

**ADDIS ABABA UNIVERSITY**

**COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCE**



**School of Graduate Studies**

**Department of Zoological Science**

**Summer General Biology MSc. Program**

**A Thesis submitted to the School of Graduate studies of Addis Ababa University in partial fulfillment of the requirement for the Degree of Master of Science in Biology.**

Title: Studies on the Assessment of Honey Production Practice and Constraints of Honey

Production in the Wachalee District Oromia Regional State, North Shoa.

Name: Berhanu Lemma Bury

Advisor: Emana Getu (PhD)

Professor of Entomology

Addis Ababa, Ethiopia; October 2021

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By: Berhanu Lemma Bury (GSK/0408/08)

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October 2021

## **Declaration**

I declare that this thesis is my original work and that all sources of data and material used for this thesis has been duly acknowledged. I solely declare that this thesis is not submitted to any other situation to anywhere for award of any academic degree or diploma certificates.

Name Berhanu Lemma Bury

Date of submitted-----

Signature -----

**Addis Ababa University**

**School of Graduate Studies**

This is to certify that the thesis prepared by Berhanu Lemma entitled:-“Studies on the Assessment of Honey Production Practice and Constraints of honey Production in the Wachalee District Oromia Regional State, North Shoa” and submitted in fulfillment of the requirements for the Degree of Masters in Biology complies with respect to originality and quality.

Signed by Examining Committee:

Advisor: Prof. Emanu Getu                      Signature\_\_\_\_\_ Date \_\_\_\_\_

Examiner: Dr. Yitbarek W/Hawariat      Signature \_\_\_\_\_ Date\_\_\_\_\_

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## **List of acronyms / Abbreviation**

AD- After Death

AMP- Apiculture Master Plan

CAC- Codex Alimentarius Commission

CSA- Central Statistical Agency

EARO- Ethiopian Agricultural Research Organization

E.C – Ethiopian Calander

FAO- Food and Agricultural Organization of the United Nation

GDP- Gross Domestic Products

GDS- Global Development Solution

HBRC- Holeta Bee Research Centre

KTB- Kenya Top Bar

MoARD- Ministry of Agricultural and Rural Development

NGO- Non-Govermental Organization

SC-UK- Save the Children-UK

## **Abstract**

*The most well-known and utilized harvestable products from honey bees is honey. Honey is the sweets substance produced by honeybees from the nectar of blossoms or from secretions on living plants, which the bees collect, transforms and store in honey combs. The study was conducted in Wachalee district, North Shoa Zone, Oromia region to studies on the constraints of honey production. The district was stratified into three Agro-Ecologies and stratified random sampling procedure was followed to select the peasant association on their agro-ecological zones. A total of 90 respondents (15 beekeepers per kebeles) from the three agro-ecologies were selected by using simple random sampling techniques was used to select respondents among society for questioner prepared. Both primary and secondary data collection methods were used for this research and the primary data were collected by using direct investigation of researcher to observe the status of honeybee colony and per house holding society. The researcher uses graphs and tables to present the survey data and analysis was made by mathematical explain to situation as it is. Beekeeping in the study area is dominantly practiced by male and about 87.8% of interviewed households were married and the remaining 12.2% was single. Traditional, transitional and modern frame hives were the three types of honeybee production system in which 64.4% of the respondents use only traditional hive, 10% use traditional and transitional hive, 24.4% use traditional and modern hive and only 1.11% use traditional, transitional and modern frame hives. The average annual honey yields per hive per year from traditional beekeeping in mid-land is higher than the high land and low land. The average annual honey yields per hive from traditional, transitional and modern bee hive were 6.49kg, 10.47kg and 16.4kg respectively. The major constraints that affect the honeybee production in the Wachalee districts are: pest and predators mis-use of agro-chemicals and absconding of bees. The major pest and predator include: - ants, wax moth, spider, lizard, birds, mites and hamagots. To sustain the beekeeping activity there should be introducing affordable and appropriate beekeeping technologies with all accessories, strengthening the appropriate beekeeping management practices, and finally mobilizing women and beekeepers in to sub-sectors through training.*

**Key words:** Honey, Honeybee, Beekeeping, Constraints, Wachalee District

# CHAPTER ONE

## BACKGROUND

### 1.1 INTRODUCTION

Bee-keeping in Ethiopia is a long-standing agricultural practice. It has been exercised as a sideline activity by many of the rural farming communities for its honey and beeswax production that contributes to income generation (MoARD, 2010). It also provides job opportunity in the sector. The role it plays in enhancing food security, poverty reduction and food production through pollination of crops has become substantial in the recent years. There is no well-documented evidence that indicates when and where beekeeping practice started in Ethiopia. According to Ayalew (1978), it had started in the country between 3500–3000 BC. From the rural community's point of view, beekeeping is an inherited tradition and an ideal occupation that contributes for improvement of livelihoods.

Ethiopia has comparative advantage for beekeeping or apiculture. There are over 7000 melliferous plant species in Ethiopia serving as forage for bees (i.e. suitable for honey production). Due to bimodal rains, honey can be harvested at least twice a year. With five wild bee species identified, it is estimated that more than 2 million bee colonies exist in the forests and crevices in the country. In addition, some special stingless bees produce medicinal honey in the forest and farmland periphery (MoARD 2007). Owing to its varied ecological and climatic conditions, the country is home to some of the most diverse flora and fauna in Africa, making it highly suitable for sustaining a large number of bee colonies (Nuru, 2007). The country has the largest bee population in Africa with over 10 million bee colonies, out of which about 7.5 million are confined in hives and the remaining exist in the forest (Nuru, 2007). This makes the country one of the largest honey producers and the 3<sup>rd</sup> largest beeswax producers worldwide. Ethiopians honey production accounts for approximately 2.48% of the world production and 21.73% of African honey production (EARO, 2000; MoARD, 2007).

The most well-known and utilized harvestable products from honey bees is honey. Honey is the sweets substance produced by honeybees from the nectar of blossoms or from secretions on

living plants, which the bees collect, transforms and store in honey combs (CAC, 2001). Honey can be consumed as soon as it is harvested from the hive (or stored for later use) or it can be used to make a variety of value-added food products such as desserts, dressings, and mead. Honey can also be used as an ingredient in other value-added products such as cosmetics and health supplements. Other harvestable products derived from honey bee include: pollen, wax, propolis, royal jelly, and venom (EARO, 2000). The quality of honey is generally evaluated by a physicochemical analysis of its constituents. Several of these constituents are of great importance to ensure the quality of the product and develop confidence among consumers. These constituents influence the storage quality, granulation, texture, flavor and the nutritional quality of the honey. In recent years, the contributions of beekeeping in poverty reduction, sustainable development and conservation of natural resources have been recognized and well emphasized by the government of Ethiopia and Non-Governmental Organizations (NGOs). As the country is endowed with varied ecological zones and different flora, there is a great potential in the country for working with communities by introducing simple and easily adaptable apiculture production systems that will lead to considerable gains in productivity beyond family consumption needs (MoARD, 2007).

Beekeeping by its nature doesn't need huge investment (financial asset), large size of land and complicated technical knowledge. The outcomes of beekeeping are real; some of its outcomes include income, material goods, wellbeing and satisfaction (Nicola, 2009). Beekeeping strength the rural community livelihood and help rural people to become less vulnerable to different shock and reduce the danger that they will fall into crisis. Ethiopia is endowed with natural resources such as natural vegetation, water, suitable climatic conditions which create favorable conditions to undertake beekeeping activities and make the country one of the potential countries for apiculture sub-sector; but the country still could not harvest this existing potential to the required level. There is conducive environment and huge potential to conduct beekeeping in the study area. However, majority of the rural households in the study area inclined to traditional method of beekeeping. It is difficult to get easily beekeeping products from the local market of the study area for home consumption and other purposes to the required quantity and quality. In recent years, Ethiopian's honey-production potential and its likely contribution to poverty reduction have been recognized and incorporated into the working agenda of the Government of Ethiopia. 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 exporters in Africa, the share of the sub-sector in the GDP has never been commensurate with huge numbers of honey bee colonies and the country's potential for beekeeping. Production has 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 receiving an advantage from the sub-sector (Gezahegne Taddese, 2001).

North part of the Oromia region is believed to have diversified type of vegetation and cultivated crops and potential for beekeeping activities. Livestock, mixed crop, poultry and honeybees are the major indicators of the wealth of the farming communities of Wachalee district. Beekeeping, which is a sustainable resource-based farming system without negative impact on the ecology and that can be practiced without competing resources with other agricultural activities and resource conservation programs, could be one of the major intervention areas to combat food insecurity in drought prone areas. In Wachalee District large proportion of inaccessible lands for agriculture are covered with various types of trees, shrubs, bushes, and field flowers that make this part of the regions still potential for beekeeping. However, it requires making efforts to address some of the major problems of beekeeping and to keep it productive in the sustainable way. So far in Wachalee district there is no compiled and reliable information on honey production system. The numbers of beekeepers, bee colonies, and amount of honey produced, type of beekeeping practiced, and constraints were not known. Therefore, this study was conducted to collect information on production system, productivity and constraints of beekeeping in Wachalee district. Thus, it is timely and relevant to assess and document important information on the subsector, which has not been yet carried out before in Wachalee district.

## **1.2 Statement of the problems**

Beekeeping is a very long-standing practice in the farming communities of the Oromia region and it plays a significant role as source of additional cash income and nutrition for many subsistence farmers. Beekeeping strength and supports the rural community livelihood to become less vulnerable to different shock and averts risk. However, the individual poor beekeeping farmers in particular and the country in general still could not harvest honey to the required amount which in turns income from this sectors to the producer, trader and the country is generally low in honey. Investigation indicated that the number of the honeybee colonies in the

country has been declining (CSA 1995) and consequently the honey and beeswax production as well as export earnings fell down (Etenesh Mekonnen *et al.*, 2001). This is attributed to drought, ever- expanding population pressure and associated vegetation changes and indiscriminate applications of chemicals. In general, it believes that there are different honey production challenges which couldn't enable the beekeepers to maximize beekeeping outputs. This work, therefore, had tried to magnify and identifies some major challenges that are obstacles to produce maximization in the Wachalee districts.

## **1.3 Objectives**

### **1.3.1 General Objectives**

- ❖ Studies on the Assessment of Honey Production Practice and constraints of Honey Production in the Wachalee district, Oromia Regional State North Shoa Zone.

### **1.3.2 Specific objectives**

- ❖ To assess the honey production practice in the Wachalee district.
- ❖ To identify the annual honey yields from different types of hives.
- ❖ To identify the constraints associated to honeybees in the Wachalee district.

# CHAPTER TWO

## 2. LITERATURE REVIEW

### 2.1 Origin and Evolution of Bees and Beekeeping

Bees likely evolved from wasp like ancestors, contemporaneously with the angiosperm plants towards the end of cretaceous period, 60 to 100 million years ago (Martin, 1976). According to Dietz (1986) the present bee fauna probably originated more than 70 million years ago. Currently, eleven families of bees are generally recognized, only some of which are identified by derived traits setting them apart from other bee families. There are about 1000 genus (and sub genus), combined with sub genera, approximately 600 generic groups and an estimated 20,000 living species of bees residing in the world's museums (Roubik, 1989).

Bees (Apoidea) are a super family of about 20,000 species, in the order Hymenoptera. The majority of bee species are 'solitary' while the minorities are social (bumble bees and stingless bees), and only a few species of social bees, are kept in hives by beekeepers. There are three families of social bees, which produce honey. These are: the Bombidae, Meliponidae and Apidae (Smith, 1960). The Bombidae are found mainly in temperate climates. Their nests are very small, often in the ground and are of no commercial importance except as pollinators of certain plants. The Meliponidae, or stingless bees, occur throughout the tropical regions of the world. Their nesting places may be holes in the ground, in hollow trees or small cavities in walls and on the underside of branches. The family Apidae, to which the honeybee belongs, is indigenous only to Europe, Africa and Asia (Crane, 1990).

A honeybee found in East Africa was reported from the upper Pleistocene period, 100,000 years ago (Dietz, 1986). This bee could not be differentiated from the contemporary African honeybee species (Dietz, 1986). 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 honor 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 (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, Zimbabwe, Morocco, Libya and Tanzania (HBRC, 1997). Honey hunting has been a very common practice even up to present generation in many parts of Africa, including Ethiopia. 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.

Beekeeping properly started when man learned to safeguard the future of the colonies of bees he found in hollow tree trunks, rock crevices or elsewhere, by a certain amount of care and supervision. 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 frames 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. Lorenzo Lorraine Langstroth made the step, which changed this, in 1851 when he discovered practical movable-frame hives with an appropriate 'bee-space'. 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, 1990).

## **2.2 Species and Races of Honeybee**

Since the late 1700s, about 9 species of honeybees have been recognized (Roubik, 1989). These are: *Apis andreniformis*, *Apis cerana*, *Apis cerana indica*, *Apis dorsata*, *Apis dorsata binghami*, *Apis florea*, *Apis laboriosa*, *Apis mellifera* and *Apis vechti*. Among these, the following are the major honeybee species and are of world economic importance: *Apis cerana/indica*, *Apis dorsata*, *Apis florea* and *Apis mellifera*. Race in honeybees is a result of natural selection and honeybees have been adapted to different geographical areas of the world for many years without the interference of mankind. In so doing, there has been an environmental effect on the anatomy and physiology of honeybees leading to differentiation.

African and European honeybees, even though were from the same species, are differing in behavior, production and on some morphological variables of importance. Hence, quite a large number of subspecies (races) of honeybees are found in the world today. Rutter (1986) reported the presence of 23 distinct geographical races using multivariate analysis of the morphometric characteristics of honeybees. In Africa alone, more than 16 subspecies or races are residing in different ecological places.

### **2.2.1 Important Races of Honeybee**

Bees that produce enough honey to be worth harvesting belong to the two sub families of the family Apidae: Apinae (honeybees) and Meliponinae (stingless bees). Apinae has only one genus, *Apis*, and about nine species of which the *Apis mellifera* species is of much greater economic importance than any others.

*Apis mellifera* ('honey- making bee') is one of the most successful species in animal kingdom. It became more adapted to wide range of environmental condition to a greater extent: one and the same species is able to survive in semi desert tropical regions as well as in cold-temperate zones (Rutter, 1986).

The races and strains of *Apis mellifera* are overriding world importance in beekeeping, and are the basis of world's beekeeping industry. These bees are native to Africa and Europe. They have

also been introduced in to almost the whole of the New World (the Americas, Australia, New Zealand and Pacific Islands) since 1500 where there were no native honeybees (Crane, 1990).

European *Apis mellifera* is the bee first studied, and it still receives by far the most attention. *Apis dorsata* and *Apis florea* are confined to tropical Asia, and each species builds a single comb in the open, unprotected or semi-sheltered area. *Apis cerana* and *Apis mellifera* live in the Old World tropics, but during evolutionary times they succeeded in spreading in to the north temperate zone of the Old World. Each builds a nest in a cavity, consisting a number of parallel vertical combs, usually up to about ten; thus, they can be managed for honey production and for crop pollination.

*Apis mellifera* is now the most productive and widely distributed in almost all places of the world. Tropical subspecies of *Apis mellifera* are smaller than temperate zone subspecies, and they have a more slender abdomen. They are generally less amenable to handling and management, swarm readily; also, the whole colony may abscond as a result of damage and disturbance of their nest or shortage of food. Moreover, the bees are easily alerted to sting and this characteristic allows their survival in the African tropics where they were liable to be attacked by many 'enemies' (Crane, 1990).

Now a day, these bees are kept in hives in almost every country of the world and beekeepers have to operate in widely different conditions. Adjare (1990) noted that the honeybee is well distributed over the globe except in the severe cold of the Polar Regions. It has, however, been shown that bees can also be kept in the desert or in urban areas and it is even been done on a New York City roof garden (Vivian, 1985). In Addis Ababa, capital city of Ethiopia, for example, there are many beekeepers that benefited from evergreen eucalyptus dominated vegetation.

### **2.3 Importance of Beekeeping in Ethiopia**

The prospect for helping peasant farmers of third world and raising their living standard through the development of beekeeping activities are bright (Robinson, 1980). Beekeeping has many advantages that help farmer beekeepers to improve their well-being. Its advantages can be itemized for the socio-economic impact of beekeeping. For instance, successful beekeepers raise their socio-economic standing in areas with subsistence agriculture, and farmers in developing

countries can substantially supplement the family income, sometimes even double it. This means the family can be food secured. Furthermore, some of the importance of beekeeping is the following:

- Unlike cultivation of crops and animal husbandry, beekeeping does not disturb the ecological balances of an area. Instead, it is an environmentally friendly activity.
- Beekeeping does not compete for resources with other agricultural activities. Hence, it can be integrated with annual and perennial crop production, animal husbandry and natural resource conservation.
- Since beekeeping is light work, it can be done by women, aged men and persons with disabilities. Moreover, since it is less labor intensive, it can be done as part time and side line activity.
- Beekeeping assists to utilize resources like pollen and nectar which otherwise are wasted. Man cannot utilize these resources without bees.
- Beekeeping can be run in areas which are not suitable for cultivation of crops and animal husbandry such as hills and escarpments.
- Bee products like honey and beeswax are not perishable and can be transported and stored for longer periods and their prices does not fluctuate very much over seasons.
- Beekeeping can be run with little or no land, because bees can forage in any place around their foraging distances and it is useful for intensification of land and also in areas where there are shortage of land.
- Beekeeping is useful in improving the quality and quantity of crop yields and contributes for the maintaining biodiversity through efficient pollination services of honeybees.

## **2.4 The honey bees and the environment**

Beekeeping is a major integral component in agricultural economy of developing countries and produce much more than food. Current interest in quality of environment is influencing the people to look more deeply at the factors upon which food production, health and aesthetic aspects of the environment depend (Martin, 1976).

It is also alerting the far-sighted people to conserve resources. In such context, bees are world resources of such great significance in human welfare. In short bees have a high degree of

adaptation to a wide range of environment, are important parts of farming systems, and do not contribute to land degradation and ecological imbalances.

## 2.5 Biology of Honey Bee

Classification of honey bee in taxonomic classification

Kingdom - Animalia  
Phylum - Arthropoda  
Class - Insect  
Order - Hymenoptera  
Family - Apiidae  
Genus - *Apis*  
Species - *mellifera*

*Scientific name- Apis mellifera*

Honey bees are social animals those live and work cooperatively that a small hive contain average of 20,000 bees and these are grouped in to three categories ,Queen, Drone and Worker and this in normally for the sake of division of jobs (Marina, 2010). Workers exceed drones by numbers and only one Queen will exist in one bee colony.

Queen normally function to lay egg and hatch it and is the reproductive group of bee. In addition to laying egg, Queen also control and regulates a colony by its especial chemical secretion called queen substance. Queen developed from fertilized egg that selectively nourished on special food called royal jelly (Marina, 2010).

Drones are a male honey bee that developed from unfertilized egg laid by queen and are purposively used to mate with queen once in its life time. Drones has no more function rather than mating and are not successively collect nectar as worker (Carola, 2009). Thus, it either dies or escapes from the colony after mating queen. Flowers which are evolved to attract honey bees are optimized their flowers to increase the chance of bee visit.

Workers are a massive group of bees functioning to collect nectar, cleaning hive, caring for young and queen, secreting waxes and form comb. Worker bees are developed from fertilized egg but not nourished special food royal jelly (Carola, 2009). The bee unwittingly carries pollen from flowers to flowers thus pollinating the plants and permitting them to reproduce. This flowering plant both attracts and rewards an insect like honey bee. The flowers are differently colored and attract bees and reward with nectar and pollen (Carola, 2009). Nectar is sweet liquid composed of mostly sucrose. The bee collects this liquids in their crop and the digestive enzyme most importantly invertase is added. By the time return to hive much of the sucrose is converted to glucose and fructose in the hive the bees empties its crop in to a comb cell or the nectar is transferred to other bee worker who takes it to honey comb for evaporation to make honey. Pollen is a dusted all over the bee as they visit flowers and the bees legs are designed to comb this pollen from their body and catch it in a tuft of bristle on third pairs of legs (Carola, 2009).

Honey bees body covered by special structure called exoskeleton as that of all other insects which is the common feature of class insect. Exoskeleton is integument structure of insects that used not only as protective covering over the body but also serve as attachment surface of muscle and water light barrier against desiccation and sensory interface with environment (Kumar, 2010).

## **2.6 Beekeeping and Honey Bee Production Practices in Ethiopia**

In Ethiopia, beekeeping has been a tradition since long before other farming systems (Gezahegne Taddese, 1996). Even though it is one of the important and the oldest farming activities in country, there are no available records, which confirm when and where beekeeping was first started. However, the Hieroglyphs of ancient Egypt refer to Abyssinia (ancient name of Ethiopia), as source of honey and beeswax and Abyssinia has been known for its beeswax export to Egypt for centuries when other items were not exported. No countries in the world may have to ancient beekeeping as Ethiopia (Fichtl and Admassu, 1994).

Moreover, the oldest basket hive in the International bee museum is from Ethiopia. Apiculture is practiced as an integral part of farming activities. It is also a source of additional income for urban communities. Other than areas with extreme climatic conditions, beekeeping is common in every village and at virtually all smallholder farms. Total honey production in 2008/9 is

estimated at 39,650 tons and there are three different hive types by which the honey is produced: traditional, transitional (intermediate) and movable frame hives. There are 5,013,848 traditional, 34,552 transitional and 100,843 frames hives in Ethiopia (GDS, 2009). Ninety-three percent of honey production comes from traditional hives. Oromiya, Amhara, Southern National Nationalities and People (SNNP), and Tigray are the major honey producing regions with production quantities of 15,492 tons, 10,834 tons, 5, 847 tons and 3904.6 tons, respectively, (GDS, 2009).

### **2.6.1. Honeybee production practices**

In the process of bee products production, there are different beekeeping practices running either independently or simultaneously. These include traditional, intermediate, and improved beekeeping practices. Details of each production practices discussed as follows:

#### **2.6.1.1 Traditional beekeeping**

In Ethiopia, traditional beekeeping is the oldest and the richest practice, which has been carried out by the people for thousands of years. Several million bee colonies are managed with the 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, 2007).

Traditional beekeeping is mostly practiced with different types of traditional hives. The most universal type of traditional hives, known to have been in use is simple cylindrical type. Beekeeping started with traditional or fixed comb hives, so called because the combs are attached to the top and sides of the hive itself and the beekeeper cannot easily remove and replace them. In its primitive form, only one end of the hive could be open, but in more advanced forms each end of the cylinder will be fitted with a removable closure. The types of hives and the way of keeping bees vary from area to area. Based on locally available materials used for construction of hives, environmental conditions and positions used to keep bees, the following variants of basic design are found throughout the country: hollowed logs, bark hive, bamboo or reed grass hive, mud (clay) hive, animal dung (mixed with ash) hive, woven straw hive, gourd

hive, earthen pot hive and so on. The beekeepers that are experienced and skilful in using these hives could do many operations with less facility. Gezahegne Taddese (2001) stated that under Ethiopian farmers' management condition, the average amount of crude honey produced from traditional hive is estimated to be 5 kg / hive / year. On the other hand, based on the survey conducted in West Showa Zone (Edessa Negera, 2005), the amount of honey harvested, from a traditional hive on average was reported to be 6.1 kg/hive/year. According to the data from GDS (2009), about 56% of the traditional hives are in the Oromiya region which contributes 40% towards national traditional hive honey production. Likewise, the Amhara region has 18.8% of the traditional hives and contributes 26.6% of national honey production using traditional hives. The SNNP region has 15.3% of the hives and contributes 15.5% of the honey production. Productivities of honeybees are very low and averages 8 kg of honey cropped per hive per year (CSA, 2008).

Traditional husbandry is practiced with many millions of fixed comb hives particularly in the remote areas of the country. For the period until modern frame-hives are introduced, these fixed comb hives can yield a modest amount of honey, and also about 8-10% of its weight is beeswax. This harvest is achieved with minimal cost and labor, and it is valuable to people living a marginal existence.

### **2.6.1.2 Intermediate beehive beekeeping**

It is a type of beekeeping intermediate between traditional and modern beekeeping methods. Generally, top-bar hive is a single story long box with sloping sidewalls inward toward the bottom (forming an angle of 115° with the floor) and covered with bars of fixed width, 32 mm for east African honeybees (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). 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 (Gezahegne Taddese, 2001). However, at zonal level (North Wello) it has been reported that production of 24-26kilograms crude honey per hive per year (Sahel, 2002), and about 8 percent as much beeswax per kilogram of honey is likely to be obtained. Total annual honey production using transitional hives is estimated at 488,556kg which is only 1.23% of the national honey production (GDS, 2009). Transitional hives are being predominantly promoted in Oromia, Amhara and SNNP regions which have 38.3%, 30.2% and 18.8% respectively of the total number of these hives. The productivity of the transitional beehives in the Amhara region, where approximately 17 kg/hive are harvested, is relatively higher than in the other regions, 14 kg/hive in Oromiya and 13.4 kg/hive in SNNP (GDS,2009).

### **2.6.1.3 Moveable hive frame beekeeping**

Moveable frame beehive beekeeping was introduced to the country in 1978, through the Ethiopian Rural Development Extension program (HBRC, 1997). Movable frame hives allow common management practices aimed at increased honey yield directly through reducing colony migration, adding supers and regular harvesting or indirectly by stimulating early colony growth, swarm control, feeding during off-season and pest and disease controlling. Bee productivity enhancing techniques like possibility and suitability to produce other hive products and easy adoption of queen rearing techniques can be applied with the frame beehive type. The productivity of frame beehives ranges between 20 and 30kg/hive/annual), which is much higher than that of the other hive types. The yield creates high motivation for its adoption provided. But strict bee and honey management technique and accessing market would be essential requirements for success and continuous adoption (SC-UK, 2006).

Frame hives are good for honey production but have the lowest beeswax production at only 1-2% of the honey produced. Since honey from frame hives is suitable for production of table honey both for local and export markets, it is currently being promoted vigorously by the government and a number of private sector processors who have integrated farms. However, since the honey and beeswax subsectors only recently have received increased attention from the government and some NGOs, the total number of frame hives stands at 100,843. The total honey

produced from frame hives in year 2008/9 is estimated at 2,149,284kg. This amount contributes by 5.4% towards the total honey production in the country (GDS, 2009). The annual productivity of frame hives generally falls within the range of 30 – 45kg/hive (GDS, 2009). The amount of beeswax produced is 1-2% of the honey yield (Gezahegne Taddesa, 2001) but in potential areas up to 50-60 kg harvest has been reported by HBRC (1997).

## **2.7 Economic Importance of Beekeeping in Ethiopia**

Beekeeping in Ethiopia is a long-standing cultural agricultural practice. It has been exercised as a sideline activity by many of the rural farming communities for its honey and beeswax production that contributes to income generation. The role it plays in enhancing food security, poverty reduction and food production through pollination of crops has become substantial in the recent years (MoARD, 2007). As beekeeping has low start-up cost and requires little land or labor, it is accessible to many rural community and is promoted as a pro-poor income generation activity (MoARD, 2007). Frequent droughts coupled with environmental degradation have threatened the livelihood of this rural community for several decades (MoARD, 2007). However, regardless of other agricultural activities, bees survive in drought-threatened areas and supplement the vulnerable communities with nutritious food, honey, and a source of income. Therefore ranges of applications emerging from apiculture development are enormous and it is considered a major tool in combating food insecurity, while protecting the environment. Furthermore, the apiculture sub-sector is emerging as a strategic means of export diversification (GDS, 2009).

Apiculture has also a great role in natural resource protection. Beekeeping is environmentally friendly activity and beekeepers are more aware about the importance of conservation of natural resource than any ordinary farmers (Nuru Adgaba, 2007). Integrating natural resource conservation programs with income generating options like utilizing the forest resources, in the form of honey and beeswax, while maintaining the natural vegetation would be an appropriate approach (Nuru Adgaba, 2007).

### **2.7.1 Honey Production**

Honey, the natural product of honeybee, has many times been described as man's sweetest food. It is an excellent energy source because it contains simple sugars that are ready for assimilation immediately on reaching the intestine. Honey contains more than 180 elements and it has several

uses (HBRC, 1997). There is a strong, local demand for honey, due to its use for the production of traditional beverage 'Tej' (honey mead). In Ethiopia, much honey has traditionally been fermented to make 'Tej' and according to Edessa Negera (2002) 85 percent of the total honey estimated to be brought for market is used for 'Tej' production and 15 percent of the total honey produced is consumed at home. Moreover, from the total honey produced in the country beekeepers are estimated to earn about 360-480 million Birr per year (Nuru Adgaba, 2002). The current annual honey production of Ethiopia is estimated to be about 43,373 tones (AMP, 2007). This makes the country the leading honey producer in Africa and one of the ten largest honey-producing countries in the world.

### **2.7.2 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 wax is mostly left or thrown away because beekeepers do not bother to collect it since it is of little practical value for beekeepers (Fichtl and Admasu, 1994) and the people do not know the local beeswax is generating attractive money. Nevertheless, the annual beeswax production of the country is estimated at about 3,658 tones (AMP, 2007). This makes Ethiopia the fourth largest beeswax producing country in the world after China, Mexico and Turkey. Beeswax supports the national economy through foreign exchange earnings. Presently, beeswax is one of the major exportable agricultural products. Ethiopia is the third largest beeswax exporter in Africa and the annual average value of beeswax is estimated at about 125 million Birr (Nuru Adgaba, 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.

### **2.7.3 Beekeeping as a Source of Livelihood**

Beekeeping contributes to peoples' livelihoods almost in every country. Still there are people who depend for their livelihood on hunting wild colonies that plays crucial in rural livelihoods worldwide. It is believed that beekeeping plays a significant role and one of the possible options to the small-holder farmers in order to sustain their livelihood. It does not only serve as a source of additional income, but also quite a number of people entirely depend on beekeeping for their

livelihood. Beekeeping as an activity offers great potential for development in almost all African countries. It is easy and cheap to start and it is an important cash crop with ready local market. Beekeeping requires little land and therefore is an ideal activity for small scale resource-poor farmers. Beekeeping gives local people an economic incentive for the retention of natural habitats such as forests and therefore is an ideal activity in any forest conservation. Attractive income could be generated from beekeeping. However, the financial outcome will depend on many factors such as skill and experience of the practitioner; the market available to the beekeepers as well as botanical resources available; climate and other factors (Nicola, 2009).

Beekeeping can raise the livelihoods of many people including village and urban traders, carpenters who make hives; tailors who make veils, clothing and gloves and those who make and sell tools and containers (Nicola, 2009). For many farmers in the world beekeeping is attractive business and high proportion of their annual income is secured from beekeeping activities. It helps in diversification of source of incomes for rural communities that help minimize the demands of land and pressure on forests. Beekeeping has gained much attention as a means of raising the productivity of farm systems in the developing world. It requires little capital input, so it does not compete with other aspects of the farm system for the scarce resources. In many regions of Ethiopia, beekeeping is considered as one of income generating activities for resource poor farmers including women, youth and underemployed sections of the community.

The exact number of people engaged in the beekeeping sub-sector is not well known in Ethiopia. However, according to Melaku Girma *et al.*, (2008) about 1 million farmers are engaged in beekeeping in the country. Beekeeping serves as source of additional income for so many thousands of farmer beekeepers. Since honey is cash crop, more than 95% of the product is brought to market and some beekeepers are able to earn 5000 to 10000 annually from honey selling only. In the country honey, selling serves to circulate money from the urban people with a relatively better standard of living to rural people with relatively lower standard of living (Nuru, 2007). In Ethiopia, an average of 420 million Ethiopian Birr or 35 million \$USD is obtained annually from the sale of honey (Giday Yirga and Teferi Mokonen, 2010). In the southwest part of the country where there is natural forest, the livelihoods of many ethnic groups entirely depend on honey hunting and beekeeping, in such societies every household keeps bees; the money from honey selling is used to purchase grains, cloths and to cover other expenses. In the

northern and central parts of the country where there is shortage of bee colonies, it is common to see honey bee colonies like any other livestock at farm gates, and market places serve as immediate source of cash income. In the south and southwest parts of the country where there is high vegetation, honey hunting and forest beekeeping are widely practiced in this area. The majority of the households keep bees in the forest: Example, in Masha and Andaracha districts of Shekicho zone of Southern Nation and Nationalities State, more than 90% of the households engaged in beekeeping which indicates the importance of beekeeping for livelihood in the rural communities without having any other agricultural activities (Nuru Adgaba, 2007). Many people are engaged in the honey production, trading and in production and selling of honey beer (tej). In every town, "tej" production is a big business and it is even served in some big bars and hotels as special cultural drink. It is estimated that more than 15,000 breweries are operating in different parts of the country, which indicates the role of the sub-sector in employment creation for such significant number of people (Nuru Adgaba, 2007).

#### **2.7.4 Crop Pollination**

Beekeeping sustains agriculture, which is the livelihood of the rural community by increasing yields through pollinating annual and perennial crops. It offers a good way for people to create income from natural resources without damaging it. It provides services of pollinating crops. Products such as wax, pollen, propolis, royal jelly and venom could be created from beekeeping activities, but their value is less than the wealth created as result of optimal pollination of crops. Beekeeping has significant role in ensuring food security through honeybee pollination services of major cultivated crops. Honeybees are responsible for one third of all foods, such as fruits, vegetables and dairy products, including ice cream. Honeybees make their contributions to the world's food supplies by pollination. Not only do bees provide the means for many foods, they also contribute to the fight against global climate change. When bees pollinate, plants grow, the planet is cooler for the vegetation and greenhouse gases are reduced. Beekeeping can help to increase the honey bee population and promote a healthy environment and chemical free food. In a time in which bee colonies are decreasing, keeping bees is more important than ever, If not for bees, a host of crops would fail, food shortages would follow (Nicola, 2009). Beekeeping activity, besides the production of honey and other bee products, has a positive contribution for cross-pollination, which will bring sustainable contribution to the agriculture and economy of the

nation. Considering this, the Government of Ethiopia has paid a close attention to the apiculture sector. As such, a proclamation providing for apiculture resources development and protection was drafted with the aim of:- Promoting household and commercial beekeeper development in areas of high apiculture resource potential to realize appropriate contribution of the subsector in the process of rapid economic development; Ensuring sustainable contribution of honey products to enhance production and food security and poverty reduction efforts; and Developing apiculture resources through conservation of the biodiversity of honeybee races and *melliferous* plants. Honey bees can be considered as providing a positive externality to individual farmers, or the agriculture industry as a whole. Unless farmers managed honey bees themselves, many farmers in the past have not had to pay for pollination services. The pollinators that existed in their area would provide this service for free, and in many cases still do today (Morse, 2000). Virtually all of the backyard beekeepers provide free pollination for growers in their area, and these growers have no incentive to pay a fee for this pollination. With the increase in the agriculture industry, the growth in the American population, and the decline in managed honey bee populations, agriculture has seen a shortage in the amount of available honey bees. This shortage has led to the emergence of rental markets for honey bee colonies, and the externality of pollination services has shifted to producers internalizing the costs (Rucker, 2012).

### **2.7.5 Beekeeping and Its Social Benefits**

The beekeeping product honey has high cultural values. It has different purposes in many traditions such as in birth, marriage and funeral ceremonies. This cultural connection is more evident in the term ‘‘ honey moon’’ in the Masai society of Eastern Africa (Nicola, 2009). Moreover, beekeeping has social values and respects in Ethiopia. In the country honey is highly regarded product and widely used in traditional medication. It is also used for different cultural, religious and ritual ceremonies in many tribes during reconciliation of tribal conflicts. Furthermore, during pray honey is very essential part of ceremony. During different occasions "tej" or “booka” is very important.

### **2.8 Challenges for Beekeeping in Ethiopia**

In underprivileged countries the beekeepers are likely to be amongst the most remote and most poor people and beekeeping is not recognizable. This is because of lack of appropriate extension

materials, lack of marketing information, lack of skilled trainers, lack of strong organizations representing interest of beekeepers, poor linkage between producers and buyers, little coordination between beekeeping and other sectors such as horticulture, forestry, health and environmental sectors, lack of promoting products, lack of policies for protection of the industry and no global agreement on honey criteria (Nicola, 2009). Despite their essential role in sustaining modern civilization the world's bees face increasing threats. The spread of industrial farming, increased use of pesticides and loss of habitats led to decline in the role of wild insect population such that they are now reported to account for just 15% of global crop pollination. In response farmers started to hire in honey bees to pollinate their fields, thus creating a market for pollination. Nicola (2009), developing countries face different constraints in beekeeping sub-sector. The constraints are biological, technical, trade and institutional.

In Ethiopia increasing human population pressures and consequently clearing of natural vegetation for cultivation of crops, cutting woods for construction purposes, intensive cultivation and over-grazing and due to these the bees and other natural resources are under continuous threat. Unwise application of herbicides and various pesticides are killing a number of honey bee colonies annually and have become critical in the development of beekeeping sub-sector. Due to deforestation and application of agro-chemicals the honey bee population is in state of continues declining. As a result, it has become a serious challenge to get honey bee colonies to start and expand beekeeping (Nuru, 2007). Despite long period of introduction of improved beekeeping technologies to the country, the numbers of beekeepers involved in improved beekeeping are very low. This is because of inadequate demonstration of improved beekeeping technologies to large number of farmers and unable to convince them that, technologies are better than their own, in-complete package distribution, un-affordability of the technologies or absence of alternative technological options, absence of adequate training that can fill the knowledge and skills gaps both at farmers and development agents that assist them. Due to usage of traditional hives and lack of matched management practices suitable for the type of honey bee races their environmental conditions, the annual average honey yield per colony is relatively low. Low productivity and poor quality of bee products are the major economic impediments for rural communities. They also face another economic concern, lack of skill to manage their bees and bee products. Most of the rural beekeepers cannot afford to invest in inputs, process, and pack and transport their products to market to maximize profit. They produce a low quality product

that they are forced to sell locally to prices much lower than in domestic commercial markets (Melaku et al., 2008). The natural quality of honey and sanitation is not maintained in the process of harvesting, storing and transporting. Much use of smoking during harvesting and adulteration are underlined as serious causes of problem. Most of the honey produced and marketed is poor quality unsuited for processing and export. At present there is no strong and formally or informally organized market for honey products in the country. This resulted in lack of grades and standards, in poor quality control, inadequate and inconsistent supply to whole sellers, processors and exporters. The low involvement of private sectors in processing and export of honey could be partially attributed to these problems. Due to lack of information on market value of beeswax, large amount of beeswax, produced in remote areas of the country usually wasted. Individual actors and the nation are losing incalculable benefits. There is no institution responsible for market research of honey. National institutions namely Agricultural research institutions, Universities, Ministry of Trade, Chamber of commerce and International agencies, all have not given due attention to the marketing research of bee products to generate information for stakeholders and policy actions. Inadequate Government support in promoting beekeeping development could be manifested in absence of strong adequate research and training institutions, policies and strategies on the sub-sector. In addition, since decades, there has been only one research and training center in the country (Holeta Beekeeping Research Center) responsible to generate technologies and transfer to the users. There is also poor extension service in the sub-sector, The Ministry of Agriculture paid attention exclusively to food crop production. Moreover, the local prices of honey and wax are high mainly because of high demand for products and partly because of high cost of production, transporting, processing and packaging. Furthermore, due to advocating of globalization many stakeholders interested in export of honey and honey products are suffering from lack of certification to be accredited to fit into the international quality standards (Beyene Tamiru and David, 2007).

## **CHAPTER THREE**

### **3 MATERIALS AND METHODS**

#### **3.1 Description of the study area**

The study was conducted in Wachale District which is located in Oromia Regional State, North Shoa administrative Zone at about 78 Kms North of Addis Ababa and bordered by Debra Libanos in the North, Sululta in the South, Abbichu Nya'a and Jidda in the East, and Yayya Gullallee and Sululta in the West. The altitude extends from 1200 m to 2880 meters above sea levels. The rain-fall is bimodal and the long rain-fall occurs from June to September and the short rain-fall occurs from March to April with the peak records usually in July and August. The mean annual rain-fall ranges from 900 mm to 1500 mm with the average minimum and maximum temperature is 3<sup>0</sup>c and 25<sup>0</sup>c, respectively. The total population of the study districts is 166,786 with the proportion of 84,627 males and 82,159 females (District Agricultural and Rural Development office, 2020).

Three Agro-ecological Zones are identified in Wachalee district. These are high land (Dega) which accounts for 60%, Mid-land (Woyna-dega) which accounts for 30% and low land (kola) covers 10% of the districts. The main crops cultivated in the district are: wheat, teff, barley, sorghum, maize, field pea and faba bean. Mixed crop and livestock farming system is the model of agricultural in the district. Farmers also engaged in beekeeping activities parallel to the above activities.

#### **3.2 Sampling and Data collection methods**

The study area stratified into three Agro-ecologies and simple random sampling was used to select respondents among society for a questioner prepared. This study was carried out in Wachalee District in six rural Kebele Administrations namely Bidaaru, Walaansoo and Ilu Itayya from High land, Baddooyee Ginbichuu and Akaakoo dayyuu katta from Mid-land and Bachoo falinii from Low land. The study was conducted between Octobers to December, 2020. Both primary and secondary data collection methods were used to achieve the objectives of the study. Both qualitative and quantitative methods were used for primary data collection. These methods include semi-structured interviews with key informants, focus group discussions, household

survey and direct observations. Secondary data were collected from different published and unpublished sources such as district agricultural offices and other published and unpublished materials.

### **3.2.1 Sources and methods of data collections**

Both primary and secondary data collection were used for the study. The primary data were collected by using direct investigation of researcher to observe the status of honeybee colony and per house holding society. Formal survey was conducted using semi-structured questionnaires with open-ended and closed ended questions. The questionnaire were prepared to collect information about house hold characteristics (sex, age, marital status and educational level), honey production practice (number of hives owned, types of hives used, amount of honey harvested per hives), honey harvesting seasons and constraints of apicultures. Key informant interview was also conducted to generate qualitative information about the activity of the apiculture. Key informants include: model beekeepers, elders and DAs working in the study area.

Secondary data collection was from the kebele agricultural sectors, district agricultural sectors, reports and files of farmers annual honey production documents. The research was carried out in Wachalee district in six rural kebele Administrations, namely: Bidaaru, Walaansoo and Ilu Itayya from High land, Baddooyee Ginbichuu and Akaakoo dayyuu katta from Mid-land and Bachoo falinii from Low land.

### **3.2.2 Method of sampling and sample size**

The study district (Wachale), consists of a total of twenty-three rural and three urban dweller kebeles. The district was stratified into three Agro-ecologies:- high land (Dega), mid-land (Woyne-dega) and low land (Kola), with 60%, 30% and 10%, respectively, such that each stratum was made up of kebele sharing similar characteristics. Stratified random sampling procedure was followed to select the peasant association on their agro-ecological zone. Totally six kebeles were selected based on the proportion of kebeles in each agro-ecological zones. The Six representative sample kebeles, three from high land, two from mid land and one from low land were selected using simple random sampling techniques. A total of 90 respondents (15 beekeepers per kebeles) from the three agro ecology were selected. The selection was made by

using simple random sampling techniques. Single house hold respondents, was used as sampling units in this study.

### **3.3 Data Analysis**

The collected data from respondents of the population sampled in the six kebeles were prepared for statistical analysis. The statistical analysis used in the study varied depending on the type of variables and information required. The analysis was conducted separately for each agro-ecology in the wachalee district and uses graphs and tables to present the data. Descriptive statistics such as:-mean, frequency and percentage were used to analysis the data.

## CHAPTER FOUR

### RESULTS AND DISCUSSION

#### 4.1 RESULTS

##### 4.1.1 Household Characteristics

###### 4.1.1.1 *Gender of the respondents*

Of a total sample household interviewed about 94.4% (94.4% low land, 93.3% mid-land and 95.5% high land) were male while about 5.6% (6.7% low land, 6.7% mid land and 4.5% high land) were female respondent beekeepers. This very limited number of female participations in beekeeping agrees with the finding of Jinanus Dinka and Tamiru Kumsa (2016) and Alemayehu Kebede (2011) who reported low level of women's participation in beekeeping. Similarly, Hartmann (2004) reported that traditionally beekeeping is mainly men's job in Ethiopia. This might be partly due to psychological fear exhibited by women towards the profession coupled with time of major activities, which are either late evening or early morning hours, which are not convenient for women due to household workloads.

###### 4.1.1.2 *Age of the respondents*

Of the total sample household interviewed about 46.7 % ( 48.9% high land, 46.7% mid land and 40% low land) under the age range of 31-45, Whereas 41.1% (35.5% high land, 43.3% mid land and 40% low land) where in the age range from 46 to 60. However, 5.6% (6.7% high land, 3.3% mid land and 6.7% low land) under the age range of less than 30 and 8.9% (8.9% high land, 6.7% mid land and 13.3% low land) were above 60 years old.

###### 4.1.1.3 *Marital status of the sample respondents*

Marital status of the sample respondents indicates that about 87.8% (84.4%High land, 86.7% Mid-land and 100% Low land) were married; whereas 12.2% (15.5% High lands, 13.3% Mid-land and 0% Low land) was single (Table 1). Marriage promotes synergy within a farm family and function as custom to cop up life challenge in the rural community. All the single households were male, but all the female household heads are widows.

#### 4.1.1.4 Educational level of the respondents

Regarding educational status, among the sample respondents 22.2% had not received any education, while 47.8% could only read and write. The rest were at stages of literacy ranging from elementary to high school level. More specifically, 27.8% and 2.2% of the sample respondents had attended elementary school and high school (Table 1). Moreover, for illiterate people there is a need of intensive training and persuading of beekeepers before distributing movable frame hives. Therefore, according to the result of this study the high level of illiteracy (22.2%) in the district limits the effectiveness of formal training programs and requires more emphasis to be placed on practical demonstration of essential concepts especially in improved beekeeping. The present illiteracy level is in line with the report of Soressa Shuma (2020) who have reported that more than 19% of the sampled respondents of Kellem Wollega, Jimma Horro district were illiterate.

Table 1: Sex, Age, Marital status and Educational level of the sample respondents (%)

Description	Response	High land(n=45)	Mid Land(n=30)	Low land(n=15)	Total sample
		%	%	%	%
Sex	Male	95.5	93.3	94.4	94.4
	Female	4.5	6.7	5.6	5.6
	Total	100	100	100	100
Age	<30	6.7	3.3	6.7	5.6
	31-45	48.9	46.7	40	46.7
	46-60	35.6	43.3	40	38.9
	>61	8.9	6.7	13.3	8.9
Marital Status	Married	84.4	86.7	100	87.8
	Single	15.5	13.3		12.2
Educational levels	Illiterate	15.6	23.3	40	22.2
	Read & write	55.6	40	40	47.8
	1-8	26.7	33.3	20	27.8
	9-12	2.2	3.3	-	2.2

n= Total number of respondents

### 4.1.2 Crop production

The most important and widely grown crops cultivated in the study area are presents in Table 2. According to the survey, the most commonly grown crops by sample farmers were reported to be wheat (30%), teeff (28.8%), Barley (15.6%), Sorghum (10%), Faba bean (10%), Field pea (3.3%), Shalo (3.3%) and Maize (1.1%). Wheat and teeff were the two top cereal crops grown by the sample farmers. The dominance of the cereals in the area may be related to the food or dietary habits of the communities as well as the local climates, which favored the types of crop production. Vegetables and various fruits were also grown for cash generation as well as for home consumption.

Table 2 The distribution of the most important crops cultivated by interviewed households in the district (%)

Major crops	Highl land (n=45)		Mid land(n=30)		Low land (n=15)		Total	
	n	%	n	%	n	%	n	%
Teff	10	22.2	10	33.3	-		25	27.8
Wheat	15	33.3	12	40	5	33.3	27	30
Barley	10	22.2	4	13.3	-		14	15.6
Sorghum	-		-		9	60	9	10
Maize	-		-		1	6.7	1	1.1
Field pea	2	4.4	1	6.7	-		3	3.3
Faba bean	6	13.3	3	10	-		9	10
Shallo/Sin ar	2	4.4	-		-		2	2.2

n= Total number of respondents

### 4.1.3 Types of Beekeeping and Colony holdings

#### 4.1.3.1 Types of Beekeeping

Based on their level of technological advancement, there are three types of beehives used for honey production in the study area. As table 3 below shows most of the Wachalee district beekeepers used to keep honey bee in traditional hive (79.2%) which is not modernized and exposed to different harmful environmental and ecological factors, transitional (6.6%) and modern (14.2) beehives. During the study it was observed that about 58% (66.7% high land, 60 % mid land and 66.6% low land) of the beekeepers in the study area use only traditional types of beehives. However, 24.4% (26.7% high land, 26.7% mid-land and 13.3% low land) of the beekeepers in the study area use both traditional and modern frame hives, while 10% (6.7% high land, 10% mid-land and 10% low land) use traditional and transitional hives and the remaining 1.11% practiced traditional, transitional and modern hive beekeeping at the same time. It is also observed that the beekeepers used locally available materials and indigenous knowledge to make traditional hives. This study was in agreement with Getachew Abreham (2018), who reported traditional, transitional and modern beehives are used for the honey production in Gesha district, South-West Ethiopia. The main reasons for low adoption rate of modern bee hives in the study area (13.2% movable frame and 6.6% intermediate bee hives) were lack of finance to buy input, technical constraints and shortage in supply of beehive accessory equipment limits the developments of improved beekeeping in the area as indicated by the respondents.

Table 3 Types of beekeeping in Wachalee district (%) by sample respondents.

Types of the hives	High land (n=45)		Mid land (n=30)		Low land (n=15)		Total (n=90)	
	n	%	n	%	n	%	n	%
Traditional only	30	66.7	18	60	10	66.7	58	64.4
Traditional and Transitional	3	6.6	3	10	3	10	9	10
Traditional and Modern hives	12	26.7	8	26.7	2	13.3	22	24.4
Traditional , Transitional and Modern hives	-		1	3.3	-		1	1.11

n= Number of respondents

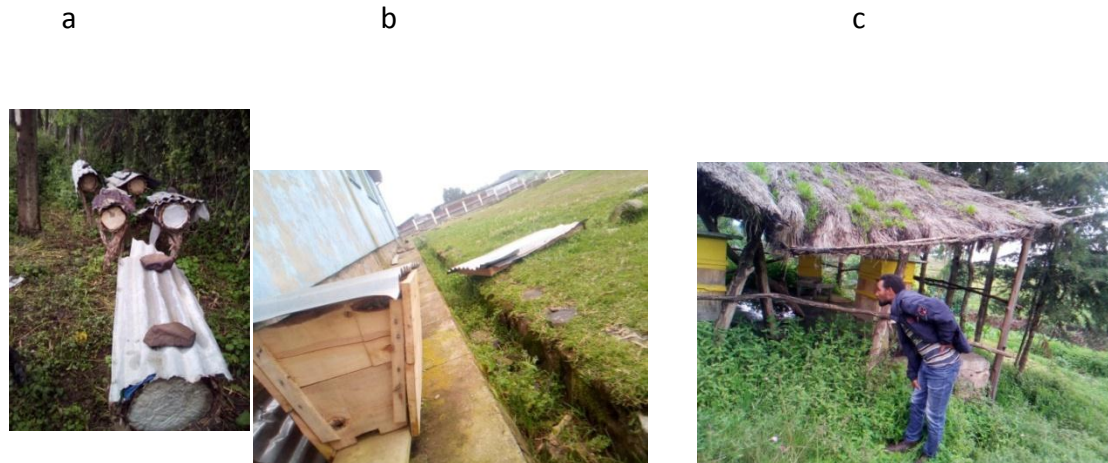


Figure 1:- Types of hive used in the study districts. a. Traditional hives b. Transitional hives  
c. Modern hives

#### 4.1.3.2 Honeybee Colony holding

In general, the beekeeping business was practiced at a very small scale level in the study districts. Considering the whole sample from all location, most farmers about 48.9% owned 1-5, 36.7% owned 6-10, 10% owned 11-15 and only 4.4% owned >16 honeybee colonies in traditional hives. The average bee colonies possessed by the beekeepers in the study district is 7.8/households. The average total honeybee colony holding of highland was 7.96/households; the colony holding of mid land was 7.3/household while the colony holding of low land was 8.3/household (Table 4). The average honeybee colony holding of the sample respondents for traditional, transitional and modern hives were 6.18, 0.51 and 1.11 respectively. The average colony holding of beekeepers in this district is comparable with the finding of Tessega Belay (2009) who reported an average of 7.75 colonies per households for Burie district of Amhara Region, Ethiopia.

According to table 4 below, only ten beekeepers were involved in intermediate beekeeping Production practice. Proportionally only about 6.6% (5% high land, 7.3% mid-land and 9.62% low land) of honey bees are kept in transitional hives while 14.2% (16.8% high land, 14.6% mid land and 6.4% low land) of the honeybee colonies of the study area are kept in movable frame hives.

Table 4 Honeybee colony holding of the sample respondents in 2020.

Hive type	Description No. of hive owned By sample respondents	Agro-ecology						Over-all mean
		High land		Mid land		Low land		
		n	%	n	%	n	%	
Traditional	1-5	21	46.7	16	53.3	7	46.7	79.2
	6-10	18	40	10	33.3	5	33.3	
	11-15	4	8.9	3	10	2	13.3	
	>15	2	4.4	1	3.33	1	6.7	
	Total number of hives	280	78.5	171	78.1	105	85	
Transitional	1-5	1	33.3	3	75	3	100	6.6
	6-10	2	66.7	1	25	0		
	>10	0		0		0		
	Total number of hives	18	5	16	7.3	12	9.62	
Modern	1-5	8	66.7	7	77.8	2	100	14.2
	6-10	4	33.3	2	22.2	0		
	>10	0				0		
	Total number of hives	60	16.8	32	14.6	8	6.4	

n= Number of respondents

#### 4.1.4 Average honey Products harvested annually per a hive

The amount of honey produced from one bee hive per year varies from places to places, which in most cases is determined by the existences of plenty pollen and nectar source plants and the level of management & input. The maximum amount of honey harvested from traditional, transitional and modern hive were 16 kg, 18 kg and 25 kg respectively and the minimum out puts from all

three types of hives in the study districts were 2 kg, 5 kg and 9kg respectively (Table 5). This result indicates the annual honey product of the modern hive seems to be very low, although a scientifically implemented and investigated proved hiving and bee management was practiced. During the survey it was observed that, this lower rate of growth in honey production was due to low level of management practice and technological adoption. Furthermore, the drought occurrence and changing vegetation coverage or bee flora in the area were among other things to be considered as causative factors. Table 5 also shows; the average amount of honey harvested from traditional, transitional and modern hive were 6.49 kg, 10.47 kg and 19.913 kg per hive respectively with over all annual yields ranging from 2-25 kg/hive. This result is similar with the result reported by Workneh *et al.*, (2008) states that the average amount of honey harvested per traditional hive in West, South West and North Shoa zones to be 6.2 kg.

Table 5 The annual honey yield of traditional, transitional and modern hive.

Hive types	Description	Types of Agro-ecology			Over-all mean
		High land Kg/hive/year	Mid land Kg/hive/year	Low land Kg/hive/year	
Traditional	Minimum	2.5	3	2	6.49
	Maximum	13	16	11	
	Range	2.5-13	3-16	2-11	
	Mean	5.97	7.43	7.43	
Transitional	Minimum	6	7	5	10.47
	Maximum	16	17	18	
	Range	6-16	7-17	5-18	
	Mean	9.83	10.875	10.7	
Modern	Minimum	10	9	10	19.913
	Maximum	25	21	24	
	Range	10-25	9-21	10-24	
	Mean	18.7	17.11	17	

Table 6: Data showing the annual honey harvest of modern hive of six kebeles in past four years (kg/hive)

Series of year E.C	Bidaaru Kg/hive	Illu Itayya Kg/hive	Wallanso Kg/hive	Akaakoo Dayyu Katta Kg/hive	Baddoye Ginbichu Kg/hive	Bachoo Fallini Kg/hive
2008	23	24	-	21	24	-
2009	23	25	23	21	22.5	22.5
2010	22.5	25	21	20	20	21
2011	20	23	20	18	17.5	19

Sources; The annual honey product from agricultural management officers (2008-2011 E.C)

As the table indicates Bidaru, Illu ittayya, Akaakoo Dayyu Katta and Baddoyee Ginbichu have continues data records indicating the amount of honey collected from modern hive each year from the kebele beekeepers. According to the data obtained from agricultural management officers; the annual honey harvest of modern hive is decreasing from (2008-2011 E.C). During the survey it was observed that, this lower rate of growth in honey production was due to low level of management practice and technological adoption. Furthermore, the recurrent drought occurrence and changing vegetation coverage (*i.e*, bee flora) in the area were among other things to be considered as causative factors.

#### 4.1.4.1 Honey harvesting frequency of bee colony per a year

As shown in *Figure 2*, more than 64% of the respondents harvested honey once a year from traditional hive and 10% and 4.6% for respondent harvest once per a year from transitional and modern hive respectively. In addition, respondents having transitional hives 80% and modern 54.5% also harvest honey twice a year, even though the hive technology is improved and (32.2%)of respondent harvest honey twice from the traditional hive. About 40.9% of the respondents having modern hive were able to harvest three time a year, which is slightly higher than noted for transitional hive 10% and much higher than the traditional hive 3.3% and It agreed with what proposed by (Welay Kiros and Tekleberhan Tsega, 2017).

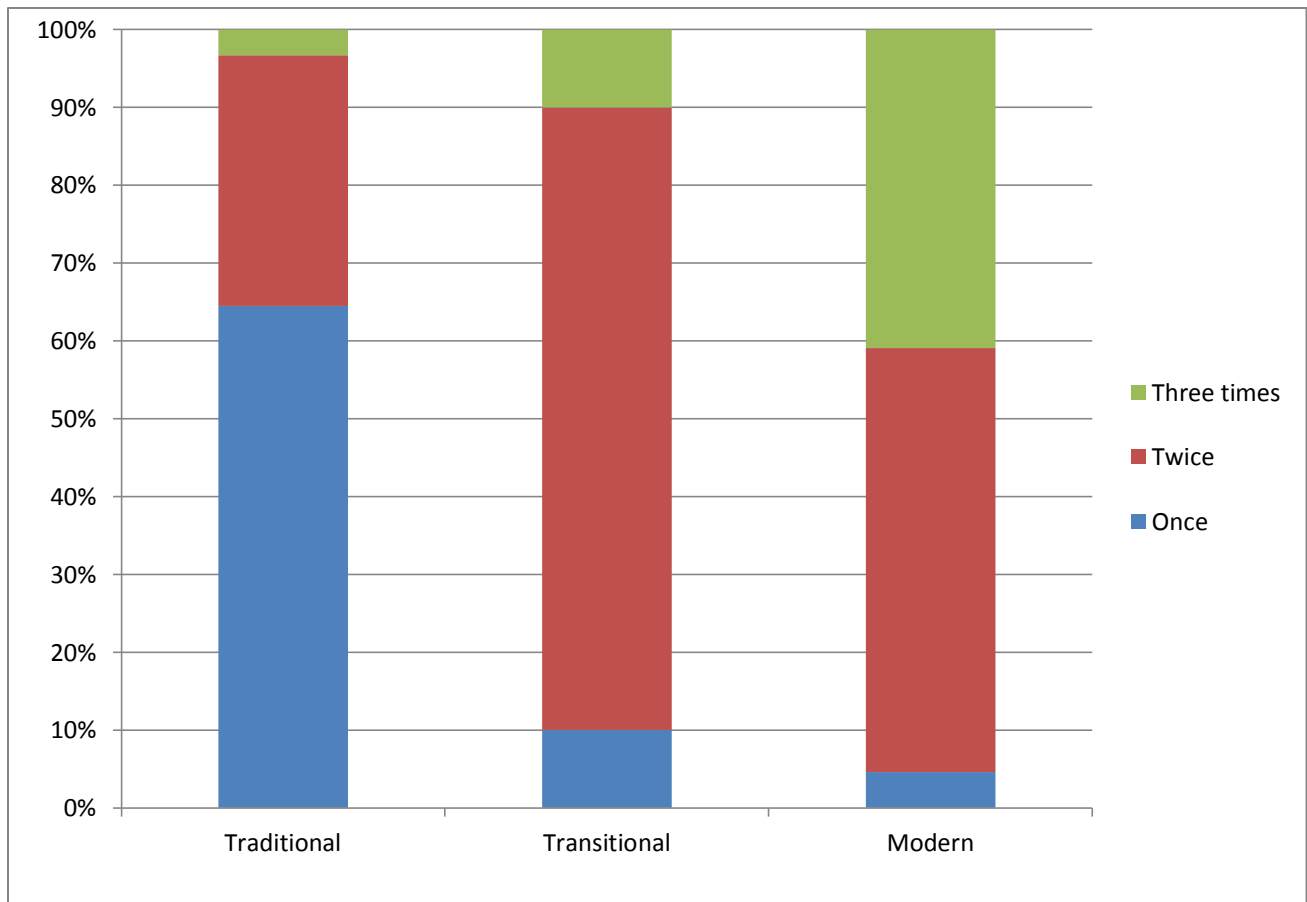


Figure 2: Honey harvesting frequency per a year

#### 4.1.5 Honey Harvesting Season

In Ethiopia, there are generally two honey harvesting seasons: the major one that lasts from October to November and the secondary one from April to June. However, in addition to these major harvesting periods, there are many small harvesting periods which depend on the type of flowering plants and rainfall patterns in different agro ecologies, which experienced beekeepers and local people easily associate the harvesting season with the botanical origin of honey in their locality. Tables 7, shows that from the respondents provided question on what season honey production is most successive and yielded high, most of them responded that honey is highly harvested in autumn season than the other yearly seasons. 96.7% (95.6% high land, 96.7% mid land and 100% low land) of the respondents collect their honey during autumn season while 3.3% (4.4% high land and 3.3% mid land) of the respondents do not collect honey at autumn

season. When compare this with summer season only 2.2% (2.2% high land and 3.3% mid land) of the respondents collect honey from their hive during summer season and 97.8% (97.8% High land, 96.7% mid land and 100% low land) of the respondents do not get any yield from their bee colonies. In the rest two season; spring and winter there are a moderate honey production and these accounts 72.2%(73.3% high land, 70% mid land and73.3% low land) and 38.9%(42.2% high land, 36.7% mid land and 33.3% low land) respondents collecting good honey yields respectively.

Table 7 The frequency of respondents on honey harvesting seasons.

Description	Response	High land		Mid land		Low land		Total	
		n	%	n	%	n	%	n	%
Autumn	Yes	43	95.6	29	96.7	15	100	87	96.7
	No	2	4.4	1	3.3	-	-	3	3.3
Winter	Yes	19	42.2	11	36.7	5	33.3	34	38.9
	No	26	57.8	19	63.3	10	66.7	56	61.1
Spring	Yes	33	73.3	21	70	11	73.3	65	72.2
	No	12	26.7	9	30	4	26.7	25	27.8
Summer	Yes	1	2.2	1	3.3	-	-	2	2.2
	No	44	97.8	29	96.7	15	100	87	97.8

n= Total number of respondents

#### 4.1.6 Honey bee management practices

##### 4.1.6.1 Placements of honeybee colonies

The majority of the respondents were keeping their bees in backyard, under the eaves, and small shelter around the house, which accounts for 55.3%, 12.4% and 32.3%, respectively. Keeping honeybee colonies under the roof of the outside part of house wall and at backyard make inspection of colony and other hive managements easier compared with that of tree apiaries and small shelter around the house.

About 87% of the sample respondents who owned traditional, transitional and frame hive kept their colonies around their homestead (back yard) mainly to enable close supervision of colonies,

whereas some of the respondents (14% and 19.6%) kept traditional and transitional hive, respectively, under the eaves of the house. Besides, 58.9% (33.3% traditional, 23.9% transitional and 31% modern) bee colonies were kept inside a simple shelter around the house so that they might attract wild swarms. According to the response of respondents in the study district no one kept modern frame hive under the eaves of the house.

Table 8 Placements of beehive % by sample respondents.

Beehive placements	Traditional hive (n=556)		Transitional hive (n=46)		Modern hive (n=100)		Total hive (n=702)	
	n	%	n	%	n	%	n	%
Backyard of the house	293	52.7	26	56.5	69	69	388	55.3
Under the eaves of the house	78	14	9	19.6	-	-	87	12.4
Inside a simple shelter or tree	185	33.3	11	23.9	31	31	227	32.3
Total								

n= Total number of hives



Figure 3: Bee hive placements a. Back yard b. Under the eaves c. Inside a shelter

#### 4.1.6.2 Honeybee Colony inspection

In the study district, all the beekeepers have inspected their bee colonies and 70% conducted external hive inspection only, whereas 30% of the respondents conducted internal and external hive inspection. The Sample respondents were interviewed to describe the frequency of inspecting their apiary and honeybee colonies and 23.3%, 21.1% and 15.6% of the respondents replied that they take a look externally into the hives frequently, some times and rarely respectively. Moreover 5.6%, 10% and 14.44% of respondents inspect internal and external hive inspection frequently, sometimes and rarely respectively (Table 9). Internal hive inspection by opening the hive is not a common practice in traditional beekeeping. Internal hive inspection is undertaken by 66.7 % of the beekeepers found in high land (mostly respondents using modern bee hive) during honey harvesting, swarming and when colonies attacked by pests. This is presumably because of fear of being stung, the risk of the colony absconding and lack of awareness of the value of doing so. The results also indicated 70% (66.7% high land,70% mid land and 80% low land) conducted external hive inspection only and 30% ( 33.3% high land, 30% mid land and 20% low land) conducted internal and external hive inspection in which the external and internal hive inspection of high land is greater than that of low land and mid land. Moreover, almost all beekeepers in the study area perform external inspection and also clean their apiary to prevent ant and other insect pests from getting access to hives. The study conducted by Kerealem Ijigu *et al.* (2009), revealed the same results. The study confirmed that internal hive inspection of traditional hive is not very common or nonexistent at all in the Amara region, Ethiopia.

Table 9 Bee hive inspection frequency (%) by sample respondents.

Types of beehive inspection	Description Or Category	Agro-ecology			Total (%)
		High land %	Mid land %	low land %	
External inspection	Frequently	35.6	40	6.7	23.33
	Sometimes	20	20	26.7	21.1

only	Rarely	11.2	10	13.3	15.6
	Total	66.7	70	80	70
External & internal hive inspection	Frequently	6.66	3.33	-	5.6
	Sometimes	11.1	10	6.7	10
	Rarely	15.54	16.7	13.33	14.44
	Total	33.3	30	20	30

#### 4.1.7 Major Constraints of Honey Production in the study Districts

##### 4.1.7.1 Honey bee Pest and Predators

In this research seven pest and predators that attack honeybees and their hives in the study location were identified based on information collected from the respondent beekeepers. These include ants, wax moth, spider, lizard, birds, mites and Hamagots/ Shelemetmet.

All respondents reported the existence of pests and predators on their farms. Table 9 shows the major pests and predators ranked depending on the extent of damage caused to the honey bee colonies. The occurrence of honeybee pests for both locations (high land and mid-land) were similar while for low land more prevalence of lizard (33.3%) occurred according to data obtained from the sample respondents. According to the respondents ranking, ants were number one predators (26.7%) followed by wax moth (20%), spider (16.7%) bee-eater birds (13.3%), lizard (12.2%) and mites (7.8%) in the Wachalee districts. Hamagot/Shelemetmet was the other minor predatory (3.3%) in the study district. None of the interviewed beekeepers responded for the availability of bee diseases in the area which could be due to its absence or lack of awareness about the various symptoms of honey bee diseases. Like all living things, honeybees are attacked at all stages of their development by various enemies either directly as predators, or indirectly, by disturbing the life of the colony in various ways. The most important of these enemies are those that destroy the combs, the stores, the hive itself and some predators that attack foraging worker bees as they leave the hive. Study conducted by Desalegn Begna (2006) in West Shewa Zone of Ethiopia also showed that from the total honeybee colonies in his study area, 44.2% of them were known to be attacked by ants every year, of which 24% absconded and 4.2% died.

Honey yield amounting 28% of the production in the zone was found to be lost per year due to the ant attack.

Table 10 Major honey bee pest and predators

Pest and predators	High Land (n=45)		Mid-land(n=30)		Low land (n=15)		Total(n=90)	
	n	%	n	%	n	%	n	%
Ants	15	33.3	8	26.7	1	6.7	24	26.7
Wax moth	10	22.2	7	23.3	1	6.7	18	20
Spiders	8	17.8	3	10	2	13.3	15	16.7
Birds	7	15.6	4	13.3	1	6.7	12	13.3
Lizards	3	6.7	3	10	5	33.3	11	12.2
Mites	2	4.4	1	3.3	3	20	7	7.8
Shelemetmat	-		2	6.7	1	6.7	3	3.3

#### 4.1.7.2 Mis-use of agrochemicals

The use of different agro-chemicals or pesticides is an important and common practice in crop production to fight against most crop damaging pest populations and diseases to produce high quantity of food round the world. However, if they are not used properly (according to their prescription for time of application and dosage), they bring about very crucial damage to pollination fauna (the honeybees in our case), environment and human health. As a result, reduction in pollinating insect population, quantity and quality reduction in hive products and crop yield reduction are some of the associated risks encountered. Furthermore, chemicals were sprayed to prevent malaria and weeds. The applied chemicals affected some of the respondents, by causing a decline up to one quarter of honey bee colony population and honey flora resources and, hence, productivity. The herbicides and pesticides are used particularly on wheat and on vegetables such as tomato and cabbage. It is rarely applied to grain crops like maize in time of large infestation with stalk borer and army worm. The time of application varied but was usually between June and September. None of the beekeepers had taken any measure to protect their

bees from the sprayed chemicals. According to the respondents, several plants that are used as source of pollen and nectar in the area are declining from time to time due to application of herbicides.

Table 11, shows that from the respondents, provided question on the use of agrochemicals, most of them 96.7% (95.5% high land, 100% mid land and 100% low land) of interviewed farmers and their neighbors had used herbicides and insecticides to control crops and livestock pest and diseases in the study districts. 58.9% (50% high land, 66.7% mid-land and 53.3% low land) use only herbicide chemicals whereas 15.6% (25% high land and 10% mid-land) use only insecticide chemicals and 25.6%(20.5% high land, 23.3% mid land and 46.7% low land) use both herbicide and insecticide chemicals.

Table 11 The use of agrochemicals in the study area.

Descriptions	Response	High land	Mid land	Low land	Total
		%	%	%	%
Did you use agrochemicals	Yes	95.5	100	100	96.7
	No	4.5	-	-	3.3
What types of agrochemicals did use?		%	%	%	
	Herbicides only	50	66.7	53.3	58.9
	Insecticides only	25	10	-	15.6
	Both	20.5	23.3	46.7	25.6

#### 4.1.7.3 Absconding of bees

Absconding is the term used when all the bees from a hive leave and desert the combs. Table 12, below shows that from the respondents, provided question on the presence of absconding; about 57.8% (46.7% high land, 65% mid land and 70% low land) of the interviewed beekeepers responded the presence of absconding of honeybee colony. In the area, the most common causes of absconding mentioned by the respondents were pest and predators (16.7%), shortage of forage (11.1%), agrochemicals (13.3%), excessive rain fall (3.3%), destructive ways of honey harvesting (6.7%) and unknown reasons (5.6%). This could be one of the reasons for the

observed high rates of absconding by the honey bee colonies. As the response of respondents, the rate of colony absconding is high in the low land (70%) while low in high lands (46.7%). Moreover, the sampled beekeepers and bee expert of the district indicated that the high land area is not suitable for crop production as it is too cold and the honeybees cannot be affected by the herbicide chemicals. This results in low rate of absconding of honeybees and high honey yield in the high land. This result is in agreement with Getachew Abreham (2018) who reported similar reasons for colony absconding in Gesha district South west Ethiopia. Usually absconding occurs as a result of shortage of food or reduction in the honey flow, disturbance of the colony, either by pests, predators, bad management by the beekeepers: excessive use of smoking during harvest and destructive ways of honey harvest, the beekeepers might use unsuitable hives (too big, too humid, bad smell) unsuitable places (too much shade, no shelter from rain or excessive heat, and exposed all day to the sun) (Abebe Jenberie *et al.*, 2018).

Table 12 Absconding and reasons for abscond

Description	Response	High land (n=45) %	Mid land (n=30) %	Low land (n=15) %	Total %
Occurrence of bee absconding	Yes	46.7	65	70	57.8
	No	53.3	35	30	42.2
What are the reasons for bees absconding?	Honeybee Pest and predators	15.7	16.3	19	16.7
	Agrochemicals	8.9	16.3	19	13.3
	Lack of bee forage	6.7	13	19	11.1
	Destructive ways of honey harvesting	4.5	9.75	6.4	6.7
	Excessive rain	6.7	3.25	-	3.3
	Unknown	4.5	6.5	6.4	5.6

## 4.2 Discussion

The primary means of subsistence in the study areas is mixed crop-livestock farming. Beekeeping is an important old traditional agricultural practice in the mixed farming systems of the area. Beekeeping in the study area is still traditional. Based on their level of technological advancement, there are three types of beehives used for honey production in the study districts. Results shows most of the Wachalee district bee keepers used to keep honey bee in traditional hive (79.2%) which is not modernized and exposed to different harmful environmental and ecological factors, transitional (6.6%) and modern (14.2%) beehives. This study was in agreement with Getachew Abreham (2018), who reported traditional, transitional and modern beehives are used for the honey production in Gesha district, South-West Ethiopia. The main reasons for low adoption rate of modern bee hives in the study area (13.2% movable frame and 6.6% intermediate bee hives) were lack of finance to buy input, technical constraints and shortage in supply of beehive accessory equipment limits the developments of improved beekeeping in the area as indicated by the respondents. The average honeybee colony holding of the sample respondents for traditional, transitional and modern hives were 6.18, 0.51 and 1.11 respectively. The average colony holding of beekeepers in this district is comparable with the finding of Tessega Belay (2009) who reported an average of 7.75 colonies per households for Burie district of Amhara Region, Ethiopia.

According to these results, only ten beekeepers were involved in intermediate beekeeping Production practice. Proportionally only about 6.6% (5% high land, 7.3% mid-land and 9.62% low land) of honey bees are kept in transitional hives while 14.2% (16.8% high land, 14.6% mid land and 6.4% low land) of the honeybee colonies of the study area are kept in movable frame hives. The number of transitional hive in the low land is much greater than the number of transitional hive found in high land and the number of modern hive is much greater in high land than that of low land. In Ethiopia, there are generally two honey harvesting seasons: the major one that lasts from October to November and the secondary one from April to June. However, in addition to these major harvesting periods, there are many small harvesting periods which depend on the type of flowering plants and rainfall patterns in different agro ecologies, which experienced beekeepers and local people easily associate the harvesting season with the botanical origin of honey in their locality. Accordingly, 96.7% (95.6% high land, 96.7% mid land and 100% low land) of the respondents collect their honey during autumn season while 3.3% (4.4%

high land and 3.3% mid land) of the respondents do not collect honey at autumn season. In the spring and winter there are a moderate honey production and these accounts 72.2%(73.3% high land, 70% mid land and 73.3% low land) and 38.9%(42.2% high land, 36.7% mid land and 33.3% low land) respondents collecting good honey yields respectively. In the study district seven pest and predators that attack honeybees and their hives in the study location were identified based on information collected from the respondent beekeepers. These include ants, wax moth, spider, lizard, birds, mites and Hamagots. The use of different agro-chemicals or pesticides is an important and common practice in crop production to fight against most crop damaging pest populations and diseases to produce high quantity of food round the world. However, if they are not used properly (according to their prescription for time of application and dosage), they bring about very crucial damage to pollination fauna (the honeybees in our case), environment and human health. As a result, reduction in pollinating insect population, quantity and quality reduction in hive products and crop yield reduction are some of the associated risks encountered.

# CHAPTER FIVE

## 5 CONCLUSIONS and RECOMMENDATION

### 5.1 Conclusion

Based on the level of technological advancement three types of beehives (traditional, intermediate and frame hives) are used for honey production in Ethiopia. Despite the long beekeeping tradition in Ethiopia, the highest bee density, being the leading honey producer and one of the largest beeswax exporting countries in Africa, the share of the sub-sector to the Gross Domestic Product (GDP) of the country has never been commensurate with the huge resources and the country's potential for beekeeping. Productivity has always been low, leading to higher domestic hive products utilization and relatively low export earnings. Honey production in the study area has been faced with multiple constraints like:- pest and predators (ants, waxmoth, spiders, birds, lizards, mites and hamagots), mis-use of agro-chemicals (herbicides and insecticides) and absconding of bees.

### 5.2 Recommendation

Based on the findings of this study, the following recommendations are forwarded:

- a. Strengthening the extension services and technical intervention in the area to enhance the development of improved beekeeping that can significantly increase the quantity and quality of honey yield.
- b. Farmers and beekeeping need to be educated on how to use, label instruction and put into practice safety measures like not to spray on blooming crops, to keep bee colony away from the farm receiving pesticides, adjust the application time to late evening, etc.
- c. To prevent pest and predators; farmers need to keeping the apiary tidy and clean from under growth, avoiding throwing/ scattering combs around the apiary site, application of ash around the hive stand, plastering the hive stand with plastic materials, finding and killing the queen of ants.
- d. Avoid deforestation and create awareness about the value of non-timber forest products should be conducted to boost the quantity and quality of honey yields in the districts.

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## Appendix 1 Questionnaire used to gather data

Questioners for respondents

1. Household characteristics:

Sex: Male----- Female-----

Age:-----

Marital status: Married----- Single-----

Educational Level: Illiterate----- Grade 1-8 ----- Grade 9-12-----

2. What are the major crops grown in your area?

1.----- 2. ----- 3. ----- 4. ----- 5. -----

6. ----- 7. ----- 8. ----- 9. -----

3. How money hive do you have? ----- Traditional ----- Transitional----- Modern -----

4. Where did you keep your bee colonies?

Places of hives	Traditional n	Transitional N	Modern N
Backyards			
Under the eaves			
Inside small shelter			

5. What is the average honey products harvested annually from:

Traditional- ----- Transitional ----- Modern -----

6. The average gram of honey from one hive per a year? -----

Traditional----- Transitional ----- Modern -----

7. What is the optimum harvesting season?

Summer----- Autumn----- Winter----- Spring-----

8. What is the reproductive rate of bee colony per a year?

Once----- Twice----- Three times ----- Above-----

9. What are the major pests and predators found in the area that threat your colonies? List in order of importance.

10. Did you use agrochemicals? Yes----- No -----

If yes, what types of agrochemicals did use?

Herbicides ----- Insecticides----- Both-----

11. Did your colonies abscond? Yes ----- No -----

If yes, What are the reasons for bees absconding? -----

12. Do you visit and inspect your beehives and colonies? 1. Yes\_\_\_\_2. No\_\_\_\_\_

If yes, which type of inspection you perform?

External hive inspection                      1. Yes \_\_\_\_\_      2. No\_\_\_\_\_

External and internal hive inspection      1. Yes \_\_\_\_\_ 2. No\_\_\_\_\_

13. Frequency of inspection

External hive inspection: (circle one or more)

i. frequently              ii. sometimes              iii. rarely

External and Internal hive inspection: (circle one or more)

i. frequently              ii. sometimes              iii. rarely

**Appendix2. Plates collected during observation.**

*A. Traditional hives*

*A*



*B*



*C*



*D*



*B. Transitional hives*



### C. Modern hives

