ASSESSMENT OF HONEY PRODUCTION AND MARKETING SYSTEMS IN THREE SELECTED *WOREDAS* OF TIGRAY REGION, ETHIOPIA

M.Sc. Thesis

BY

ATSBAHA HAILEMARIAM

July, 2012
Jimma University

ASSESSMENT OF HONEY PRODUCTION AND MARKETING SYSTEMS IN THREE SELECTED *WOREDAS* OF TIGRAY REGION, ETHIOPIA

M.Sc. Thesis

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In Partial Fulfillment of the Requirements for the Degree of
Master of Science in Animal Production

By

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APPROVAL SHEET

SCHOOL OF GRADUATE STUDIES

As thesis research advisor we hereby certify that we have read and evaluated the thesis prepared, under our guidance, by **Atsbaha Hailemariam**, entitled **"Assessment of Honey production and Marketing systems In Three Selected Woredas of Tigray region Ethiopia ''** We recommend that it can be submitted as fulfilling thesis requirement.

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As members of Board of Examiners of the M.Sc. thesis open defense examination, we certify that we have read, evaluated the thesis prepared by Atsbaha Hailemariam**,** and examined the candidate. We recommended that the thesis could be accepted as fulfilling the thesis requirement for the Degree of Master of Science in Animal Production.

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DEDICATION

This work is dedicated to all my beloved families, especially to my sisters Asqual Hailemariam,Rahwa Hailemariam,Kiros Kahsay,my brothers Biniam Hailemariam, Awet Weldesemayat and my Friends Micheale Kahsay,Hagos Hadis ,Yemane Gebru,Teweldebrihan Tekle for their affectionate and strong support that helped me a lot in my academic career.

STATEMENT OF THE AUTHOR

I declare that this thesis is my original work and all sources of materials used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for M.Sc. degree at Jimma University, College of Agriculture and Veterinary Medicine and put at the University Library to be made available to borrowers under the rules of library.

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BIOGRAPHICAL SKETCH

The author was born in Adigrat, Ganta afeshum District, Eastern Zone of Tigray Region, on August 12, 1985. He attended his Elementary School Education in Agazi elementary school, his junior Education in Tsinsetlemariam Catholic School and later on in Agazi comprehensive Senior Secondary school. He completed his high school education in 2002/2003 and joined Jimma University College of Agriculture and Veterinary Medicine.

After graduation he was employed by Tigray Food Security office in January, 2007 to serve as Food security Expert in Raya Azebo woreda Southern zone of Tigray, He also served as Livestock expert for another one year. Moreover, he also duly served as team leader of projects, team leader of watershed in the mentioned District.He also served in GIZ as supervisor of three woredas on contract employment basis. Finally, he rejoined the School of Graduate Studies of Jimma University on October, 2010 to pursue his M.Sc study in Animal Production.

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LIST OF ABBREVATIONS

AMP	Apiculture Master Plan
ANOVA	Analysis of Variance
BoARD	Bureau of Agriculture and Rural Development
BoA	Bureau of Agriculture
CSA	Central Statistical Agency
DA	Development Agent
DCSI	Dedebit Credit and Saving Institute
ETB	Ethiopian Birr
EARO	Ethiopian Agricultural Research Organization
FAO	Food and Agriculture Organization
FENI	Feed Enhance Nigeria Initiative
GIZ	German International Cooperation
GDP	Gross Domestic Product
GMM	Gross Market Margin
GO	Governmental Organization
HBRC	Holeta Bee Research Center
IHMR	International Honey Marketing
ILCA	International Livestock Center for Africa
ITC	International Trade Center
IBRA	International Beekeeping Research Association
KWARD	Kolla-tembenWoreda office Agriculture and Rural development
MoA	Ministry of Agriculture
MoARD	Ministry Of Agriculture and Rural Development
MWARD	Medebe-zanaWoreda office Agriculture and Rural development
NGO	Non-governmental Organizations
NMM	Net Marketing Margin
PRA	Participatory Rural Appraisal
RWARD	Raya-azebo Woreda office Agriculture and Rural development
SPSS	Statistical Package for Social Science
TARI	Tigray Agricultural Research Institute
TBoARD	Tigray Bureau of Agriculture and Rural Development
UEPB	Uganda Export Promotion Board

TABLE OF CONTENTS

TABLE OF CONTENTS (*CONTINUED*)

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ASSESSMENT OF HONEY PRODUCTION AND MARKETING SYSTEMS IN THREE SELECTED WOREDAS OF TIGRAY REGION, ETHIOPIA

ABSTRACT

The study was conducted in three selected woredas of Tigray Region in 2011/12.The objectives of the study were to assess the honey production and marketing system and identify the constraints and opportunities of the study areas. For this study three woredas(Raya-azebo,Kolla-temben and Medebe-zana) were selected purposively based on beekeeping potential and were further stratified in to three peasant associations(PAs) based on altitude variation as high land (>2300), mid land (1500-2300) and low land (<1500)masl. Thirty beekeepers were selected from each PA using systematic random sampling method to conduct formal survey with semi structured questionnaire making a total of 270 interviewed bee keepers. The maximum and minimum colony number in each beekeeper in traditional and frame hives ranged from 0-40 and 0-24, repectively.The mean amount of honey produced annually from traditional and frame hive in kg in the study areas were 12.79 and 28.29, respectively. There was highly significant difference (P<0.001) in the average price of one kg honey from traditional (45.810 Birr) and frame (51.724 Birr) hives. The mean amount of honey produced per household in Raya-azebo, Kolla-temben and Medebe-zana woredas were 83.47, 69.97 and 82.22 respectively. There was highly significant difference in the income of the households (P<0.001).This difference might be due to the quality of their product in relation to the way they strained the honey, the difference in the physical appearance of the honey because of impurities and difference in financial strength .The gross marketing margin share of producers from consumers fall down ward (40%) to the gross marketing margin of honey collectors, wholesalers and retailers (60%).This might be attributed to the inefficiency of the honey marketing system due to presence of unproductive market participants such as unlicensed honey traders. The regression of honey price showed that the honey demand will change by 8.417 for every coming year. Based on the result of the study, the first two constraints in the areas were poor marketing system and colony swarming. On the other hand, the opportunities for beekeeping in the study areas were existence of honey bee colonies, availability of potential flowering honey plants, presence of experienced beekeepers, land rehabilitation, availability of credit sources, and increase demand of honey, and improvement in productivity and overall production of honey. To conclude, the study areas possess potentials for beekeeping though there are constraints that hinder the beekeeping sub-sector that need to be solved.

***Key words**: Honeybee, Honey marketing, honey production, Major bee flora, Tigray region*

1. INTRODUCTION

Beekeeping is an important component of agriculture and rural development programme of many countries. It helps to provides security in nutrition, economy and ecology. Besides, it does not compete with other resources in the farming system, it is income generation activity and supplement annual income for the beekeepers through sell of bee Products (honey, wax and bee colonies. It also serves to get bee products which are vital for the health of consumers (FAO, 1990). According to Crane (1990), it increases Citrus sinensis by 30%, water melon by 100% and tomatoes by 25% through pollination.

According to IHMR (2012), the international honey market is under the influence of global weather patterns, bee health problems and global financial conditions. Global honey production in 2011, reduced due to natural disasters like floods, drought, cold and untimely rains. In USA, the honey production declined from 160 to 150 million pounds and is the lowest honey crop production in history. However, China topped its honey production from 172,448,000 to 898,000,000 pounds in 2012.

Africa is blessed with numerous types of wild honeybees (Adjare, 1990). Ethiopia is one of the countries in the continent, which has the largest honeybee populations and owns big potential of honey production. Owing to its varied ecological and climatic conditions, Ethiopia is home to some of the most diverse flora and fauna in Africa. Its forests and woodlands contain diverse plant species that provide surplus nectar and pollen to foraging bees (Girma, 1998 and MoARD, 2006).

Ethiopia, having the highest number of bee colonies and surplus honey sources of flora, is the leading producer of honey and beeswax in Africa. Ethiopia produces about 24000 tons of crude honey per year, thus shares 24% of Africa and 2% of world's honey production. This makes the country 1st in Africa and 10th in the world (AMP, 2007). Currently, more than 7000 species of flowering plants are estimated to be found in the country, of which most of them are honeybee plants (Girma, 1998).

Despite the long tradition of beekeeping in Ethiopia, having the highest bee population and being the leading honey producer as well as one of the largest beeswax exporting countries in Africa, the share of the sub-sector in the GDP has never been commensurate with the huge numbers of honeybee colonies and the country's potentiality for beekeeping. The honey productivity per hive is low resulting low production of honey for export earnings. Thus, the beekeepers in particular and the country in general are not benefiting from the sub sector (Nuru, 2002 Beyene and David, 2007).

Investigation indicated that the number of the honeybee colonies in the country has been declined (CSA, 1995) and consequently the honey and beeswax production as well as export earnings fell down (Gezahegne, 2001). This is attributed to drought, ever- expanding population pressure and associated vegetation changes and indiscriminate applications of chemicals.

The honey production trend is increasing from year to year in the country. Although thousands of tones of honey are produced every year, it is usually poorly managed and unattractive in appearance. Because of this its place in the local market as high as 90% though the country is still importing honey. Traditional hive honey is of good quality as long as it is in the hive, while faulty handling from the time of its harvest until it reaches to market is responsible for its inferior quality.

Recently, different beekeeping development endeavors have been made by the governmental and non-governmental organizations in the region in particular and in the country in general. On the government side, more attention has been given for the promotion of movable frame hive through the Ministry of Agriculture and Rural development extension system. Special fund has been allocated and more number of movable frame hives with expensive beekeeping accessory equipment has been provided with subsidized prices. On the other hand, non-governmental organizations have been prompting low-cost and appropriate hive technologies. Market oriented Beekeeper Organization has also been initiated and formed in different districts. But this Rapid promotion of improved beekeeping technologies has been constrained by different Problems. Moreover, studies that are aimed for exploitation of full beekeeping

potentials of the Tigray region in relation to introduction of improved hive technologies are encouraging but not to the extent it is expected (TBoARD, 2010).

Beekeeping is a long standing practice in Tigray region with the early settlement of the north part of Ethiopia. According to GIZ (2011), the region owns 354,000 bee colonies. From the total colonies 34% are with frame hives and 66% are with traditional hives. According to TAMPA (2010), the production and market of honey is increasing from year to year due to the good feed back by international market.

The honey production system includes three types the traditional beekeeping, intermidate beekeeping and the frame hive beekeeping. It also includes the management of beekeeping products (honey, beeswax, bee venom, Royal jelly etc) for its better use.

The opportunities and constraints of the country (Ethiopia) varies from place to place and are not equally pressing through the its location (Challa, 2010)

Honeybee production system study is important to identify problems and come up with research findings relevant to the problems and to formulate appropriate development plan. Hence, characterization of production system, identifying and prioritizing the available constraints and suggesting possible interventions areas, were the first steps towards any development planning in any fields and also in the apiculture sub-sector. Moreover, farming system approach to research and development was recognized as the most appropriate method used to describe, diagnose and gain knowledge of the technologies and factors affecting production at farm level (Amir and Knipscheer, 1989).

1.1. Statement of Problems and Significance of the Study

So far in Kolla-temben, Raya-azebo and Medebe-zana woredas, there was no compiled and reliable information on honey production and marketing systems resulted from appropriate analysis. Besides, the potential bee flora of the these woredas were not well organized for the best flow of investors, NGOs and other interest individuals to enhance the development of the

sub sector and the income of the region in particular in which in turn would have role in the GDP of the country.Morever, the number of beekeepers, bee colonies, amount of honey produced, type of beekeeping practices, constraints and opportunities were not well differentiated.

Hence, the significance of the study was to provide information of beekeeping for responsible stallholders, to indicate future research areas for those who would like to conduct researches on beekeeping, for optimum utilization of identified opportunities, to alleviate constraints that hinder honey production and marketing system, to give appropriate recommendation honey production and marketing system and to improve the awareness of beekeepers through disseminating the thesis findings of the study areas .Moreover, the data may be used as secondary for researchers and any interested stalk holders working in the study areas after this study accomplished.

1.2. General Objective

The general objective of the study was to assess honey production and marketing systems in three selected woredas of Tigray region.

1.2.1. Specific objectives

1. To assess honey production systems of these three woredas
2. To assess marketing systems of honey of these woredas
3. To identify the constraints and potentials of beekeeping of these woredas
4. To give appropriate recommendation of the study areas

2. LITERATURE REVIEW

2.1. Overview of the Global Apiculture Sector and Honey Market Analysis

Apiculture is one of the fastest growing sectors worldwide. A number of countries have made strategic moves towards the development of this industry. Recent developments show a shift from a situation where beekeeping was considered a hobby and not business enterprise. In Northern Ireland, for example, mostly old and retired men practiced beekeeping. To-date Ireland produces one of the best honeys in the world (UEPB, 2005).

Honey is the major product of apiculture industry worldwide and produced in nearly all countries. This is attributed to the qualitative nature of honey produced from different floral / nectar sources in different geographical regions. According to ITC (2003), the total world production of honey is estimated at 1.3million metric tons (MT) per annum, valued at US$ 452 million. However, only about 400,000 MT of the honey is traded in the export market annually, indicating a dominance of domestic markets of honey is within the producing countries (about 67%).The major importers of honey Per annum are EU (150,000 MT), USA (100,000 MT), and Japan (50,000 MT). USA market alone consumes about 45% of the globally traded honey. The top exporters are China (100,000 MT), Argentina (70,000 MT), Mexico (40,000 MT) Australia, India, Canada, and New Zealand. Developing Market Economy's exports represent 60% of world exports (ITC, 2003). The trend in world's supply has continued to rise, but the earnings have declined by about US$ 20 million. Asia is the main producing continent, followed by Europe and America in the third place. African honey has generally been traded locally and exports into the major countries have been low. Cooperative organizations and Non-governmental Organizations have spearheaded small and medium investments in apiculture and encouraged local trade (UEPB, 2005).

2.2. Overview of Beekeeping in Ethiopia

In Ethiopia, beekeeping has been a tradition since long before other farming systems (Gezahegne, 1996). Even though it is one of the important and the oldest farming activities in the country, there are no available records, which confirm when and where beekeeping was first started. However, the Hieroglyphs of ancient Egypt refer to Abyssinia (ancient name of Ethiopia), as source of honey and beeswax and Abyssinia has been known for its beeswax export to Egypt for centuries when other items were not exported. It was assumed that the keeping of bees in baskets may have started about 5000 years ago in the Northern regions along with the early settlements. No countries in the world may have ancient beekeeping as Ethiopia (Fichtl and Admassu, 1994; Gezahegne, 2001). Moreover, the oldest basket hive in the International bee museum is from Ethiopia.

2.3. Importance of Beekeeping in Ethiopia

The prospect for helping beekeepers of Ethiopia positive and raising their living standard through the development of beekeeping activities are bright (Robinson, 1980)**.** Beekeeping has many advantages that help farmer beekeepers to improve their well-being. Its advantages can be itemized for the socio-economic impact of beekeeping. For instance, successful beekeepers raise their socio-economic standing in areas with subsistence agriculture, and farmers in developing countries can substantially supplement the family income, sometimes even double it. This means the family can be food secured. Furthermore, some of the uses of beekeeping are the following:

1. Bees are cosmopolitan: they adapt to wide range of environment. In much of lower land, at altitudes below 400 m a.s.l. where cattle rearing may be severely constrained due to *tsetse* or other reasons, harvest could be obtained from beekeeping.
2. Smallholders and landless peasants can practice beekeeping. The hive occupies very little space and bees can collect nectar and pollen from any where they can get; so wild, cultivated and wasteland areas all have value for beekeeping.
3. Beekeeping does not compete for resources with other agricultural endeavors and can be run with other agricultural activities: Man cannot utilize nectar and pollen in the absence of beekeeping.

4. Bee culture does not disturb ecological balance, as cultivation of crops and practices of animal husbandry.
5. The investment and running costs are relatively low with minimal risk. Beekeeping is possible even for people with few resources; bees can be obtained from the wild, equipment can be made locally, and in most cases bees do not need the beekeepers' help.

6. Globally, the honeybee provides pollination service. This is an indispensable activity in the crops and fruits production process. So that beekeeping plays significant role to the agricultural economy at large.

7. The honeybee produces honey, beeswax and propolis. These commodities have long shelf life and can be marketed locally or abroad.

8. The amount of time involved can differ according to the beekeepers interest for leisure time, sideline or fulltime involvement. No matter at which level of intensity a beekeeper operates; honey and beeswax can be harvested.

9. The whole family can become involved since men, women, or elder children can do the work in most cases at home. That means, it can help efficient utilization of family labor.

10. A beekeeper can develop knowledge and skill, which is rewarding and generate self-reliance.

11. Other local traders benefit by making hives and equipment, and from using and selling the products.

2.4. Types of Beekeeping in Ethiopia

In Ethiopia, the beekeeping has started with traditional and later developed through introduction of the intermediate hives .Morover, the advance of beekeeping led to introduction of frame hives to increase the quantity and quality of the honey until the present(HBRC,1997).The development of beekeeping is overviewed as follows;

2.4.1 Traditional beekeeping

In Ethiopia, traditional beekeeping is the oldest and the richest practice, which has been carried out by the people for thousands of years. Several million bee colonies are managed with the some old traditional beekeeping methods in almost all parts of the country (Fichtl and Admasu, 1994). Traditional beekeeping is of two types: forest beekeeping and backyard beekeeping. In some places, especially in the western and southern parts of the country, forest beekeeping by hanging a number of traditional hives on trees is widely practiced. In other most parts of the country backyard beekeeping with relatively better management is common (Nuru, 2002). Traditional beekeeping is mostly practiced with different types of traditional hives. The most universal type of traditional hives, known to have been in use is simple cylindrical type. Beekeeping started with traditional or fixed comb hives, so called because the combs are attached to the top and sides of the hive itself and the beekeeper cannot easily remove and replace them.

In its primitive form, only one end of the hive could be open, but in more advanced forms each end of the cylinder will be fitted with a removable closure. The types of hives and the way of keeping bees vary from area to area. Based on locally available materials used for construction of hives, environmental conditions and positions used to keep bees, the following variants of basic design are found throughout the country: hollowed logs, bark hive, bamboo or reed grass hive, mud (clay) hive, animal dung (mixed with ash) hive, woven straw hive, gourd hive, earthen pot hive and so on. The beekeepers that are experienced and skilful in using these hives could do many operations with less facility. Gezahegne (2001) stated that under Ethiopian farmers' management condition, the average amount of crude honey produced from traditional hive is estimated to be 5 kg / hive / year. Traditional husbandry is practiced with many millions of fixed comb hives particularly in the remote areas of the country. For the period until modern frame-hives are introduced, these fixed comb hives can yield a modest amount of honey, and also about 8-10% of its weight is beeswax. This harvest is achieved with minimal cost and labor, and it is valuable to people living a marginal existence.

2.4.2. Transitional beekeeping

It is a type of beekeeping intermediate between traditional and modern beekeeping methods. Generally, top-bar hive is a single story long box with slopping sidewalls inward toward the bottom (forming an angle of 115o with the floor) and covered with bars of fixed width 32 mm (Segeren, 1995; Nicola, 2002). Adjare (1990) and IBRA (1997) suggested that for technical and economic reasons, most African countries are not yet in the position to use movable-frame hives, and for them top- bar hive represents a satisfactory compromise. Although movable frame hives are recommended for experienced beekeepers that want to optimize honey production, the Kenya top-bar (KTB) hive has been proved to be most suitable because of its low cost and the fact that the beekeepers or local carpenters can easily construct it. Transitional beekeeping started in Ethiopia since 1976 and the types of hives used are: Kenya top-bar hive, Tanzania top-bar hive and Mud- block hives. Among these, KTB is widely known and commonly used in many parts of the country (HBRC, 1997). The advantages of KTB over fixed comb hive and movable frame hive is discussed by Segeren (1995), Nicola (2002). Top-bar hive in an ideal condition can yield about 50 kg of honey per year (Gezahegne, 2001).

2.4.3 Frame hive beekeeping

Modern beekeeping methods aim to obtain the maximum honey crop without harming bees (Nicola, 2002). Modern movable- frame hive consists of precisely made rectangular box hives (hive bodies) superimposed one above the other in a tier. The number of boxes is varied seasonally according to the population size of bees. Practical movable- frame hive was invented in 1851 by Lorenzo Lorraine Langstroth in U.S.A. (Vivian, 1985). Later on different countries developed their own movable frame hives (for instance Zander, Dadant) and Langstroth was the prototype of movable frame hives used today. In many countries Langstroth hive boxes have proved to be convenient for handling and management. there is also Chefeka hive introduction as new beekeeping technology.

In Ethiopia, movable frame hives were introduced since 1970 (HBRC, 1997) and the most commonly used are: Zander and Langstroth style hives. Based on the national estimate, the average yield of pure honey from movable frame hive is 15-20 kg/year, and the amount of beeswax produced is 1-2% of the honey yield (Gezahegne, 2001). However, in potential areas, up to 50-60 kg harvest has been reported (HBRC, 1997). Movable frame hives allow colony management and use of a higher level of technology, with larger colonies, and can give higher yield and quality honey but are likely require high investment cost and trained man power

2.5 .Importance of Beekeeping in Ethiopia

Beekeeping has been part of the farming system in Ethiopia since time immemorial. It has been a tradition since long before other farming systems. Beekeeping is a very long-standing and deep rooted practice in the rural communities of the country and it has been and still plays a significant role in the national economy of the country as well as for the subsistence smallholder farmers. The contribution of honey bees and hive products, though difficult to assess, is probably one of the most important small-scale income generating activities for hundred thousands of farmer beekeepers. Beekeeping has many advantages that help farmer beekeepers to improve their well being (TBoARD, 2010). The socio-economic impact of beekeeping and the main hive products and importance of beekeeping are summarized as follows:

Honey, the natural product of honeybee, has many times been described as man's sweetest food. It is an excellent energy source because it contains simple sugars that are ready for assimilation immediately on reaching the intestine. Honey contains more than 180 elements and it has several uses (HBRC, 1997). There is a strong, local demand for honey, due to its use for the production of traditional beverage '*Tej' (*honey mead). In Ethiopia, much honey has traditionally been fermented to make *'Tej* and according to Edessa (2005) 85 percent of the total honey estimated to be brought for market is used for '*Tej'* production and 15 percent of the total honey produced is consumed at home. Moreover, from the total honey produced in the country beekeepers are estimated to earn about 360-480 million Birr per year (Nuru, 2002).

The current annual honey production of Ethiopia is estimated to be about 43,373 tones (AMP, 2007). This makes the country the leading honey producer in Africa and one of the ten largest honey-producing countries in the world. But the production of honey varies from place to place and also from season to season. In several regions of the country, beeswax collection is not significant and the beeswax produced by bees, which could be harvested by beekeepers, is wasted. The wax is mostly left or thrown away because beekeepers do not bother to collect it since it is of little practical value for beekeepers (Fichtl and Admasu, 1994) and the people do not know the local beeswax is generating attractive money. Nevertheless, the annual beeswax production of the country is estimated at about 3,658 tones (AMP, 2007). This makes Ethiopia the fourth largest beeswax producing country in the world after China, Mexico and Turkey. Beeswax supports the national economy through foreign exchange earnings. Presently, beeswax is one of the major exportable agricultural products. Ethiopia is the third largest beeswax exporter in Africa and the annual average value of beeswax is estimated at about 125 million Birr (Nuru, 2002). Like honey, beeswax is also a multipurpose natural bee product, which is used in the manufacture of more than 300 commodities. Honey and beeswax also play a big role in the cultural and religious life of the people of the country.

Bees are essential parts of the agricultural system. Although the value of honeybees in crop pollination is under estimated, it has a significant role in increasing national food production and regeneration of plant species. Honeybees are the prime pollinating agents in the world. Their service in pollination is estimated to be worth over 15 times the value of all hive products together, although it is much more difficult to quantify their benefit (EARO, 2000). Hackett (2004) estimated the value of honeybee pollination to U.S. agriculture to be 14 billion U.S $ annually.

Honeybee is also believed to play a significant role in the economy of Ethiopia through pollination services. Pollination is one of the most important factors that affect seed production in agricultural crops. In Ethiopia, an experiment was conducted to determine the effect of pollination on Niger (*Guizotia abyssinica*) and the result showed that honeybees increased the seed yield of Niger by about 43% (Nuru, 1999) and Onion *(Allume Cepa)* by two fold (Admasu *et al*, 2008).

Beekeeping is believed to play a significant role and one of the possible options to the Smallholder farmers in order to sustain their livelihood. It does not only serve as a source of additional income, but also quite a number of people entirely depend on beekeeping and honey selling for their livelihoods. Nuru (2002) indicated that honeybee and their products provide direct cash income for beekeepers. In areas where honey production is not attractive, beekeepers can sell their colonies in the market. In this regard honeybees serve as 'near cash' capital which generate attractive money. In Tigray, the price of one established bee colony in a traditional hive ranged from 400-750 Birr (TBOARD, 2010). On the other hand, some beekeepers in Tigray region that are involved in beekeeping technology packages, were reported to earn up to 3503.74 birr annually from sale of honey (Meaza, 2009), making up for the large portion of their annual income. This indicates the high potentiality of beekeeping as a source and means of diversification of income for the rural communities.

2.6. Major Constraints in Beekeeping

Ethiopia has enormous untapped potential for promoting beekeeping; both for local use and for export purpose. However, like any other livestock sector, this sub sector has been ceased by complicated constraints. The prevailing production constraints in the beekeeping sub sector of the country would vary depending on the agro ecology of the areas where the activities is carried out (Edessa, 2005). Variations of production constraints also extend in socio-economic conditions, cultural practices, climate and behaviors of the bees. According to HBRC (1997), Ayalew (2001) and Edessa (2005), the major constraints in the beekeeping sub sector are the following: the unpleasant behaviors of bees (aggressiveness, swarming tendency, and absconding behaviors); lack of skilled manpower and training institutions; low level of technology used; high price of improved beekeeping technologies; drought and deforestation of natural vegetation; poor post harvest management of beehive products and marketing constraints; indiscriminate application of agrochemicals; honeybee disease, pest and predators; poor extension services; absence of coordination between research, extension and farmers; absence of policy in apiculture; shortage of records and up-to- date information; and inadequate research institutions to address the problems. But all these problems may not be constraints to all parts of the country and may not be equally pressing to every place.

Besides, the bees and their products are vulnerable to various diseases, parasites and pests. The existences of two adult honeybee diseases namely *Nosema apis* and *Melpighamoeba mellificae* and their distribution was studied and reported by Gezahegn and Amsalu (1991); and Desalegn and Amssalu (1999). The occurrence of brood disease known as Chalk brood in Ethiopia for the first time was reported by Desalegn (2006). Some major types of honeybee pests and predators, magnitude of their damage, and some possible solutions to minimize the damage they cause on bees and their products were discussed by Desalegn (2001). Moreover, the occurrence of small hive beetle (*Aethina tumida* Murray; *Coleoptera*: *Nitidulidae*) in honeybees was assessed by Desalegn and Amssalu (2006) and recently the effect of ant (*Dorylus fulvus*) on honeybee colony and their products in West and Southwest *Shewa* zones was examined by Desalegn (2006). The most commonly known honeybee diseases reported to exist in Ethiopia are Nosema, Amoeba and Chalk brood diseases (Gezahegn and Amssalu, 1991; Desalegn and Amssalu, 1999; Desalegn, 2006).

Beekeeping research is new in Ethiopia. Holeta Bee Research Center (HBRC) is the main mandated institution undertaking applied and adaptive apicultural research that would support development (Gezahegne, 1996). The beekeeping research so far conducted in the country although encouraging is not satisfactory because one center could not address all parts of the country. Most of the research work is still being carried out on-station with modern technology and management systems. However, the great majority of beekeeping production is based on traditional production systems where the results of on-station research may not often be applicable to the local conditions. An introduction of improved hives and working tools to the rural community are beyond the pockets of farmers and not so easily available even for those who could afford it. Many beekeeping projects that were implemented by government and various organizations to boost honey and beeswax production were not successful mainly due to inadequate management and above all the beekeepers lack of awareness and interest.

Likewise, it was not implemented on the bases of identification of potentials, constraints, attitudes and economic level of the communities. So it is very essential to identify the

potential development constraints. As indicated in the Comprehensive Bees and Beeswax Marketing Plan 2nd draft document(MoARD, 2008), the country has set a long-term plan to raise the current 43,373 tones of honey and 3,658 tones beeswax annual yield to a level of 149,056 tones and 9,928 tones of honey and beeswax, respectively. It was also planned to export 80% and 50% of the total honey and beeswax production, respectively (MOARD, 2008). An investigation indicated that the number of the honeybee colonies in the country has been declining (CSA, 1995). Thus, it requires making efforts to address some of the major problems of beekeeping and to keep it productive in a sustainable way. Still the country has potentials with enormous nectar and pollen resources that have not yet been exploited, and beekeeping could probably be a profitable activity to undertake. The potentiality of apiculture could be backed up by research and the beekeepers' indigenous knowledge which should be assessed. In this regard it is important and right time to conduct apicultural research in order to assess the situation at the grass-root level: to identify the opportunities, challenges, socio-economic importance, attitudes and analyze the performance of the existing beekeeping situation before any development program interventions.

3. MATERIALS AND METHODS

3.1. Description of the Study areas

Raya-azebo is one of the 36 woredas in the Tigray Region of Ethiopia. This woreda is bordered on the south by Alamata, on the southwest by Ofla, on the northwest by Endamehoni, on the north by Hintalo Wajirat, and on the east by the Afar Region. The administrative center of this woreda is Mehoni. Based on the 2011 RWARD, the woreda has a total population of 176,205, of whom 86281 are men and 89924 women. From this 11.82% are urban inhabitants. The area coverage of the woreda is 2,132.83 square kilometers. This is located in the southern zone between 120 18 ’15’’ and 120 38’ 15’’ and it is about 112km far from Bekelle city. The elevation of the district ranges from 694-2367masl having average elevation of 1700masl. The Woreda has high livestock potential having cattle number 146, 705; Sheep number 16865, goat number 952, Mule number 135, Donkey number 15383, Camel number 14479, Poultry number 91885,4700 beecolnies which shows potentiality of the Woreda for animal production. The temperature ranges from 16 to 25^{o}c with rain fall ranging 490mm to 680mm (RWARDA, 2011).

Kolla-temben is one of the 36 woredas in the Tigray Region of Ethiopia. It is named in part after the former province of Tembien. Part of the central Zone, Kola Tembien is bordered on the south by Abergele, then by the Tekezé River on the west which separates it on the west from the Western Zone, on the north by the Wari River which separates it from Naeder Adet and Werie Lehe, on the east by Eastern Zone, and on the southeast by Degua Tembien. The administrative center for this woreda is Abiy Addi which is 95km away from Mekelle. The latitude and longitude of the area is 1337'0.120"N and 390'0.000"E respectively. Based on the 2011 KWARD, the woreda has a total population of 148282, of whom 73,873 are men and 74,409 women. This woreda is endowed with an area of 2,538.39 square kilometers. The rainfall is a low and erratic 450-550mm per year and has 5500 bee colnies. The Woreda is low land dominated consists of plateaus and hilly areas. The altitude of the Woreda ranges from 547-2435 masl. The average annual temperature of the woreda is 25-30 ^{o}c. The average elevation 1350masl ranges from 558-2400 masl (KWARDA, 2011)

Medebe-zana is one of the 36 woredas in the Tigray Region of Ethiopia. Part of the North western zone, Medebe-Zana is bordered on the south by the Tekezé River which separates Tahtay Adiyabo from Tselemti, on the southwest by Asigede Tsimbela, on the northwest by Tahtay Koraro, on the north by La'ilay Adiyabo, and on the east by the Central Zone. The administrative center of this woreda is Seleh Leha which is 270km away through the main road. The latitude and longitude of the area is 14° 6' 50N and 38° 28' 32E respectively. Based on the 2007 MWARD, the woreda has a total population of 142559, of whom 70711 are men and 71848 women; the area coverage of this woreda is 2,685.12 square kilometers. The livestock potential of the Woreda is cattle 135615, Sheep 43141, Goat 103169, Chicken 134553, Camel 1823, Mule 189 and Donkey 11594,6400 bee colonies indicating the endowment of the area for animal production. The elevation of the woreda ranges from 854 to 2670 masl. The annual rain fall ranges from 650 to 950mm while the average temperature is 26 ^{0}C (MWARDA, 2011).

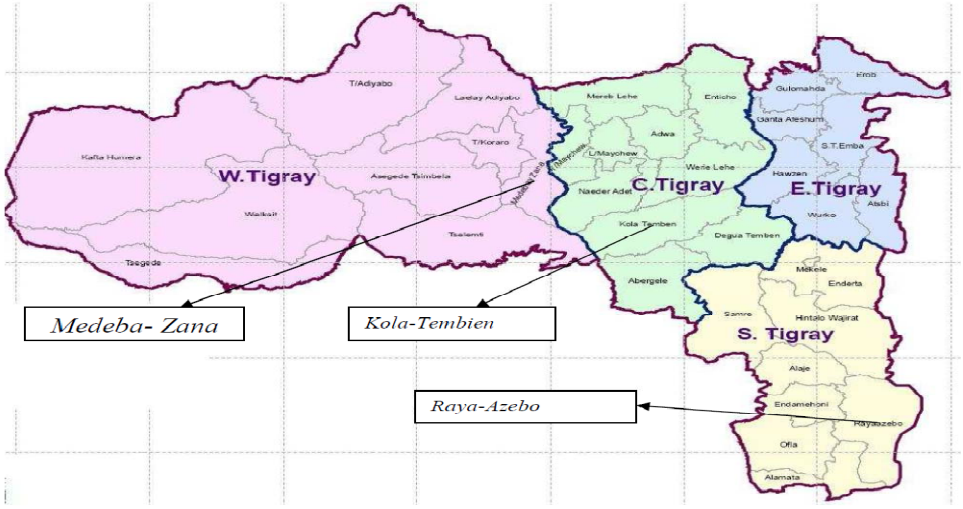

Figure 1. Map of study areas

3.2. Sampling Techniques and Sample Size

The study was conducted in three selected woredas of Tigray region mentioned above. These woredas were selected purposively based on their honey production potential. Three peasant association (PAs) were stratified in to high land (>2300), mid land (1500-2300) and low land (<1500), based on altitude variation from each woreda. From the list of households in each

PA, thirty respondents were selected using a systematic random sampling technique. Hence, the total numbers of households were 270 in the study areas.

3.3. Data Source and Method of Data Collection

Before the start of the formal survey, Participatory Rural Appraisal (PRA) was used with key informants and experts in the Office of Agriculture and Rural Development of the respective woredas (8-15 in each PA) for focus group discussion. The information generated during the PRA was used for the preparation and enumerator selection for a formal survey. A single-visit-multiple –subject formal survey (ILCA, 1992) was used to collect data on honey production and marketing system.

3.4. Method of Data Analysis

Descriptive statistics such as means, mean deviation, frequency distribution, range and percentages was used to analyze the qualitative data using SPSS version 16.0(SPSS,2007). Categorical data were subjected for analysis following chi-square procedures of SPSS 16.0. Duncan's multiple range test was used to separate means and mean differences were considered significant at $P<0.05$. Data requiring order of importance were analyzed using percentage. Least square method was used to forecast the trend of demand of honey in the study areas. The commodity approach method of marketing was used to study the efficiency honey marketing (Yemane, 2011 and Zekarias, 2010) in the study areas.

4. RESULTS AND DISCUSION

4.1. Socio-Economic Characteristics of Households

4.1.1. Age, Experience, family size and land holding of house holds

The results for the socio-economic characteristics of beekeepers for the study area are presented in (Table.1). The mean ages of the beekeepers in Kolla-temben, Medebe-zana and Raya-azebo were 44.82±1.224, 45.31± 0.988and 39.12±1.028, respectively. This survey result showed that people in the most productive age are actively engaged in beekeeping activities and the beekeepers had mean experiences of 42.82±1.077, 43.99±0.785 and 30.27±1.195 in the three districts mentioned, respectively. This result is in agreement with Challa (2010), in that people in most productive age are actively involved, accommodating experiences from elders and finally become independent beekeepers in his study area. This result also associates with Gidey (2011) in that young people gradually move on to become independent beekeepers as soon as they obtain their own lives.

Based on this study the mean family sizes of beekeepers of Kolla-temben, Medebe-zana and Raya-azebo were 5.43±0.195, 5.48± 0.182 and 4.28±0.297 in the order of importance of the respective districts. The beekeepers have average land holdings per household of 1.176±0.071ha, 1.103±0.034 ha and 1.704±0.121ha of the three districts in similar order of importance (Table1). Generally, the average land holding in the three districts showed statistically significant difference ($p<0.001$) and higher than the National average household land holding of 1.0-1.5 ha (Tessega, 2009). This could be due to large areas of land for farm, back yard and forest areas in the study districts.

Table 1. Age, experience, family size and land holding of households (n=270)

Socio-economic indicators	Woreda, Mean			SE	P
	Kolla-temben	Medebe-zana	Raya-azebo		
House hold age(Yrs.)	44.82±1.224[a]	45.31±0.988[a]	39.12±1.028[b]	0.643	***
Experience (Yrs.)	42.08±1.077[c]	43.99±0.785[a]	30.27±1.195[b]	0.694	***
Family size	5.43±0.195[a]	5.48±0.182[a]	4.28±0.297[b]	0.137	***
Land holding(ha)	1.176±0.071[b]	1.103±0.034[b]	1.704±0.121[a]	0.051	***

Rows having different superscript are significantly different at P<0.05, n=number of respondents, (***) statistically significant at P<0.001.

4.1.2. Status and involvement of the households in the community

In the study areas of Kolla-temben, Medebe-zana and Raya-azebo, the respondents replied that 83.3%, 97.8% and 75.6% respectively were married. This can justify that people under go beekeeping regardless of their marital status (Table2) and this result is consistent with Tessega (2009) and Challa (2010).

With regard to the religion in the study areas all (100%) Kolla-temben and Medebe-zana respondents were orthodox while in Raya-azebo (90%) were orthodox and 10% were Muslim (Table2). The result is in contrast with Tessega (2009) that all his respondents were orthodox. But this coincides with Gidey (2011) that both Muslim and Christian respondents practice beekeeping in his study areas.

Regarding to level of education, the result showed that 43.3%, 21.1% and 22.2% had not received any formal or informal education in Kolla-temben, Medebe-zana and Raya-azebo

districts, respectively. The rest were in different level of literacy ranging from reading and writing skills to completion of college/university (Table2).

Gichora (2003) noted that for more advanced beekeeping, one should have a good grasp of bee biology and behavior of bees for better colony management. Moreover, for illiterate people there is a need of intensive training and persuading of beekeepers before distributing movable frame hives. Therefore, according to the result of this study the high level of illiteracy (43.3%, 21.1% and 22.2%) in the three above mentioned districts limits the effectiveness of formal training programs and requires more emphasis to be placed on practical demonstration of essential theoretical concepts for beekeeping. According to the survey result education has significant role ($P<0.001$) for improving beekeeping activities. The result is disagrees with the findings of Challa (2010) and Tessega (2009) that education has insignificant role in beekeeping in their study areas (Table2).

Table 2.Status of house hold in the community (n=270)

Variables	Characteristics	Woreda,%			P
		Kolla-temben	Medebe-zana	Raya-azebo	
MSTAT	Married	83.3	97.8	75.6	***
	Single	6.7	1.1	14.4	
	Widowed	5.6	1.1	5.6	
	Divorced	4.4	0	4.4	
Total		100	100	100	
Religion	Orthodox	100	100	90	***
	Muslim	0	0	10	
Total		100	100	100	
CHHP	Political leader	7.8	6.7	37.7	***
	Spiritual leader	14.4	6.7	5.6	
	Elder	18.9	41.1	18.9	
	Development group	22.3	5.6	1.1	
	Youth affair	2.2	0	0	
	Women affair	1.1	0	0	
	Farmers	33.3	39.9	36.7	
Total		100	100	100	
ESHH	Illiterate	43.3	21.1	22.2	***
	Read and write	21.1	20	11.1	
	Elementary	11.1	34.4	16.7	
	Junior	11.1	18.9	22.2	
	High school	6.7	5.6	27.8	
	College/University	6.7	0	0	
Total		100	100	100	

MSTAT=Marital Status, CHHP=Community Household Participation, ESHH=Educational Status of the Household, n=number of respondents, (***) statistically significant at P<0.001.

4.1.3. Off farm activities of various Respondents from the study areas

According to the survey result, people are engaged in different off farm activities. From the off farm activities, beekeeping accounts the largest share (42.2%, 65.6%, 53.9%) in Kolla-temben, Medebe-zana and Raya-azebo, respectively indicating that beekeeping has the largest contribution for the rural beekeepers. The respondents were also engaged in different off farm activities (Table3).This indicates that beekeeping can be practiced side by side with other off farm activities among the districts. There is significant different (P<0.001) in the type of off farm activities. This shows that people are engaged in different off farm activities in the three

districts to full fill their food gaps in addition to the on farm activities. This finding is in line with Tadele *et al* (2008) in that beekeeping can be practiced with other on and off farm activities. This study also agrees with Challa(2010) that beekeeping can practiced integrated with other farm activities with his study area land holding ranges from 0.25-10ha to indicate for the on farm contribution in beekeeping.

Table 3. Off farm activities of the various respondents from the study areas (n=270)

Work characteristic	Activities	Woreda,%			P
		Kolla-temben	Medebe-zana	Raya-azebo	
Off farm	Beekeeping	42.2	65.6	53.9	
	SLMP	2.2	5.1	3.2	
	Beekeeping and SLMP	11.2	8.7	7.8	
	Beekeeping ,Safety net and SLMP	32.2	17.3	24.3	***
	Beekeeping and safety net	10	0	0	
	Beekeeping and House construction	0	1.1	2.2	
	Beekeeping and pity trade	2.2	2.2	8.6	
Total		100	100	100	

n=number of respondents, SLMP=Sustainable Land Management Project, (***) statistically significant at P<0.001.

4.1.4. Livestock composition of the study areas

The mean livestock holding per house hold is shown in (Table4).the major livestock reared in the area are cattle, sheep, goat chicken, equine, beekeeping and camel. In general, the range of cattle,sheep,goat,equine,chicken,camel and bee colony number ranges from 0 to 20,0 to 15,0 to 20,0 to 5,0 to 50,0 to 10 and 2 to 40, respectively. This indicates that beekeeping is highly integrated with other livestock production. This result is in agreement with the findings of Meaza (2010) that even for those who have or who have not livestock; beekeeping can be practiced for the improvement of their livelihood through providing income to the beekeepers. This is also in line with the findings of Tessega (2009) that beekeeping can be practiced integrated with other livestock production. Besides, beekeeping can enhance livestock production through nutrition (FENI, 2004).

Table 4. Livestock composition of the study areas

Animal species	Minimum	Maximum	(n=270)	
			Mean	S.D
Cattle	0	20	6.90	3.694
Sheep	0	15	2.67	3.774
Goat	0	20	6.17	6.482
Equine	0	5	0.56	0.787
Chicken	0	50	6.80	5.547
Camel	0	10	5.00	7.071
Bee colony**	2	40	8.47	3.570

**refers for the traditional and frame hives=number of respondents, S.D=Standard Deviation

4.1.5. Purpose of keeping livestock

As an integral part of the mixed farming system, livestock production plays a substantial role in the household food security in the areas. It meets urgent financial need, dietary requirements, draught power, transport, dowry and gift and breeding. Besides it serves for social and cultural functions. This indicates that majority of respondents keep bees for the purpose of cash income (66.29%) followed by consumption (18.1%) in the study areas (Table5).The result is in line with Daniel(2008) that livestock have multi-purpose benefits to households .The finding is also in agreement with (HBRC,1997) that beekeeping activities have several uses for the beekeepers in their livelihood.

Table 5. Respondents' opinion for the purpose of keeping livestock (%)

	(n=270)					
Animal species	Cash income	consumption	Draught	Transport	Dowry and Gift	Breeding
Cattle	14.27	45.4	25.03	-	9.23	5.77
Goat	65	25	-	-	-	10
Sheep	76.5	17.5	-	-	-	6
Equine	-	-	-	100	-	-
Chicken	69.19	30.01	-	-	3.8	-
Camel	33.4	-	-	70.6	-	-
colony**	66.29	18.1	-	-	15.2	2.41

**refers for respondents of traditional and frame hives (%), n=number of respondents

4.1.6. Availability of credits

According to the results of this survey, 95.9% of interviewed households have access to credit services. The main credit sources of the sample respondents were Dedebit Credit and Saving Institute (65.9%), Bureau of Agriculture and Rural development (21.1%), service cooperatives (6.7%) in the areas (Table6). However, about 4.1% of the sample respondents do not use credits for their farming operations. This is because of high interest rate (48.5%), late delivery (28.1%) and details are indicated in (Table6).Tessega (2009) also explained that the problems for credit provision were high interest rate (30%),late delivery (19.2%),lack of cash for down payment (12.5%),restrictive procedure (11.7%),lack of knowledge (10%),inflexibility (9.2%),lack of collateral (5%) and no problem (2.5%). The result also indicates that the institutions are improving their provision of credit through evaluating their problems as most of the problems occurred in Tessega (2009) were minimized. The result also showed that the Muslim society were not interested with the package of beekeeping as it has interest rate and could not fully use financially from the credit institutions. This might be due to the religion that they thought taking money with interest rate is sin (*haram*) in the study areas (Table 6).

Table 6. Credit sources and problems for the respondents (n=270)

Source of credit	%	Credit problem	%
DCSI	65.9	High interest rate	48.5
BoARD	21.1	Late delivery	28.1
Service cooperatives	6.7	Inflexibility	11.9
DCSI and service cooperatives	0.7	Religion(*Haram*)	2.6
DCSI and BoARD	1.1	No problem	4.8
DCSI,BoARD and service cooperative	0.4	-	-
Own	4.1	-	-
Total	**100**	**Total**	**100**

DCSI=Dedebit Credit and Saving Institute, BoARD=Bureau of agriculture and rural development=number of respondents.

4.2. Major beekeeping activities

Under this section beekeeping practices, sources, numbers, and trends of colonies owned by beekeepers, types of equipment used, and the overall beekeeping activities in the honey production and marketing systems of the study areas are discussed.

4.2.1. Honeybee colony holdings and service years of the hives

The average honeybee colony holding of the sample respondents for traditional and moveable frame hives were 8.44 and 3.56, respectively (Table7). Whereas the maximum service year of these traditional and modern frames hives were 58 and 14 years respectively in the study areas. This indicates that the adoption rate of the frame hive is very low. This may be due to late introduction of the technology leading to less exposure of the beekeeping practicing farmers.

This result is in line with the findings of Tessega (2009) that mean number of traditional hives were greater than mean number of frame hives showing the ease of affordability of the traditional beekeeping for the beekeepers in the study areas. He also explained that there were also intermediate hives in his study; while, there were no intermediate hives in the study

areas. Presence of the intermediate hive might result in producing comparable amount of honey for the poor traditional beekeepers. Challa (2010) indicated that the maximum mean service year for traditional is longer (19.02) than that of frame hives (4.25) in Gomma woredas of Jimma zone. This could be due to the less level of adoption for frame hives than traditional hives and to the less exposure for accommodation of experiences, knowledge and skill in the study areas.

Table 7. Types of hives, colony number and service years (n=270)

Types of Hives	**Colony number**				**Service Years**			
	Min	Max	Mean	S.D	Min	Max	Mean	S.D
Local	0	40	8.44	6.433	2	58	19.02	10.521
Frame	0	24	3.56	2.971	1	14	4.25	2.550
Intermediate	-	-	-	-	-	-	-	-

n=number of respondents,S.D=Standard Deviation

4.2.2. Source of colony, Apiary sites and reasons of beekeeping in the areas

The main sources for bee colonies in the study areas were buying and swarming (40.4%), Swarming (18.1%), family and swarming (16.3%), family and buying (11.5%) in the study areas (Table8). The result is associated with that of Tessega (2009) who noted the sources of colony such as catching swarms, buying and gift from parents in his study areas. Challa (2010) also explained as the sources of colony in his study area were buying colony, buying and family, family and catching and from parents.

In all sampling areas, the majority of beekeepers place their hives in and around homestead details (Table8). This is because to help them follow up and supervise their colonies. For fewer colonies in forests, the fear of thief is also another reason in the study areas. The result is in line with the finding of Gidey (2011) and Challa (2010) that the placements of hives in their areas were mainly in back yard, under the roof of the house, inside the house and few in forests. According to the results of this survey, reasons for involvement of the farmers in beekeeping were for sale of honey (91.2%), for household consumption (6.3%) and for

cultural use (5.5%) in the study areas. This shows that the beekeepers mainly practice beekeeping for income generation.Tessega (2009) also noted that beekeepers practice beekeeping for income generation (50.4%), consumption (44.5%) and rearing (5.1%) in his study area.

Table 8. Source of colony, placement of hives and reasons of beekeeping (n=270)

Source of colony	%	Placement of hives	%	Reason of beekeeping	%
Family	3.3	Back yard	21.5	House hold consumption	6.3
Buying	5.2	Under the roof of the house	11.5	Cultural use	5.5
Family and buying	11.5	Inside the house	19.3	Sale	91.2
Swarming	18.1	In forest	3.3	-	-
Family and swarming	16.3	Back yard and inside house	10.7	-	-
Buying and swarming	40.4	Back yard, inside house, in forest	30.4	-	-
Buying and rearing	1.1	Inside and under roof	0.4	-	-
Family and dedebit	1.5	Back yard and under roof	0.4	-	-
Swarming, buying and rearing	1.5	Under roof and hanging near home	2.2	-	-
Swarming and rearing	1.1	Back yard and hanging near home	0.4	-	-
Total	100	Total	100	Total	100

n=number of respondents

4.2.3. Availability of beekeeping equipments in the study areas

Most of the interviewer was asked for availability of materials, (98.1 %) of them use homemade hives, 1.1% of them purchase hive from producers, and 76.3% of them from credit institutions (Table9). When the beekeepers were asked to list the equipments, they were able to mention them based on experiences and exposures to them. The equipments are the following: smokers, hives, water sprayer, bee brush, queen excluder, knife, honey container, cast molding and honey extractor. It was observed during the survey that, the respondents were not able to have accessories such as honey extractor and casting mold. These materials honey extractor (3-5) and casting mold (1) in number in each peasant associations were reserved in each FTC (farmer training center). This was because the materials are expensive

and to serve the entire frame hive adopters of the peasant associations discouraging the traditional beekeeping followers. Though the intention were to make the other beekeepers participate in modern beekeeping, it is not important to neglect the traditional beekeepers until they get exposure and convince themselves on the new technology. This result is in line with the result of Melaku (2008) that showed most beekeepers use traditional hives due to accessibility and ease of experience for the poor beekeepers. Challa (2010) also noted that beekeepers mostly use local hives as frame hives were costly in his study area.

Table 9. Availability of various beekeeping equipments (n=270)

Beekeeping equipments	Available (%)	Unavailable (%)
Hive home made	98.1	1.9
Hive purchased and locally made	1.1	98.9
Hives on credit	76.3	23.7
Smoker home made	96.3	3.7
Smoker purchased on credit	10	90
Water sprayer home made	85.9	14.1
Water sprayer purchased on credit	64.8	35.2
Queen catcher home made	84.1	15.9
Queen excluder purchased	73.3	26.7
Knife home made	93	7
Bees wax(pure)	76.3	24.7
Frame wire provided on credit	74.1	25.9
Uncapping fork purchased locally	62.2	37.8
Honey container home	98.5	1.5

n=number of respondents

4.2.4. Pigmentation and Behavior of bees (farmer perception)

Based on their indigenous knowledge, beekeepers have their own methods of categorizing their honeybees, mostly based on the color of the honeybees. Sample respondents were asked to describe local name and possession of their honeybee colonies .they described the honeybees of their area as Ambeleway and possess (34.8%) for mixed

color(Table10),Challa(2010) also noted that there were color variation in the bees in his study areas in which they were mostly black and yellow. Tselim and possess (31.1%) for black color, Keyih (4.8% for red color, Hamukushtay for grey color (0.7%), black and mixture possess (16.7%), black and red possess (11.9%) in the study areas.

Majority of the respondents characterized ambeleway less aggressive than Tselim and more productive than keyih and hamukushtay but similar in productivity with black. According to the survey, 75.2% of the respondents replied that their bees are medium in size, 10.7% medium and small, 9.3% small and 4.8% large the variation in size might be due to race difference of bees. According to Amsalu (2004), there are five bee races in Ethiopia. These are Apis melifera Jementica, Apis melifera monticola, Apis melifera bandasi, Apis melifera bandasi, Apis melifera scuttellata and Apis melifera woyi-gambela. Nuru (2002) indicated that Apis melifera jementica vary in color but mostly yellow having medium to small size variation.

Moreover, Apis melifera are found in the Northern high lands of Ethiopia having black color in most cases (Amsalu, 2004).Some areas might have inter and intra colonial variance due to introgression (Amsalu, 2004).Therefore, the races of the study areas might be Apis melifera jementica and Apis melifera monticola as they have medium to small size variation, aggressive behavior, monophasal swarming tendency and mixed to black color in most cases. The other color variations might be due to mating of drone to queen from other sources. The races of the study areas are in line with (Nuru, 2002), that the Apis melifera jementica are found in North West and North East of Ethiopia. The result is also in agreement with the finding of Amsalu (2004) who noted that Apis melifera are found in different agro ecology but mostly in the high lands of Ethiopia.

Table 10. Behavior of bees (farmer perception) in the study areas (n=270)

Color	%	Characteristics	%	Size	%	Productive	%
Mixed	34.8	Aggressive	67.3	Large	4.8	Mixed	47.8
Black	31.1	Very aggressive	17.4	Medium	75.2	Black	46.3
Red	4.8	Docile	12.3	Small	9.3	Red	5.2
Grey	0.7	-	-	Medium & small	10.7	Grey	0.7
Black & mixed	16.7	-	-	-	-	-	
Black & red	11.9	-	-	-	-	-	
Total	100	Total	100	Total	100	Total	100

n=number of respondents

4.2.5. Mean amount of honey produced from both traditional and frame hives per annum (Kg) for each area

The mean amount of honey produced from traditional hive per annum in Kolla-temben, Medebe-zana and Raya-azebo were 11.95, 17.94 and 7.57, respectively. There is significant difference at P<0.001.This variation might be due to variation in potentiality of bee forages, water and the level of management in each study areas (Table11). This result is in agreement with Gidey (2011) that productivity and overall production increases with the level of management, experience and area potentiality. According to Assefa (2009), the mean amount of honey produced from traditional per annum per hive was12.77kg in his study area.

Table 11. Mean amount of honey produced from traditional hive per kg per annum (n=270)

	Area category			Average
	Kolla-temben	Medebe-zana	Raya-azebo	
MAHPTPA	11.95^{b}	17.94^{a}	7.57^{c}	12.79
SE	0.648	0.712	0.348	0.452
P	***	***	***	

Rows having different superscript are significantly different at P<0.05, n=number of respondents4545t, MAHPTPA=Mean amount of honey produced from traditional per annum in kg, statistically significant at P<0.001(***), SE=Standard Error.

The mean amount of honey produced from frame hive in Kolla-temben, Medebe-zana and Raya-azebo were 27.64, 35.82 and 22.34kg, respectively (Table12). There was highly significant difference at P<0.001. This might be due to the difference in the level of management, potentiality, the exposure of beekeepers to the new technology (frame hive) and the nature of the technology at large. According to Assefa (2009) the honey production of frame hives might boost with level of management and potentiality in resources. He noted that the mean of honey produced from frame hive was 35.75kg in his study area.

Table 12. Mean amount of produced from frame hive per annum (kg)

		(n=270)	
Area category	MAHPFPA	SE	P
Kolla-temben	27.64^{b}	1.510	***
Medebe-zana	35.82^{a}	1.476	***
Raya-azebo	22.34^{c}	1.150	***
Total	28.79	0.865	

Column having different superscript are significantly different at P<0.05.MAHPFPA =Mean amount of honey produced from frame hive per annum in kg, statistically significant at P<0.001(***), n=number of respondents, ES=Standard Error.

4.2.6. Mean amount of honey produced per traditional and frame hives (Kg)

According to the survey result, the mean amount of honey from traditional and modern is 12.79 and 28.29kg per annum respectively (Table13). This shows that there is very highly significant difference in the honey yield of the two hives at (P<0.001). The result is in line with Gidey (2011) that the honey yield of traditional hive was significantly lower than frame hives. Similarly, Challa (2010) also explained that there was significant difference between traditional (7.2kg) and frame (23.72kg) hives in his study area. This variation in productivity in traditional and frame might be attributed due to the suitability of the frame hive for management (hive inspection, hive supering etc) and the highest emphasis given by governmental(TBoARD) and non governmental institutions(GIZ) in the study areas.

Table 13. Mean amount of honey produced from traditional and frame hives (kg) per annum

		(n=270)	
Types of hives	Mean	SE	P
Traditional	12.79[b]	0.452	***
Frame	28.79[a]	0.865	***
Total	20.79	0.659	

Column having different superscript are significantly different at P<0.05, statistically significant at P<0.001(***), n=number of respondents.

4.2.7. Mean amount of honey produced from both traditional and frame hives per annum among the three districts

The mean amount of honey produced per annum from different (traditional and frame) hives in Kolla-temben, Medebe-zana and Raya-azebo were 69.97, 82.22 and 83.47kg in the areas respectively. The study showed that Kolla-temben is significantly lower than the two other (Medebe-zana and Raya-azebo) study areas (Table14). This could be attributed to variation in the level of potentiality, management, ideality of the apiary sites together with the variation in the impact of the constraints, pests and chemicals in the study areas. According to Assefa(2009) the honey production per house hold per annum may increase with the level of management, with the potentiality of the area and with the type of technology(traditional/or frame) used. He also indicated as the mean amount of honey produced per house hold per annum was reached 98.89kg in his study area.

Table 14. Mean amount of honey produced from both traditional and frame hives (kg) per annum among the three districts

		(n=270)	
Area category	MAHPA	SE	P
Kola-temben	69.97[b]	2.952	*
Medebe-zana	82.22[a]	3.769	ns
Raya-azebo	83.47[a]	3.769	ns
Total	78.55	2.799	

Column having different superscript are significantly different at P<0.05.Mean amount of honey per annum in kg=MAHPA, Statistically significant at P<0.05(*), insignificant (ns) at p>0.05, n=number of respondents, ES=Standard Error.

Fig 2. Honey produced in the study areas

4.2.8. Number of honeybee colonies and trend of honey yield in traditional hives for the study areas

According to the survey result, the colony trend of traditional hive in Raya -azebo increased from 287 to 1543 from 2007 up to 2012. There is also colony increment in traditional hives from 759 to 1085 in Medebay- zana. Unlike the two districts, there is tremendous decrease of traditional colony numbers from 975 to 638 within 2007 to 2010 and slower increase (from 638 to 884) within 2010 to 2012 in Kolla- temben district (Fig2). This result showed that the number of traditional hive increased facing different challenges and constraints (bee forages, drought, water etc) together with the introduction of the new technology (frame hives) in the study areas. This is also in agreement with GIZ (2011) that the shift of traditional to modern hive in Tigray region reached 66 to 34% indicating that the promising introduction of the new technology. According to TBoARD (2011) the trend number of bee colonies increased from year to year facing different problems.

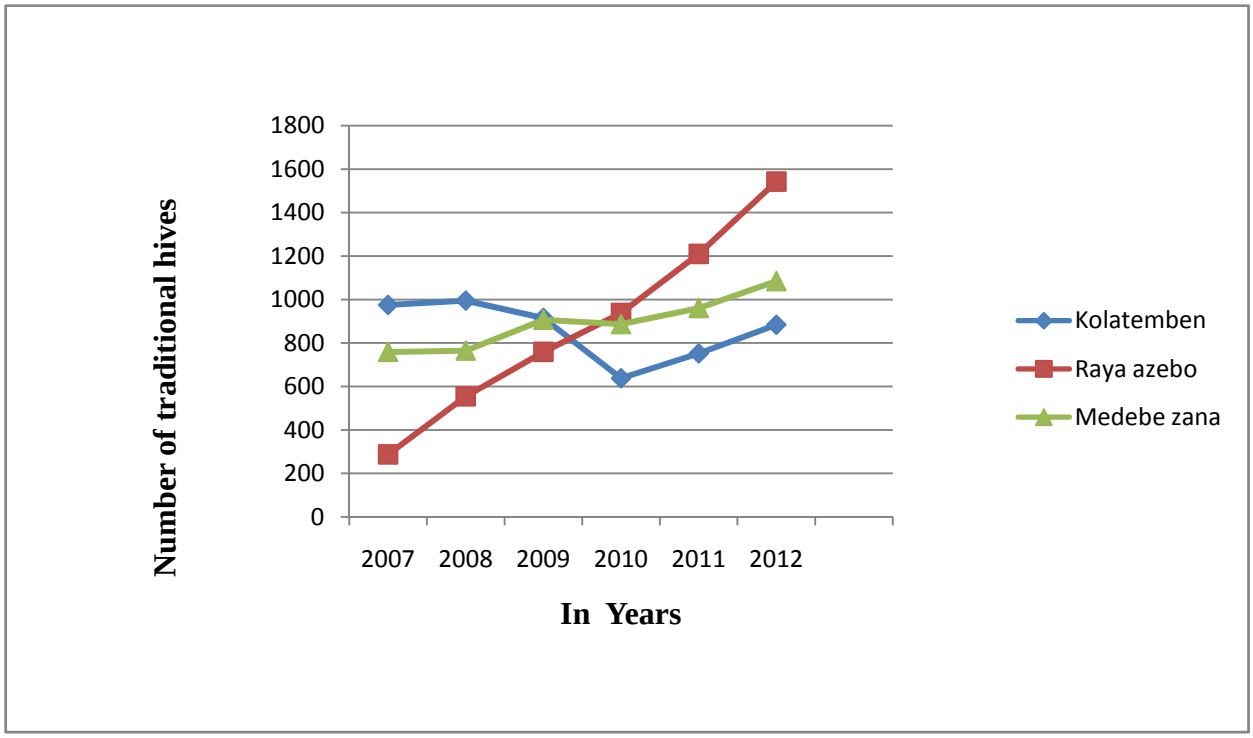

Figure 3. Number of bee colonies in traditional hives in the study sites.

According to the survey result, the honey yield trend of Medeb- zana increased from 9545kg to 19287kg in the year 2007-2012.But in Raya azebo there is slight increase in honey yield (7908kg to 11510kg) from 2007-2012 fiscal years. however, in Kolla -temben there is increase in honey yield from 6041 to 8623kg from 2007-2009 but there is also decrease from 2009-2010(8623kg to 5367kg.Morever, there is also increase from 2010-2012(5367kg to 9021kg).The result showed that the honey yield in traditional increased from 2007 to 2012 fiscal year facing different challenges and constraints for the optimum honey yield (Fig3) in the study areas. This result is in agreement with Challa (2010) that honey production trend was increased though there were many challenges and constraints to boost the honey production in his study area.

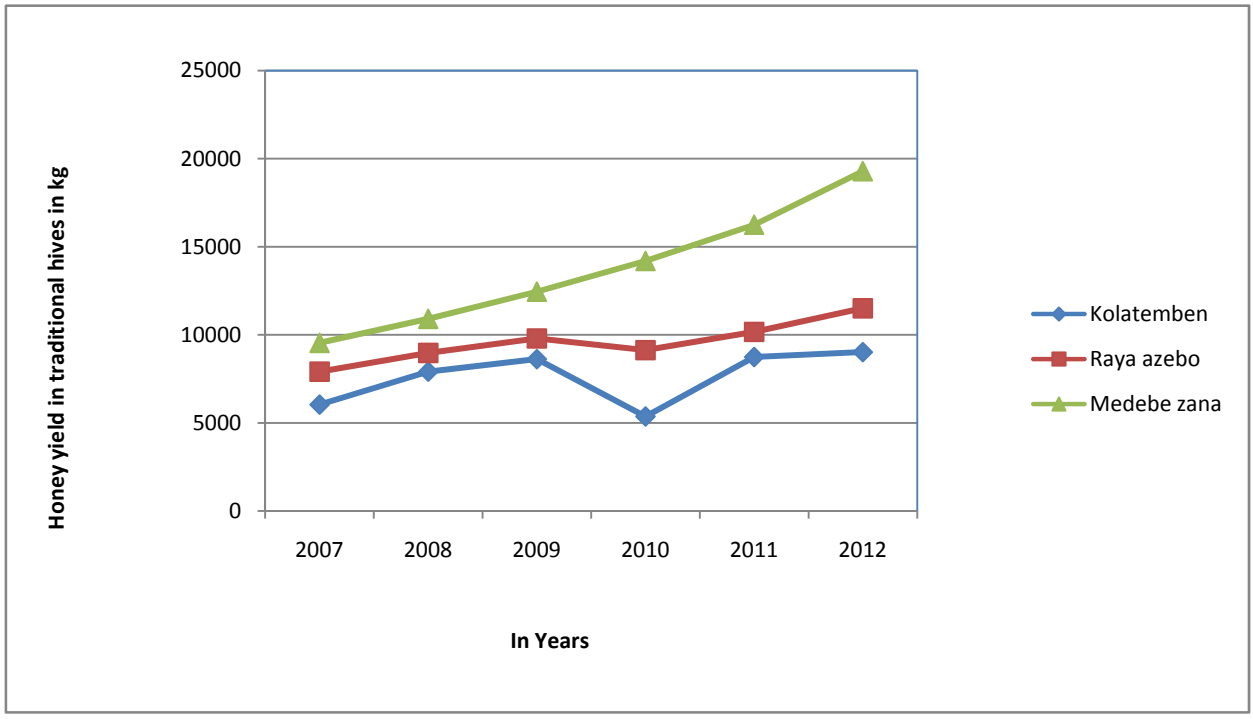

Figure 4. Trend of honey yield in traditional hives for the study sites

4.2.9. Number of honeybee colonies and trend of honey yield in frame hives for study sites

According to the survey result, the number of honey bee colonies in frame hives in Kolla - temben increased from 420 to 1087 from 2007 to 2012 fiscal year. There is tremendous increase from year to year in this district. Besides there is also increase in the number of colonies in frame hives in Medebe- zana .But there is variation in the rate of increment. The number of frame hives increase from 367 to 997 in the fiscal year 2007-2012.As far as the Raya- azebo is concerned, the number of frame hives increase from 287 to 982 in the fiscal year 2007 to 2012.This variation in the rate of increment of frame hives might be due to the variation in the level of adoption, level of awareness and difference in the attention given to the off farm activities as compared to on farm activities including beekeeping (Fig4). This

result is in line with Assefa (2009) that there is high introduction rate of the frame hives from year to year in his study areas. Moreover, Assefa (2009) indicated that the beekeeping was not fully exploited though the farm land was fragile in his study areas. Hence, it can be justified as more awareness creation, training, experience sharing and demonstration of the beekeeping activities by taking pilot practicing areas for the beekeepers. Though the government provided farmers training center (FTC), in most case they are not better than the indigenous beekeepers in many cases and few or nothing can be learned by farmers from them. So, beekeepers in the study areas need the right training center to do the right practical oriented work so that acceptance level the new technology would be able to go in advance.

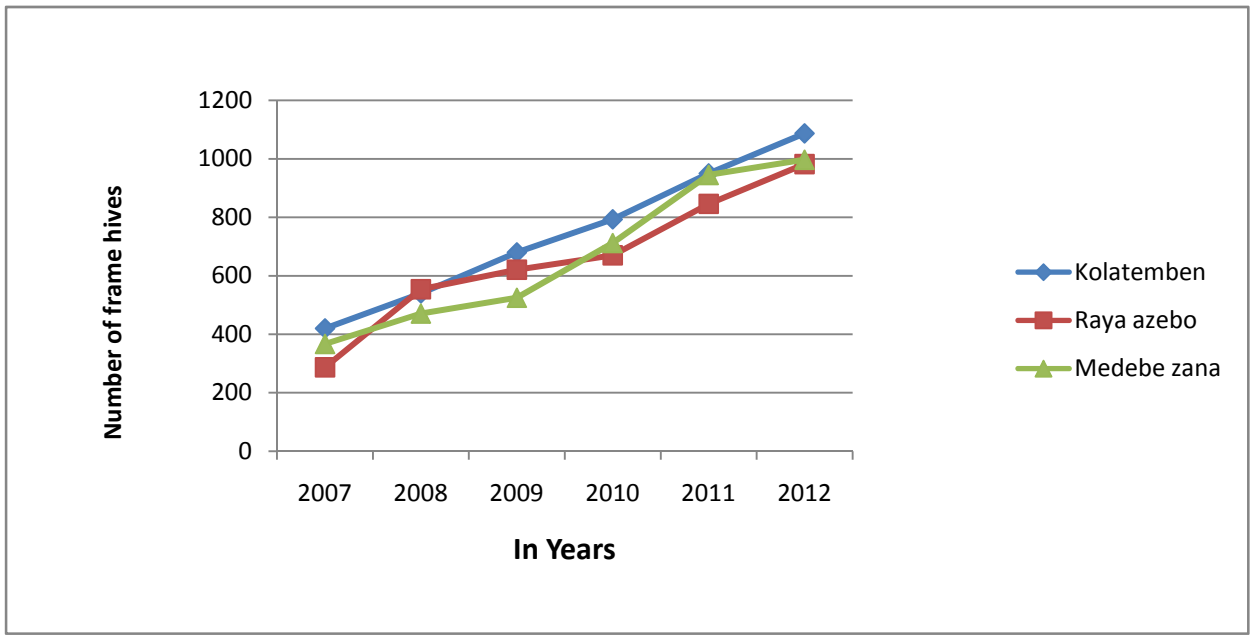

Figure 5. Trend frame hives number in the study sites

According to the survey result, the trend of honey yield from frame hive increased (10500 to 25922kg) from 2007 to 2012 fiscal year in Kolla -temben at faster rate. Besides, in Medebe-zana, the increase in honey yield is increasing (6973 to 16128kg) from year to year though the increasing rate varies. Moreover, in Raya-azebo the rate of honey yield is increasing but not as fast as Kolla-temben and Medebe-zana due to identified reasons**.** These might be due to

variation in the amount of income they obtained from off farm and on farm (majority of Kolla- temben is hilly area but the two are comparatively plain suitable for farming) activities in addition to the challenges and constraints of beekeeping in the study areas. The rate honey yield generally shows increasing from time to time (fig5) .This might be due to technology adoption, exposure and experience of the new technology, land rehabilitation, existence of bee forage plants and water availability in the sites of the study areas. This shows that the beekeeper farmers in Medebe-zana and Raya-azebo perceive the beekeeping activity as side line business giving emphasis for the on farm activities.But,in Kolla-temben the beekeeping farmers perceive beekeeping as partially full business as their land is scarce ,hilly and fragile for on farm activities.thi result is in agreement with Nuru(2002) and Tessega(2009)that the honey yield of frame might boost to 50 to 60kg resulting in high yield depending on the level of management ,potentiality of the area, ideality of the apiary sites for beekeeping. Moreover, TBoARD (2011) explained that the trend of honey yield increased from year to year facing different problems.

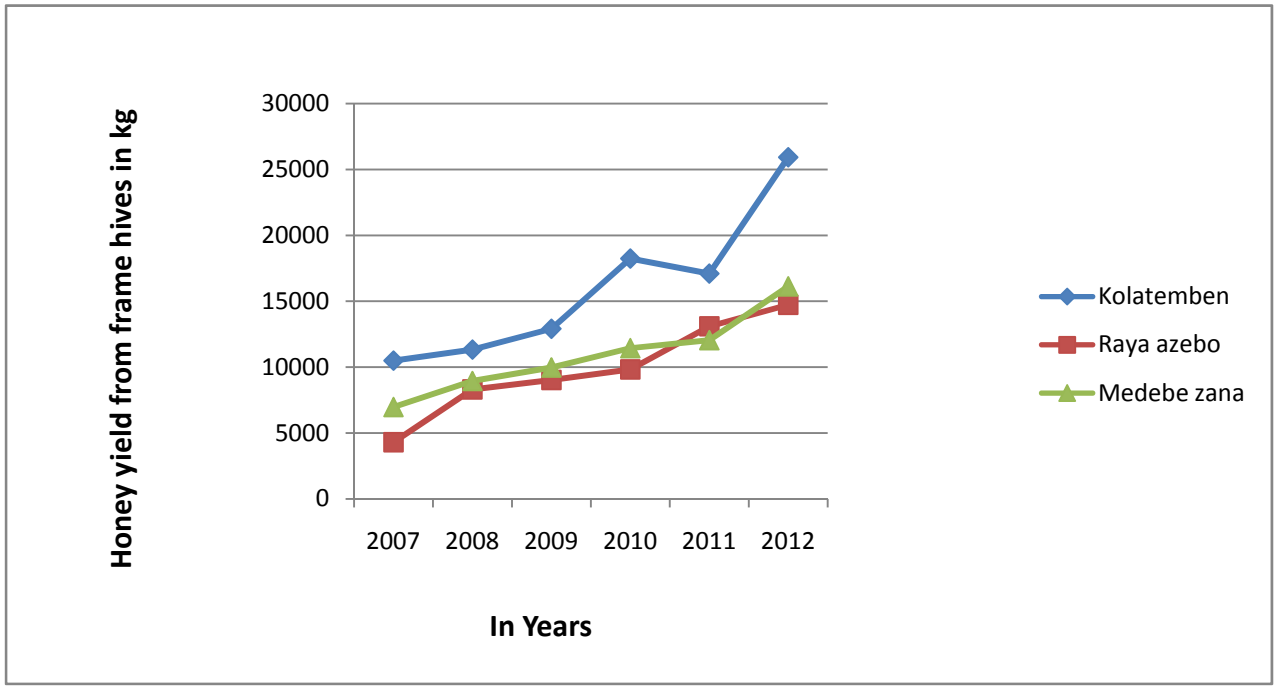

Figure 6. Trend honey yield in frame hives in the study sites

4.3. Mean Cost (ETB) of Honey from Both Traditional and Frame Hives per Kg for Different Colors for Each Area

The mean cost of white honey per kg in traditional hive was 68.60, 64.50 and 65.63 ETB in Kolla-temben, Medebe-zana and Raya-azebo, respectively. However, the mean cost of red honey from traditional hive per kg in traditional was 32.38, 32.24 and 38.11 ETB in the areas. The total mean cost for white honey, yellow honey, red honey, brown honey, and mixed honey were 66.39, 47.75, 33.80, 38.93 and 42.18 ETB, consecutively. The overall mean price of honey from traditional hive was 45.810 ETB for all honey colors. The survey result showed that the mean price of white honey was higher than any other honey color types in traditional hive. There was significant difference ($p<0.001$) in the price of different honey colors among the study areas (Table15).Tessega (2009) explained the mean price of yellow honey (19.16 ETB) was higher than the mean price of white honey (17.80 ETB).Nevertheless, the result disagrees with the findings of Tessega (2009) that mean price of white honey was higher than yellow honey in the study areas.However,the result is in line with the finding of Assefa(2009) that butter-type white honey has the highest price than any other honey color types in his study area.

Table 15. Mean cost (ETB) of honey from traditional hives per kg for different colors (n=270)

Woreda	MCHFTPK						
	WH	YH	RH	BH	MH	SE	P
Kola-temben	68.60^{a}	51.84^{a}	32.38^{b}	38.75^{b}	41.52^{b}	0.575	***
Medebe-zana	64.50^{b}	41.00^{c}	32.24^{b}	37.16^{c}	41.12^{b}	0.438	***
Raya-azebo	65.63^{b}	48.95^{b}	38.11^{a}	40.54^{a}	44.23^{a}	0.643	***
Total	66.39	47.75	33.80	38.93	42.18	0.384	
Over all(H)					45.810	0.077	***

Column having different superscript are significantly different at $P<0.05$. Mean cost of honey from traditional per annum per kg= MCHFTPK, H=Total mean cost of honey horizontal summation for different colors, n=number of respondents, WH=White Honey, YH=Yellow Honey, RD=Red Honey, BH=Brown Honey, MH=Mixed Honey, statistically significant at $P<0.001$, ES=Standard Error.

The mean cost of white honey per kg in frame hive was 76.62, 74.24 and 75.46 ETB in Kolla-temben, Medebe-zana and Raya-azebo, respectively. However, the mean cost of red honey from frame hive per kg in frame hive was 35.01, 38.29 and 40.68 ETB in the areas. The total mean cost for white honey, yellow honey, red honey, brown honey, and mixed honey were

76.39, 57.38, 38.13, 40.95 and 45.77 ETB consecutively (Table14). The overall mean price of honey from frame hive was 51.724 ETB for all honey colors. The survey result showed that the mean price of white honey was higher than any other honey color types in frame hive. There was significant difference ($p<0.001$) in the price of different honey colors among the study areas (Table16).The result is in line with the finding of Workneh (2007) and Gidey (2011) that white honey has higher price than other honey color types in their study areas. Assefa (2009) also indicated that white honey has the highest price due to high demand by consumers.

Table 16. Mean cost of honey (ETB) from frame hives per kg for different colors (n=270)

Woreda	MCHFFPK						
	WH	YH	RH	BH	MH	SE	P
Kola-temben	79.62^{a}	62.56^{a}	35.01^{c}	38.17^{b}	43.45^{b}	646	***
Medebe-zana	74.24^{b}	53.66^{b}	38.29^{b}	39.87^{b}	45.80^{a}	0.803	***
Raya-azebo	75.46^{b}	55.09^{b}	40.68^{a}	43.47^{a}	47.23^{a}	0.588	***
Total	76.39	57.38	38.13	40.95	45.77	0.434	
Overall(H)					51.724	0.087	***

Column having different superscript are significantly different at $P<0.05$. Mean cost of honey from frame hives per annum per kg= MCHFTPK, H=Total mean cost of honey horizontal summation for different colors, n=number of respondents, WH=White Honey, YH=Yellow Honey, RD=Red Honey, BH=Brown Honey, MH=Mixed Honey, (***) statistically significant at $P<0.001$, ES=Standard Error.

4.4. Mean Amount of Income from Each Study Areas

The mean amount of income in Kolla-temben,Medebe-zana and Raya-azebo were 3268.61,4359.56 and 4937.22 respectively(Table17).The variation in income might be due to variation in the number of honey beneficiaries, amount of honey produced, the color of honey and the management level of producers in the study areas. This result is in line with Workneh (2007) that mean amount of income varies with the amount of honey harvested, the honey marketing condition, with costumer's demand of honey and the color of the honey.Meaza (2011) also noted the income from honey may increase with the potentiality, management level, demand and supply of honey in her study area.

Table 17. Mean amount of income (ETB) from honey by selling per annum (n=270)

Area category	MIHFSPA	SE	P
Kolla-temben	3268.61[b]	171.471	***
Medebe-zana	4359.56[a]	257.987	***
Raya-azebo	4937.22[a]	467.222	***
Total	4188.46	190.885	

Column having different superscript are significantly different at P<0.05. MIHFSPA=Mean amount of income (ETB) from honey by selling per annum, (***) statistically significant at P<0.001, n=number of respondents, ES=Standard Error.

4.5. Forecasting Demand of Honey for the Study Areas

The result in (appendix3) showed the regression equation for the honey price demand become=19.7375+8.417T.This honey price trend justifies for the study areas as for each additional unit of time, the demand of honey price of will change positively by 8.417 for the coming years. This is in line with Zekarias (2010) that trend of a given product can be forecasted using least square method for the coming years.Yemane (2011) explained that estimation of the future demand of a given product (honey, resin) on the basis of the past and present demand data, helps to producers to decide producers and hence how much input to use so as to get maximum profit without wasting the input and the outputs.Zekarias (2010) also indicated that forecasting can be done in different ways. But one of the most commonly used techniques is least square method.

Table 18. Forecasting demand of honey for the areas

Year	T	Y	TY	T^2
2007	0	22.67	0	0
2008	1	28.3	28.3	1
2009	2	34.56	69.12	4
2010	3	40.3	120.9	9
2011	4	53.62	214.48	16
2012	5	65.24	326.2	25
Σ	15	244.69	759	55

T=consecutive time series in year, Y= consecutive mean price demand of the study areas, TY=the product of time series and mean price demand of honey for the study areas, T^2=Time square in year,

4.6. Market Structure/Marketing Channel

In the study areas, different honey marketing participants were identified. Honey marketing participants in the study areas includes producers/farmers, honey collectors/assemblers, wholesalers, Tej houses, retailers and final consumers of the product.

Producers: Producers/farmers sell their honey to different buyers at village or district market center. The market place that is the closest to the residence of the producer is the first choice with regard to minimization of costs and to perform other on and of farm activities.

Honey collector: The honey collectors found in the study areas buy the honey produce directly from farmers in a small village markets for resell to other collectors, wholesalers, retailers, and consumers who come from various areas of the region in the district's market center (Challa, 2010).

Wholesalers: These collect honey from producers and honey collectors there by selling honey in large amount to others such as to retailers, Tej houses in and out of the study areas within the region. The wholesalers in the study areas are two types. the licensed wholesalers having license of honey trading and the unlicensed wholesalers in honey trading but having license of other commodities(sugar selling, cosmetic selling etc)using as marginal trading material in the study areas.

Retailers: These are the actors in the chain and who sell honey to consumers in small units. These are also the link in the channel that delivered honey to consumers. The majority of honey retailers found at the areas have their own small stores and retail shops. There are also retailers that sell honey storing in their residence (Zekarias, 2010).

Tej- houses: These buy honey mostly from honey collectors, wholesalers and producers**.**
These are also the link in the channel that delivered Tej and/or honey to consumers.

Consumers: From the consumers' point of view, the shorter the marketing chain, the more likely is the retail price going to be affordable. Consumers for this particular study mean those households who purchased and consume honey. They are individual households who are buying the commodity for their own consumption.

According to Mendoza (1995 and Challa, 2010), marketing channel is the sequence through which the whole of honey passes from producers to consumers. The analysis of marketing channel is vital to see the flow of the goods and services from produce to consumer. Therefore, during the survey, the following honey marketing channels were observed.

Moreover, the analysis of marketing chain is also important to see the marketing margin to decide the efficiency of the marketing system there by comparing the share of consumers price among the marketing channel participants to decide who is going to proceed, who is going to eliminated, who is going to controlled and who is going to be appreciated in the marketing system.

I. Producer - consumers (41.1%)

II. Producer - honey collectors- consumers (8.5%)

III. Producer - retailers- consumers (4.1%)

IV. Producer - honey collectors'- retailers'- consumers (5.6 %)

V. producer – honey collector – Tej houses – consumers (4.1%)

VI. Producer - Tej houses – consumers (22.6%)

VII. Producer-wholesaler-consumer (6.7%)

VIII. Producer-wholesaler-retailer-consumer (3.2%)

IX. Producer-wholesaler-Tej house-consumer (1.5%)

X. Producer-honey collectors-wholesalers-Tej house-consumer (2.6%)

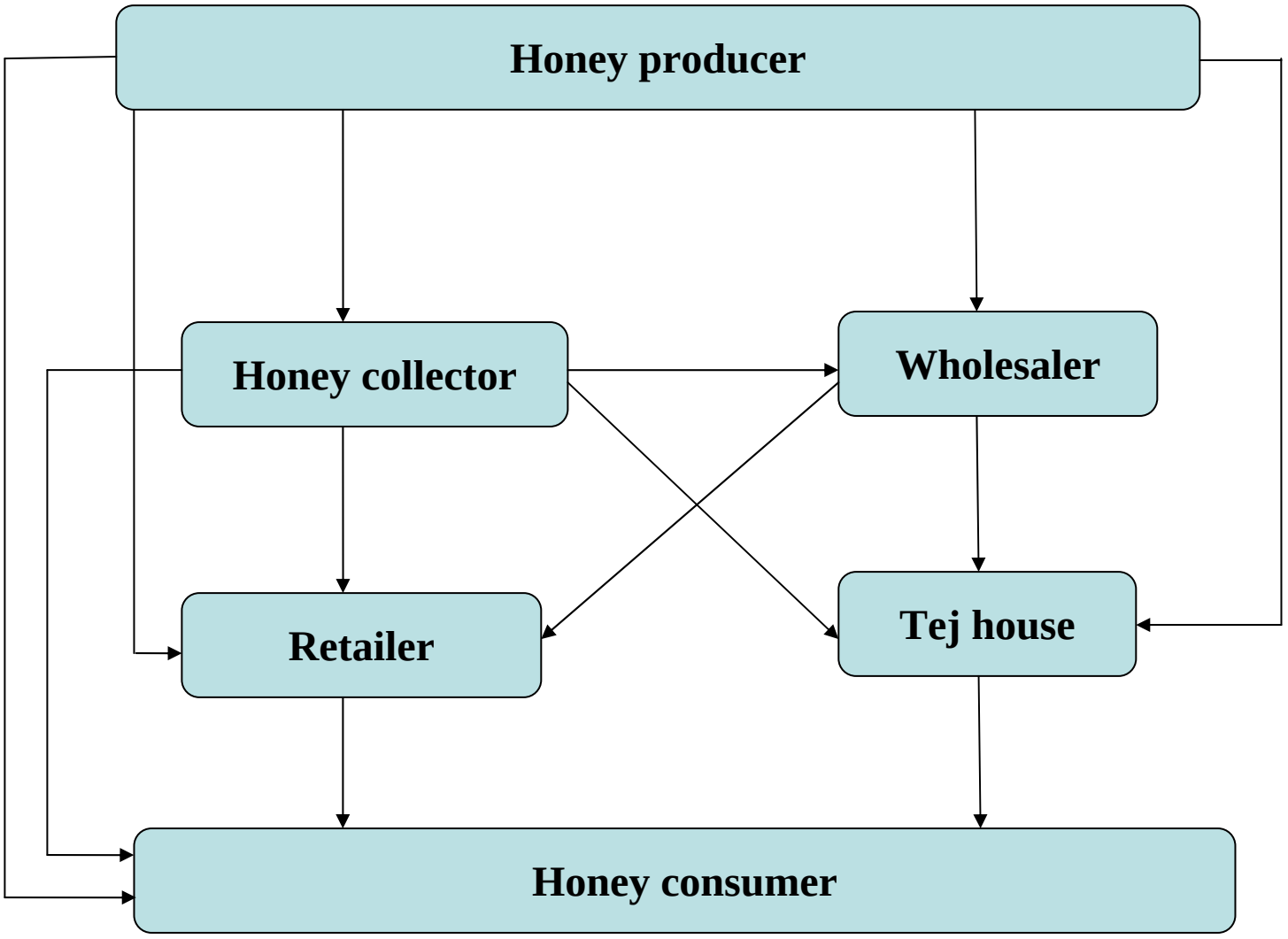

Figure 7. Marketing channels of the study areas

4.7. Margin Analysis for the Market Chain Participants in the Study Areas

According to the survey result, from the price paid by consumers (87.50 ETB) the share of benefit for retailer, wholesaler and honey collector is 6%, 40% and 14%, respectively (Table19). While the gross marketing of the producers are 40%.This shows that the majority of benefit is shared among the retailers, wholesalers and honey collectors though the producers are expected the first to be benefited from the marketing chain. This indicates that the marketing chain is inefficient due to presence of unproductive market participants. The

unproductive market participants are the wholesalers in general but the wholesalers who are unlicensed, licensed for other commodities but selling honey in their home/shop as marginal commodity take the majority for the inefficiency of the marketing channel in the study areas. This might be due to poor honey marketing system which includes even traders which do not have know how on how to store, handle and transport honey. Hence, there should be a means for improvement of the marketing system of the study areas by responsible stalk holders. This result is in line with Yamane (2011) that the marketing system of his study area was poor discouraging the producers for expansion of their overall production.

Table 19. Market chain participants and their selling price in kg in the study area (n=270)

Chain Participants selling in kg	Selling price of in ETB
Producers' price	35(A)
Honey collectors' price	47.5(B)
Wholesalers' price	82.4(C)
Retailers' price	87.5(D)
Consumers' price	-

Consumer price=Purchasing price of consumer (87.50 ETB) =E

4.8. Beekeeping Activities and Responses for Each of the Study Areas

According to the respondents of each study areas, there was no significant difference for colony absconding and for profitability of beekeepining.This shows that all the study areas are profitable and there were no areas without absconding behavior. But there was significant difference for the other beekeeping activities in the study areas (Table20).This result is in agreement with Tessega (2009) that there was no area without absconding and the area was profitable in case of beekeeping in his study.Challa (2010) also explained that there was absconding and the area has potentiality for profitable beekeeping to boost honey production.

Table 20. Beekeeping activities and responses for each of the study areas (n=270)

Beekeeping activities	Kolla-temben		Medebe-zana		Raya-azebo		X^2	P
	Yes	No	Yes	No	Yes	No		
PLEP	81	19	97	3	94	6	182.533	***
BFL	83	17	98	2	90	10	206.281	***
CFOP	91	9	100	0	90	10	206.281	***
CCS	90	10	100	0	90	10	202.800	***
BCFL	29	71	48	52	96	4	6.533	***
POEH	22	78	6	94	32	68	97.200	***
COLAB	62	38	50	50	60	40	5.926	ns
CHAP	89	11	100	0	94	6	213.333	***
ECHBE	89	11	100	0	88	12	215.207	***
WATB	93	7	100	0	100	0	246.533	***
SWACE	100	0	100	0	50	50	120.000	***
FSBEES	89	11	98	2	73	27	148.148	***
HONST	10	90	78	22	41	59	5.089	***
PROBK	99	1	100	0	100	0	266.015	ns
BEPAR	86	14	99	1	94	6	199.348	***
ACCT	83	17	79	21	34	66	26.133	***
NEDFT	46	54	67	33	64	36	10.881	***

PLEP= Participation in livestock extension package, BFL= Benefit from livestock extension package, CFOP= Credit for farm operation, CCS=currently credit service, BCFL= Buying colony from locality, POEH= Possession of empty hives, COLAB= Colony absconding, CHAP= Chemical application, ECHBE= Effect of chemicals for bees, WATB= Water availability for bees, SWACE= Swarm catching experience, FSBEES= Feed supplementing of bees, HONST= Honey straining, PROBK= Profitability of beekeeping, BEPAR= Beekeeping extension participation, ACCT= Access to training, NEDFT=Need for training, (***) statistically significant at $P<0.001$, insignificant (ns) at $p>0.05$,n=number of respondents.

4.9. Indigenous Knowledge of Beekeeping

In the study areas, the producers have rich experience on the beekeeping practice and management. According to the interviewee, the indigenous know ledges used by beekeepers were swarm controlling, bee sting minimization, identification of adulterated honey (Table21) in the study areas. This study is in agreement with Tessega (2009) that beekeepers exposed to various experiences such as quality identification, sting minimization and swarm controlling mechanism in his study areas.

Table 21. Indigenous knowledge of the respondents in the areas

	(n=270)
Descriptions	Indigenous knowledge
Swarming	Brushing and rubbing the hives using plant materials(tsomer,awli,sesseg),fumigation, increase hive volume and remove queen cells, hive plastering using wax and dung,
Bee sting protection	Wear protective materials, Naked body, avoid bee disturbance, No running, No hitting the bee, Jump in to water source in case of danger,smoking,spray water
Sting pain minimization	painting using honey, soil rubbing, remove the stinger from skin
Bee colony strengthen	Supplementary feeding, uniting weak colony, spray chemical at night, manual weeding, leave honey inside hive
Bee product as medicine	Coughing treatment mixed with flour and boiled, honey mixed with unknown plants for the majority but known by few
Quality honey	Visual observation, tasting, No cutting while droping,spray cocka,honey source area identification(area of gesho bitter taste),smearing on the hand for granules
Bee problem identification	Unusual buzz of bees, not able the bees to fly, crowding the bees around the entrance, decrease size of colony
Making local hives	Construct from lighter tree plants such as Hasti ,kolkual ,from mud by fermenting and mixing with grasses, straw

4.10. Constraints and Opportunities in Beekeeping Development

Though there are many constraints, there are also many opportunities to increase the productivity and overall production of beekeeping in the study areas as discussed bellow;

4.10.1. Constraints to beekeeping in the study areas

Based on the result of this study, beekeepers have encountered with a number of difficulties and constraints that are hindering with the success desired in honey production. Major problems in beekeeping arise from bee characteristics or environmental factors that are beyond the control of the beekeepers, while others have to do with poor marketing infrastructure and storage facilities. After having identified the major problems facing the beekeeping activities, farmers were requested to list their priority in order of importance. According to the response of the beekeepers and available information the major constraints of the beekeepers, other than unpleasant nature of bees and technical shortcomings, are listed in (Table22) the study areas. This has lead to poor honey production and inefficient utilization of the modern bee hives distributed. Because of lack of knowledge on application of chemicals against ants such barnos (Dore) which cause to spray chemicals through campaign, some farmers complained their bee hives are being affected. There is high marketing problem for honey producers and due to improper marketing system they even knock doors saying “do you need honey?” in the peak production season though they incur many cost to produce the honey. This result agrees with the result with Challa (2010) and Tessega (2009) except rank difference in the study areas.

Table 22. Major constraints of beekeeping in the study areas (n=270)

Constraints	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Rank
Beehives	-	3.6	6	6	15.5	4.8	8.3	11.8	8.3	25	3.6	-	-	-	-	-	-	7.1	13
Equipments	5.9	2.7	15.9	15.5	24.1	8.6	10	7.3	5.9	1.8	1.4		-	-	-	-	-	0.9	14
Bee colony	18.9	6.7	10	11.1	15.6	10	8.9	5.6	5.6	3.3	3.3	-	1.1	-	-	-	-	-	17
Bee forage	10	11.4	10.9	8.5	23.9	19.9	9.5	-	0.5	2.5	0.5	-	-	-	2.5	-	-	-	16
Water	-	1.3	8	5.3	10.7	16.7	37.3	6	4	6.7	-	2	-	-	2	-	-	-	5
Drought	36.3	24.1	19.6	16.3	0.4	1.9	-	0.4	-	-	-	1.1	-	-	-	-	-	-	6
Absconding	9.6	15.7	18.7	32.3	11.6	6.1	1.5	1	2	0.5	0.5	0.5	-	-	-	-	-	-	10
Pests and predator	35.2	33.3	11.2	9	5.6	3.4	0.7	0.7	-	-	-	0.7	-	-	-	-	-	-	7
Disease	-	11.1	-	-	-	-	-	5.6	16.7	-	11.1	5.6	-	22.2	-	27.8	-	-	11
High temperature	-	25	-	-	35	10	5	-	-	-		5	10	10	-	-	-	-	8
High wind	-	16.3	6.7	3.8	16.3	4.8	11.5	26.9	7.7	1	1	-	1.9	-	-	-	1.9		12
High rain	-	-	-	3.8	3.8	5.7	7.5	15.1	39.6	7.5	-	5.7	1.9	-	-	-	7.5	1.9	3
Chemical spray	2.4	5.9	22	19.7	17.7	11	13.8	3.5	3.9	-	-	-	-	-	-	-	-	-	15
Death of colony	-	-	-	-	-	33.3	-	16.7	-	-	8.3	-	-	-	16.7	-	-	25	9
Migration	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Swarming	-	-	19	-	-	-	42.9	4.8	-	-	-	-	4.8	14.3	-	9.5	4.8	-	2
Storage facilities	-	-	-	-	-	7.7	7.7	15.4	-	-	-	-	-	38.5	15.4	7.7	-	7.7	4
Marketing	-	-	9.1	13.6	4.5	9.1	-	45.5	13.6	-	-	-	-	4.5	-	-	-	-	1

4.10.2. Pests and predators of the areas

Based on the result of this study, the existence of pests was a major problem to the honeybees and beekeepers. After having identified the major pests facing the beekeeping activities, farmers were requested to rank them and the result indicated that wax moth *(Galleria mellonella,),honey badger(Mellivora capensis)*, ants, bee eater birds, monkey, lizard, spider, prey mantis, bee lice (*Braula coecal),* beetles (*Aethina tumida*),wasps and snake were the most harmful pests in order of decreasing importance. Challa (2010) ranked ant s (as first), wax smoth (as second), honey badger (as third) and this shows the pests and predators are in one way or another playing role in decreasing number of colonies and honey yield. As there is poor inspection, the hives have bad smell and the producers assume as if the bees were diseased .Though the real cause needs deep research if diseases causing or others were cause for bad smelling and wetting of the hive it can be presumed as if the cause were wax moth as it were the most prevailing pest ranked by bee producing farmers of the study areas (Table23).

Table 23. Pests and predators (n=270)

Major pests and predators	1	2	3	4	5	6	7	8	9	10	11	12	Rank
Ants	41	42.2*	10.4	5.2	1.1	-	-	-	-	-	-	-	3
Wax moth	51.8*	18.4	20	5.1	3.9	0.8	-	-	-	-	-	-	1
Bee lice	3.6	11.4	21.8	15	16.1	28.5*	3.1	-	-	-	0.5	-	9
Beetles	-	3	15.2	27.5*	27.1	18.2	9.1	-	-	-	-	-	10
Spiders	1.3	14.6	16.5	8.9	29.1*	12	14.6	1.9	1.3	-	-	-	7
Wasps	-	3.8	-	-	15.4	7.7	23.1*	23	11.5	15.4	-	-	11
Prey mantis	-	15.2	10.1	29*	22.8	17.7	3.8	1.3	-	-	-	-	8
Lizard	0.6	-	7.2	16.8	31.7*	10.2	25.7	6	1.8	-	-	-	6
Snake	-	1.2	2.9	10.5	19.1*	3.8	11.4	4.1	12.8	10.6	15.3	18.2	12
Monkey	-	-	9	29.5	32.1*	20.5	5.1	3.8	-	-	-	-	5
Bee eater Birds	7.3	8.1	16.2	37.7*	15	15.2	-	-	0.6	-	-	-	4
Honey badger	1.7	16.7	46.7*	15.9	5	6.7	6.6		0.8				2

Figure 6. Prevalence of Wax moth in the study areas

4.10.3. Major honey bee enemies and control measures (farmers perception)

The survey result showed that beekeepers underway control measures for the honey bee enemies based on experiences and their indigenous knoweledge(Table24).Tessega (2009) and Challa(2010) explained that beekeepers control or minimize the effect of pests and predators using their rich experience and exposure in their study areas.

Table 24. Major honey bee enemies and control measures (farmers perception)

	(n=270)
Pests and predator	
Wax moth	Clean, Disupering and strong colony
Honey badger	Keeping, Having dogs around, fencing and Tying hives using rope
Ants	Fresh ash,oil,use water in the foot of hives ,brush using white soil and fumigation inside hives
Bee eater birds	Use wonchif, use stone and make elders to keep apiary
Monkey	Guarding turn by turn, make shelter and fencing and make follow the shepherds
Lizard	Fumigation inside hives, keeping and killing
Spiders	Web cleaning, make clean the hives and inspection
Prey mantis	Clean the apiary and follow up of the hives
Bee lice	Fumigation, make large hives to avoid suffocation
Beetles	Narrow the entrance of hives using cover steel,cleaning,pick using hand and also kill
Wasps	Cleaning the apiary, Kill in their sources
Snake	Killing and keeping, put artificial man around the apiary

4.10.4. Suspected poisonous plants

During this survey, beekeepers were interviewed if they know poisonous plants in their localities. The experienced beekeepers listed few poisonous plants. These can be plants whose nectar or pollen is toxic to the bees themselves, and those in which the honey produced from their nectar are toxic to humans. Fortunately, there are relatively few such plants reported in the study areas .Similarly Challa (2010) reported some poisonous bee plants in his study area. The plants that are suspected to be toxic to bees and humans include"Nim"(Azadirachtaindica),"Kotsliaslamay","mestenager","Eka","Kebkeb"Gindae" and Shilean in the study areas (Table25). Experienced bee keepers explained that the bees become unconscious and show the act of drunker by rotating around the poisonous plants.

This might be due to the presence of anti-nutritional factors in these plants. But for full evidence farther research should be done on these species to see their importance for bee and human health at large.

Table 25. Some lists of poisonous plants in the areas

Scientific name	Vernacular or common name	Flowering period
Azadirchta indica	Nim/min	September to October
Unidentified	Katsliaslamay	August to November
Unidentified	Mestenagir	October to November
Agave Americana L.	eka	October November
Unidentified	Kebkeb	yearly
Unidentified	Gindae	January to February
Unidentified	Shilean	June to August
Unidentified	Kotslitalian	November to January

4.10.5. Major opportunities for beekeeping development

According to the respondents, the major opportunities for bee keeping in the study areas include existence and abundance of honeybee, availability of potential flowering plants, availability of water sources for bees, beekeepers' experience and practices, land rehabilitation, credit availability, emphasis for irrigation by government, increase honey demand from year to year, increase in productivity and overall production , marketing situation of bee products, the honey of the areas have good feed back by consumers, there is indigenous knowledge for beekeeping, training availability, the presence of governmental and non- governmental organizations(GIZ) who are involved partially in beekeeping activities.

Vegetation characteristics of the study areas are considered to be an important indicator for potentialities of the area for beekeeping. According to the results of this survey, the honeybee plants of the study area comprise trees, shrubs, herbs and cultivated crops which are a source of nectar and pollen. Some important honeybee plants of the study areas were recorded in vernacular (common) and scientific names with their flowering periods. Beekeeping is more dependable on ecological suitability of an area than any other livestock production (Nuru, 2002). He also noted that, the honeybee population and their productivities in general are

mainly influenced by the nature of honeybee flora of an area. The resources supplied by plants are important sources of nectar, pollen and Propolis, some are also important for hive construction while others used in local procedures for scenting new hives to attract swarms.

The honeybee flora compositions of the study areas are perennial crops (mango, papaya), annual herbs, and some natural trees having significant contribution for beekeeping. This variation in vegetation characteristics of the areas could be potentially suitable for effective distribution of honey production. This result was in agreement with Challa (2010) and Alemtsehay (2011) showing presence of perennial crops, herbs and natural trees (Table26) in the study areas.

Table 26. List of some major honey bee floras of the areas

A/Trees

Scientific Name	Vernacular or common name	Flowering period
Acacia etbica	Seraw	March to may
Asystasi gangena	Girbia	September to December
Spina christy	Gaba	June to August
Accia chsiberina	Chea	March to June
Accacia albid	Mommona	March to June
Echinops hispidus	Dender	October to February
Cordia africana	Awhi	October to December
Leucas abyssinica	Shiwakerni	September to January
Euphorbia candelabrum	Kolkual	September to December
Accacia lahay	Lahay	April to July
Becium grandifolum	Tebeb	September
Syzgium paniculatum	Liham	February to April
Croton macrostachys	Tambuk	May to June
Euclea schimperi	Kilio	March to May
Aloe berhana	Ire	November to March
Ocimum Basilicum	Sesseg	September to November
Plectranthus punctus	Meseguh	September to August
Bides panchyloma	Gelgellemeskel	September to December
Parkonsomia	Shewithagay	September to June
Eucalyptus camaldulensis	Bahrizaf/Kalamintos	March to July
Shinus molle	Tikurberbere	May to July
Carica papaya	Papaya	December to February
Mangifra indica	Mango	September to December
Citrus sinsis	Orange	September to December
Optinia ficus indica	Belles	February to April
Carissa edulis	Egam	March to May
Agave Americana L.	Eka	October November
unidentified	Hosti	September to December

B/Shrubs and Herbs

Scientific Name	Vernacular or common name	Flowering period
Trigonella foenu graecum	Messi	September to January
Pterolobium stellatum	Kenteftefe	October to December
Rumex nervosus	Hohot/hakot	September toDecember
Brasilca carinata	Hamli	September to October
Hyposte forskoli	Saeri	September to December
Achyranthes spea	Muchello	September to November
Unidentified	Titibo/Awon	All year round

C/Field crops

Scientific name	Vernacular or common name	Flowering period
Zea Mays	Maize/mishela bahri /efun	September to October
Rhmnus prinoides	Gesho	March to June
Coffee Arabica	Coffee/buna	September to November
Teff ergoistatis	Teff	September October
Sorghum dicor	Sorghum	September to November

5. SUMMARY, CONCLUSION AND RECOMMENDATION

The study was conducted in three selected woredas of Tigray region to assess honey production and marketing systems with the following summary, conclusion and recommendations.

5.1. Summary and Conclusion

The study was conducted in Raya-azebo, Kolla-temben and Medebe-zana woredas. In these study areas, Three peasant associations (PAs) each woreda, 30 respondents each PA, 3*3*30 and a total of 270 were used for data collection and analysis.

The mean amount of honey produced from traditional and frame hives were 12.79 and 28.29kg, respectively. The result showed highly significant difference ($P<0.001$) for the mean amount of honey produced from both traditional and frame hives. Moreover, the honey production trend increased from year to year facing different problems.

The mean amount of honey produced in the study areas was 78.55kg per household per annum. The mean amount of honey produced in Kolla-temben (69.97kg) was significantly lower than the mean amount of honey produced in Medebe-zana (82.22kg) and Raya-azebo (83.47kg) woredas.

The price of white honey per kg in Kolla-temben is significantly higher (79.62 ETB) than the two other study areas. This might be due to variation in the number of consumers, nearness to Mekelle city, level of production and the preference of consumers in this study area. Besides, the mean annual income (3268.61 ETB) from the sale of honey per annum was significantly lower than the other study areas. Moreover, the insignificant difference ($P>0.05$) in profitability of beekeeping in the study areas indicated that beekeeping was profitable in all cases.

The study areas showed the price trend of honey will change positively by 8.417 for the coming T years. This might be attributed due to increase in demand, the increase population growth, decrease in supply and high inflation rate from year to year for the honey product.
According to the survey result, the share of producer(40%) was less than the share of other market chain actors(60%) showing that the honey market was inefficient which in turn causes discouragement for the producers to scale up their honey production.

The major constraints to exploit the untapped potential of beekeeping activity in the woredas are poor marketing system, uncontrolled swarming, and high rainfall during raining season (especially for traditional beekeeping), poor storage facilities, water and drought in decreasing order of importance. Hence, the poor marketing system led the producers to knock doors saying "do you need honey" during the prime production season though they incur many costs. As to the pests and predators, the wax moth was the most prevalent in the study areas.

Even though, there are many challenges and constraints currently facing the beekeeping practices, there are still enormous opportunities and potentials to boost the honey production and marketing system of the three (Kolla-temben,Raya-azebo and Medebe-zana) selected woredas. Moreover, the honey production and marketing is increasing from year to year enhancing the livelihood of beekeepers in the study areas.

5.2. Recommendation

Based on the result of the study, the issues that require consideration by any development organizations are:
Increasing the productivity and production of honey by improving the management of the traditional hives and introducing frame hives increasing the productiveness of bee colonies by planting bee forages and providing feed and water is crucially important.

1. Marketing system should be design to ensure the right benefit for the value chain actors.
2. The beekeepers should be organized to form cooperative/or union so that they can sell

their honey at the right place and time for optimum benefit

3. Beekeepers have lack of financial resources. Thus, there should be appropriate beekeeping extension package that alleviates the problem of both Christian and Muslim societies.
4. Efforts should also be made to alleviate the main constraints that hindered beekeeping development in the areas. Therefore, there should be provision of equipments, minimizing spraying of chemicals, selecting appropriate apiary sites, and planting multipurpose and drought resistant honey bee flora, land rehabilitation and conservation, integrating beekeeping and crop production is essential for sustainable production in the study areas.
5. There need to be honey processing plant in the study areas so that the producers and processors get optimal benefit from these areas.
6. There has to be appropriate honey marketing policy in the study areas.

Future research areas

Farther research is needed by researchers for the following untouched beekeeping areas of study in the study areas

1. The quality of honey in the study areas should be addressed through scientific research
2. The composition, structure and species diversity of bee flora and poisonous plants of the study areas should be confirmed through scientific research.
3. The indigenous knowledge of the producers should be scientifically approved.
4. The races, diseases and pests should be approved through scientific research.

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7. APPENDICES

Appendix 1.Plates used in the study areas

Appendix plate 1.Frame hives covered by plastic material in the areas

Appendix plate 2.Traditional Log hives covered with plastic and grass

Appendix plate3.Swarm catching using mud hives hanging on tree

Appendix plate 4.Poisonous plant “Kotsliaslamay” in the study areas

Appendix plate 5.poisonous plant"Kotslitalian" in the study areas

Appendix plate 6.Honey bee flora in the study areas (Cordia africana)

Appendix plate7.Honey marketing in the study areas

Appendix plate 8. Some of the honey containers in the study areas

Appendix 2.Questionaire used in the study areas

QUESTIONNAIRE FOR THE STUDY OF HONEY PRODUCTION AND MARKETING SYSTEMS in Three Selected woredas of Tigray region, Ethiopia

1. Interviewee details

1.1 General

i) Name of respondent_____ ii) Age_____ iii) Sex_____

iv) Region _____ v) Zone _____ vi) Woreda _____

vii) PA/Kebele _____viii) Village (Got) _____

1.2 House hold characteristics

i) Name of house hold head_____

ii) Number of years lived in the area_____ iii) Age of the house hold_____

iv) Religion of household: Orthodox ☐Muslim ☐ Protestant ☐Catholic ☐ Other (specify) _____

v) Marital status (circle the number): Married ☐Single ☐ Widowed☐ Divorced☐

vi) Education level of house hold: illiterate☐ Basic education ☐ Grade 1-4☐ Grade 5-8 ☐ Grade 9-12 ☐ Other specify_____

vii) Position of house hold head in the community: Political leader ☐Spiritual leade☐lder ☐ Other specify_____

vii) Family size and educational level of family members

No	Female	Male	Age	Level of education

viii) Do you / your family involve in any off-farm activities? ☐ Yes ☐ No

ix) If yes, what type of off-farm activities you/ your family involved?

No	Types of off-farm activities	Family member	ETB	Grains	Others
1					
2					
3					

2. Crop Production

2.1 Landholding (ha):

i) Total land holding _____ii) Farmland _____

iii) Forest land _____ iv) Grazing land _____ v) Others _____

2.2. Major crops grown and their purpose of production

No	Crop type	Area (ha)	Yield (qt)	Consumption	Seed	Sale	Wages in kind	Animal Feed	Others
1	Annual								
1.1									
1.2									
1.3									
1.4									
1.5									
2	Perennial								
2.1									
2.2									
2.3									

2.3 What are the major crop production problems you encountered (use tick mark)?

No.	Major crop production problems	Yes	No	Remark
1	Shortage of farmland			
2	Shortage of oxen			
3	Drought			
4	Soil fertility			
5	Inputs (seed, fertilizer)			
6	Weeds			
7	Insects			
8	Diseases			
9	Rodents			
10	Others (specify):			

3. Livestock Production

3.1. Which livestock species do you have? How many?

Ox	Cow	Bull	Heifer	Calves	Sheep	Goat	Donkey	Horse	Mule	Chicken

3.2. What is the purpose(s) of keeping your livestock and poultry?

3.2.1. Cattle: Draught ☐ Milk ☐ Beef ☐ Breeding ☐ Others_____

3.2.2. Sheep: Mutton ☐ Milk ☐ Breeding ☐ Others_____

3.2.3. Goats: Meat ☐ Milk ☐ Breeding ☐ Others_____

3.2.4. Equines: Transportation ☐ Draught ☐ Others_____

3.2.5. Chicken: Meat ☐ Eggs ☐ Others_____

3.3. What are the major livestock production constraints to you?

☐ Shortage of feed

☐ Shortage of grazing land

☐ Shelter and housing

☐ Lack of drinking water

☐ Parasites

☐ Diseases

☐ Low productivity

☐ Market unavailability

☐ Others (specify): _____

3.4. Do you participate in livestock extension packages? Yes ☐ No ☐

3.4.1. If yes, describe the type of livestock extension packages you participate?

No	Livestock extension packages	Years of participation	Remarks
1			
2			
3			
4			
5			

3.4.2. Do you benefit from livestock extension packages you participate?

Yes ☐ No ☐

4. Credit Sources and Availability

4.1. Do you ever-obtained credit for your farming operations? Yes ☐ No ☐

4.1.1. If yes, for what purposes you get credit? _____

4.2. Who are / were your sources of credits? (Circle one or more).

☐ Micro finance institutions (name it): _____

☐ Service cooperatives ☐ Relatives

☐ Ministry of Agriculture ☐ Individual lenders

☐ NGO ☐ Others, specify: _____

4.3. Do you receive credits for your farming activities during this cropping season?

Yes ☐ No ☐

4.3.1. If yes, for what activities you are using the credit? _____

4.4. What are the major problems you face to get input on credit?

☐ Inaccessibility of credit agents

☐ Debit collection problem

☐ High interest rate

☐ Unavailability of credit

☐ Others, specify: _____

5. Beekeeping Activities and Potentials

5.1. Honeybee ownership

5.1.1. Do you keep honeybees? Yes☐ No☐

5.1.2. If yes, when did you start beekeeping? _____ Year (s).

5.1.3. How do you start beekeeping? (Source of bees and type of technologies used for the first time)

No	Sources	Quantity	Traditional	Intermediate	Movable-frame
1					
2					
3					
4					
5					
6					

5.1.4. If the answer for question 5.1.3 is buying, does the bee colony sale in your locality?

Yes ☐ No ☐

5.1.4.1. If yes, what is the price of one colony? _____ ETB

5.1.5. How many honeybee colonies you owned?

No	Years			

5.1.6. Where did you keep your bee colonies? Please put tick mark.

No	Site or placement of hive	Traditional	Intermediate	Movable-frame
1	Backyard			
2	Under the eaves of the house			
3	Inside the house			
4	Hanging on trees near homestead			
5	Hanging on trees in forests			
6	Others (specify)			

5.1.7. For how many years your colony remains or stays in the hive?

1. Traditional: Minimum _____year (s) Maximum _____years
2. Intermediate: Minimum _____year (s) Maximum _____years
3. Movable-frame: Minimum _____year (s) Maximum _____years

5.1.8. Do you have empty beehives? Yes ☐ No ☐

5.1.9. If yes, list the number of empty hives you have

No	Types of beehives	Numbers	Reasons
1	Traditional		
2	Intermediate		
3	Movable-frame		

5.1.10. What is the trend of your colony number and honey yield (in question 5.1.5)?

No	Types of beehives	No harvest	Increasing	Stable	Decreasing
1	Traditional				
2	Intermediate				
3	Movable-frame				

5.1.10.1. If there is an increase in trend in number of bee colonies and honey yield over the years, what are the causes?

☐ Good market price

☐ Added more bee colonies

☐ Use of new technologies

☐ Others (specify) _____

If there is decrease in trend in number of bee colonies and honey yields over years, what are the causes in order of importance?

No	Causes	Rank	Season of occurrence	Measures taken
1	Lack of bee forage			
2	Lack of water			
3	Drought (lack of rainfall)			
4	Migration			
5	Absconding			
6	Pests and predators			
7	Diseases			
8	Pesticides and herbicides application			
9	Death of colony			
10	Decrease in price of honey			
11	Increased cost of production			
12	Luck of credit			
13	Others (specify)			

5.1.11. Did your colonies abscond? Yes ☐ No ☐

5.1.12. What are the reasons for bees absconding hive? _____

5.1.12.1. If drought is a problem how is its frequency of occurrence? Every_____year(s)

5.1.13. What are the major pests and predators found in the area that threat your colonies?

List in order of importance.

No	Pest /Predators	Rank	Local control methods
1	Ants		
2	Wax moth		
3	Bee lice		
4	Beetles		
5	Spiders		
6	Wasps		
7	*Prey mantis*		
8	Toads		
9	Lizard		
10	Snake		
11	Monkey		
12	Birds		
13	Honey badger		
14	Others (specify)		

5.1.14. Do you observe any honeybee diseases in your apiary? Yes ☐ No ☐

5.1.14.1. If yes, what are the diseases you observed?

No	Local name	Adult affect	Brood affect	Symptoms	Incidence period	Local control measures
1						
2						
3						
4						
5						
6						

5.1.15.2. In which hives your colonies do more likely affected by the diseases?

☐ Traditional

☐ Intermediate

☐ Movable-frame

5.1.15. Do you use agrochemicals/chemicals in your locality? Yes ☐ No ☐

5.1.15.1. If yes, why do you apply agrochemicals/chemicals?

☐ Crop pest's control

☐ Weeds control

☐ Malaria control

☐ Tsetse fly control

☐ Others (specify): _____

5.1.15.2. When do you use agrochemicals/chemicals (months)? _____

5.1.15.3 What type of agrochemicals/chemicals are farmers using? _____

_____

5.1.15.4. Do agrochemicals/chemicals affect your honeybees? Yes ☐ No ☐

5.1.15.4.1. If yes, how many colonies did you lost due to chemicals? _____

When? (Year and months):_____

5.1.15.4.2. What is the estimated honey you lose? _____ Kilograms.

What will be the estimated price? _____ETB

5.1.15.4.3. What measures do you take to protect your bee colonies from agrochemicals /chemicals? _____

_____

5.1.16. What are the sources and costs of the beehives you used?

No	Items	Traditional	Intermediate	Movable-frame
1	Constructed by himself/herself			
2	Constructed locally and bought			
3	Bought from market			
4	Supplied by governments			
	• On credit basis			
	• Free of charge			
5	Supplied by NGO's			
	• On credit basis			
	• Free of charge			
6	Price of one hive (ETB)			
7	Service time (years)			

5.1.17. What are the major advantages of your beehives?

No	Variables	Traditional		Intermediate		Movable-frame	
		Yes	No	Yes	No	Yes	No
1	Material availability						
2	Suitability to harvest						
3	Quality of honey						
4	Temperature maintenance						
5	More swarming frequency						
6	Convenience to construct						
7	Durability						
8	Cost effective						
9	To get more colony through colony split						
10	Less dependent on external input /accessories/						
11	Others (specify)						

5.1.17.1. Based on the above comparisons parameter which hive is the best for you?

Traditional ☐ Intermediate ☐ Movable frame ☐

5.1.18. What are the major limitations of your beehives?

5.1.18.1 Traditional. 1. _____

2. _____

3. _____

5.1.18.2 Intermediate 1. _____

2. _____

3. _____

5.1.18.3 Movable-frame 1. _____

2. _____

3. _____

5.1.19. List the types of traditional beehives you used.

No	Types of materials made	Shape	Length	Diameter
1				
2				
3				
4				

5.1.20. Have you practiced honey hunting? Yes ☐ No ☐

5.1.15.1. If yes, in which month (s) and year (s)? _____

5.1.15.2. The amount of honey harvested: _____kilograms

5.2. Vegetation, honey plants and water availability

No	Local/ Common name of the plant	Type of the plant Tree, shrub, herb, cultivated crop	Flowering time (months)	Source (nectar, pollen, propolis	Other uses 1. feed 2. medicine
1					
2					
3					
4					
5					
6					
7					

5.2.2. Is there any poisonous plant to bees in your area? Yes ☐ No ☐

5.2.2.1. If yes, mentioned these poisonous plants and their flowering time.

No	Local/ Common name of the plant	Type of the plant (Tree, shrub, herb, cultivated crop)	Flowering time (months)	Source (nectar, pollen, propolis)	Effects on 1. bees 2. human
1					
2					
3					
4					
5					
6					

5.2.3. Does water available for your honeybees at all the time? Yes ☐ No ☐

5.2.3.1 If yes, where do your honeybees get water? (Circle one or more)

☐ Streams ☐ Ponds

☐ Rivers ☐ Water harvesting structures

☐ Lakes ☐ Others: specify_____

5.2.3.2. If your response is no, how do you provide water to your bee colonies?

5.3. Beekeeping equipments and protective materials

5.3.1. Which of the following beekeeping equipments and protective materials you have or available to you when ever required?

No	**Materials**	**Home made**	**Locally made and purchased**	**Provide on credit (purchased)**	**Donated by GO or NGO's**	**Price (ETB)**		**Service period (years)**
						Rent	Purchase	
1	Hives							
2	Smoker							
3	Veil							
4	Gloves							
5	Overall							
6	Boots							
7	Water sprayer							
8	Bee brush							
9	Queen catcher							
10	Queen excluder							
11	Chisel							
12	Knife							
13	Embeder							

14	Frame wire							
15	Honey presser							
16	Beeswax (pure)							
17	Casting mold							
18	Uncapping fork							
19	Honey extractor							
20	Honey strainer							
21	Honey container							
22	Others							

5.3.2. What are the smoking materials you are using? (Rank) Dry grass, straw, cow dung

1. _____
2. _____
3. _____
4. _____

5.4. Colony characteristics, Management and Honey harvesting

5.4.1. What are the characteristic features of your honeybees?

5.4.1.1. Behavior: Docile ☐ Aggressive ☐ Very aggressive ☐

5.4.1.2. Color: Black ☐ Red ☐ Grey ☐ Mixture ☐

5.4.1.3. Size: Big ☐ Medium ☐ Small ☐

5.4.1.4. Which one is productive?

Behavior ☐ Color ☐ Size ☐

5.4.2. Do you visit and inspect your beehives and colonies? Yes ☐ No ☐

5.4.2.1. If yes, which type of inspection you perform?

☐ External hive inspection

☐ Internal hive inspection

5.4.2.2. Frequency of inspection

5.4.2.1.1. External hive inspection:

Frequently ☐ sometimes ☐ rarely ☐

5.4.2.1.2. Internal hive inspection:

Frequently ☐ sometimes ☐ rarely ☐

5.4.2.3. If no inspection, what is the reason? _____

5.4.3. Do you clean your apiary? Yes ☐ No ☐

If no, why? _____

5.4.4. When the following major activities occur in your locality?

No	Major activities	Season(s) of occurrence			
		September to November	December to February	March to May	June to August
1	Brood rearing period				
2	Colony Swarming				
3	Colony Migration				
4	Colony Absconding				
5	Honey flow season				
6	Honey harvesting time				
7	Dearth period				

5.4.5. Swarming

5.4.5.1. Does swarming occur in your colonies or locality? Yes ☐ No ☐

5.4.1.1.1. If your response is yes, what is the frequency?

☐Every season

☐Every year

☐Once in two years

☐Others, specify: _____

5.4.5.2. When does swarming occur more frequently? (Months)

From_____ to _____

5.4.5.3. Is swarming advantageous to you? Yes ☐ No ☐

5.4.5.3.1. If yes, describe the reason(s)

☐To increase my number of colony

☐To sale and get income

☐To replace non-productive bee colonies

☐Others specify: _____

5.4.5.4. Do you control / prevent/ swarming? Yes ☐ No ☐

5.4.5.5. What methods do you use to control / prevent/ swarming?

☐Removal of queen cells

☐Harvest or cut honey combs

☐ Return back to the colony

☐ Supering

☐ Using large volume hive

☐ Others, specify: _____

5.4.5.6. Do you have swarms catching experience? Yes ☐ No ☐

5.4.5.6.1. If yes, do you use swarm attractant materials? Yes ☐ No ☐

5.4.5.6.2. If your response in question 5.4.5.6.1 is yes, describe what types of attractants and methods of application you use (rank them).

No	Attractant materials	Sources	Methods of application
1			
2			
3			
4			

5.4.5.7. How many swarms do you catch in this production year? _____

5.4.6. What kind of beehive products you produce?

No	Products	Traditional	Intermediate	Movable-frame	Honey hunting
1	Honey				
2	Crude beeswax				
3	Propolis				
4	Others, specify				

5.4.7. List the amount of your beehive products and frequency of harvest per annum.

No	Types of beehives	Honey production		Crude beeswax		Propolis	
		Kg/hive	Frequency	Kg/hive	Frequency	Kg/hive	Frequency
1	Traditional						
2	Intermediate						
3	Movable-frame						
4	Honey hunting						

5.4.8. While harvesting does you remove all honeycombs? Yes ☐ No ☐

5.4.9. Do you harvest all brood combs? Yes ☐ No ☐

5.4.9.1. If no how much honey /no of combs/ left? _____

5.4.10. While harvesting does your bee colony evacuate? Yes ☐ No ☐

5.4.11. List the home use of honey.

- ☐ As a food
- ☐ As a medicine
- ☐ For beverages
- ☐ For cultural and ritual ceremonies
- ☐ Others (specify):_____

5.4.12. If you collect crude beeswax list the sources.

- ☐ Empty honeycomb during harvesting
- ☐ Discarded, old and broken combs
- ☐ Uncapping and spout beeswax
- ☐ From colony absconding hives
- ☐ After home utilization of honey
- ☐ Others, specify _____

5.4.13. Why you are collecting crude beeswax?

- ☐ For income generation
- ☐ Candle making

☐ Foundation sheet making

☐ Religious and cultural use

☐ Others, specify:_____

5.4.14. If you don't collect/produce beeswax what is (are) the reason (s)?

☐ Lack of market

☐ Lack of knowledge

☐ Lack of processing skills

☐ Lack of processing materials

☐ Others specify: _____

5.4.15. Do you collect propolis? Yes ☐ No ☐

5.4.15.1. If yes, for what purpose you are using the propolis?

☐ For sale (marketing)

☐ As a medicine to treat diseases

☐ Others specify: _____

5.4.15.2. If your response is no, what is (are) the reason (s)?

☐ Lack of market

☐ Lack of knowledge

☐ Others specify: _____

5.4.16. Describe the utilizations of your beehive products.

No	Types of products	Total %	Percentage of product utilized of				
			HH consumption	Sale	Wages in kind	Gift	Others
1	Honey						
2	Beeswax						
3	Propolis						

5.4.17. What are the sale prices of your beehive products?

No	Products	Traditional		Intermediate		Movable-frame	
		Amount	Price(Birr)	Amount	Price(Birr)	Amount	Price(Birr)
1	Honey						
	First harvest						
	minimum						
	maximum						
	Second harvest						
	minimum						
	maximum						
2	Beeswax						
	First collection						
	minimum						
	maximum						
	2nd collection						
	minimum						
	maximum						
3	Propolis						
	First collection						
	minimum						
	maximum						
	2nd collection						
	minimum						
	maximum						

5.4.18. Did you feed your honeybee colonies? Yes ☐ No ☐

5.4.18.1. If yes, when do you feed your honeybees? (Months): _____

5.4.18.2. What kind of feed you offer to your honeybees?

No	Types of feed	Amount offered per season /colony	Costs per kg (ETB)
1	Besso		
2	Shiro		
3	Sugar syrup		
4	Honey + Water		
5	Others (specify)		

5.4.20. Do you practice migratory beekeeping? Yes ☐ No ☐

5.4.20.1. If yes, what are your reasons for bee colony migration?

☐ Crop pollination

☐ Honey production

☐ Fetch of forage and water

☐ Disease control

☐ Agrochemicals prevention

5.4.20.2. When do you bring back your colonies?

☐ September to November

☐ December to February

☐ March to May

☐ June to August

4.4.20.3. Are there indigenous know ledges of beekeeping practice in your area?

Yes ☐ ☐ No , if yes list the indigenous knowledge practiced_____

6. Post Harvest Management

6.1. Do you strain your honey? Yes ☐ No ☐

6.1.1. If yes, what materials do you use for straining?

☐ Honey extractor

☐ Honey presser

☐ Cloth

☐ Sieve

☐ Decantation

☐ Using hand

6.1.2. If you strain, what is the advantage and price of 1 kg strained honey?

6.1.2.1. Advantage: _____

6.1.2.2. Price of 1 kg strained honey: _____ETB

6.1.3. If you don't strain your honey why? (Circle one or more).

☐ Lack of materials

☐ Lack of knowledge how to strain

☐ Consumer do not prefer strained honey

☐ The amount of honey will be reduced if strained

☐ Others specify: _____

6.2. For how long do you store your honey? (Circle one or more).

☐ I don't store, I will sale / it will be consumed during harvesting

☐ One to six months 3. Seven to twelve months

☐ One year to two years 5. More than two years

☐ For what reason do you store honey? _____

☐ What is the maximum storage year of your honey? _____Years.

☐ List the container you have been used to store your honey, price, service years and problems you have been encounter.

No	Types of container used	Price (Birr)	Service (years)	Problems observed in use
1	Gourd			
2	Earthen pots			
3	Tin			
4	Plastic container			
5	Animal skin and hide			
6	Others (specify)			

6.6. If your honey is crystallized, did you change it to viscous honey? Yes ☐ No ☐

6.6.1 If yes, what methods do you use?

☐ Direct heating using fire

☐ Putting in a boiled water bath

☐ Using sunlight

☐ Others, specify: _____

7. Marketing Condition

7.1. Do you sale your honey? Yes ☐ No ☐

7.2. What is the annual income from sale of hive products?

No	Types of produce	Quantity	Unit price (Birr)	Total price(Birr)	When do you sell
1	Honey				
2	Crude beeswax				
3	Propolis				
4	Bee colonies				

7.3. What are the factors that govern the price of the honey in your locality?

☐ Seasons of the year

☐ Colors and taste of the honey

☐ Distance from market

☐ Traditional ceremonies

☐ Others (specify): _____

7.4. During this harvesting season what is the price of 1 kg of honey?

No	Colour of honey	Price of honey (Birr/kg) produced from		
		Traditional hive	Intermediate hive	Movable-frame hive
1	White			
2	Yellow			
3	Red			
4	Brown			
5	Mixed			

7.5. Who are your customers?

- ☐ 'Tej' houses
- ☐ Middlemen
- ☐ Retailers
- ☐ Wholesalers
- ☐ Consumers
- ☐ Beekeepers co-operative
- ☐ Others /specify/ _____

7.6. How do you evaluate the local market price? High ☐ Medium ☐ Low ☐

7.7. How is the price trend of honey in your locality?

No	Price trend	Reasons
1	Increasing	
2	Stable	
3	Decreasing	

7.8. How did you fix the price of honey? (More than one answer is possible)

- ☐ Consideration labor and other cost incurred
- ☐ Market force (supply and demand)
- ☐ Color of honey
- ☐ Table honey and crude honey
- ☐ Customs and Traditional ceremonies
- ☐ Others (specify_____

7.9. Where is your major sell place? (More than one answer is possible)

- ☐ In your home
- ☐ Nearby market place
- ☐ Major honey market place
- ☐ Beekeepers cooperatives
- ☐ Other (specify)_____

7.10. What is the demand of honey in the market?

Very high ☐ High ☐ Medium ☐ Low ☐ Very low ☐

7.11. What is the supply of honey in the market?

Excess ☐ Enough ☐ Not enough ☐

7.12. Out of your family members, who is responsible for honey marketing?

_____

7.13. Who is controlling the money? Why? _____

7.14. How do you transport the honey if you are selling in the market?

1. Containers: Same ☐ Different ☐

2. Means of transportation /specify/ _____

7.15. List problems you have been come across to bring your product to market. _____

_____

7.16. What are the labor requirements for honeybee production systems?

No	Activities	Performed by	No of days (hours) required/hive	Estimated costs (In terms of Birr
1	Hive construction			
2	Hive plastering			
3	Hive smoking			
4	Hive inspection			
5	Apiary cleaning			
6	Swarm control			
7	Transferring			
8	Supering			
9	Harvesting			
10	Processing of products			
11	Sale of bee products			
12	Feeding			
13	Watering			
14	Migrate bee colonies			
15	Others			

8. Constraints of beekeeping

8.1. What are the major constraints of beekeeping in the area? (Rank them)

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

8.2. Does beekeeping profitable to the area? Yes ☐ No ☐

8.3. Do you participating in beekeeping extension packages? Yes ☐ No ☐

8.4. Do you get beekeeping training? Yes ☐ No ☐

8.4.1. If your response is yes:

No	Places of the training	Duration	Organized by
1			
2			
3			

8.4.2. If your response for question 8.4 is no, do you need beekeeping training?

Yes ☐ No ☐

Appendix 3. Check list used in the study areas

Check list developed for the assessment of honey production and marketing systems in Three Selected woredas of Tigray region, Ethiopia.

1. Requirements of the check list
   - ✓ Have Three groups of focus discussion(3FGD)
   - ✓ Within one focus group have key informants with individual households ranging from 8 to 15
   - ✓ The individual includes delegate elders, delegate youth, delegate woman, all DA's,Kebelle leader,Kebelle manager, religion leaders, bee technician ,bee expert and three experience enriched farmers

2. Method to approach

- ❖ Introducing yourself, duty and responsibility
- ❖ Let the key informants in the focused group introduce themselves, their duty and responsibility
- ❖ Costs are express in birr while asking the honey cost in the marketing system

3. Check list content

A/Ask them general information to overview about their area of living

- ✓ Such as their got, their major production, the livestock species they have ,the purpose they keep etc
- ✓ The major production constraints(both livestock and crop production)

- ✓ Discuss about credit service availability, purpose intended ,the major problem to get credit service etc

B/ Ask them the general information of beekeeping

- ✓ Ask the trend of beekeeping production in the area
- ✓ Ask them their experience, knowledge and skill in beekeeping
- ✓ Ask the type of hives in the area, sources of bee colony, the location of the apiary site etc.
- ✓ Ask the stay year of the colony ,the trend of colony and honey yield from 2000-2004
    - If increase why
    - If decrease why
- ✓ Ask to list the major pests and predators in the area, rank based on importance and the way they control locally
- ✓ Ask the disease bee in the area, their incidence and the way they control locally
- ✓ Ask the effect of the disease in different hives
- ✓ Ask chemicals used in crop production and their effect for beekeeping
- ✓ Ask the source of hive and their relative costs
- ✓ Ask the advantage and disadvantage of each hive in the area

C/Ask the general information about bee flora of the area

- ❖ List the major bee flora in the area
- ❖ Ask the trend of coverage of these plants in the past, present and their fate in the future
- ❖ Ask about season of flowering for the plants in the area
- ❖ Ask the amount of honey produce per year per hive in the area
- ❖ Ask availability of bee poisonous plants in the area and the way they control locally

D/ Ask general information about beekeeping equipment availability

- ✓ List the bee equipment in the area
- ✓ Discuss about the characteristics of the bees in the area
- ✓ Ask the way and type of bee hive inspection

E/Ask general information for swarming

- ❖ Ask season of swarming
- ❖ Experience in swarming catch in the area
- ❖ Attractant materials used in the area
- ❖ List and rank the attractant materials if any
- ❖ Discuss about bee products and their use
  - ✓ Honey
  - ✓ Bees wax
  - ✓ Propolis
  - ✓ Type of hive

3. Marketing system of beekeeping

- ✓ Ask the price of hive products
  - ❖ Honey minimum_____kg maximum_____kg
  - ❖ Bees wax minimum ____kg maximum____kg
  - ❖ Propolis minimum_____kg Maximum_____kg
- ✓ List factors that affect the price of honey in the area
- ✓ Tell the hive type and the price of various honey types and their preference
  - ❖ White_____Yellow_____Red_____brown_____mixed____
- ✓ Ask the honey market participants in the area
- ✓ Ask the marketing place of the locality
- ✓ Ask the transport system in the area

4**. Ask the beekeeping major opportunities of the area**

- ✓ Ask about water availability
- ✓ Training availability
- ✓ Credit availability

- ✓ Bee forage availability etc
- ✓ Profitability of beekeeping in the area
- ✓ The indigenous knowledge of the area
- ✓ Others

5. Ask the beekeeping major constraints

- ❖ Absence of bee flora
- ❖ Absence of training support
- ❖ Absence of water etc

6. Ask general information to conclude

- ✓ Give open discussion for points not yet raised in the discussion if any
- ✓ Ask suggestion, comment and question about the interview

Appendix 4. Equations and formulas

Appendix 3.1.Method of forecasting honey demand (Least square technique)

The price trend of honey is forecasted using the least square method formula:

For Y= a + bT (Y=the influenced variable=influencing variable), the value (b) can be calculate

$$b=\frac{\Sigma TY-nTavYav}{\Sigma T^2-nT^2av},\ b=8.417$$

Where; Y= demand of the honey, a = constant and b = coefficient, T=time

$\Sigma TY=759$, $\Sigma T=15$, $\Sigma Y=244.69$, $\Sigma T^2=55$, Tav=2.5, Yav=40.78, a= Yav-bTav, a=19.7375

The honey price trend equation for the honey trend becomes=19.7375+8.417T

Appendex 3.2. Ranking index method

For parameters required ranking, indices were calculated to provide major pests and predators for honey production in the study area (Mula *et al,* 2006). The indices were calculated as follows;

Index= Sum of (3 x number of household ranked first + 2 x number of household ranked second + 1 x number of household ranked third) given for an individual reason, criteria or

preference divided by the sum of (3 x number of household ranked first + 2 x number of household ranked second + 1 x number of household ranked third) for overall reasons, criteria or preferences.

Appendix 3.3.Marginal analysis

$GMM_{HC} = \frac{B-Ax100}{E}$

$GMM_{HC} = \frac{47.5-35x100}{87.50}$

$GMM_{HC} = \frac{12.5x100}{87.50}$

$GMM_{HC} = 13.71$

$GMM_{HC} = 14$

$GMM_{WS} = \frac{C - B}{E} x100$

$GMM_{WS} = \frac{82.4 - 47.5}{87.50} x100$

$GMM_{WS} = \frac{34.9x100}{87.50}$

$GMM_{W} = 39.89\%$

$GMM_{W} = 40\%$

$GMM_{R} = \frac{D-C \times 100}{E}$

$GMM_{R} = \frac{87.5-82.4 \times 100}{87.50}$

$GMM_{R} = 5.8\%$

$GMM_{R} = 6\%$

Total Gross marketing margin= $GMM_{HC}+GMM_{WS}+GMM_{R}$

Total Gross marketing margin= 14+40+6

Total Gross marketing margin= 60%

Gross marketing margin of producers (GMMp) =100%_$GMM_{HC}+GMM_{WS}+GMM_{R}$

GMMp=100%_60%, GMMp=40%