Jimma University

College of Natural Sciences

School of Graduate Studies

Department of Biology

Assessment of Honey Production System, Quality and Beekeeping Practices in Bako Tibe District, Oromia Regional State, Ethiopia

By

Million Chimdessa Gobena

A Thesis Submitted to Department of Biology, College of Natural Sciences, School of Graduate Studies, Jimma University, in Partial Fulfilment of the Requirement for the Degree of Master of Science in Biology (Ecology and Systematic Zoology)

August, 2014

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Statement of the Author

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Biographical sketch

The author was born from his father Chimdessa Gobena and his mother Kuleni Debela at Babo Chokorsa, Sibu Sire district, East Wollega Zone, Ethiopia on August 2, 1986. He attended his Elementary School at Gunjo Mareyiam and Secondary School at Sibu Sire High School. He completed his High School Education in 2003 and attended Nekemte Compressive Preparatory school in 2004 and 2005 and joined Ambo University Collellege, Studied Applied Biology (Micro Biology and Parasitology) from 2006 up to 2008 and graduated on July 10 in 2008 with Degree program in Applied Biology.

After graduation he has been employed by Oromia Educational Bureau in July 11 in 20008 as Teacher at Bako Tibe District of West Showa. He joined the School of Graduate Studies of Jimma University on March 10, 2011 to pursue his Studies for Master of Science in Biology (Ecology and systematic Zoology) and at present, he is a Post Graduate Student in the Jimma University.

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List of Abbreviation and Acronyms

AMP: Apiculture Master Plan

ANOVA: Analysis of Variance

BSE: Biological Society of Ethiopia

BoA: Bureau of Agriculture

CACC: Central Agricultural Census Commission

CIDA: Canadian International Development Agency

CSA: Central Statistical Agency

EARO: Ethiopian Agricultural Research Organization

FAO: Food and Agricultural Organization of the United Nations

GDP: Gross Domestic Product

HBRC: Holeta Bee Research Centre

IPMS: Improving Productivity and Market Success

ILRI: International Livestock Research Institute

KTB: Kenya Top Bar

MoA: Ministry of Agriculture

MoARD: Ministry of Agricultural and Rural Development

NGO: Non-Governmental Organization

TBH: Top Bar Hive

WARDO: Woreda Agricultural and Rural Development Office

DAs : Development agents

SD: Standard Deviation

SOS: Save-Our Soul, Sahel International. UK.

SNNPR: South Nation,Nationalities and people of Regional state

Abstract

The study was conducted to assess honey production system and beekeeping practices in Bako Tibe districts. The main purposes of the assessment was to identify and document the existing honey production system, honey quality and beekeeping practice of the district, while identifying major constraints and opportunities in the study area. For this purpose, data were collected from six Kebele selected purposively from three different agro-ecological zones (Lowland 3, Mid-land 2 and Highland 1) based on stratified sampling techniques. Thus, 60, 40 and 20 beekeepers were selected respectively from each agro-ecological zone using proportional allocation giving a total of 120 beekeepers and interviewed using questionnaire, Fuscous group discussions. For honey quality test, 13 honey samples each weighing about100gm from the three different agro-ecology zones were collected from beekeepers randomly for physico-chemical evaluation (moisture content, PH, acidity and ash content) and for plant source identification. From this study, three types of beekeeping systems were documented, namely: (1) Traditional beekeeping systems (2) Transitional beekeeping systems and (3) Modern beekeeping systems. About 91.7% of respondents practiced traditional beekeeping. Only 8.3% of the respondents' practice traditional, transitional and modern beekeeping system. The mean bee colony holding sizes of the respondents were about 14.6 /household. Honey yield/hive from traditional, transitional and improved hive were 10.1kg/year, 18.5kg/year and 29.6kg/year, respectively. There were two honey flow seasons in the study area, namely November to December and April to May. Based on the results of this study, the major challenges of beekeeping were, Bee disease, pests and predators, pesticide poisoning, bee forage, lack of beekeeping equipments and materials, markets, lack of honey storage facilities, lack of skill poor extension service. The physico chemical composition of honey was significant ($P<0.05$) in PH and Acidity when compared to the different agro-ecological zone and within hive types, where as moisture contents significant only within agro-ecological zone only , while ash, content were not significant ($p>0.05$)with in both agro-ecology and hive types. Almost all parameters measured for honey samples (Moisture=19.81%, PH=3.4.23, Free acidity=21.43milli.equiv.acid/kg and Ash= 0.11 %) were within the acceptable range of the world and national standard. Due to high potential of the study area for apiculture and good quality standard of the honey, it is recommended to exploit the potential for export market with better intervention. Further study is also required to characterize the honeybees of the area and major pests and diseases of economic importance and their control.

Key words: *Bako Tibe, Beekeeping practice, Honey production system, Honey Quality, Agro-ecological zone.*

1. Introduction

In Ethiopia, beekeeping is a deep-rooted traditional practice; of all the counties in the world no country has a longer tradition of beekeeping than Ethiopia (Ayalew and Gezahegn, 1991). Even if it is hard to know the exact figure, estimates are indicating that about 1.5-1.8 million people of the country engaged in honey production, collection, processing, packing, retailing or selling and other activities (MoARD,2012;Gidaye *et al*., 2012).Beekeeping serves as economic, social, and cultural and nutrition benefit to all actors in the value chain.

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 (Fichlt and Admasu, 1994).As a result, the country is with the largest honeybee colony population and the leading honey and beeswax producer in Africa. Even though, the country is with high potential and the leading bee products producer, the benefit obtained from the sub-sector to the nation and beekeepers is not commensurate with its huge potential (Ayalew and Gezahegn, 1991; MoARD, 2006).About 4,601,806 hives exist in Ethiopia, out of which about 95.5% was traditional, 4.3% transitional and 0.20% frame hives (Beyene and Davide, 2007). The traditional beekeeping accounts for more than 95% of the honey produced and nearly all the beeswax produced in the country.

Despite the long tradition of beekeeping in Ethiopia, having the highest bee density 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. Productivity has always been low, leading to low utilization of hive products domestically, and relatively low export earnings. Thus, the beekeepers in particular and the country in general are not benefiting from the sub sector (Nuru, 2002).This constraint was further aggravated by inadequate extension coverage, lack of skills, Limited beekeeping training and research in the beekeeping sector. Because of these and other related factors, the region and the rural beekeepers have not sufficiently benefited from the beekeeping subsector (Gidey and Mekonen,2010).However, in order to reduce poverty, focusing on high potential areas of agricultural sector and making them more productive is of paramount importance.

Beekeeping is a very long- lasting and deep rooted house hold activity for rural society in Ethiopia that stretches back in to thousands of years of the countries early history. It seems as old as the history of the country and it is essential activities of the community (Adebabay, 2008).Even, there is no well-documented evidence that indicates when and where the beekeeping practice started in Ethiopia, there is an ancient tradition for beekeeping in Ethiopia that stretches back into the millennia of the country's early history (Workneh *et al.*, 2006). However, as described in Ayalew (1978) beekeeping had started in the country between 3500-3000 B.C.

Ethiopia, having the highest number of bee colonies and surplus honey plants is the leading producer of honey and beeswax in Africa. Ethiopia produces about 54,000 metric tonnes of crude honey per year. This makes the country rank 1st in Africa and 9th in the world (MoARD, 2012). The country is also one of the four largest beeswax producing countries in the world. In Ethiopia, beeswax is one of the 12 major exportable agricultural products (Girma, 1998).

Production system study is important to identify problems and come up with relevant solution to the problems that lead to formulate appropriate development plan. Hence, characterization of production system, identifying and prioritizing the available constraints and suggesting possible interventions areas are the first steps towards the development planning in the apiculture sub-sector. Moreover, farming system approach to research and development is 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)

Therefore, this study aimed to assesses honey production system and the main constraints of beekeeping in Bako Tibe district, Western Ethiopia.

1.1 Statement of the Problem

Bako Tibe is one of the districts in Oromia regional state with high potential for beekeeping development and a number of people are involved in a beekeeping activity to obtain all the benefits from the practices.

However, there is no adequate information on the honey production, honey quality beekeeping and honey harvesting practices of the district that leads to broad recommendations on the determinants of the technology, socio-economic factors influencing beekeeping practice and financial benefit of beekeeping. So far in Bako Tibe there was no compiled and reliable information on honey production system and beekeeping practice. The numbers of beekeepers, bee colonies, and amount of honey produced, type of beekeeping practiced, and constraints are not yet well documented. Therefore, this study was conducted to collect information on production system, productivity, marketing, bee flora and constraints of beekeeping in Bako Tibe district, western Ethiopia. Thus, it is timely and relevant to assess and document important information on the subsector, which has not been carried out before in Bako Tibe district.

1.2. Objectives

1.2.1. General objective

- To assess honey Production system, Quality and beekeeping practices in Bako Tibe district, Ethiopia.

1.2.2. Specific objectives

- To assess honey production and characterize beekeeping system in the study area
- To assess honey harvesting techniques and seasons in the study area
- To identify the main constraints of honey production system in study area
- To determine the honeybee management practices, and honey quality aspects in study area

1.3. Significance of the study

The significance of the study is to increase the understanding of the beekeepers on honey production system and beekeeping practice and useful to develop appropriate beekeeping development strategy plan and indicate future research areas for those who would like to conduct researches on beekeeping. Moreover, the data may be used as secondary data for researchers and any interested parties working in the study area. Hence, this study is paramount significant in identifying apiculture development determinants in Bako Tibe district, which are helpful to all actors in the value chain (producers, collectors, processors, packers, exporters, policy makers, researchers and organizations involved in beekeeping development programs) to join hands and device development enhancing mechanisms.

1.5. Limitations of the study

The main limitation of this study was mainly related to coverage of the study area and lack of budget to measure all parameters. There are a number of well known districts in honey production in the region. However, the study focused only in Bako Tibe district due to lack of budget and time limitations. The other limitation of the study was that, this study being the first kind in the district, it lacks many detail secondary information.

2. Literature Review

2.1. Beekeeping in Ethiopia

Beekeeping, which is today, practiced over a greater area of the earth's surface than perhaps any other single branch of agriculture, passed through different stages of development: honey hunting, traditional (forest and backyard) and improved (movable-frame and movable top-bar)methods of beekeeping. It is likely that man hunted for wild nests of bees and looked for their honey during the whole of his existence. Early man probably took honey from bees' nests wherever he found them, and the collection of honey from wild nests continued except in some regions where it has been entirely superseded by beekeeping (Crane, 1990).

There are many references to honey in ancient records and literature, but most of them gave no clue as to whether the honey was obtained by honey hunting or beekeeping. Wherever writing was known, honey was mentioned so many times in the Holy book of the people, and it often held a place of honour in their rights (FAO, 1986).

The earliest known evidence of honey hunting scenes was a painting made in a rock shelter in the mountains of eastern Spain in Mesolithic times, probably dated to about 5000 BC (Dams,1978 cited by Crane, 1990). Africa has many rock paintings about honey hunting than any other continent and some of the countries, which can be mentioned are South Africa (Natal),Zimbabwe, Morocco, Libya and Tanzania (HBRC, 1997).

Crane (1990) reported that by 2500 BC, before forest beekeeping is known to have existed, fully fledged beekeeping was being practiced in ancient Egypt and the earliest written records that relate to the keeping of bees in hives are from about 1500 BC. Generally, the earliest known evidence of beekeeping has been found in the Africa continent (Crane, 1990).
Beekeeping up to 1500 AD continued in the traditional form using primitive hives. Of all the regions under consideration, tropical Africa has the oldest tradition of beekeeping and still with primitive hives (FAO, 1986). Between 1650 and 1850 AD many hives with top-bars and movable frames hive were invented, but after these two centuries of effort there was still failure on the fundamental point: whatever bars or frames were used, the bees attached their comb to the walls of the hive as well, and the combs could, therefore, only be removed from the hive by cutting them out. The pattern of modern beekeeping was thus established between 1850 and 1900 AD. Different equipments were invented in this period, but Langstroth is

advance in 1851 remains the basic principle of the box hive, and thus of our beekeeping today (Crane, 1976).

Beekeeping is a long-standing practice in the rural communities of Ethiopia and appears as ancient history of the country (Ayalew and Gezahegn, 1991). In the country, beekeeping is an integral part of the life style of the farming communities, and except for a few extreme areas, it is a common practice in every place where humankind has settled.

According to MoARD (2003) the most important honey and beeswax production in Ethiopia are Oromia (about 46% of the total production),South Nation, Nationalities, Regional state, SNNPR (22%), Amara (25%) and Tigray (5%).In south western parts of Ethiopia, some households entirely depend on honey hunting and forest beekeeping for their entire livelihood. Honey hunting is also common in pastoral communities in which beekeeping seem impossible.

In Ethiopia the extension program on beekeeping activity was started in 1978 together with other activities in the Livestock Department of Ministry of Agriculture. In order to start beekeeping extension activities the prepared program was first to make trials of improved hives in selected sites (Keralem, 2005)

The favourable climate of the country allows having about 10 million honeybee colonies of which 7 million are kept in different man made hives and the balance exists as wild colonies (EMA, 1981). Because of the long tradition of beekeeping in the country, beekeepers have developed indigenous technical knowledge on traditional hive construction from different locally available materials, on honeybee management practices like honey season identification, swarm catching and attractant methods, swarm control method, honeybee enemy protection, traditional methods of sting protection and reduction of pain (Workneh,*et al.*,2006). According to Holeta Bee Research Centre (2004), there are four different types of beekeeping practices in Ethiopia namely, traditional forest, traditional backyard, transitional and improved beekeeping. However, there are variations in the types of beekeeping practices in different parts of the country and the specific beekeeping systems of some areas are described as below.

2.1.1. Beekeeping in Northern Ethiopia

Indigenous technical knowledge of beekeepers varies from region to region in the country. As a result, beekeepers' practices also show differences. Accordingly, beekeepers of the northern Ethiopia have well developed indigenous technical knowledge on beekeeping (Nuru, 2002). The same source indicated that beekeepers in the northern region keep their bees in backyard either under separate shelter or around the house wall or even inside the house i.e. with domestic animals and family members without any problem (Keralem *et al*, 2009). They hang their beehives inside their living rooms and provide entrances on the sides of the walls. The beekeepers of the area construct beehives for different purposes; for instance, small hive to induce reproductive swarming and big hives for honey production. The beekeepers also practice feeding and moving their colonies to other places for searching bee forage.

2.1.2. Beekeeping in Southern Ethiopia

As the other part of the country, beekeeping is one of the oldest agricultural practices in this area. Traditional, transitional and improved beekeeping management is being practiced. As noted by Amsalu (2002) in the south western part of the region particularly (Mash area, indeed this area is categorized as "south-western") farmer beekeepers use natural forest only for beekeeping purposes. The forest is distributed among beekeepers and one cannot use for beekeeping without the permission of the forest owner (beekeeper). In some areas of the region as revealed by Nuru (2002) every family has its own forest land to use for traditional beekeeping, which is known as kobo. According to kobo system one cannot be allowed to cut a single stick or to hang hives in the forest which is not belonging to him. The practice is contributing much for high forest conservation in the area. Generally in the area, traditional forest beekeeping is predominant. A beekeeper can have 10-200 honeybee colonies. The beekeepers get honeybee colony mainly through trapping swarms. In relation to honeybee management, no attention is paid to honeybee colonies. Beekeepers visit their honeybee colonies only during honey harvest. The honey harvesting practice requires climbing up big tree and sending the hive with rope or dropping it then harvesting the honey with the mixtures of pollen and beeswax. There are mainly two honey flow seasons in that area, namely April to May and September to November. The beekeepers are mainly selling their honey to "*Tej"* (local beverage) makers and few honey collectors.

2.1.3. Beekeeping in western Ethiopia

In the areas, there are better natural forest and cultivated crops with suitable climatic condition for beekeeping (MoARD, 2003). As a result, large honeybee population exists in the area. In the area beekeeping is mostly practiced in the forest by hanging hives on very big trees. It is common to observe up to 50 honeybee colonies in one tree. The honey harvesting method is similar with southern part of the country. However, in this area, after the honey harvest, they shake down the bees and store the empty hives until the next swarming season. In the region, there is cultural belief of the beekeepers that once the colony is touched for honey harvest, the colonies tend to abscond and never stay in their hive (Nuru,2002).The same source showed that beekeeping in the area has constraints of traditional practices like hanging the hive on tall tree that causes difficult to manage the bees properly, make difficult work for women and old man to climb long tree, wastage of bee colonies by shaking the bees during honey harvest that causes the loss of thousands of colonies every year, forest fire in dry seasons, and the like. In this region, transitional, improved, and honey hunting practices are also being undertaken. There are also beekeepers that keep their bees under the roof and use the colony for a long time.

2.1.4. Beekeeping in Eastern and Central highlands of Ethiopia

In central and eastern highlands honeybee colonies are kept in backyard and in the forest. Backyard beekeeping using traditional beehives are more predominantly exercised in the area and the traditional beehives are made up of pot, bamboo, locally available shrubs and trees (Amsalu, 2002).The shape of the traditional beehives in use in the area are cylindrical in shape with the dimension of around one meter in length and a diameter of around 20 cm (Workneh *et al*., 2006).

According to Solomon (2009) most of the south east and central highland of the beekeepers put baiting hives on braches of trees in the forests, valleys and around river banks to catch the swarm. However, some of them did not take their baiting hives out of their apiaries for such purposes.

According to Kerealem *et al*. (2006) most of the beekeepers in the central Ethiopia had got their bee colonies by trapping swarms using baiting hives. Method of fumigating the new hive is by digging the hole and preparing the smoke and digging another hole adjacent to the first hole then connecting the two holes internally by producing small hole which helps to pass smoke and putting the new hive up side down on the hole which has no fire. The new

hive may be fumigated until the internal color of the hive gets brown. Beekeeping management such as regular visiting of colonies, feeding, watering and protection from honeybee enemies are being under taken in the area. Beekeepers also practice migratory beekeeping i.e. moving their colonies to place where plenty of bee forages are available.

2.2. Beekeeping Systems in Ethiopia

Ethiopia is blessed with adequate water resources and various honeybee floras, which create fertile ground for the development of beekeeping. Honey hunting and beekeeping have been practiced in the country for the exploitation of honey (Girma, 1998). In places where wild colonies of bees living in hollow trees and caves are found, honey hunting is still a common practice in Ethiopia. Currently, in the country bee husbandry has been exercised in the following systems:

2.2.1. Traditional Beekeeping.

More than 95% of the honeybee colonies in Ethiopia are managed using traditional local methods (MoARD, 2012). Beekeeping takes place mainly in the forest using traditional beehives. Several million bee colonies are managed with the same 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 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. Under Ethiopian farmers' management condition, the average amount of crude honey produced from traditional hive is estimated to be 5 kg / hive / year (Gezahegn, 2001). On the other hand, based on the survey conducted in West Showa Zone, the amount of honey

harvested from a traditional hive on average was reported to be 6.1 kg/hive/year (Edessa, 2005).

2.2.2. Transitional Beekeeping

It is a type of beekeeping intermediate between traditional and modern beekeeping methods. Top-bar hive is a single story long box with slopping sidewalls inward toward the bottom (forming an angle of 115^{o} with the floor) and covered with bars of fixed width, 32 mm for east African honeybees (Segeren, 1995; Nicola, 2002).

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) and SOSS (2002).

Top-bar hive in an ideal condition can yield about 50 kg of honey per year, but under Ethiopian condition, the average amount of crude honey produced would be 7-8 kg/hive/year (Gezahene, 2001). However, at zonal level (North Wello) it has been reported that production of 24-26 kg/hive/year crude honey (SOS, 1999), and about 8 % as much beeswax per kilogram of honey is likely to be obtained.

2.2.3. Frame beehive Beekeeping

Modern or frame beekeeping methods aims to obtain the maximum honey crop, season after season, without harming bees (Nicola, 2002). Modern or frame hive consists of precisely made rectangular box hives (hive bodies) super imposed one above the other in a tier. The number of boxes is varied seasonally according to the population size of bees. Practical frame hive was invented in 1851 by Lorenzo Lorraine Langstroth in U.S.A. (Crane, 1976). 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.

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

2.3. Importance of Beekeeping in Ethiopia

Beekeeping in Ethiopia plays an important role in income generation for beekeepers. Moreover, honey production of the country meets beverage requirements of the urban and rural population. It is also demanded for its nutritional and medicinal values. In addition, honeybees play a great role in ecological environment by pollinating both natural and cultivated plants. Particularly, self-sterile plants should get pollinating agents to maintain viable seed. The yield of plants pollinated by honeybees can be increased in quality and quantity. Honeybees can increase the yield of *Citrus sinensis* by 30%, water melon by 100% and tomatoes by 25% (Crane, 1990). Amsalu *et al.* (2004) also reported that onion yields had increased by 94% due to honeybee's pollination. In addition, beekeeping sub-sector has a lot of relative advantages. For instance, it does not require fertile land as well as large area. Males and females of all working age groups can practice it with little initial capital.

2.3.1 Economic importance

2.3.1.1. Honey Production

Honey is the natural product of honeybee which 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. 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% of the total honey estimated to be brought for market is used for '*Tej'* production and 15 % of the total honey produced is consumed at home.

2.3.1.2. Beeswax Production

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 beeswax 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 bees wax in generating income. However, the national estimate for the beeswax production of the country shows about 5000 tons (MoARD, 2012). 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.

2.3.1.3. Other beehive products

Royal jelly, pollen and bee venom are also in very high demand globally. However, these Products have never been utilized in the Ethiopian context (Ayalew and Gezahegn 1991).

2.2.2. Ecological importance

Beekeeping is a sustainable form of agriculture that is beneficial to the environment and provides economic benefits for the retention of native habitats and potentially increases yield from food and forage crops (Jones, 1999). Beekeeping has various relative advantages and some of them are as follows (Robinson, 1980).

Bees are Cosmopolitan i.e. they adapt to wide range of environment. They can survive at altitude below 400 m asl where cattle production may be severely constraints due to tsetse or other reasons. Small holders and landless peasants can practice beekeeping. The hive occupies very little space and bees can collect nectar and pollen from anywhere they can get. Beekeeping does not compete for resources with other agricultural endeavours and can be run integrally with other agricultural activities. Man cannot harvest and utilize nectar and pollen in the absence of bees. Bees' culture does not disturb ecological balance, as cultivation of crops and practices of animal husbandry. The investment and running costs are relatively low

with minimal risk. Beekeeping is a very long-standing and deep rooted practice in the rural communities of the country and around one million farmers are estimated to keep bees (Gebereyesus, 1973). Beekeeping has been and still plays a significant role in the national economy of the country as well as for the subsistence smallholder farmers. Beekeeping has many advantages that help farmer beekeepers to improve their well being. 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, 2002).

2.4. Honey Quality

Honey is a natural sweet substance and is produced by honeybees from the nectar of blossoms, from secretion of living parts of plants. Honeybees collect this material, transform and combine it with specific substances of their own, store and leave in the honey comb to ripen and mature for their own consumption (Codex Alimentarius, 1989). Freshly extracted honey is a viscous liquid, has a greater density (1.5g/cm3) than water (1g/cm3 at 4ºc), having a strong hygroscopic character, relatively low heat conductivity, low surface tension and various colors that are basically all nuances of yellow amber (Bibil *et al.*, 2008).

Chemical composition of honey mainly depends on the vegetation sources from which it derives, though external factors like climate, harvesting conditions and storage can also influence it (Crane, 1980). Careless handling of honey can reduce its quality. Amongst the factors that most influence quality is high temperature, length of storage and moisture content greater than 21 % (Nuru, 1999).Moisture content is one of the most commonly monitored parameters as international quality standards for honey (Ethiopian Quality Standard Authority, 2005).

3. Materials and Methods

3.1. Description of the study area

Bako Tibe district is found in Western Showa zone, Oromia Regional State, Western Ethiopia at about 250 km from Addis Ababa and 125 km away from the zonal capital, Ambo.Bako Tibe is bordered on the South and West by the East Wollega Zone on the north by the Horo Gudru Wollega Zone, and on the East by Chaliya and Ilu Gelan district of Western Showa zone (Figure 1). Bako Tibe has latitude of 9°08'-9.133°N and 37°03'-37.050° E longitude with an elevation of 1743 meters above sea level. It has an altitude at Dega (Highland, 12%), which ranges from 2400 m to 3000 m, Woyinadega (Midland, 37%) ranging from 1800 m to 2400 m and Low land (51%) ranging from 1650-1800m above sea levels. It has climate of ranges from cool to warm. The mean temperature of the area is 21.2^{o}c and 1500 mm of annual mean rainfall (Bako Tibe ARD office Personal Communication, 2013).

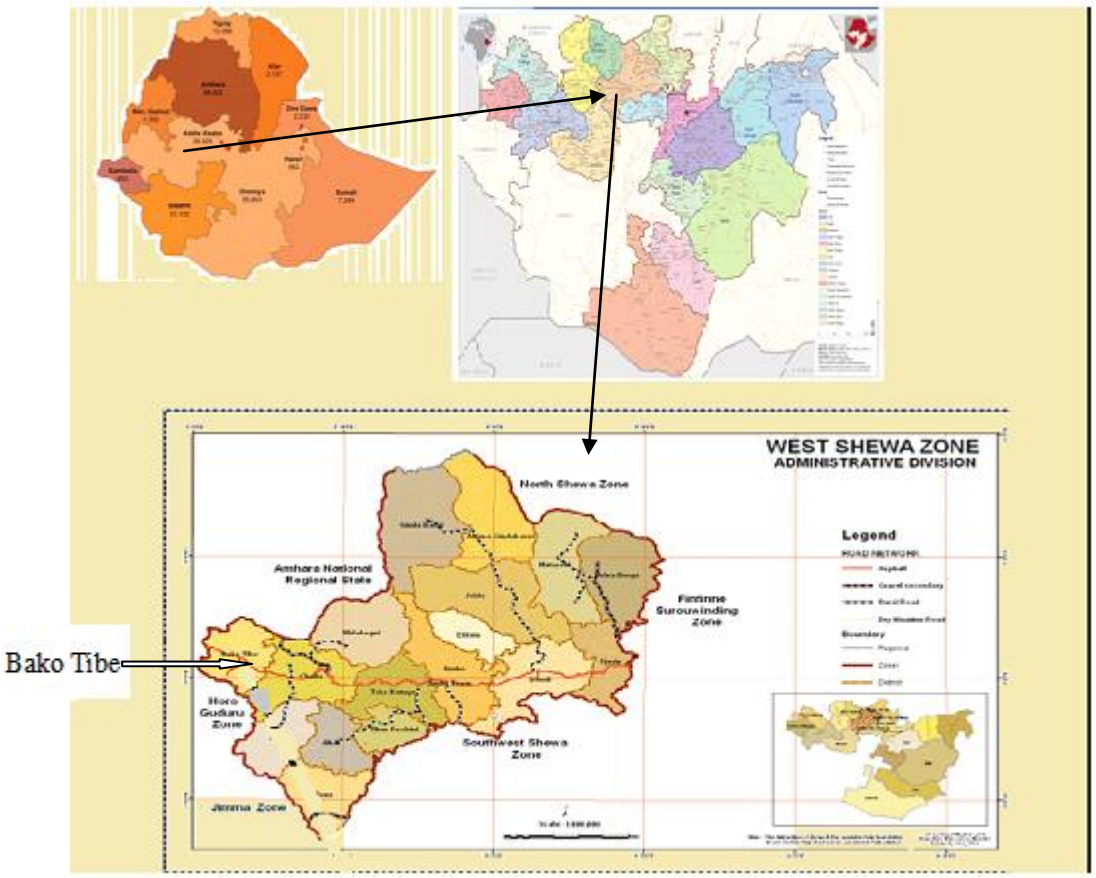


Figure 1: Map of the study area.

3.2. Population

According to the information from the district, Agricultural and Rural Development Office (2013).Bako Tibe district has a total population of 123,558 of which 61,266 and 62,292were males and females respectively. Urban and rural population is 22,849 and 100,709 respectively (Bako Tibe ARD Office of Personal Communication, 2013).

3.3. Socio-Economic activities

The district is characterised by favourable condition for crop and livestock production having relatively better cultivated crops and natural plant coverage, which are mainly bee forage. Due to these the district sustains large number of hived bee colonies. According to the information from Bako Tibe District ARD planning office, the dominant cereals crops of the area are barley, teff, maize and sorghum. Among the pulses, beans, field pea and lentil are the major dominant crops. There are also cattle, sheep, goat, and beekeeping (Table 1).

Table 1: Livestock population in the study are.

No	Livestock type	Unit	Total
1	Cattle	Number	13637,2
3	Goat	‘’	142,212
4	Donkey	‘’	8415
5	Sheep	‘’	12502
6	Muel	‘’	1023
7	Horse	‘’	3685
9	Poultry	‘’	96742
10	Honeybee colony	Bee colony in beehives	26,706

(Source: Bako Tibe ARD Office Personal communication, 2003)

3.4. Infrastructure

The district has schools at different levels i.e. 16 (1-4 grade), 42 (1-8 grade), 3 (9-10grade), and 1 (11-12 grade).In addition, it has all weather roads, which connect Addis Ababa and Nekemt also with Shambu and neighbouring districts. In the district and its neighbouring districts, the forest coverage is large (Table 2).It is a good opportunity for beekeeping activities as a number of nectar and pollen sources plants are major composition of the forest. In addition, there are about 64,469 hectares of land put under area enclosure, which is also an

opportunity for being serving as bee forage plants growing areas. In the area enclosure, it is possible to integrate bee forage, which is contributing much to honey production of the area.

Table 2: Land use pattern in the study area.

No	Land type	Unit	Amount
1	Cultivated land	Hectare	17,407
2	Ready cultivated	‘’	33,623
3	Grazing land	‘’	6647
5	Forest land	‘’	1,289
8	Investment land	‘’	5503
7	Total		64,469

(Source: Bako Tibe ARD Office report, 2013)

3.5. Survey

3.5.1. Study Design

The study design was based on community-based cross-sectional. This included the representative respondents from beekeepers of selected Kebeles of different agro-ecology and key informants also participated in giving important information on beekeeping practices and constraints.

3.5.2. Sample size and sampling technique

The study was conducted in beekeeping potential areas of Bako Tibe district, Oromia region. Prior to the actual survey information was gathered from secondary data from reports of district Agricultural Development Office and informal consultation with key informants. Based on the information obtained from secondary data and informal survey, a structured questionnaire was developed and pre-tested for its consistency and applicability to the objectives of the study. Based on the representativeness from the three agro ecological zones with respect to honeybee colonies potential, 6 Kebeles administrations (Lowland 3, Mid-land 2, and High land 1) were selected out of 28 Kebeles administrations in the district using purposive sampling technique. Per Kebeles administration 20 beekeepers a total of 120 respondents from the three agro-ecological zones were selected by systematic sampling method. Probability proportional to size approach was used to determine the number of

sample households from agro ecology. Single household respondent was used as sampling unit in this study.

To analysis the quality of honey, 13 honey samples were randomly collected from the three agro ecological zones (Kolla 6, Woyinadega 4, and Dega 3) from beekeepers of beekeeping Kebeles administrations of Bako Tibe district. About 100gm of fresh honey samples from each sampling point were collected during the peak honey harvesting season (November to December) from the three types of hives (Table3).

Table 3: Honey sample taken for laboratory analysis in different agro-ecology from different hive in the study area.

No	Agro-ecological area	Type of hives in the study area			Total
		Traditional hive	Transitional hive	Modern hive	
1	Kolla	2	2	2	6
2	Woyinadega	2	2	-	4
3	Dega	3	-	-	3
4	Total	7	4	2	13

3.5.3. Data collection tools

Prior to the actual survey, pre-testing of tools was done by involving beekeepers who were not selected for the study.

A. Semi-structured questionnaire

The primary data was collected from sample respondents through the semi-structured questionnaire. A semi-structured questionnaire was developed and used, which was prepared in English language. On the basis of information obtained during pre-testing, modification has been made on the questionnaire. Information obtained during pre-testing has been included to the questionnaire and the final questionnaire has been translated into *Oromifa*.Then, the enumerators were recruited from the study area and made acquainted with the questions, trained on methods of data collection and interviewing techniques. The respondents were those who engaged in beekeeping activities. After taking the list of beekeepers and each beekeepers was assigned by a number of written on a piece of paper and placed in a container from which each respondent randomly picked to be interviewed.Interviewing the sample respondents through questionnaires was needed as the respondents may not read and write to fill the questionnaires. Then; the information was

collected through field surveys made to the target beekeepers from the three agro-ecological areas.The researcher adequately administered and supervised the data collection process and checked the quality of the returns to avoid bias and errors on the spot.

B. Focus group discussion (FGDs)

For obtaining the relevant information on honey production system and beekeeping, focus group discussion was conducted with potentially honey producers of beekeepers, extension workers (development agents) from Kebeles administration of three agro ecology and beekeeping extensions of the district. The beekeepers who were for focus group discussion were those beekeepers who are not included in the house hold survey and are known by their bee keeping performance and selected with help of development agent. In the focus group discussion, farmer's idea towards beekeeping was assessed to evaluate the main constraints of honey production system and beekeeping practice of the district.Discussion guides were developed and used to facilitate the focus group interview. Key informants (knowledgeable observers of the sub-sector) were also identified and interviewed in order to obtain their views, opinions and suggestions about constraints and opportunities.

3.6. Laboratory Analysis

To determine the quality of honey, honey samples were randomly collected from three different agro-ecological zones. Moisture content, pH, acidity and ash content were determined according to the Harmonized Methods of the International Honey Commission (Bogdanov, 2002; Geremew, 2005) and also pollen identification was done. The laboratory test of honey were done at HBRC and Ethiopian quality standard of honey at Addis Ababa.

3.6.1. Moisture Content of honey

The moisture contents of honeys were determined using the refractometer. The equipment was used to determine the percentage of moisture in honey. About 2g of honey was transferred using a stick on the lens of refractive index by opening the lead, and the lead was closed and observed through the eye piece of the refractive index.Water contents of sample was read from refractive index and the result was recorded. Finally the refractive index was cleaned and used again.

3.6.2. PH content of honey

The PH of each honey sample was determined using digital PH meter.10g of honey sample was dissolved in 75 ml of distilled water in 250 ml beaker. The solution was stirred and pH electrode was immersed in the solution and pH value was recorded.

3.6.3. Acidity of honey

Ten grams of honey were weighed with the help of electronic balance and poured in conical flask and 75 ml of distilled water were added by rinsing the utensil. The solution is titrated against 0.1 N NaOH solutions in burette using phenolphthalein as indicator. The titration was carried out till the solution turns pink from colour less. The acidity was determined using the formula (Agbagwa, *et al*., 2011)

$$\text{Total Acidity} = \frac{Titration\ reading\ x\ Normality\ of\ NaOH}{Weight\ of\ Sample} \text{ x } 9$$

3.6.4. Ash content of honey

Two grams of honey were weighed and taken in a silica crucible and 3-4 drops of olive oil were added to avoid fluttering and kept in muffle furnace at 600 ^{O}C for 3-4 hours. The weights of the ash were determined by deducting the weight of empty crucible from the total weight of empty crucible and ash. The percentage of ash was calculated by using the following formula (AOAC, 1990)

$$Ash\% = \frac{(Weightofcrucible + ash) - (Weightofemptycrucible) \times 100}{Sampleofweight}$$

3.6.5. Extraction of pollen from honey samples

From each honey sample, 10 gm of honey was dissolved in 40 mm distilled water and the solution centrifuged for about 10 minutes. After decanting the supernatant, the remaining residue was diluted again with 10 mm of water. After centrifuging for further 5 minutes, the sediment was transferred on to a slide of microscope for observation. Then glycerin jelly was added to make the pollen grains clear. After that, the pollen grains were examined under a microscope with a 400x magnification power. Pollen grains examined and identified were counted in each sample and Percentage occurrence of pollen was used to determine their

frequencies following the system adopted by (Louveax, 1978) for determining the major honey plants.

3.8. Data analysis

The collected data were coded and tabulated for analysis. The statistical analysis used for survey study was descriptive statistics using SPSS version 16.0 to mainly analyses parameters like mean, Cross tab and frequency. Honey quality parameters were also analyzed using SPSS version 16.0.using ANOVA to test the mean differences among honey quality parameters. The qualitative data gathered through group discussion were summarized by putting the same responses in the same category.

4. Results and Discussion

4.1. Socio-demographic characteristics of respondents

Of the total of 120 respondents interviewed to generate qualitative and quantitative data on beekeeping, about 99.2% were males and the rest 0.8% were females (Table 4). The study showed that, very limited number of females engaged in beekeeping.The main reason for low participation of female could be attributed to the forest beekeeping system of the area that culturally prohibit women involvement in beekeeping for the reason they cannot climb up the tree either to bait swarm bees or to undertake beekeeping by hanging on big tree. This was in line with the reports of Hartmann (2004) who noted beekeeping as the man's job in Ethiopia and Solomon (2009) who indicated beekeeping as main activity of male in Bale highlands of South East Ethiopia.

The mean age of respondents was 34.97 years (range 20 to 68 years).This survey result showed that people in the most productive age were actively engaged in beekeeping activities and the beekeepers had an average experience of 17.2$\pm$7.4 years(range from 1 to 36 years). The beekeepers' experience was long that an individual was continuously engaged in beekeeping. This indicates that the beekeepers of the area had long beekeeping experience and were actively engaged starting from an early age in helping older parents to undertake basic tasks. Based on this exposure, young people gradually move on to become independent beekeepers as soon as they can obtain their own hives. Similar result was also reported by Gichora (2003) young people become independent beekeepers as they gain experience from their family and obtain their own hive. They could continue accumulating experience by seeking technical advice from fellow beekeepers and development agents (DAs) whenever necessary. Similar study was undertaken by Aseffa (2009) and Workneh (2007) who documented that beekeepers with longer beekeeping experience were able to adopt the use of improved box hive than beekeepers with short beekeeping experience.

Of the total respondents, 89.2% were married while 9.2% and 1.7% were single and divorced, respectively. They reported that honey production done since it has economic and nutritional value and also used to help their family to educate children.With regard to religion, the majority of the respondents (60%) were protestant and 35% and 5% were Orthodox and Muslim respectively (Table 4). This result showed that beekeeping could be practiced by any person coming from any religion in the study area.

Table 4: Socio-demographic characteristics of respondents in study area (n=120).

Status	Variable categories	Frequency	Percent (%)
	Male	119	99.2
Sex	Female	1	0.8
	Single	11	9.2
Marital struts	Married	107	89.2
	Divorced	2	1.7
	Orthodox	42	35.0
Religion	Muslim	6	5.0
	Protestant	72	60.0
	First cycle	16	13.3
	Second cycle	40	34.2
Educational status	High school	22	18.3
	Preparatory	1	0.8
	Illiterate	40	33.4

4.2. Educational status of the respondents

Regarding to educational status, 33.4 % of the respondents were not educated and of this 6.7% could read and write. While about 66.6% were educated specifically 13.3%, 34.2%, 18.3 and 0.8% attend 1^{rst} cycle(1-4), 2nd cycle(5-8), high school(9-10)and preparatory school (11-12) respectively, whereas, 26.7% of beekeepers were not able to read and write (figure 2). As sited by Gichora (2003) for advanced beekeeping, one should have a good grasp of bee biology and behavior of bees for better colony management. The involvement of illiterate in beekeeping activities could be attributed to the cultural influence existing in the study area.

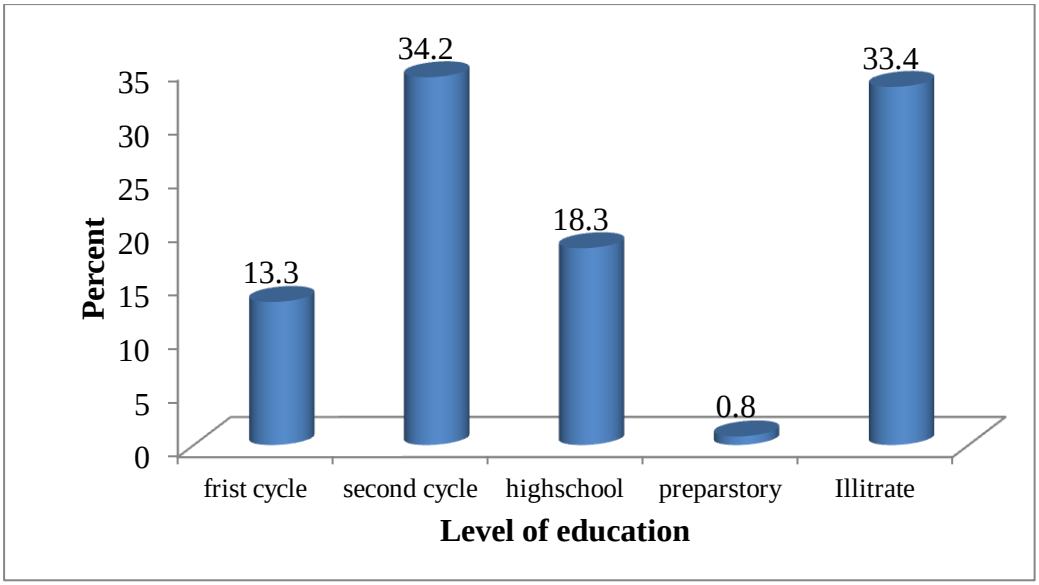


Figure 2: Educational status of the respondents in the study area.

4.3. Land holding

Of the respondents 53.3% had their own land for cultivation of crops and as grazing land for their livestock and on the average they had 1.2, 0.05, 0.2 hectare of farm land, forest land and grazing land, respectively (Table 5).Form the total land holding of the respondents, the mean land holding was 1.45 hectares (range 0– 6 hectares). About 46.7% of the respondents had no private land holdings which indicates, beekeeping can be applied even with those who have no land. Beekeeping does not require fertile land and uncultivated area is suitable for beekeeping: for landless farmers, having apiary site is sufficient for engaging in the activity (Workneh, 2007). The study in agreement with report by Tessega (2009) who reported that beekeeping can be practiced with those beekeepers who have no their own land in Bure district.

Table 5: Land holding of the respondents in the study area.

Land	N	Minimum	Maximum	Mean	Std. Deviation
Farm land	120	0.00	4.50	1.18	1.32
Forest land	120	0.00	0.50	0.05	0.12
Grazing land	120	0.00	1.00	0.20	0.27
Total land holding	120	0	6	1.45	1.60

4.4. Livestock holdings and purpose of beekeeping

The major livestock which reared in the study area includes cattle, goat, donkey, sheep, Horse, poultry and honeybee. The mean livestock holding per house hold is shown in (Table 6). As an integral part of the mixed farming system, livestock production plays a substantial role in the household food security in the area. It meets urgent financial need, dietary requirements, draught power, transport, loan repayment, dowry and gift, fuel, fertilizer, as a buffer in the case of crop failure, and also for social and cultural function. In general, among the respondents, 24.2% owned no ox, indicating that resource poor farmers were also participating in beekeeping. However, 20% of the respondents owned one ox, 26.7 % owned two and 29% owned more than two oxen. According to the ARD Office report, about 26,706 honeybee colonies within the beehive in district. The mean honeybee colony holding of respondents was 14.64 colonies (Table 6).

Table 6: Livestock and honeybee colony holdings of respondents in the study area.

Livestock	N	Minimum	Maximum	Mean	Std. Deviation
Oxen	120	0.00	6.00	1.90	1.60
Cow	120	0.00	10.00	2.54	1.89
Goat	120	0.00	3.00	0.33	0.83
Sheep	120	0.00	6.00	1.13	1.54
Camel	120	0.00	1.00	0.01	0.09
Mule	120	0.00	1.00	0.15	0.36
Donkey	120	0.00	2.00	0.49	0.62
Poultry	120	0.00	8.00	2.42	2.04
Horse	120	0.00	7.00	0.14	0.72
Honeybee colony in hive	120	3.00	120.00	14.64	14.84

4.5. Characterizing honey production system and Beekeeping practices

A) Source of honeybee colonies to start beekeeping

The study showed that the knowledge of beekeepers differs from beekeeper to beekeepers and from area to area, based on their experiences, training and educational level. When

beekeepers were asked to explain how they started beekeeping, 22.5% started beekeeping by learning from neighbours. About 51.7% learned beekeeping practices from their parents, while about 17.5% of the respondents reported that they were learned about beekeeping from others such as, friends, respectively (Figure 3).The results agreed with the study of Tessega (2009) and Chala (2010) who reported that, beekeeper of Bure district of Amahara region and Gomma district of Jimma zone establishing bee colonies by catching swarms, buying, gift (from parent), training and Agricultural office.

Only 8.3% of the respondents acquired beekeeping knowledge through training, this indicates that little work has been done in promoting beekeeping practice in the study area. The main reason to start beekeeping from the family was experience during the early stage. According to the respondents catching, swarm was not much practiced by beekeepers to increase their bee colony in the study area. However, they used traditional way to increase bee colony by hanging new hive on a tree after smoking the hive with dry comb, Agamsa (*Carissa edulis*) and spray fresh cow milk were added in the hive to get bee colony during the flowering season.

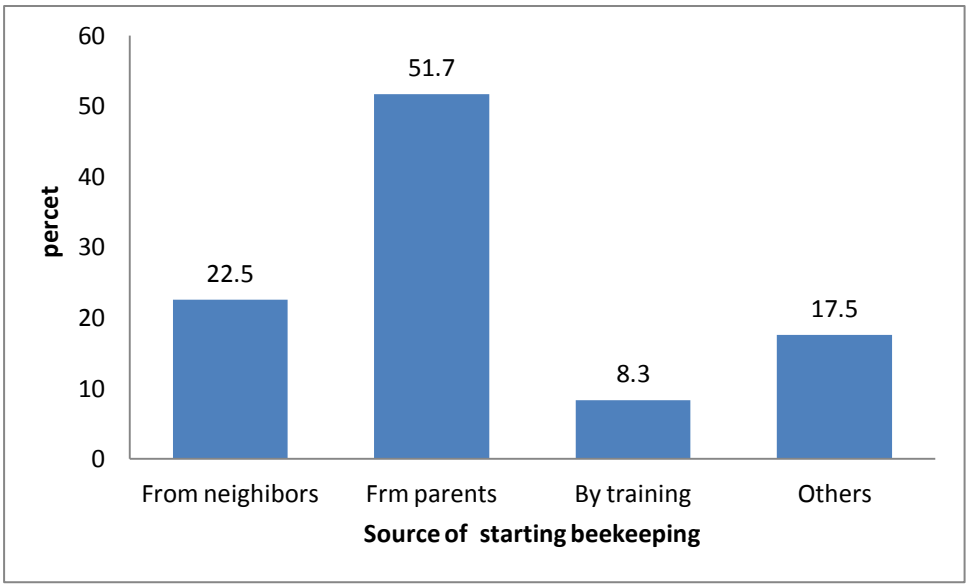


Figure 3: The source to starting of beekeeping in the study area**.**

B) Placement of honeybee colonies

Beekeepers of the study area kept their honeybee colonies in different areas among which about 41.7% at backyard, 28.3%, 27.5%, 2.5% under the roof of the house, both under roof of house and in forest (hanging on the tree) and in forest, respectively (Table 7).

Table 7: Placement of different beehives after colony capturing in the study area

	Frequency	Percent
open back yard	50	41.7
In forest	3	2.5
under the roof	34	28.3
under roof & in forest (on the tree)	33	27.5

Only few beekeepers put modern beehives and transitional beehives near their house (backyard) and/or in forest (Plate 1).Most of the respondents in the study area kept their hives in the back yard. This might help them to manage easily their colonies to provide shelter, provide feed and water frequently and protect them from bee enemies. Similar result also reported by Maeza (2010) and Nuru (2002) who showed that some beekeepers distributed their hive along all apiary site in most part of the country in order to protect their bee colony.

Plate 1: Placement of beehives in different apiaries in the study area.

4.6. Beekeeping extension service

This study showed that about 54.2% of the respondents were aware of using improved box hive through the support of development agents informally without any demonstration during field visit and also during other formal meetings such as "Idir "meeting and about 45.8% of beekeepers were not aware. Moreover, only about 3.3% of beekeepers received improved beehives. This reflects the need for creating awareness through beekeeping extension system in the future for sustainable beekeeping developments in Bako Tibe distinct.

According to the result of this survey, 76.7% of the respondent reported that the problem was improved box hive was not available in the study area and 20% of respondents reported it was very expensive to buy the improved box hive.

4.7. Beekeeping practices in Bako Tibe distinct

The results indicate that, 1673, 47 and 10 hives were traditional, transitional and modern with honey bee colony respectively and 709, 23 and 4 hives were traditional, transitional and modern without honey colony, respectively. Traditional beekeeping is the most predominant in the district. This could be due to the lack of knowledge, experience, limited training, access of credit and low awareness to adopt the transitional and modern hives .This was in line with the finding of the study by Amsalu *et al.* (2004) who reported that beekeeping practice in Ethiopia was pre dominantly traditional.

A. Traditional beekeeping

About 91.7% of respondents practiced traditional beekeeping. In the study area traditional beehive used were mostly cylindrical in shape with the dimension of around 1m in length and diameter of around 20cm (Plate 2).The traditional beehives were constructed from ”Soyama’’ *(Vernonia thomasoniana*), ”Koso*’’ (Hagenia abyssinica*), Eukalaptus, Dhokonu (*Grewia ferruginea*), Bamboo and other locally available materials. This is in agreement with the report by Fichtl and Admasu (1994) who reported that traditional hive were made from locally available materials. The internal part of the hives was smoothened with mud or cow dung and the external part of the hive, were covered with the grass to protect from rain.

The beekeepers attract bee colony to the new hive by smoking the new beehives with ‘ejersa’ (*Olea afircana*), Sombo (*Ekebergia capensis*), Tungit (*Otostengia intergrifolia*), Kusayee (*Lippia doensis*),”dokima’’(*Syzgium guinneese*),”Bessobila’’(*Ocimum sanctum*),’’Wanza’’ (*Cordia africana*).Method of smoking the new hive was done by digging the hole and preparing the smoke and putting the new hive upside down which has fire. The new hive may be fumigated until the internal colour of the hive gets brown .Then; the hives were hanged up in trees where the bee swarm can be caught and then ready to be transferred to the ground. Often, such hives were placed in a kind of bee house that protects the hives from the heat and rain such as backyard, under house roof (Plate 2.)

This finding agreed with the result of Workneh *et al*. (2006) who reported that beekeepers of west south, western and North showa zone smoke new hives with Kusaye (*Lippia doensis*), Ejersa (*Olea afircana*), Sombo (*Ekebergia capensis*), “Tungit *(Otostengia intergrifola)*, ”Bessobila”(*Ocimum sanctum*, “Itan” (*Boswelia papifera*) ”Tejsar’’ beeswax and “Wanza” (*Cordia africana*) to attract bee colony.

Plate 2: Placement of traditional hives in different apiary in the study area.

During honey harvesting from traditional hives, beekeepers cut and pull the fixed combs one by one and some combs would be left intact without being harvested. Beekeepers harvested the honey or brought the hive to the ground to harvest by using smoke. Most of the beekeepers interviewed in the study area used wood for smoking during harvesting, while the rest of beekeepers used dried animal dung. The use of this traditional smoker during honey harvest could have a big problem in some areas as they miss fire in hive. This may cause burning of the beehives with entire bee colony and also high chance that the colony (queen) killed during harvesting time.According to the survey results, the mean number of traditional hives per respondents was 13.94 with minimum of 3 hives to a maximum of 90 hives. The average yield obtained from a given traditional hive per annum in the survey area was about 10.1kg/hive (range 5kg to 15kg/hive).The study indicated that the yield obtained from traditional hive increase as compared to the survey result reported by Workneh *et al.* (2006) conducted in west, south west and north Showa zone which was about 6.2kg.The results show that there is honey production potential in the area.

B. Transitional beekeeping

According to the survey results, about 5% of the respondents used both the transitional and traditional beehive in the study area. The number of transitional hives owned/house hold has a mean of 5.2 with minimum of 2 to maximum of 20 hives which was very low and needs Bako Tibe district Agricultural office to increase the utilization of transitional hive since it is a bridge to modern hive technology. The productivity from one transitional hives had a mean of 18.55kg/hive ranging from 15kg to 23kg/hive which was harvested once per year.

The study showed that in the area there was no nongovernmental (NGO) and Research center which initiated the beekeepers to use transitional hive and improved box hive except the district agricultural bureau which give training without demonstration or practical application how to use box hive. But, without practical training, beekeepers were encouraged to construct

the transitional hives from locally available materials such as Bambo (*Arudinaria alpina*),"Shembeko" (*Arudina donax*), "Shimel" (*Oxytenathera abyssinica*) and "Nech Beharzaf" (*Eukcalaptus globulas*) and they plastered by animal dung (plate 3).The result is in line with the study conducted by Chala (2010) who reported that in Gomma district of Jimma zone beekeepers made transitional hive from locally available materials and plastered with fresh cow dung and fumigated with smoking materials. Some beekeepers construct their transitional hives from lumber and others from mud, which is a mixture of clay, cow dung and ash (plate 3).

Plate 3: Types of transitional beehives in study area.

C. Frame beekeeping practice

The study shows that, about 3.3% of respondents used the combination of all traditional, transitional and modern box hives. The average number of modern hives/house hold is 2.5 and only1.7% of modern hives was without colony because of lack of equipments (accessories) and lack of practical knowledge. The productivity ranged from 25 to 36kg/hive with mean of 29.67kg.The result shows that, lack of experience and extension support in the study area highly impacted the use of improved box hive. According to observation during survey, some of the respondents placed their modern box hive in appropriate place (Plate 4) where as some respondents was not placed at appropriate area due to lack of skill to use and lack of extension support beekeepers put near the toilet and others put empty without bee colony.

Plate 4: Properly placement of modern beehives in the study area.

Therefore, providing accessories, training and credit availability would be the best solution to improve beekeeping in the study area. Credit access is important for beekeepers to purchase modern box hive, initial capital for start modern beekeeping management and honey production and hence increase honey production at individual and community level. But in the district, 100% there was no credit access for beekeepers to purchase modern hive. This was constraint for beekeeping development and adopting the modern hive by beekeepers in the district. Similar study was conducted by Workneh (2007) who reported that lack of initial capital hinders the beekeepers particularly resource poor beekeepers from adopting modern hive. Crane (1990) also reported that modern hives could allow appropriate colony management and use of a higher level technology, with larger colonies, and might give higher yield and quality honey, but is likely to require high investment cost and trained manpower.

4.8. Equipments used during honey harvesting season

According to the study, 94.2% of the respondents had no improved honey harvesting materials during honey harvesting season and they used locally made smoker from dried animal dung, knife, bee brush made from grass and some of them used the leaves of plant and only 5.8% used, smoker, overall bee veil, hand glove, and boot shoe during bee colony inspection and honey harvesting season. The study showed that about 59.2% of the respondents reported that there was no protective material in the study area and 35% of the respondents had no idea about the use of protective materials; however, they used traditional mechanism during honey harvesting season. Apart from the known basic hive equipment, many of the materials were either non-existent or kept by quite few numbers of respondents. Even, there was no honey extractor, and casting moulds reserved at district of Agricultural and Rural development Office or livestock agency office which serves the entire district beekeepers' for demonstration purpose and to give for beekeepers during honey harvesting season.

4.9. Honey harvesting techniques and season

The study showed that, the respondents used different indicators during honey harvesting time. About 65% of the respondents could identify through undertaking internal inspection of hive during honey harvesting time. Internal inspection might be difficult for traditional hive to inspect comb for honey harvest and brood disease as it can be in the transitional and modern hives.

About 24.5% of the respondents made external inspection to check the readiness of honey harvest when bee colony clustered in front of the hive, 10.5% by associating with end of flowering season and weighing of the hive. Some beekeepers could identify honey ripeness by inserting a thin sized stick in to the hive. If there is honey, the stick comes out bearing honey strips. These methods of indicators are not efficient in exactly detecting whether the honey is ready or ripe enough to be harvested. But in the case of transitional and modern hive the maturity of honey and pure honey can be easily observed through undertaking internal inspection by lifting up the top bars and the frames.

Regarding to honey harvesting practice, the traditional method was more or less similar with that of transitional and improved practice of honey harvesting. This is because, in the three beehives traditional equipment such as traditional smoke using dry animal dung, using grass or leaves brush and local knife for cutting comb were commonly used. Any production obtained in the remaining periods of the year would be left as food for the colony in the hive to strengthen it for the next harvest.

Most of the beekeepers in the study area identified honey harvesting season by the experiences they developed in their respective areas. Based on the survey result, about 87.5% of respondents made honey harvesting only once per year, while 12.5% harvest two times per year. The study shows that, 81.7%, 5.8% and 12.5% of the respondents harvests their honey from November to December, December to January and both November to December and April to May, respectively. This result was agreed with Tessaga (2009) and Chala (2010) they reported that honey was harvested once or twice in Bure and Gomma district, respectively. Similar results also reported by Mathewos *et al.*(2004)and CSA (2008) who indicate that the majority honey flow season was November to December in different part of Ethiopia.

4.10. Management of honeybee colonies

The study shows that, the management of honeybee colony in the study area was less and this was attributed to limited knowledge of the beekeepers on seasonal bee management. The study also indicated that mostly, internal hive inspection was limited to those honeybee colonies placed at backyard and under the roof of the house. During the survey period it was observed that beekeepers did not manage the place of bee hive properly. The result agreed with the study of Gebereyesus (1976) who reported that beekeepers do not pay much attention to bee management activities, but harvest honey when it is there by killing the bees, which is very common in many part of the country even today. To this fact, the study group reported that training of beekeepers was one of the essential inputs in the beekeeping sector in order to carryout proper colony management, increase yield, to attain good management practice, to sustain business, appropriate input utilization, honey quality maintenance and handling, honey bee forage development, and pest and disease control.

4.11. Honey extraction, processing and storage methods

According to the results of this study, about 83.5 % of the respondents harvested crude honey, which was obtained by breaking honey combs into smaller pieces by hand or a stick. Crude honey mostly dominated in the study area. This might be due to less accessibility of modern technology and equipments to process honey. Similar result was also reported by Nuru (1999) who describe that low productivity and poor quality of bee product in Ethiopia was due to the lack of manage bees and bee products. In principle, honey harvested with brood can be spoiled rapidly and should be separated at harvesting time from the pure honeycombs. According to this study, only 16.5% of the respondents separated honey from beeswax and sale it as pure honey at local to different governmental workers and others.

The study indicated that, 60% of the respondents' stored honey in plastic jars, 16.7% of beekeepers using combination of all materials such as plastic jar (sac of fertilizers at moisture free area) and 23.3% used traditional storage containers like clay pot and guard. The containers were fitted with lids made of locally available materials and sealed with mud and ash mixed. Such traditional containers were liable to breakage and canal so absorb moistures or may change the flavour of honey that lead to honey quality deterioration. The beekeepers reported that they sold the largest proportion of their honey during harvesting season at low price mainly to meet their demand for cash to pay taxes, debts and other social obligations.

The result is in agreement with Beyene and David (2007) ensuring small scale producers in Ethiopia to achieve sustainable and fair access to honey markets.

4.12. Honey and beeswax production

A. Honey

Based on the survey result, the mean bee colony (hives/respondent) were 13.94, 5.2 and 2.5 for traditional, transitional and modern hive, respectively. Nevertheless, based on respondents estimate, the crude honey yield per hive ranged from 5- 15 kg, 15kg - 23 kg and 25 -36 kg for traditional, transitional and modern hive, respectively (Table7).The mean weight of honey produced in different ecological zones varied depending on the beehive type. Accordingly, the yields obtained were 12.1±12.1, 9.9±2.5 and 9.5±2.2 kg from traditional hive in Dega, Woyinadega and Kola, respectively. Whereas, 18.6±3.3 and 18.5±2.5kg from transitional in Woyinadega and Dega, respectively. About 28±7.7 and 30.5±0 from improved hive from Woyinadega and Dega zone, respectively (Table 7).

Table 8: Honey yield (kg/hive/year) from different beehives of different agro-ecological zones in the study are.

Agro-ecology	n	Type of hive in study area								
		Traditional			Transitional			Modern hive		
		Min.	Max.	Mean (±SD)	Min.	Max.	Mean (±SD)	Min.	Max.	Mean (±SD)
Dega	3	6	15	12.1±12.1	Ns	Ns	Ns	Ns	Ns	Ns
W/Dega	6	5	13	9.9±2.5	15.0	21.0	18.6±3.3	28.0	28.0	28.0±7.7
Kola	4	5	15	9.5±2.2	15	23	18.5±2.5	25.0	36.0	30.5±0
Total	13	5	15	10.1±2.6	15.0	23.0	18.5±18.5	25	36	29.6±5.6

** SD=Standard deviation, Ns=No sample*

The quantified honey yields were more of estimations by the respondents. This could be due to the fact that it was difficult to accurately determine (lack of measuring instruments) the honey produced in the study area as most of beekeepers were not correctly weigh the amount of honey harvested. The survey result show that honey yield of the study area was increasing as compared to national average of honey which is 5 kg 12-15 kg and 15-20 kg,respectively for traditional intermediate and movable frame hives, respectively (MOARD, 2003;Gezahegne, 2001). The survey conducted in West Showa Zone showed that, average

honey yield of traditional hives was 6.1 kg per hive per annum (Edessa, 2002).There was a similar report from study by Bezabih (2010) and Edessa (2005) which showed that the current honey production in Ethiopia increased. This might be due to the introduction of transitional hive, modern hive and policy guidance of beekeeping in several part of the country. However, the amount of honey produced in a given area may depend on the availability of bee flower and the level of bee management knowledge of beekeepers in the study area.

These results (in table 7) were indicators of the existence of increasing performances of these beehive managements through good management practices coupled with favourable beekeeping environment. This may include favourable weather condition, increment of beekeeping participant and in some case due to shortage of farming land they go to beekeeping practice as source of income generation. However, it is yet not satisfactory in relation to its potentiality; this could be due to less extension support, use of traditional beehive, less attractive market for bee products and there is no organized beekeeping enterprises which provides the immediate potential for increasing the supply and the quality of both the honey and wax through the development of well structured supply chains, and the construction of facilities and uptake protocols for handling, processing and storage. Still inEthiopia beekeeping practiced and considered successful but honey yield Kg/hive were remain low. According to Musumhi (2013) in other country like China the average honey produced from modern hive was between 50-150 kg of honey per hive, whereas several African countries average 15-25 kg per hive. The difference shows that, still less attention is given to honey production system and there is an adequate training, lack of using technology to increase the yield in Ethiopia.

B. Beeswax

The study shows that, only 16.7% of respondents collected beeswax alone by extracting crude beeswax in the study district. Hence, about 83.3% of the beeswax produced was wasted for not having understood its values. This showed that, only few beekeepers collected crude beeswax from their hive and used as a candle light at home or give the produce as an offer to Orthodox churches. Consequently, beeswax was not often harvested for market in the study areas, but only few farmers do so for home use. The major reason was lack of knowledge of its use, lack of processing skill how to harvest it, absence of demand in the local market and lack of processing material. The same results also reported by CSA (2008) and Tessega

(2009) who described that bee wax is mostly left or thrown away in Bure distinct of Amara region. Fitchtl, Admasu (1994) also reported that in several region of Ethiopia, bee wax collection is not significant and considered as wastes.

4.13. Honeybee Feed and Plant source

Honeybees store honey for their own consumption during dearth period. Beekeepers were harvesting honey, which the honey bees stored for themselves. As a result, honeybees face starvation due to lack of feed. To overcome the problem, supplementary feed is required for the honeybees. In the study area, it was found that about 64.2% of the respondents had no ideas of providing supplementary feed to their own bee colony during dearth period, whereas 35.8% of the respondents are providing supplementary feed. The supplementary feeds include Beso *(*18.3%), Shiro (0.8%), Honey (3.3%) and other (13.3%) such as sugar syrup. This was agreed with the study by Workneh (2007) who reported that the supplementary feed for honey bees include sugar, barley flour, peas and bean flour. In addition, to supplementary feeding, planting bee forage was also practiced to get the intended honey yield. Bee forage determines the amount of honey yield obtained. In the study area, there was no improved bee forage promotion. Moreover, there was no extension activity which encourages beekeepers to conserve indigenous bee forage but the beekeepers cultivated indigenous plant for different purpose of incomes such as Sun flower, "Girawa" (*Vernonia anygdalina),* "Gesho*" (Rhmnus prinoides),*"Sespania "(*Sesbania sesban),* "Bahirzaf*" (Eucalyptus globules) '*'Wanza'' *(Cordiana africana)* and "Tenadam" (*Ruta chalepensis*) serving as honeybee pollen and nectar sources (Plate 5 and Table 8).The result of study is in line with the result of study by Tessega (2009) who reported that beekeepers of Bure district have no indigenous knowledge to planting bee forage ,but they plant for their own purpose to income generation, which serving as honeybee pollen and nectar sources for honeybees .

Plate 5: Some bee flowers in the in the study area

Table 9: Some honeybee plant species in the study area(n=120)

No	Local name(Oromiffa)	Scientific Name	Frequency	%
1	Wadeessa	*Cordiana africana*	120	100
2	Tufoo	*Guizotia scabra*	120	100
3	Bargamoo	*Eucalyptus globules*	120	100
4	Eebicha	*Vernonia anygdalina*	120	100
5	Siddisa	*Trifolium rupliannum*	113	94.2
6	Makkanisa	*Croton macrostachys*	119	92.2
7	Dhumugaa	*Justitia schimperana*	94	78.3
8	Laftoo	*Acacia abyssinica*	93	77.5
9	Hagamsa	*Carissa edulis*	60	50
10	Koshimii	*Dovalis abyssinicus*	59	49.2
11	Qobboo	*Pinunus communis*	45	37.5
12	Baddeessa	*Syzygium guineense*	27	22.5
13	Kelloo	*Bidens patchloma*	25	20.5
14	Ejersa	*Olea Africana*	25	20.5

*****Percentage exceeds 100% because of multiple response

The major honey flow season was from November to December and the minor flow season is from April to May .The major bee forage plants identified by survey and group discussion in district was presented in Table 8 and 9 which are natural plant and cultivated, respectively.

There were also areas allocated for forest development and soil conservation works in the district. Similar studies reported that *Bidens prisnaria, Guzotia scrabra, Trifolium spp, Oil crops, Pulses* were documented to be a major source of honey in central highland (Admasu, 1996; Nuru, 2002). Moreover, *Guzotia scrabra*, *Trifolium rupliannum*, *Bidens prestinaria* and *Caylusea abyssinica* were the most common weeds in Ethiopian and they were mentioned as important source of nectar of honey.

It was also documented that locally cultivated crops like Maize (*Zea mays)*, Peas (*Vicia faba)* ,Nug (*Guizoti abyssinica)*, Mango (*Mangifera indica)*, Sorghum (*Lens culiaris)*, Papaya *(Carica papaya)*, Beans (*Pisum sativa)*, lentil (*Lens culiaris)*,Onion (*Allium cepa*) were highly contributing as honeybee forage (Table-9)

Table 10: Major crops used as source for honey bees in the study srea (n=120)

No	Local name	Scientific name	Frequency	%
1	Boqqolloo	*Zea mays*	108	90
2	Nuugii	*Guizotia abyssinica*	98	81.7
3	Maangoo	*Mangifera indica*	54	45
4	Mishingaa	*Lens culiaris*	31	25.8
5	Papayaa	*Carica papaya*	24	20
6	Atara	*Vicia faba*	18	15
7	Baaqelaa	*Pisum sativa*	16	13.3
8	Misira	*Lens culiaris*	3	2.5
9	Shunkurtii	*Allium cepa*	53	44.2

Percentage exceeds 100% because of multiple responses.

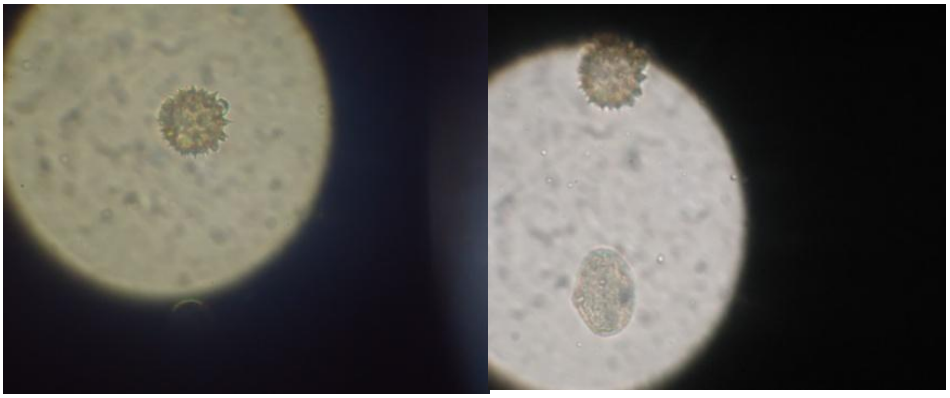
4.14. Identification of plant used as pollen source by honey bees

Laboratory pollen analysis of the honey collected from the study areas was conducted to identify the botanical origin of the honey (Plate 6).Accordingly, *Guizotia spp* (84.6%), *Vaciafaba* (53.8%), *Zea mays (46.2%), Bidens pachyloma (38.7%*), *Plantago lanceolata* (30.8%), *Sorghum bicolour* (30.8%), *Ocimum bacillus* (23.1%), *Vernonia spp (*23.1%), *Trafolium spp* (23.1%), *Hypostes forskolii (*15.4%), *Eucalyptus spp (15.4%), Pisum sativa* (7.1%), *Petrolobium stellatum* (23.1%), were identified as plants contributing to honeybee food sources in the area (Table.10), plant was identified from 13 honey sample as the major honey plants for they represent most of the percentage distribution.

Table 11: Honey plant species identified through pollen analysis in Bako Tibe district, Ethiopia (n=13)

Name plants	N	Frequency	%
Guizotia spp	13	11	84.6%
Bidens pachloma	13	5	38.5%
Plantago lanceolata	13	4	30.8%
Hypostes forskoli	13	2	15.4%
Ocimum bacillus	13	3	23.1%
Trafolium spp	13	3	23.1%
Vernonia spp	13	3	23.1%
Vetrolobium stellatum	13	3	23.1%
Eucalaptus spp	13	2	15.4%
Zea mays	13	6	46.2%
Sorghum bicolour	13	4	30.8%
Pisum sativum	13	1	7.7%
Vacia faba	13	7	53.8%
Adaatodo schimperiana	13	2	15.4%

Key: *Percentage exceeds 100% because of pollen observed in all honey samples.



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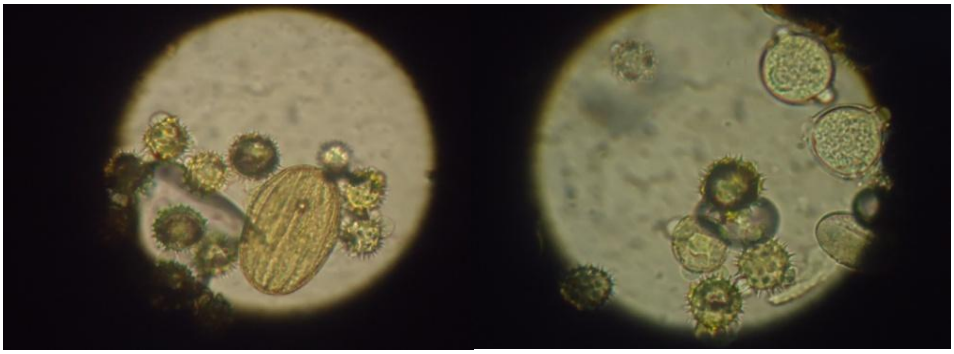
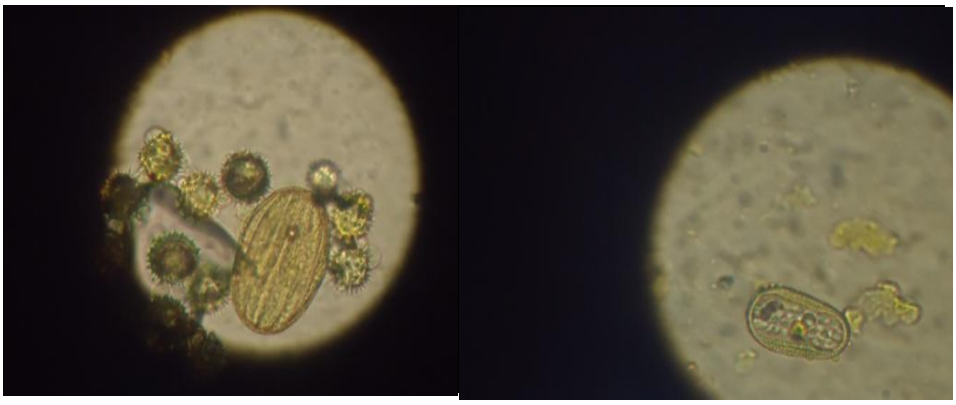


C. D



E F

Plate 6: Plant source identified using pollen analysis in the study area.

(A) *Guizotia spp* (B) *Guizotia spp and pisum sativum*,(C) *Guizotia spp, Hyposteforskoli spp and Vacia faba, (*D) *Guizotia spp, Trifolium spp,* (E) *Guizotia spp, Trifolium spp, Vacia faba, (* F) *Adaatodo schimperiana*

4.15. Constraints of beekeeping in the study area

The respondents reported that they have encountered with a number of difficulties and challenges. After having identified the major problems facing the beekeeping activities, the beekeepers were requested to identify which was the first in order of importance. Accordingly, the major challenges of the beekeepers are presented in Table 11.According to this ranking, it seems constraints related to honeybee health and bee forage deserved high attention. To this fact, disease pests and predators, agro chemicals application ranked 1st and 2nd, respectively (Table 11).

Table 12: Constraints of beekeeping in the Bako Tibe district, Ethiopia (n=120)

Constraints	Frequency	Percent	Rank
Disease, pests and predators	39	32.5	1
Agro chemical application	22	18.3	2
Shortage of bee forage	18	15.0	3
Lack of technical support	16	13.3	4
Reduction of honeybee colony	9	7.5	5
Lack of beekeeping materials	9	7.5	6
Marketing	7	5.8	7

A. Diseases, pests and predators

About 32.5% of the interviewed respondents responded to the presence of honey bee disease, pests and predators. But they do not know the type of disease; simply they reported a mass death of honey bee in the hive. Even comparing among the major pests challenging the beekeeping activities, ants (*Dorylus fulvus*), small hive beetle (*Aethina tumida*), spider (*Pardosa atlantica)*, wax moth *(Galleria mellonella)*, Little bee-eater bird (*Merops pusillus)*, honey badger (*Mellivora capensis)* and lizard were the most pests in the study area in order of decreasing importance, respectively (Table 12).

Table 13: Bee disease, pestes and predators in the Bako Tibe district, Ethiopia

Pests	Frequency	%	Rank
Ant(*Dorylus fulvus*)	54	45	1
Hive beetle(*Aethina tumida*)	18	15.0	2
Spider(*Pardosa atlantica*)	13	10.8	3
Wax moth*(Galleria mellonella)*	11	9.2	4
Little bee -eater Bird(*Merops pusillus)*	10	8.3	5
Honey badger(*Mellivora capensis)*	9	7.5	6
Lizard	5	4.5	7

Similar findings were registered in the central highlands of Ethiopia and in the highlands of south east Ethiopia (Desalegn, 2001; Solomon, 2009).

Based on the results of this survey, 71.7% of respondents reported that honeybee enemies as major reason for honeybee colony absconding. From this, about 45% of the account was taken by ants (*Dorylus fulvus*). These results with regard to the effects of ants (*Dorylus fulvus*) on honey bees agree with different studies conducted so far (smith, 1953; Crane, 1990; Amsalu and Desalegn, 1999; Desalegn, 2001; Desalegn and Amsalu, 2001; Desalegn and Yoseph, 2005). To overcome the problem, beekeepers have developed their own indigenous knowledge. Some of the methods were: dusting ash under the hive stand, plastering the hive stand with plastic materials finding, some of them using burned oil and killing the queen of ants. The next most serious pest which is ranked as second is small hive beetle (*Aethina tumida*) by accounting 15%.The beekeepers reported that, hive beetles was protected by cleaning the area of hive apiary. The third problem ranked was spider (*Pardosa atlantica)* by 10.8%, which forms network on the hive entrance to catch bees to eat. Beekeepers protect spider by cleaning their hive. The next most series in some area was wax moth *(Galleria mellonella).*The beekeepers recognized that their bees could suffer from pests like wax moth *(Galleria mellonella)* which results in distraction of honey comb in the hive. However, the beekeepers did not know the real causes. Some beekeepers also responded as if they observed brood disease, which results in bad smell of the hive and formation of worms. But the real reason is that wax moth is causing that effect on bee's comb through its larvae which the beekeepers get confused with worms formed due to disease. According to the respondents' response, fumigation of hive with 'Ejersa' *(Olea africana)* is important for

protecting wax moth particularly when the bee colony gets weak. Beekeepers also protect little bee-eater birds (*Merops pusillus*) from their hive by putting objects to the bird eaters in the apiary; removing branches of trees near apiary, expelling bird from the surroundings. Honey Badger was also another enemy of honey bees. Beekeepers protect it from their apiary by catching by "Wotemad" and protecting by dog. Similar result also reported by Tesfaye and Tesfaye (2007) in Adami Tullu Jido Kombolcha district who documented that beekeepers had no special protection method to control disease. However, beekeepers protect their bee colony by simple protection measure by their experience.

B. Agro-chemical application

About 18.3% of respondents ranked agrochemical applications for crop protection and public health uses as the second problem to harm beekeeping activity. As reported from key informants and respondents , the use of agrochemicals to control crop pests, *Tsetse* fly, mosquitoes' and household pests damaging the bees and their products in the district . This is in agreement with the study of Gezahegn (2001) who reported that the promotion of some agricultural inputs such as pesticides as well as the use of deadly chemical for malaria program have substantially reduced honey production. The study showed that using agro-chemical in the district was increasing. However, extension workers should try to encourage farmers to practice hand weeding and apply the chemicals at time when honey bees were not foraging.

C. Shortage of bee forage

As indicated in table-11, shortage of bee forage and its manifestation of honey bee colony reduction were ranked 3rd and 4th, respectively.Population pressure and high demand for farmlands had put pressures. These created deforestation, and ecological degradation to the areas. Coupled with above mentioned factors, burning of undergrowth has resulted in a reduction of honey producing floras and foraging areas. This elimination of good nectar and pollen producing tree species in many areas made difficult to maintain productive bee colonies. Hence, shortage of bee forage was ranked as third problem to expand beekeeping activities in the areas. This is consistent with the study of Kerealem *et al*. (2009) who reported that shortage of bee forage due to population pressure, lack of land use policy and the high demand for farmlands put pressures on mountainous areas to be used for crop production and livestock grazing.

D.Reduction of bee colony

The traditional way of wild bee capturing as honeybee colony source is becoming inefficient. This is due to habitat destruction as a result of expansion of farmland and due to the above mentioned factors. Therefore, acquiring honeybee colonies is becoming a major problem either to start beekeeping or to expand the existing ones. The study showed that agrochemical application as one of the problems for reduction of honey colonies followed by shortage of bee forage. Of the total interviewed, only 4.5% of respondents practiced colony multiplication using overcrowding and splitting techniques, while about 95.5% of the respondents have no idea, about the techniques of honeybee colony multiplication method. The analysis shows that majority of the respondents obtained bee colony by hanging traditional beehive on long trees to capture wild colony during the reproductive swarming season.

E. Lack of beekeeping materials and beehive

About 91.7% of respondents practiced using traditional system, with all limitations. Only 8.3% of the respondents practiced both traditional and improved beekeeping system. This might be attributed to the lack of access of credit, high costs and unavailability of improved beekeeping materials to the rural communities. Most of the basic tool, that would be needed to work with bees like bee veil, hand gloves, smoker, and overall (beekeepers suit) were reported relatively expensive.

F. Lack of technical support and beekeeping training

During the survey, it was observed that some respondents managed their apiaries of beehive badly due to lack of technical support and beekeeping training in the study area. Some of the problem observed were hives not placed properly, had no shade and poor hive sanitation (plate 7).The study showed that out of 120 respondents only 8.3% got beekeeping training and 91.7% of respondents practiced beekeeping by experience by getting information informally from neighbours, from family, from other beekeepers and development agents during community meeting without any demonstration. The respondent who goes training reported that training was useful to get knowledge and skill on inspection of hives, feeding and colony management and about 6.5% of respondents could transfer honey colony by getting skill from the training. Training is an important aspect of beekeeping development in both national and

district level. This helps the beekeeper for proper handling of honey, preparing apiary site, understanding the market, understanding the management, understanding the technology and to motivate beginner beekeepers. This is in consistent with the study reported by Rahman (2007) and Workneh (2007) who indicated that training provides technical competency, more exposure to the subject matter and to adopt the improved beekeepers.

Plate 7: Improper placement of beehives in the study area.

G. Market problem

The study showed that, 95.8% of the respondents readily got access to market for bee products mainly honey. About, 58% of respondents sold their honey at market found in nearby town, 35.5% at*" Tej*" houses and 6.5% at farm get. However, about 94% of respondents reported that, there was no ready market for beeswax. But, for most of the beekeepers, the local markets are far away from them and are not easily accessed. Therefore, the beekeepers must travel on foot for several hours carrying the honey either on shoulder or on the back of animals to reach to the market place to sell honey. Moreover, lack of pricing based on honey quality didn't encourage farmers to produce high quality products. Thus, the price of honey changes widely based on the production seasons, which is high during the slack season and low during the peak season. This is in agreement with the study by Workneh (2007) who reported that the availability of market for the hive products enhances the adoption of beekeeping technologies. Gezahegn (2001) discussed the constraints to marketing of honey and beeswax in the country and these include low and discouraging price of honey and beeswax in local markets, lower quality of products, lack of market information, absence of organized market channel, transportation problem, lack of appropriate technologies for collecting, processing, packing and storage of honey to keep its natural quality, lack of government support in market development, and low involvement of private sector.

4.16. Honey quality analysis

A. Moisture content

Moisture content is one of the important parameter to be considered in the quality of honey. The moisture content of honey in the study area varied from 18% to 24% with mean 19.88% in different agro ecological zones of different hive .The mean moisture content of honey from the three different agro-ecological zones was 18.00±0.0, 19.38±0.25, and 21.17±2.25 in Dega, Woyinadega and Kolla, respectively, and 18.57±0.6, 20.25±0.86 and 23.75±0.35 in Traditional, Transitional and Modern hive, respectively. Moreover, there was significant difference ($P< 0.05$) in moisture content of honey collected from Woyinadega and Kolla agro-ecological zones. This result indicated that moisture content of honey was probably increased due to premature honey harvesting and in appropriate storage condition, which increased the moisture content of honey in some areas. Previous reports indicated that honey quality might be reduced when stored in traditional containers (Nuru 1991; 1999).Among the honey samples 84.6% had moisture content within the accepted range (17.5%-21%) and 15.4% had higher moisture content than the standard permissible limit which showed that the majority of honey produced in the study area had better quality of the honey.

The moisture content of honey is related to its degree of fermentation. The control moisture in honey was an important requirement (Codex Alimentarius Commission Standards for honey, 2001), which sets an upper limit for moisture of 21 % for honey in general. The mean moisture content of the study area was in agreement with honey moisture content reported by Nuru (1999) who reported mean moisture content of 20.5% but higher than that of (Latif *et al.*, 1956) who reported the moisture content within the range of 14.3 and 18.6% from Pakistan.

B.PH

The PH of honey samples from the study area ranged from 4 to 4.4; with mean 4.23.The detected pH values of honey were 4.23±0.115, 4.07±0.095 and 4.33±0.05 for honey sample from Dega, Woyinadega and Kola, respectively and 4.25±0.127, 4.15±0.17 and 4.30±0.00 for honey samples from traditional, transitional and modern hives, respectively. There was a significant difference ($P< 0.05$) in PH values of honey samples collected from Dega and kolla agro-ecological zones and for honey sample collected from traditional and modern hive (shown in Table 13 and 14).

Table 14: Results of honey parameter analysis in different agro- ecological zones, in the study area (n=13)

Agro-ecology Zone	Moisture content Mean(±SD)	P^H content Mean(±SD)	Acidity of honey Mean(±SD)	mineral content Mean(±SD)
Dega	18.00 ±0.0[a]	4.23±0.115[b]	21.08±3.52[b]	0.15±0.41[a]
Woyinadega	19.38±0.25[b]	4.07±0.095[a]	29.85±0.64[b]	0.16±0.023[a]
Kola	21.17±2.25[b]	4.33±0.05[b]	15.98±2.38[a]	0.05±0.025[a]
Total mean	19.88±1.98	4.23±0.13	21.42±6.56	0.11±0.057

**b- Correlation is Significant at p < 0.05, SD=Standard deviation and a - non-significance*

The mean honey p^H in all the agro-ecological zones and different beehives fall within the national and international quality standards.The result was in agreement with that of Jose *et al*. (2009) who reported a pH value of 3.47 to 4.24, with an average of 3.91 and Bogdanow (2002) reported that P^H value of honey should be between 3.2 and 4.5.Published reports also indicated that acceptable pH of honey is between 3.2 and 4.5 (Codex Almentarius Commission,2001).The low pH of honey inhibits the presence and growth of micro-organisms and makes honey compatible with many food products in terms of pH and acidity. This parameter is of great importance during the extraction and storage of honey as it influences the texture, stability and shelf life of honey (Kirkwood *et al*., 1960; Adebiyi *et al*., 2004)

C. Acidity

The mean free acidity of honey samples in the study area was 21.42±6.56 meq/kg (range of 11.8- 30.4). However, the mean acidity for honey samples from Dega, Woyinadega and kolla was 21.08±3.52, 29.85±0.64 and 15.98±2.38, respectively and honey samples from traditional, transitional and modern hive was 22.46±5.72, 22.47±8.98 and 15.7±0.7, respectively. However, there was significant difference ($p < 0.05$) in acidity values of honey samples collected from traditional and modern hive, and also from transitional and modern production hives.

Based on the comparison of agro-ecological zone, significant difference ($P < 0.05$) was observed from honey sample collected from Dega and Woyinadega. The results were relatively similar to those of Nuru (1999) who reported that mean acidity for Ethiopian honey was 39.9 meq/kg and White *et al.* (1962) who reported that acidity of honey was 29.12meq/kg. When the acidity becomes high, the honey becomes sour. According to Almeida-Muradian *et al (*2007*)* higher acidity value may be due to fermentation of sugars to alcohol by microorganisms and further oxidation to carboxylic acids. Higher moisture content and high environmental temperature could be favorable to these reactions. Latif *et al.* (1956) who also reported formic acid content of Pakistani honey to be within the permissible limits of international standards. Similarly, Stinson *et al.* (1960) evaluated honey samples for their acid components and found these to contain butyric, acetic, formic, lactic, succinic, pyrogutamic, malic and citric acids.

D. Ash Content

The ash content of honey samples collected ranged from 0.03 – 0.2 with mean value of 0.11±0.057 (Table 14).According to the Codex Alimentarius Commission Standards (2001) for normal honey, proposed ash content should not be more than 0.6%. In this study, the mineral content of all honey samples falls within the accepted quality standard. This finding was in line with the result for ash content of honey samples (0.1-1.0%) (Nuru, 1999; Crane, 1976). Similarly, Mclellan (1975) evaluated honey samples for their ash content and different minerals. The ash content of honey was generally low and varied in different agro-ecological areas. Ash content for honey samples from Dega, Woyinadega and kolla was 0.15±0.41, 0.05±0.025 and 0.05±0.025, respectively. And ash content for honey samples from traditional, transitional and modern hive was 0.12±0.025, 0.12±0.049 and 0.06±0.021, respectively. However, there was no significant difference ($p>0.05$) observed in ash content of the honey collected from different hive types and from agro-ecological zones (Table 13 and 14).The mean difference of ash contents of honey may be due to chemical composition of nectar that varies according to the different botanical sources involved in honey formation. This agrees with the study of White *et al.* (1962) who reported that the marked difference in ash content of honey could be attributed to the soil where the honey bee plants grow.

T**able 15**: Measurement of honey parameters in honey samples collected from different types of beehives in the study area (n=13).

Type of hive	moisture content Mean(±SD)	PH content Mean(±SD)	acidity of honey Mean(±SD)	Ash content Mean(±SD)
Traditional	18.57±0.6[a]	4.25±0.127[b]	22.46±5.72[b]	0.12±0.025[a]
Transitional	20.25±0.86[a]	4.15±0.17[a]	22.47±8.98[b]	0.12±0.049[a]
Modern	23.75±0.35[a]	4.30±0.00[b]	15.7±0.7*[b]	0.06±0.021[a]
Total mean	19.88±1.98	4.23±0.13	21.42±6.5	0.11±0.057

*b-Correlation is Significant at $p < 0.05$.

The variation of moisture content in different agro-ecology might be due to harvesting of unripe honey, excessive smoking during harvesting, mixing of honey with pollen, beeswax, broods and other hive products such as propolis and storage material of the respondents. This result is in agreement with the study of Finola *et al*. (2007) who reported that water content of honey depends on various factors such as harvesting season, degree of maturity reached in the hive and climatic factors. In this result the moisture content of honey from traditional and top bar hive are lower than modern hive. The result inconsistent with the study of Nuru (1999) who reported that honey from traditional hives usually has higher moisture content than the honey collected from improved hives. This might be caused due to pre matured honey harvesting, storage condition and lack of experience of using modern hive during honey harvesting time.

There was significant difference in PH and acidity of honey collected from Dega and kolla, and Dega and Woyinadega agro-ecological zones, respectively. Based on the hive type significant deference in PH was observed for honey sample collected from traditional and modern hives, and in acidity of honey from traditional and modern, and transitional and modern hives. The variations in PH might mainly be resulted due to different acids found in different floral types. Hussein (1989) observed a significant difference in honey pH of different floral types. Ecological variation in acidity of honey among different honey samples could be attributed to floral origin or to variation because of the harvest season.

5. Conclusions and Recommendation

5.1. Conclusions

Beekeeping is a well established practice in the farming communities of the Bako Tibe district of Oromia region and it plays a significant role as source of additional cash incomes and nutrition for many farmers. However, in spite of its significant economic contribution and its great potential for sustainable development for the district, the attention given to the sector until recently was not satisfactory.

Based on the survey result, 99.2% of respondents of the district engaged in beekeeping were male. There were very limited numbers of females engaged in beekeeping practice in the study area. Based on the result, people in the most productive age are actively engaged in beekeeping activities with having a moderate experience of beekeeping. Only 8.3% of the respondents acquired beekeeping knowledge through training, this indicated that little work has been done in promoting beekeeping practice in the study area. In the district, three types of beekeeping systems namely: Traditional beekeeping, Transitional beekeeping and Modern beekeeping systems have been observed. More than 91.7% of the respondents were engaged in traditional beekeeping; where as 8.3% practiced the combination of all traditional, transitional and modern beekeeping systems. According to this survey, transitional and modern hives resulted in higher honey production per colony (18.5±18.5 and 29.6±5.6 kg/hive respectively) compared with local hives. On the other hand, from this survey it can be concluded that the traditional honey production system was economically affordable and appropriate system for the rural areas that makes relatively good use of locally available resources. The study also showed that, all of the respondents reported that, they lack adequate financial resources to invest on improved honey production technologies, storage, processing facilities and packaging.

The district had adequate natural resources and a long tradition of beekeeping. However, mainly because of lack of technological, institutional supports and access to market and value chain development, the district in general and the rural beekeepers in particular have not been sufficiently benefited from the sub sector. Yet, despite all the constraints and challenges currently facing the beekeeping sub-sector, there are still enormous opportunities and potentials to boost the production and quality of honey production in the district.

The major constraints to exploit the untapped potential of beekeeping activity in the district were diseases, pests and predators, agrochemical application, shortage of bee forage,

reduction of honey colonies, lack of beekeeping materials and beehive, Lack of access to credit, lack of extension support and beekeeping training, marketing problems, high price of beekeeping equipment and lack of knowledge regarding colony management.

Almost all samples of honey analysed were within the acceptable range of the world and national quality standard in terms of moisture content, pH, free acidity and ash content of honey sample.

5.2. Recommendations

Beekeepers from the study areas have rich indigenous knowledge nearly in some area of beekeeping. Identification and documentation of such knowledge can open new doors for researchers to verify and integrate the indigenous knowledge with main stream science and introduce new practice in the area where by farmers knowledge is not productive and guarantees sustainability.

Generally, the following possible recommendations can be drawn from this study;

- ❖ Agricultural and Rural Development office of the district should create awareness among the rural community on the value of beekeeping(specially, to increase the participation of women in beekeeping and honey production system)
- ❖ The government and NGO ought to provide formal training on beekeeping and its management (including pests and diseases management, bee forage development, colony management, honey harvesting, extraction, processing, etc.), quality control and link model beekeepers with big traders, exporters and processing factories.
- ❖ The government should avail proper market link and credit facility to individuals who are to be organized and involve in the production, collection, processing, packing and marketing of honey and other hive products.
- ❖ Both governmental and nongovernmental organization should give a high priority to exploit the resource in appropriate and sustainable way.
- ❖ Agricultural development agents in the district should create linkage with bee research centers and stakeholders' to bring a significant change as desired.
- ❖ The government should encourage the private sector to manufacture and import beekeeping equipment for distribution.
- ❖ Further study is also required to characterize the honeybees of the area and major pests and diseases of economic importance and their control.

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Appendix

Appendix 1: The honey quality standard

Parameter	Study area	Standard		
	Result(mean)	FAO/WHO	National	World
Moisture content,% by mass	19.88	21 – 23	17.5-21	18 – 23
Total ash, % by mass	0.11	0.6 – 1	0.60 max.	0.25 – 1
Acidity, milli equiv. acid/kg	21.42	40/kg	40/kg	5 – 54
PH	4.23	-	-	3.2 - 4.5

Appendix 2.The major honey plant in Bako Tibe district

Amaric	Oromic	*Scientific name*	flowering period
Girar	Laaftoo	*Acacia abyssinica*	February – March
Buna	Buna	*Coffea arabicana*	April – June
Wenza	Waddeessa	*Cordiana africana*	January – March
Mache	Tuufoo	*Guizotia scabra*	September – October
Nug	Nuugii	*Guizotia abyssinica*	November – December
Besobila	Mosobila	*Ocimum basilicum*	Unidentified
Kega	Roosa	*Rosa abyssinica*	February – May
Mashilla	Mishingaa	*Sorghum bicolor*	September – November
Bokolo	Boqollo	*Zea mays*	September – November
Bakela	Baaqela	*Vicia faba*	November
Atar	Atara	*Pisum sativa*	September – October
Bahirzaf	Bargamoo	*Eucalayptus globules*	March – May
Bisana	Makkanisa	*Croton macrostachys*	March – April
Maget	Siddisa	*Trifolium steudneri/accaule*	September – October
Girawa	Eebicha	*Vernonia spp*	Nov-Jauary
Agam	Hagamsa	*Carissa edulis*	March – May
Dokima	Baddeessaa	*Syzygium guineense*	February
Mango	Maangoo	*Mangifera indica*	March
Papaya	Paappayyaa	*Carica papaya*	February
Shunkurt	Shukkurtii	*Allium cepa*	Year round

Telba	Talbaa	*Linum vsitatissiumum*	September – October
Serdo	Saardoo	*Eleusine floccifolia*	August – November
Berbere	Barbarree	*Capsicum annuum*	September – November
Misir	Missira	*Lens culiaris*	January
Wayira	Ejersa	*Olea africana*	All the year round
Gulo	Qobboo	*Pinunus communis*	December
Kontire	Qonxor	*Petrolobium stellatum*	March
Gesho	Gesho	*Rhamnus prinoides*	All the year round
Adeyababa	Kello	*Bidens spps*	Sebtember to october
Simiza	Dhumuga	*Justitia schimperina*	Decemberto may
Koshim	Koshim	*Dovalis abssinicus*	All the year round

Appendix 3: **Questionnaires used in the study**

JIMMA UNIVERSITY

School of Graduate studies College of Natural Science Department of Biology (Ecology &Systematic zoology)

The main objective of this questionnaire is to obtaining the information from the beekeepers on honey production system and beekeeping practice by beekeepers in Bako Tibe distinct

1. House hold characteristics

1.1. Name of enumerator_____

1.2. Name of household head_____

1.3. Sex_____Age_____

1.4. Marital status

1. Single 3. Widow
2. Married 4. Divorced

1.5. Have you attended formal education Yes No

1.5.1. If yes, what is the highest grade attended? _____grade

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

1.6. Religion of household

1. Orthodox 2. Muslim 3. Protestant 4. Catholic 5.Other specify

2. Land utilization

2.1 Do you own land? Yes _____ No_____

2.1.1 If yes what is allocation (hect)

No	Land allocation	Hect.	remark
1	Total land holding		
2	Farmland		
3	Forest land		
4	Grazing land		
5	Total land		

3. Do you own livestock? yes___ No____

3.1 If yes, what are your own livestock currently?

N0	Livestock	Total number	No	Livestock	Total number
1	Oxen		6	Muel	
2	Cow		7	Donkey	
3	Goat		8	Poltury	
4	Sheep		9	Honeybecoloney (in hive)	
5	Camel		10	Others	

4**.** Beekeeping

4.1. Do you keep bees? Yes ___ No _____

4.2. If yes when did you start beekeeping? _____Years

4.3. How did you start beekeeping?

1. Fron neighbours 4. Trained

2. By purchasing honeybee colony 5 .Interest

3. Through inheritance 6. Any other (specify)_____

4.4. Where do you keep your honeybees?

1. Backyard 2. In forest

3. Under the roof 4. In the house

4.4.1. If you keep at backyard, what is the size of your backyard? ___timed.

4.5. Are you aware of improved box hive? Yes _____ No _____

4.5.1. If yes, from whom you hear about it?

1. Extension agent 4. Neighbor

2. Radio 5. Chart and post

3. Field day 6.Any (specify) _____

4.6. Which type of beekeeping sytem system do you use?

A. Traditional beekeeping system B.Transitionl beekeeping system

C. modern beekeeping D.all

4.7. Have you ever used improved box hive? Yes _____ No _____

4.7.1 If yes, when did you start utilizing box hive? _____ E.C

4.7.2. If yes, what type of improved box hive do you have?

1. Zandar 3.Foam

2. Lang troth 4. Any other specify_____

4.8, Can you buy improved box hive whenever you want to buy? Yes ____ No_____

4.8.1. If no, why did you not use improved box hive?

1 It is expensive 4. No bee forage

2. It is not available 5. Lack of land

3. It needs skill 6. Satisfaction with the existing number

7. Any other (specify) _____

4.9. Do you have protective materials? Yes ____ No _____

4.9.1 If yes, show the available materials using ` √ `

Smoke	Suit	Veil	Glove	Boot

4.9.2. If no, why?

1. Not found 3. I use traditional

2. Expensive 4. Any other_____

4.10. Do you get accessories (honey extractor, casting mold) to hire in your vicinity? Yes __ No ____

4.11. Is there any bee-keeping equipment that you discontinued using? Yes____ No_____

4.11.1. If yes, which is it? (One or more answer is possible)

1. Improved beehives 4. Smoker

2. Honey extractor 5. Veil

3. Honey presser 6. Glove 7.Any other_____

4.11.2. If yes, what are the reasons for discontinuing?

1. It is expensive 3. It is not profitable

2. It is unavailable 4. Its utilization is complex

5. Culturally not accepted 6. Any other_____

4.12. Have you constructed hive shading? Yes_____ No _____

4.12.1. If no, why did you not construct hive shading?

1. Lack of wood 3. Any other _____

2. The temperature is not hot

4.13. Do you provide supplementary feed to your honeybee during dearth period?

Yes _____No _____

4.13.1. If yes, what do you feed your honey bees?

1. Sugar 2. Barely flour (beso)

3. Shiro 4. Honey

5. Any other _____

4.14. Do you plant bee forage? Yes _____ No _____

4.14.1 If yes, please list the name of the plants

No	Name of bee forage	Total in hect. (number of seedling)
1		
2		
3		

4.15. Are there any pests of honeybees in your apiary? Yes____ No _____

4.15.1. If yes, what are the major pests found in your apiary? Rank the

Pest causing the highest damages as 1

NO	Pest	Rank	No	Pest	Rank
1	Ant		5	5 Birds	
2	Wax moth		6	Honey badger	
3	Spider		7	Hive beetle	
4	Lizard		8		

4.15.2.. If there are ants, do you use improved ant protection method?

Yes _____ No _____

4.16.2.1. If yes, what types of ant protection methods you use?

1. Cone shape lamera 2. Cone shape plastic

3. Burned oil 4. Any other_____

4.16. Do you practice colony multiplication? Yes _____ No _____

4.16.1. If yes, what type of colony multiplication methods do you practice?

1. Overcrowding 2. Splitting 3. Any other_____

4.17. Do you get pure beeswax? Yes_____ No _____

4.17.1 If yes, how do you get?

1. by purchasing 3. Any other (specify)_____

2. Extracting crude beeswax

4.18. How do you handle your honey?

1. By storing in the recommended equipment (plastic jar)

2. By storing in moisture free area

3. By extracting and purifying properly

4. By using all the methods mentioned above

5. Any other (specify) _____

4.19. Is there any absconding from your box hive? Yes ___ No_____

5.20.1. If yes, what are the reasons for absconding?

1. Lack of feed 2.Honeybee enemies

3. Honeybee disease 4.Indiscriminate agrochemical application

5. Any other (specify)_____

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

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

3. Fixing the queen excluder on the entrance of the hive

4. Any other (specify) _____

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

4.20. How do you get extra honeybee colonies for the absconded colony?

1. By caching the swarm 2. By purchasing

3. Multiplying the colony 4. From family

5. Any other (specify) _____

4.21. How many honeybee colonies (hives with bees) do you own? (Fill in table)

Status	Traditional	Intermediate	Improved	Total
With Honeybee colony				
Without honeybee colony				

5. Beekeeping extension

5.1 Do you have contact with extension agent? Yes ____ No _____

5.1 If yes, how many times do you contact per month? _____per month

5.2. Who assisted you for utilizing improved box hive? Show in rank

No	Category	rank
1	Agricultural and rural development	
2	Non-Governmental organization	
3	Research center	
4	Neighbor	
5	Relative	

5.3. What kind of hive products did you produce before using box hive?

1. Crude Honey 2. Crude Beeswax

3. Crude honey & beeswax 4. Any other (specify)_____

5.4. What kind of hive products did you produce after using box hive?

1. Pure Honey 2. Pure Beeswax

3. Queen rearing 4. Pure honey and beeswax

5. All products mentioned above

5.4.Did you ever get beekeeping training? Ye_____ No_____

5.4.1 If yes, from where did you got the training

1. Research center 2. Agricultural and rural development

3. Non Governmental Organization (NGO) 4. Any other (specify)_____

5.4.2. If yes, on what area did you get training?

1. Colony multiplication 2. Bee management

3. Hive products 4. Marketing

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

1. Lecture 2. Demonstration

3. Group discussion 4. Combination of all

5. Any other_____

5.4.4. If yes, did you find the training useful? Yes _____ No _____

5.4.4.1. If yes what changes in the training would have made it more useful?

1. Understanding effective way of using box hive

2. Understanding improved beekeeping management (feeding, inspecting, supering etc.)

3. Any other (specify) _____

5.4.4.2. If yes, can you undertake transferring of honeybee colony from traditional to box hives? Yes No

5.4.4.3. If yes, can you undertake honey extraction using honey extractor? Yes No

5.4.4.4. If yes, can you make foundation sheet using casting mold? Yes ____ No____

5.4.4.5. If no, what was wrong with the training?

1. It focuses only on theory 2. The training duration is too short

4. Lack of experienced trainer 5. It was not based on my need

6. Any other (specify)_____

5.7. Do you make experience sharing with beekeepers? Yes_____ No _____

6.7.4.1 If yes, on what occasion do you undertake?

1. During formal meeting 2 . During beekeeping training

3. during `idir` meeting 4. Any other_____

6. Honey haresting

7.1 How many times do you harvest honey per annum? _____months

7.1 When is the peak honey production period? _____ Months

7.3. What is the amount of hive products you get from the following hive per annum?

No	Unit	Traditional			Transition			Improved box hive		
		Season 1	Season 2	total	Season 1	Season 2	Total	Season 1	Season 2	Total
Pure honey	Kg/hive									
Crude honey	Kg/hive									
Pure beeswax	Kg/hive									

7.4. Did you use the credit offered for beekeeping to other purposes? Yes_____ No__

7.4.1. If yes, for what purpose did you use?

1. For educating children3. For purchasing seed, fertilizer

2. For purchasing cloth5. For purchasing goat or sheep

6. Any other (specify)_____

8. Market

8.1 Is there ready market for your hive products? Yes ____ No _____

8.1.1 If yes, where do you sell your honey?

1. At market found in nearby town3. Cooperative
2. At farm gate 4. Tej house
5. Any other (specify) _____

8.1.2. If yes, can the market absorb all the quantity you need to sell? Yes___ No ____

9. Knowledge

9.1 When do you undertake transferring?

A. During flowering period B. After flowering period C. Before flowering period

9.2. What are the activities do you undertake during colony transferring from traditional to improved box hive

a. Bringing the traditional hive to the transferring area

b. Preparing the box hive

c. Arranging the frames and wiring

d. Making foundation sheet and attaching to the frames

e. Smoking then opening the traditional hive and cutting combs

f. Catching the queen and putting in the queen cage

9.3. How do you identify exact honey harvesting time?

A**.** By internal inspection of the hive

B. By external inspection of the hive

C. By observing the honeybees symptom

9.4. How do you control swarming?

A. By removing the queen cell B. By adding box (giving space) **C.** a and b

9.5 What is the importance of queen excluder?

A. To protect the queen from the honey chamber

B. For allowing the queen to the honey chamber

C. Any other _____

1O. Constraints of beekeeping

12.3What are the major constraints for beekeeping practice in the area? Show by"√"

No	Constraints	Answer
1	Lack of modern bee hives	
2	Lack of beekeeping material	
3	Disease, and pest	
4	Reduction of number of honey colonies	
5	Shortage of bee forage	
6	Agro chemicals application	
7	Lack of technical support support	
9	Market	
10	Beekeeping skill	

Appendix 4. Guide line for group discussion

JIMMA UNIVERSITY

School of Graduate studies College of Natural Science Department of Biology (Ecology &Systematic zoology)

The main objective of this questionnaire is to obtaining the relevant information on honey production system and beekeeping, by focus group discussion withpotentially honey producers of beekeepers, extension workers (development agents) fromKeble administration andbee extensions of the district

1. Name of group_____Kebele administration_____

2. Total _____Male_____Female_____

3. Which type of beekeeping systems adopted in the area?

A. Traditional beekeeping system B.Transitionl beekeeping system

C. Modern beekeeping D.all

4. What are the main problems in adopting and using of beekeeping technologies?

5. Are there any pests of honeybees in the distinct? Yes____ No _____

5.1. If yes, what are the major pests found in your apiary?

5.2 .If there is pests, how do you protect them from you hive?

6. What are the major constrain of beekeeping in the distinct?

7. What about access of market for honey product in the distinct?

8. What are the major honey plants in the district?

Appendix 5. Photo profile during study time in (2013)

1. The survey result photo during data collection

Plate 1: Interview with beekeepers and kebele administrative

Plate 3: Group discussion participant in the study area

Plate 4: Smoking of traditional hive to get new colony

Plate 5: the placement of traditional hive in forest and backyard

Plate 6: Different type of transitional hive and their placement

Plate 7: Modern hive and their placement

Plate 8: protection of their hive using ash and burned oil at back yard in the study

Plate 9: Inappropriate putting of traditional and modern hive in the study area.

Plate 10: Observationof HBRC and Laboratory room with Dr. Dessalegn Begna.

Plate 11: laboratory work of moisture content at Holeta Bee Research Centre

Plate 12: Laboratory work during pollen analysis at Holeta Bee Research Centre