.0011***
Otherwise	8(26%)	67(89%)	75(69%)	
Experience				
Yes	21(68%)	18(23%)	39(36%)	0.0326**
Otherwise	10(32%)	50(64%)	60(55%)	
Credit availability				
Yes	26(84%)	32(41%)	58(53%)	0.0789*
Otherwise	4(13%)	46(59%)	50(46%)	

Source: Survey data, 2019

4.5 Factors influencing household income of smallholder beekeeping farmers

Ordinary least squares was done on share of income from beekeeping, off-farm income, cost of honey extractor, tangential honey extractor, kilograms of honey extracted, radial honey extractor, credit availability, household size, market access, manual honey extractor, electric honey extractor, cost of the honey extractor, crushing and straining, heat method and melting method to determine the direction of influence of these variable on household income of the small-holder beekeeping farmer. The results were summarized and presented in table 6 below

Results from table 6 indicate that there is a positive relationship between the share of income from beekeeping and household income of the small-holder beekeeping farmer. This implies that increased share of income from beekeeping increases the household income of a beekeeping farmer. These results are in line with the findings of a study done by Omari (2010) who revealed that beekeeping contributes about 44% to the household income of beekeeping farmer's income. Similarly off-farm income was positively related to household income of the small-holder beekeeping farmer. This indicates that increased participation on non-farm activities increases the household income of the beekeeping farmer.Lekobane (2016), in his study stated that participation in off-farm activities is very relevant as it acts as source of capital for the farm

activities.Gebiso (2015) indicates non-farm income as one of the determinants of modern beekeeping adoption.

There is a negative relationship between the use of crushing and straining method and household income of the small-holder beekeeping farmer as shown in table 6. This is likely due to the fact that the crushing and straining is a traditional technology which is slow and produces semi-processed honey which in most cases, is sold at a 'throw away price'. Otieno (2019) pointed out that modern farming positively and significantly contributes to household income. On the other hand, the use of radial honey extractor is positively related to household income. This can be attributed to the fact that radial honey extractor is machine used in extracting honey either manually or automatically. Therefore this is a modern technology of extracting honey from combs. Hippolyte (2015), points out that, there is a significant relationship between the use of modern honey production technologies and beekeeping productivity.

As presented in table 6, there is negative relationship between the cost of honey extractor and the household income of beekeeping farmer. This shows that increased cost of extracting machines reduces the household income of beekeeping farmer. This will ultimately bring in the demand for credit by the small-holder beekeeping farmers. Abebe (2009), points out that inadequate credit facility is among the major challenges in honey production and marketing. Similarly, the use of tangential honey extractor by the small-holder beekeeping farmer was found to be positively related with the household income of the beekeeping farmer. This is also a modern technology which is more efficient in extraction and produces pure honey. This can then be exported to

international markets at reasonable prices. This concurs with the findings of Ondati (2014), who highlighted that, advanced value adders generate more income hence better savings.

Results from table 6 indicate that the use of manual honey extractor is positively related with household income. This is likely because the method is a modern technology which is also more efficient compared to traditional technologies and produces pure honey which can also be exported to international market also at reasonable prices. This is in line with the findings of Omari (2010), who discovered that value added honey has higher returns compared to unprocessed or semi-processed honey. In the same way, results from table 6 indicate that there is also a positive relationship between the use of electric honey extractor and the household income of the smallholder beekeeping farmer. This might be attributed to the fact that electric honey extractor is a modern technology which operates automatically and therefore works more efficiently compared to the other technologies. It leads to production of pure honey which also allows access to international markets. This is in line with the findings of Kiptarus et.al (2011) who found out that the use of modern technologies enhances production hence increased household incomes.

A kilogram of honey extracted is positively related to the household income of the small-holder beekeeping farmer as pointed out in table 6. This shows that increased kilograms of honey extracted increases the household income. This is so because it leads to more sales and makes it possible for the small-holder farmers to make use of machines due to economies of scale. Kilograms of honey extracted is closely linked to kilograms of honey produced, hence the need

for adoption of modern production technologies to generally improve on household income Alghamdi et.al (2017). From table 6, the use of heat method of honey extraction was found to be negatively related to household income. This is so, due to the fact that the method is a traditional technology which is less efficient, leads to losses and also leads to production of semi-processed honey that is honey containing impurities (Oladimeji, 2017).

Availability of credit was found to be positively related with the small-holder beekeeping farmer's household income as in table 6. This implies that availability of credit leads to increased household incomes. This is due to the fact that the farmers can borrow loans to start beekeeping businesses and can also borrow to purchase machines for extraction. This will ultimately lead to increase in productivity of the enterprise. These findings are in line with the findings of Hippolyte (2015) who discovered that there is a significant relationship between the use of modern honey production technologies and beekeeping productivity. Table 6 points out that the use of melting method of extraction is negatively related with the household income of the beekeeping farmer. This can also be attributed to the fact that melting method is a traditional technology which is also inefficient and leads to impurities in the extract. This goes hand in hand with the findings of Muya (2014), who concluded that, economically, new technologies produces higher net returns compared to old technology.

Results presented in table 6 pinpoints out that there is a negative relationship between the household size and the household income of the beekeeping farmers. This means that increased number of members of a household reduces the household income of the beekeeping farmer.

This is likely due to the fact that increased household members puts pressure on the available resources, hence decreased household income. These results are contrary to the findings of Gebiso (2015), who pointed out increased number of household members increases the household income due to increase in participants in beekeeping. Finally, results from table 6 indicate that access to markets increases the household income of the small-holder beekeeping farmer. This suggests that, the more the farmers access markets, both input and output markets, the more their incomes. Access to markets enables farmer's to sell their products at reasonable prices reducing post-harvest losses hence better savings. These findings accord with the findings of Heckleet a. (2018), who identifies that, access to markets is one of the major determinant's of a farmers' decision to take up beekeeping. Access to markets enables farmers to purchase modern honey extracting technologies which leads to production of pure honey which can be sold at higher prices (Berem, 2015).

Table 6: Factors influencing household income of smallholder beekeeping farmers

Variable	**Coeff**	**Std err**	**T**
Share of income from beekeeping	0.144	0.691	1.023
Off-farm income	0.125	0.625	0.987
Crushing and straining method	-0.011	0.003	0.001
Radial honey extractor	0.105	0.223	0.302
Cost of honey extractor	-0.100	0.111	0.096
Tangential honey extractor	0.096	0.126	0.110
Cost of transport	-0.101	0.012	0.106
Manual honey extractor	0.099	0.009	0.003

Electric honey extractor	0.321	0.896	1.968
Kgs of honey extracted	0.213	0.463	0.623
Heat method	-0.106	0.362	0.511
Credit availability	0.161	0.753	0.763
Melting method	-0.197	0.854	1.886
Household size	-0.146	0.701	0.697
Market access	0.162	0.710	1.023
_cons	-53.431	62.170	-0.86

Significance at 5%, F.ratio, 97.823; Adjusted R-square 0.693421; R square, 0.716320; S.E of regression, 7.005230; Sum of squared residuals, 1203.6352; log likelihood, -79.63450; Durbin Watson stat, 1.023198

4.6 Marginal effects of factors influencing adoption of use of modern honey extracting technologies

As introduced in chapter three, the investigation began with finding out whether the factors hypothesized were suitable for the model. Multicollinearity, heteroscedasticity and link test analysis were done. Additionally, significant variables were explained in the methodology section.

4.6.1 Statistical econometric result tests

The findings of the statistical models resulted to omitting or uniting some variables under investigation so as to get a prudent model. The investigation was performed as presented by the stages below:

4.6.2 The designated model for multinomial logistic regression model

Comparison of several models was done and the model with the lowest likelihood ratio equal to-19.829 was selected. The model had a chi-square likelihood value of 0.000 and was in line with the theory of economics and rationale for responding to economic theory and logic for additional investigation.

In addition to link test, the predicted value (*_hat*) indicates how well the dependent variable is explained by the independent variables that were included in the model and the predicted valuable square (*_hatsq*) indicates how important the omitted variables were.

From the table 4.4 the coefficient of (*_hat*) was statistically significant at 1 percent while that of (*_hatsq*) was not statistically significant even at 10 percent. Therefore, the two hypothesizes that the model did not fit well the data and that some variable (s) that might have been omitted were rejected.

Table 7: link test analysis

Modern honey extracting technologies	**Coef.**	**Std.Err.**	**Z**	**P>z**	**[95% conf. Interval]**	
_hat	.8956865	.15364278	5.02	0.000	.6002157	0.856789
_hatsq	-.00876862	.06152489	-0.09	0.900	-.07852	.1003698
_cons	.0245896	.32658974	0.12	0.987	-.56487	.5689752

Source: Survey data 2019

Contingency coefficient was performed to find out if there was any correlation among the discrete independent variables. The decision rule for this is that when its value approaches 1, multicollinearity problem exists between the discrete explanatory variables.

Table 8: Contingence coefficient's estimate for discrete variables

	Method of extraction	Level of education	Gender	Experience
Methodofextraction	1.000			
Level of education	0.089	1.000		
Gender	0.0169	-0.0161	1.000	
Experience	0.342	0.337	0.064	1.000

Source: Survey data 2019

Results from table 9 indicate that there is no problem of multicollinearity between the continuous variables. This is due to the fact that no variance inflation factor exceeded 10. Therefore generally, from the results of the investigations above, it was discovered that there was no serious problem of correlation between the variables. Therefore, the variables were maintained in the model.

Table 9: VIF for continuous independent variables

Factor	**VIF**	**1/Variance inflation factor**
Household size	1.343	0.744601
Kilograms of honey processed	1.186	0.843170
Off-farm income	1.040	0.961538
Land size	1.247	0.801925
Information search cost	1.323	0.755858
Age	1.963	0.509424
Cost of honey extractor	1.232	0.811688
Group membership	1.442	0.693481
Credit availability	1.115	0.896861
Mean VIF	**1.339**	

Source: Survey data 2019

Heteroscedasticity test

Constant variance among the errors is one of the assumptions of multiple regression analysis.This is referred to as heteroscedasticity (Maddala, 1992). The problem in this study is minimized by choosing the best functional form and also checking the result using statistic test. After eliminating experience in the use of modern honey extracting technologies among the smallholder beekeeping farmers, based on Breusch-Pagan/Cook-Weisberg test which resulted to chi^2 value of 0.12 which means failure to reject the null hypothesis, hence no heteroscedasticity problem in the model.

Ho: Constant variance (homoscedasticity)

H1: Not constant variance (heteroscedasticity)

From the results of this test, it was concluded that there was no violation of the assumption of heteroscedasticity, that is,there was constant variance of the error term.

Discussion of significant variables

The result from table 10 below gives the probability of household adopting the use of alternative honey extracting technologies. The technologies included in the model include; traditional technologies (heat method, melting method and crushing and straining) and modern technologies (use of tangential honey extractor, radial honey extractor, manual honey extractor and electric

honey extractor). The computation of marginal effects from table 10, allows changes in probability of an event as a consequence of unit change in independent variable.

Kilograms of honey extracted: This variable was the most important variable in influencing the decision to adopt honey extracting technologies. Kilograms of honey extracted was found to be negatively correlated with the traditional technologies but positively correlated with the modern technologies as indicated by the marginal effects. This is likely because increased kilograms of honey extracted brings up the need of a more efficient technology for extraction and also covers all the costs that comes up with economies of scale. Farmer's will see the need for a honey extractor when the production is high. This is due to the fact that honey extractor improves the quality of the honey produced and the overall productivity of the enterprise (Mercyline, 2021). As expected, the variable had a positive influence on adoption of modern honey extracting technologies.

Level of education: This variable was found most important in influencing adoption of modern technologies. The variable was significant in influencing adoption of tangential, radial, electric, heat and melting methods of extraction. The marginal effects from table 10 indicates that the variable was positively related to tangential, radial and electric honey extractors and negatively related to heat and melting methods of extraction. The variable was highly significant in influencing the adoption of an electric honey extractor compared to other technologies. An increased year of education increases the likelihood of a beekeeping farmer adopting the use of modern honey extraction technologies. This could be because; learned people have knowledge

and skills to make use of modern technologies. These results are in line with those by Abebe (2009) who mentioned illiteracy as one of the major challenges to beekeeping technology adoption. Trainings should be provided to farmers on the importance of beekeeping and the related technologies. As expected, the variable had a positive influence on adoption of modern honey extracting technologies.

Access to information: From table 10, the marginal effects indicate that access to information was significant and negatively related to heat, melting and crushing and straining methods. In contrary, the variable was significant and positively related to manual and electric honey extractors. This is likely because access to information enables farmers to understand the various technologies available for use, their prices and their locations. This in most cases influences the adoption of modern technologies. These results are in line with the findings by Suraj (2018) who observed information asymmetry as one of the determinants of poor technology adoption among small-holder beekeeping farmers. Hence farmers chose to use traditional methods in cases where information on modern technologies is lacking. As expected, access to information, had a positive effect on adoption of modern honey extracting technologies.

Household size: Table 10 indicates that household size was significant in influencing the adoption of crushing and straining method and electric extractor. The variable was positively correlated with crushing and straining and was negatively correlated with electric extracting machine. This is likely because increase in the members of a family means increased number of participants in beekeeping projects. Increased number of participants is likely to increase total

production which is likely to increase adoption of electric honey extracting technology due to economies of scale. These results are consistent with the findings of Amanuel (2018) who argued that Adoption of modern beehives technology has significant effect on hives productivity. Contrary to the expectation, the variable had a negative influence on adoption of modern honey extracting technologies.

Age: Marginal effects from table 10 indicates that age is significant and positively related to adoption of tangential, radial, manual and electric honey extractor. Contrastingly, it is significant and negatively related to heat, melting and crushing and straining methods of extraction. As seen, the variable age is very important in influencing adoption. Older generation is less likely to adopt modern honey extraction technologies due to ignorance and illiteracy compare to the younger generation. As mentioned earlier most participants in the beekeeping projects in the area of focus of the younger generation comprised 62% of the total participants. Abebe (2009) mentioned illiteracy as among the major challenges to production and marketing of honey. As expected, age had a negative influence on adoption of modern honey extracting technologies.

Cost of honey extracting technologies: Similarly, the variable was important in influencing adoption of honey extracting technologies. The marginal effects from table 10 indicate that the variable was significant and positively related to adoption of traditional technologies and negatively related to modern technologies. Increased cost of modern honey extracting technologies coupled with lack of credit among the smallholder beekeeping farmers decreases the probability of adoption of modern honey extracting technologies. The results go in line with the findings of Natukunda (2012) who mentioned financial problems as one of the factors

affecting choice of apiculture technologies. As expected, the cost of honey extractor had a negative influence on adoption of modern honey extracting technologies.

Group membership: Results from table 10 indicates that group membership is significant and positive in influencing the use of crushing and straining method and is also positive in influencing the use of an electric honey extractor. This is likely due to the fact that membership to groups decrease the transaction cost of carrying out activities. It also makes it easier for farmers to access institutional services such as credit, extension, trainings and information which are the major factors determining adoption of modern technologies. These results are also consistent with the findings of Natukunda (2012) who argued that, financial problems, pests and predators, poor extension services, water scarcity, shortage of bee forages, high input cost are among the factors affecting choice of apiculture technologies. In contrary being a member of a group can as well influence farmers to continue using the traditional commonly used technology that is crushing and straining method. As expected, group membership had a positive influence on adoption of modern honey extracting technologies.

Availability of credit: Table 10 points out from the marginal effects that the variable is moreover, important in influencing adoption decision. The variable is significant and positively influences the decision to use improved methods of extraction, but is significant and has a positive correlation with the use of conventional technologies. The variable is highly significant at 1% in influencing both electric honey extracting machine and heat method of extraction. Access to credit makes it possible for the smallholder beekeeping farmers to make use of modern beekeeping technologies. This is likely due to the fact that most of the smallholder beekeeping

farmers in the area of study are living in a state of poverty and financial problems is one of the challenges hindering adoption of modern beekeeping technologies (Natukunda, 2012). Suraj (2018) also observed lack of credit as one of the determinants of poor adoption of beekeeping technologies. As expected, the variable had a positive consequence on adoption of modern honey extracting technologies.

Off-farm income: The variable was found to be significant in influencing adoption decision. It was significant and negatively related to traditional technologies. On the other hand, off-farm income was positively related to adoption of electric honey extractor. The variable was highly significant at 1% in influencing adoption of heat method of extraction. This is likely due to the fact that availability of off-farm income makes it possible for farmers to purchase modern equipments used in beekeeping enterprises. It may also act as source of informal credit among family members which can be used to purchase capital to start beekeeping enterprises. This may overcome the challenge of lack of credit or inputs to adoption of modern beekeeping technologies as pointed out by Abebe (2009), Natukunda (2012), Suraj (2018) and Jagiso (2018). As expected, the variable as well, had a positive influence on adoption of modern honey extracting technologies.

Table 10**: Marginal effects of the factors influencing choice of honey extracting technologies**

	Adopted honey extracting technologies						
Variables	**Heat method adopters**	**Melting method adopters**	**Crushing and straining method adopters**	**Tangential honey extractor adopters**	**Radial honey extractor adopters**	**Manual honey extractor adopters**	**Electric honey extractor adopters**
Kilograms of honey extracted (kgs)	-0.0093*	-0.220*	-0.0014***	0.221**	0.113**	0.0021*	0.2041***

Level of education (1= none, 0= otherwise)	-0.1015**	-0.335*	0.035	0.122*	0.096*	0.046	0.1789***
Land size (Acres)	0.0153	1.258	0.096	-0.036	0.092	0.097	0.0273
Access to information (1= yes, 0= Otherwise)	-0.0041**	-0.742*	-0.0007***	-0.169	0.052	0.0007*	0.1639***
Household size (number)	0.1301	0.215	-0.056**	0.115	0.136	0.045	0546***
Age (years)	0.00244*	0.159*	0.005***	-0.013*	-0.001*	-0.005***	-0.0527**
Cost of honey extractor (kshs)	0.225*	0.258**	0.063*	-0.224*	-0.362**	-0.067*	-0.1413**
Group membership (1= yes, 0=otherwise)	0.234	0.242	0.032**	0.136	0.553	0.053	0.0267***
Credit availability (1= yes, 0= otherwise)	-0.143***	-0.199**	-0.043**	0.413*	0.068*	0.043*	0.3037***
Gender (0= male, 1= female)	-0.246	0.158	0.125	-0.211	0.129	0.101	0.1623
Off-farm income (kshs)	-0.036***	-0.168**	-0.069*	0.156	0.005	0.073	0.1085**
Market access (1= yes, 0= otherwise)	0.211	0.069	0.246	0.102	0.007	0.395	0.0664
Extension service access (1= yes, 0= otherwise)	-0.025	-1.113	0.191	0.251	0.118	0.124	0.1623
Constant	1.760	0.271	0.663	0.365	0.569	0.223	0.801

No of observations: 109; Chi-square-: 71.099; -2 log likelihood: 19.829; Prob>chi2 = 0.000

Pseudo R square: 0.84; **** ** * 1%, 5%, 10% shows significance level respectively

Source: survey 2019

CHAPTER FIVE
SUMMARY OF THE FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The aim of this study was to provide an economic assessment of factors influencing adoption of new honey extracting technologies in Baringo County, Kenya. Primary data were used. A sample of 185 household s was drawn and the field survey was conducted in April 2019. The collected data were about household socio-cultural, institutional and economic characteristics. The data was entered and statistically analyzed using statistical package for social scientist (S.P.S.S). The initial objective was investigated with the use of descriptives and t-tests. The multinomial logit model was use to establish factors that influence the farmer's decision to use modern honey extracting technologies.

Out of descriptive statistics results, majority 35% of the respondents used crushing and straining, 29% used melting, 14% used heat method, 13% used manual honey extractor while 4% used electric honey extractor. Therefore, generally, those who were using traditional technologies were (78%) while those using modern technologies formed the remaining 22%.

T-tests indicated that difference in age between adopters and non-adopters existed significantly standing at 10%. Most of the adopters (58%) were below 35years of age while majority of non-adopters (46%) were above 46years of age. On the other hand, the level of education was found to have significant variance between adopters and non-adopters at 5%. Majority of adopters (58%), had attained tertiary level of education while majority of non-adopters (54%) had no formal education.

Similarly, group membership was found to have significant difference between the two groups. Majority of the adopters (81%) were group members while majority of non-adopters (63%) were not members to any formal groups. The variable was highly significant at 1%. In the same way, access to information was found to be highly significant at 1%. This indicates that there was significant difference in access to information between the two groups. Majority of the adopters (74%) had access to information while majority of the non-adopters (89%) had no access to information.

Experience on the other hand was significant at 5%. This indicates that there was significant difference in experience between the two groups. Majority of the adopters (68%) had past experience in beekeeping while majority of the non-adopters (64%) had no past experience in beekeeping. Correspondingly, there was significant difference in access to credit between the two groups. The variable was significant at 10%. Majority of adopters (84%) pointed out that they had access to credit while majority of the non-adopters (59%) stated that they had no access to credit services.

Using a 5% level of significance, Ordinary least squares was carried out to find out the factors influencing the household income of the small-holder beekeeping farmers. Adjusted R-squared was 0.693421 which indicates how well the variables fit the model. The results indicated that increase in share of income from beekeeping, off-farm income, use of radial honey extractor, use of tangential honey extractor, use of manual honey extractor, use of electric honey extractor, increase in the kilograms of honey extracted, availability of credit, and access to market

improves the household income of the small-holder beekeeping farmer. Alternately, use of crushing and straining method, use of melting method, use of heat method, increase in the cost of honey extractor, increase in the cost of transport and increase in the household size led to decreased household income of the beekeeping farmer.

Finally the marginal effects resulting from multinomial logistic regression indicated thata kilogram of honey extracted was significant in influencing the decision to adopt and use honey extracting technologies. The variable had a negative effect on the use of traditional technologies a positive influence on the use of modern technologies. Correspondingly, education level was statistically significant with a positive effect on the farmer's decision to use tangential, radial andelectric honey extractor and a negative effect on the decision to use heat and melting methods of extraction.

Identically, access to information was significant with a positive influence on the decision to use manual and electric honey extractor and a negativeeffect on the decision to use heat, melting and crushing methods of extraction. Household size was significant and positive in influencing adoption of crushing and straining method and negative in influencing electric honey extracting machine.

On the other hand, age had a positive and significant influence on adoption of tangential, radial, manual and electric honey extractor and a negative influence on the decision to use heat, melting

and crushing and straining methods. The cost of honey extracting machine was significant and had a negative influence on adoption of traditional technologies and a positive influence on adoption of modern technologies.

Furthermore, membership to groups was significant with a positive influence on both crushing and straining and electric honey extracting technologies. It was also stipulated that, availability of credit was significant also with a positive influence on adoption of modern technologies and a negative influence on adoption of traditional technologies. Eventually off-farm income had a negative influence on the decision to adopt traditional technologies and a positive influence on decision to adopt traditional technologies. The variable was found to be significant in influencing adoption of the two categories of technologies.

Conclusions of the study

Conclusively, T-test demonstrated that difference between the two groups in terms of age, level of education, membership to groups, access to information, experience and access to credit existed significantly and statistically.Gender and marital status between on the other hand, exhibited no statistical difference the two groups.

Ordinary least squares pointed out that, share of income from beekeeping, off-farm income, radial honey extractor, tangential honey extracting machine, manual honey extracting machine, electric honey extracting machine, kgs of honey extracted, credit availability and market access

were positively related with household income of the small-holder beekeeping farmer. Crushing and straining method, cost of the extractor, cost of transport, heat method, melting method and household size were negatively related with the household income of the beekeeping farmer.

The marginal effects of the logistic regression model shows that kilograms of honey extracted, level of education, access to information, household size, age, cost of honey extractor, group membership, credit availability and non-farm income represented relevant statistically significant independent variables. Contrastingly, land size, gender, market access and extension service access were insignificant in influencing the decision to adopt the alternative technologies.

Recommendations

Following the results of this research the analyst makes the following judgments.

1. Farmers to frequently attend trainings, seminars, workshops, shows and exhibitions in order to access information and get educated on how to make use of modern honey extracting technologies
2. Farmers to form farmer groups in order to work as a group making it easier to adopt and use modern honey extracting technologies
3. Farmer's to diversify income in order to eliminate the risk adverse behavior common with low-income farmers. This will enable them to purchase modern extracting technologies

4. Farmers to look for ways of getting financial services especially credit services to be able to purchase new machinery used in extraction
5. Farmers to ensure each member of the household participates in the activity in order to improve on the overall returns
6. Farmers to make use of other modern pre-harvest technology especially the modern hives in order to increase honey produced, extracted and hence the overall productivity of the enterprise.

Suggestions for further study

This research was done in Baringo County among small-holder honey producers. The analyst therefore proposes more research in the following fields:

- Related research to be done in various locations of varying ecological zones to determine factors influencing farmer's decision on the use of advanced honey extracting technologies for contrasting purposes.
- Research involving large scale honey extractors should be done to minimize the likelihood of prejudice in analytical factors.
- Study involving female gender should be done to determine how these factors influence women decisions on adopting modern honey extracting technologies and the influence of these technologies on their incomes.

REFERENCES

Abdullahi, A., Isekenegbe, J., & Mohammed, U. S. (2014). Comparative economic analysis of modern and traditional bee-keeping in Lere and Zaria local government areas of Kaduna State, Nigeria.

Adgaba, Nuru, A. Al-Ghamdi, A. G. Shenkute, SobhyIsmaiel, Safar Al-Kahtani, YilmaTadess, M. J. Ansari, WorknehAbebe, and M. Q. A. Abdulaziz. "Socio-economic analysis of beekeeping and determinants of box hive technology adoption in the Kingdom of Saudi Arabia." *JAPS: Journal of Animal & Plant Sciences* 24, no. 6 (2014).

Affognon, Hippolyte D., W. S. Kingori, A. I. Omondi, M. G. Diiro, B. W. Muriithi, S. Makau, and S. K. Raina. "Adoption of modern beekeeping and its impact on honey production in the former Mwingi District of Kenya: assessment using theory-based impact evaluation approach." *International journal of tropical insect science* 35, no. 2 (2015): 96-102.

Agricultural sector development strategy (2000-2020) addressing vision 2030

AlBar, Adnan Mustafa, and MdRakibulHoque. "Factors affecting the adoption of information and communication technology in small and medium enterprises: A perspective from rural Saudi Arabia." *Information Technology for Development* 25, no. 4 (2019): 715-738.

Al-Ghamdi, Ahmed A., NuruAdgaba, Ahmed H. Herab, and Mohammad J. Ansari. "Comparative analysis of profitability of honey production using traditional and box hives." *Saudi journal of biological sciences* 24, no. 5 (2017): 1075-1080.

Amulen, Deborah Ruth, Marijke D'Haese, Elizabeth Ahikiriza, Jacob Godfrey Agea, Frans J. Jacobs, Dirk C. de Graaf, Guy Smagghe, and Paul Cross. "The buzz about bees and poverty alleviation: Identifying drivers and barriers of beekeeping in sub-Saharan Africa." *PLoS one* 12, no. 2 (2017): e0172820.

Arage, Ayantu. "Honey Value Chain Analysis in Gera District, Jimma Zone of Oromia National Regional State, Ethiopia." PhD diss., Haramayauniversity, 2018.

AynalemAbejew, Tessema, and ZelekeMekuriawZeleke. "Study on the beekeeping situation, the level of beekeepers knowledge concerning local honeybee subspecies, their productive characteristics, and behaWanjama, J. K., I. Onyango, D. M. Mutyambai, S. K. Kabochi, and P. N. Ndegwa. "Occurrence of Nosema species in honey bee colonies in Kenya." *Bulletin of Animal Health and Production in Africa* 64, no. 1 (2016): 129-135.vior in Eastern Amhara Region, Ethiopia." *Advances in Agriculture* 2017 (2017).

Bett, Caleb Kiplimo. "Factors influencing quality honey production." *International Journal of Academic Research in Business and Social Sciences* 7, no. 11 (2017): 281-292.

Bunde, A. O., and K. Kibet. "Socio-economic factors influencing adoption of modern bee keeping technologies in Baringo County, Kenya." *International Journal of Science and Research* 5, no. 6 (2016): 960-969.

Chege Martha N. (2016). A study on demystifying the use of honey in diabetes management: A case of type two diabetes patients at Kenyatta national hospital, Nairobi, Kenya.

Chemwok, Christopher Kipruto. "Factors influencing Honey Production in Marigat, Baringo County Kenya." PhD diss., Moi University, 2016.

Chepkemoi, Mercyline. "Development of an extractor to improve the processing of quality honey harvested From Indigenous Hives And natural colonies." Phd Diss., University Of Eldoret, 2021.

Gebiso, Tamrat. "Adoption of modern bee hive in Arsi Zone of Oromia Region: determinants and financial benefits." *Agricultural Sciences* 6, no. 03 (2015): 382.

Gachanya (2015). Analysis of minimum requirements in honey processing. The case of Kenya retail markets

GoK(2018). Establishment of a Grant coalition government comprising of the president and the new post of prime minister

Grant Thornton (2014). International business report on challenges facing marketing of agricultural produced

Haftu, K., D. Daniel, B. Gebru, G. Tsegay, A. Guash, G. Guesh, Z. Mulualem, and G. Gebrekiros. "Analysis of honey bee production opportunities and challenges in central

HECKLE, Renaud. "Beekeeping adoption in Kenya." (2017).

John, JohakimKatekele. "Adoption of Co-branding Strategies in the Expansion of Honey Market in Tanzania." PhD diss., Mzumbe University, 2018.

Kabamba, H. E. Z. E. K. I. A. H., and A. M. B. A. Y. E. B. A. Muimba-Kankolongo. "Adoption and impact of conservation farming on crop productivity among smallholder farmers in KapiriMposhi District of Zambia." *Journal of Animal & Plant Sciences* 3, no. 2 (2009): 205-214.

Kalanzi, Fred, Susan Nansereko, Joel Buyinza, Peter Kiwuso, YonahTurinayo, Christine Mwanja, George Niyibizi, Samuel Ongerep, Jude Sekatuba, and Denis Mujuni. "Socio-economic analysis of beekeeping enterprise in communities adjacent to Kalinzu forest, Western Uganda." (2015).

Khan, Naushad, and Wali Khan. "Review of past literature of honey beekeeping and its production in rural area of the world." *Food Science and Quality Management* 74, no. 6 (2018): 18-23.

Lekobane, Khaufelo R., and Tebogo B. Seleka. "Determinants of household welfare and poverty in Botswana, 2002/2003 and 2009/2010." *Journal of Poverty* 21, no. 1 (2017): 42-60.

Muli, Dickson M. "Determinants of financial performance of processing small and medium enterprises in Kituicounty." PhD diss., 2019.

Mutaki, Pauline. "An Assessment Of Forest Product Extraction In Kakamega Rainforest And Associated Human Impact, Kakamega County, Kenya." PhD diss., University of Nairobi, 2018.

Muya, Benson I. "Determinants of adoption of modern technologies in beekeeping projects: the case of women groups in Kajiado County, Kenya." PhD diss., University of Nairobi, 2014.

Ngomo, Lilian K. "Determinants of Production and Performance of Honey Processing Projects: the Case of Kitui County." PhD diss., University of Nairobi, 2021.

Nzano, Patricia N. "Increasing Kavuko Community's Appreciation of Bee Conservation as a Food Production and Security Strategy." PhD diss., University of Nairobi, 2018.

Ominde, Gladys O. "Influence of value addition in bee-farming products on the livelihood of bee-farmers in Kakamega central sub-county, Kenya." PhD diss., 2014.

Paji, Kelvin. "Contribution of beekeeping towards rural household livelihood in Tanzania." PhD diss., The University of Dodoma, 2016.

RatchaneewanChuchird, Nophea Sasaki and Issei Abe (2017). An article on factors influencing the adoption of agricultural irrigation technologies and the economic returns: A case study in Chalyapur province, Thailand

Salau, E. S., A. Y. Lawee, G. E. Luka, and D. Bello. "Adoption of improved fisheries technologies by fish farmers in southern agricultural zone of Nasarawa State, Nigeria." *Journal of Agricultural Extension and Rural Development* 6, no. 11 (2014): 339-346.

Sharma, S., and D. Das. "Factors affecting adoption of beekeeping and associated technologies in Kamrup (rural) district, Assam state, India." *Biodiversity International Journal* 2, no. 3 (2018): 279-284.

Serda, Biressaw, TessemaZewudu, MogesDereje, and Mohammed Aman. "Beekeeping practices, production potential and challenges of bee keeping among beekeepers in Haramaya District, Eastern Ethiopia." *Journal of Veterinary Science & Technology* 6, no. 5 (2015): 1-5.

Wafula, Joshua, Yusuf Karimjee, Yvonne Tamba, Geoffrey Malava, Caroline Muchiri, Grace Koech, Jan De Leeuw, JosephatNyongesa, Keith Shepherd, and Eike Luedeling. "Probabilistic assessment of investment options in honey value chains in lamu county, Kenya." *Frontiers in Applied Mathematics and Statistics* 4 (2018): 6.

Yadeta, GemechisLegesse. "Honey production and marketing in Ethiopian." *American Journal of Life Sciences* 3, no. 1 (2015): 42-46.

Zone of Tigray, Northern Ethiopia." *International Journal of Scientific and Research Publications* 5, no. 4 (2015): 1-6.

APENDICES

APENDIX 1: Table 1: Difference between manual and electric honey extractor

Manual honey extractor	**Electric honey extractor**
Has two to four frames	Has more than four frames
Used by smallholder farmers with ten or less bee hives	Used by commercial beekeepers with more than 10 beehives
Cheaper to purchase	Expensive to purchase
Has an handle to manually spin the frames	Uses electricity to spin the frames

APENDIX 2: Figure1: Radial honey extractor

Source: Franz, 2019

APENDIX 3: Figure 2: Crushing and straining method of extraction

Source: Anderson, 2016

APENDIX 4: Questionnaire for smallholder beekeeping farmers

The researcher is a student from the University of Nairobi conducting an academic survey on Determinants of Adoption of Modern honey extracting Technologies in Beekeeping Projects. You have been randomly selected to participate in this survey. Kindly give your honest opinion on all the items on the questionnaire. All information you give will remain strictly confidential and it will be used only for research purposes.

Background information

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

Gender Male/female (tick)

Age

18-35yrs☐

36-50 ☐

50 and above ☐

Marital status

Single☐

Married☐

Others (Specify)

Number of participants in your family…….

Education level of respondent: (none) (primary) (Secondary) (University/college)

Socio-cultural factors

To what extent do the following factors influence adoption of new processing technology in your beekeeping project?. Please indicate with an "X" using a scale of 1-5 the influence command in your beekeeping project where 1=strongly disagree, 2= disagree, 3= Neutral, 4= Agree 5= strongly agree

Socio-cultural factors

Socio-cultural factors	**1**	**2**	**3**	**4**	**5**
Sex of the household					
Marital status					
Size of the household					
Age of the household head					
Size of the land					
Level of education					

To what extent do you agree with the following statements on adoption of modern processing technologies in beekeeping? Use a scale of 1-5 below, where 1= strongly disagree, 2=disagree, 3= not sure, 4= agree, 5= strongly disagree

Important information on socio-cultural factors	1	2	3	4	5
Farmers with large families easily adopt new honey processing technologies					
New processing technologies increases the quality of honey produced which contributes to small holder					

beekeeping farmer family satisfaction by improving their household income					
Education positively influences adoption of new honey processing technologies					
The use of modern processing method improves the quality of honey produced hence the price					

The following statements relate to the size of the land available in relation to the adoption of new processing technologies in beekeeping projects. Kindly use the scale of 1-5 to relate them in the table below where 1= strongly disagree, 2=disagree, 3=neutral, 4=agree, 5= strongly agree

Information on land size	1	2	3	4	5
Beekeeping activity can be undertaken on small land size					
One of the relative advantages of beekeeping activity is that it is not resource intensive and is less drought dependent					

Culture has been found to have great influence on implementation of modern technologies in beekeeping projects

Agree ☐ Disagree ☐

Institutional factors

The institution of extension is the main factor necessary for the transfer of new technologies in processing honey. Using the likert scale of 1-5 provided as a measure ofdispersion where 1=strongly disagree, 2=disagree, 3= not sure, 4= agree and 5= strongly agree, kindly rate the statements accordingly with regard to your group

Important statement	1	2	3	4	5
Extension services help farmers to make their own decisions by increasing the options from which they can choose a method of processing their honey					
Extension plays a key role in popularizing post-harvest technologies					
Extension officers must work closely with farmers in order to make the farmer capable or more efficient					
Extension services enhances negotiation between the different individuals in beekeeping project and also serves as a platform for beekeeping farmers interaction.					
Information on marketing, honey processing and means of transport is readily available to beekeepers					
Access to financial institutions, markets and input supply institutions are the roles played by institutions					
Farmers aspiration for change through adopting different technology that is suitable for their					

beekeeping activities is facilitated by institutional services					

The following information relates to the institutional factors kindly indicate the ones you have access to:

Institutional factors	Tick where appropriate
Access to extension services	
Information access	
Training facilities	
Access to finance institutions	
Access to market after processing	
Group membership	

Using a scale of 1-5 where 1=strongly disagree, 2=disagree, 3= not sure, 4=agree, 5= strongly agree. Kindly rate the following statements

Important conclusions	**1**	**2**	**3**	**4**	**5**
Promoting new processing technologies is a collective responsibility of research, extension agents, farmers and other service providers. The task cannot be left to extension agents alone					
Engaging in collective responsibility demands new skills for integration and working together in partnership with key stakeholders					
Management of rural knowledge is important for					

beekeeping as it links various actors who have and seek knowledge to bring together their knowledge and experiences					

Economic factors

There are important economic issues that influence adoption of new modern technology in beekeeping. Use the scale provided to rate the statements below, where 1=strongly disagree, 2= agree, 3= not sure, 4= agree, 5= strongly agree

Economic factors	**1**	**2**	**3**	**4**	**5**
Perception of the farmer determines the probability of adopting new processing technologies					
High yields are sufficient conditions to persuade beekeeping to adopt technology					
Beekeeping must be profitable than other alternatives for new technology to be applicable					
High quality of honey is not sufficient condition to persuade beekeepers to adopt a new processing technology					
Farmers yields and net benefits should increase when farmers adopt new processing technologies					
Economic incentives are the most important determinants of the time farmers wait before adopting new technology					
The use of modern honey extracting machine					

results in higher net return per kg of honey compared with local methods					
The difference in profitability between the new and old processing method determines the probability of adopting a new technology					
The use of honey extractor produces honey of high quality which fetches higher price compared to other processing technologies					
The cheapest honey extracting technologies is the use of crushing and straining method					
The cost of honey extracting machine greatly contributes to expenses incurred in beekeeping project					
Lack of skills and experience greatly contributes to low adoption of honey extractor technology					
High quality honey fetches higher price compared to low quality honey					
Means of transporting processed honey to the market is readily available at an affordable price					

It has been found that most beekeepers process rarely employ workers to process their honey

Agree ☐ Disagree ☐

If disagree

Is the labor used available at an affordable price?

Yes No

Section B: Honey extracting technology and household income

How many kgs of honey do you produce in a 3-month cycle?

Below 10kgs☐

(10-20)☐

(20-50)☐

(50-100)☐

How many kgs of honey do you process……..

Which processing method do you use

Electric driven honey extractor ☐

Manually driven honey extractor☐

Radial honey extractor☐

Tangential honey extractor☐

Crushing and straining☐

Heat method ☐

Other (specify)

What is the cost of the equipment used in honey processing…….

What is the cost of the labor used…… Indicate if any

What is the cost of transporting the processed honey to the market…….

At what price do you sell per kg…….

What cost do you incur while searching for information on market, equipment and transport…… Indicate if any

Any other expenses……..Indicate the cost if any

What is your average monthly income on beekeeping project?

Below 10,000ksh ☐

10,000-15,000 ☐

16,000-25,000 ☐

26,000-35,000 ☐

36,000 and above ☐

Do you have any other income generating activity besides beekeeping?

Yes ☐

No ☐

If yes, tick appropriately

Farm income ☐

Non-farm income ☐

Off farm income ☐

Other (specify)……

	Source of income	Did anybody receive income in the house-hold in the first 1 yr(Yes, No)	If yes Who received	Yes, amount received in the normal year
1	Farm income			
2	Non-farm income			
3	Off farm income			
4	Other (specify)			