



**ADDIS ABABA UNIVERSITY**

**COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCE**

**DEPARTMENT OF ZOOLOGICAL SCIENCES**

**INVESTIGATION OF FACTORS THAT AFFECT BEEKEEPING AND HONEY  
PRODUCTION PRACTICES IN SAYO DISTRICT, WESTERN OROMIA, ETHIOPIA.**

**A THESIS SUBMITTED TO SCHOOL OF GRADUATE STUDIES OF ADDIS ABABA  
UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE  
DEGREE OF MASTERS IN GENERAL BIOLOGY**

**By: TIZAZU TESFA BURAKA**

**September, 2018**

**Addis Ababa, Ethiopia**

## **ACKNOWLEDGEMENTS**

First of all, I would like to thank the Almighty GOD for taking care of my life in all movements I have been passing. I would like to express my thanks to my advisor Dr. Sisay Dugassa for his acceptance as his advisee, for his professional supports, valuable comments and guides from the very beginning of Title selection and designing the research proposal up to thesis write up.

I thank Mr. Amana Genati and Mr. Yohannis Terfa who are experts of animal and fish resources development and Mr. Abera Chala who is Rural and Agricultural Office leader of the district for showing interest to help me in the selection of kebeles, giving more information about Sayo district and guiding me how I contact with the field workers (Development agents)

My thanks also go to Mr. Itana Bishawu, Mr. Asfawu Galata, and Mr. Ibsa Baburi they were the Development agents of the selected kebeles who support me in the selection of household beekeepers and on the way of Survey data collection. Mr. Fedesa Apiculture of Mr. Lencho Kanea workers and Mr. Merga GIS's team head for his drawing map of study area description, and Mr. Reda Nemo guide me on the writing of proposal and giving comments on the way of writing of the thesis.

Finally, I would like to express my deepest love and thank to my beloved wife Mrs. Deribe Kebede for her encouragement to my graduate study, support and giving me due attention especially in writing and editing the text.

# Table of Contents

| <b>Contents</b>   | <b>Pages</b> |
|---|--------------|
| ACKNOWLEDGEMENTS.....                                     | i            |
| List of Tables .....                                      | v            |
| List of Figures.....                                      | vii          |
| List Acronyms and Abbreviations .....                     | viii         |
| ABSTRACT.....   | viii         |
| CHAPTER ONE.....  | 1            |
| INTRODUCTION .....  | 1            |
| 1.1 Background of the study .....                         | 1            |
| 1.2. Statement of the Problem .....                       | 2            |
| 1.3 Objectives of the study.....                          | 4            |
| 1.3.1 General objectives .....                            | 4            |
| 1.3.2 Specific objectives .....                           | 4            |
| 1.4. Significance of the study .....                      | 4            |
| 1.5 Scope and limitation of the study.....                | 5            |
| CHAPTER TWO.....  | 6            |
| LITERATURE REVIEW .....                                   | 6            |
| 2.1 Origin, evolution and distribution of honey bees..... | 6            |
| 2.2 Life cycle of Honeybee .....                          | 7            |
| 2.3 Honeybee Species in Ethiopia.....                     | 8            |
| 2.4 Beekeeping production in Ethiopia.....                | 9            |
| 2. 4. 1 Traditional forest beekeeping.....                | 9            |
| 2.4.2 Traditional backyard beekeeping.....                | 9            |
| 2.4.3 Transitional Beekeeping.....                        | 9            |

|  |    |
|--|----|
| 2.4.4 Frame beehive beekeeping practices .....                 | 10 |
| 2.5 Beekeeping Production in Sayo .....                        | 10 |
| 2.6 Beehive Products.....                                      | 11 |
| 2.6.1. Honey.....  | 11 |
| 2.6.2. Beeswax.....  | 12 |
| 2.6.3. Propolis.....   | 13 |
| 2.6.4. Pollen.....   | 14 |
| 2.6.5 Royal Jelly .....  | 15 |
| 2.6.6 Venom .....  | 16 |
| 2.6.7 Bee Brood.....   | 16 |
| 2.7. Factors Affecting Honeybee productions.....               | 17 |
| 2.7.1 Botanical origin of Honeybee’s Flowers .....             | 17 |
| 2.7.2. Types of Beehives Used .....                            | 18 |
| 2.7.3. Harvesting and processing methods .....                 | 19 |
| 2.7.4. Packaging and Packaging Materials .....                 | 20 |
| 2.7.5 Honeybee Diseases, Pests and predators .....             | 20 |
| 2.7.6. Seasonal Management .....                               | 21 |
| 2.7.7. Use of Agro-chemicals (Herbicides and Pesticides) ..... | 22 |
| CHAPTER THREE .....  | 23 |
| MATERIALS AND METHODS.....                                     | 23 |
| 3.1. Description of the study area.....                        | 23 |
| 3.1.1. Location.....   | 23 |
| 3.1.2. Demographic structure .....                             | 24 |
| 3.1.3. Topography, Altitude and Climate .....                  | 25 |
| 3.2. Research Design.....                                      | 25 |

|   |    |
|---|----|
| 3.3 Types and Sources of Data.....  | 25 |
| 3.4 Methods of Data Collection .....  | 25 |
| 3.4.1 Household Survey.....   | 25 |
| 3.4.2. Key Informant Interview .....  | 26 |
| 3.5 Sampling Procedure and Sampling Size .....                              | 26 |
| 3.6 Methods of Data Analysis .....  | 27 |
| CHAPTER FOUR.....   | 27 |
| RESULTS AND DISCUSSIONS.....  | 28 |
| 4.1. Scio-economic characteristics of the respondents.....                  | 28 |
| 4.1.1 House Hold Characters .....   | 28 |
| 4.1.2. Educational Level of the respondents.....                            | 30 |
| 4.2. Beekeeping Practices and Production Potential .....                    | 31 |
| 4.2.1. Sources of honeybee colony and Apiary sites .....                    | 31 |
| 4.2.2. Honeybee colony holding in the study area.....                       | 32 |
| 4.2.3. Beekeeping practices and trends in Study Area .....                  | 33 |
| 4.2.3.1. Beekeeping practices in Study Area.....                            | 33 |
| 4.2.3.2. Types of Beekeeping in Sayo .....                                  | 36 |
| 4.2.4. Occurrence of Absconding .....                                       | 38 |
| 4.2.5. Honeybee colony Swarming and Means of control.....                   | 39 |
| 4.2.6. Inspection of honeybee colonies.....                                 | 40 |
| 4.2.7. Hive products (Honey and wax) harvesting season.....                 | 41 |
| 4.2.8. Honey and Beeswax yields from different types of beehive .....       | 41 |
| 4.3. Factors Affecting Beekeeping and Production of Honey and Beeswax ..... | 42 |
| 4.3.1. Extension Services.....  | 42 |
| 4.3.2. Lack of Improved Beekeeping Equipment.....                           | 43 |

|   |           |
|---|-----------|
| 4.3.3. Lack of beekeeping training .....                    | 43        |
| 4.3.4. Methods of Processing and Storage Materials .....    | 44        |
| 4.3.5. Major beekeeping constraints .....                   | 45        |
| 4.3.5.1. Honeybee pests and predator .....                  | 45        |
| 4.3.5.2. Unsafe use of agrochemicals .....                  | 46        |
| 4.3.5.3. . Poisoness plants to honey bee .....              | 47        |
| 4.4. Honey and Beeswax Marketing and market constrints..... | 48        |
| 5. CONCLUSION AND RECOMMENDATIONS .....                     | 49        |
| 5.1 Conclusion.....   | 49        |
| 5.2 Recommendations .....                                   | 50        |
| <b>REFERENCES.....</b>                                      | <b>51</b> |

## List of Tables

|   |    |
|---|----|
| Table 1. Age Distribution of the Respondents.....                                       | 29 |
| Table 2. Socio- economic characters of the sample HHs.....                              | 29 |
| Table 3. Proportion of Educational level of respondents .....                           | 30 |
| Table 4. Sources of honeybee colonies in the study area.....                            | 31 |
| Table 5. Arrangements (placement) of different beehives after getting colony. ....      | 32 |
| Table 6. The Average honeybee colony holding per HH in the study area.....              | 32 |
| Table 7. Distribution and composition of bee hive types .....                           | 33 |
| Table 8. Averages Traditional Hive per HHs .....  | 34 |
| Table 9 . Causes of decreasing trend of beekeeping in Sayo .....                        | 38 |
| Table 10. Factors responsible for absconding of honeybee .....                          | 39 |
| Table 11. Frequency of reproductive swarming occurs.....                                | 40 |
| Table 12. External and internal hive inspection frequency.....                          | 40 |
| Table 13. Mean and Range Comparison of honey yields in kg per traditional hive.....     | 42 |
| Table 14. Major Constraints identified by respondent beekeepers in the study area. .... | 45 |

## List of Figures

|   |    |
|---|----|
| Figure 1. 1life cycle of honebee.....   | 8  |
| Figure 2. Map of the study area .....   | 23 |
| Figure 1. Traditional beekeeping practices at near home stead and in the forest ..... | 34 |
| Figure 4. Transitional beekeeping practices at backyard and under the shade.....      | 34 |
| Figure 2 Movable frame beekeeping practices at backyard and under the shade.....      | 35 |
| Figure 6. Beekeeping trends in Sayo district .....                                    | 35 |
| Figure 3. Beeswax productions in the study area. ....                                 | 41 |
| Figure 8.“Abaaboo Diimaa” Poison Plant to bees and humans.....                        | 47 |

## **List Acronyms and Abbreviations**

|         |       |   |
|---------|-------|---|
| BSCIC   | ----- | Bangladesh Small Cottage Industries Corporation |
| FAOSTAT | ----- | Food and Agricultural Organization Statistics   |
| HBRC    | ----- | Holeta Bee Research Centre                      |
| HHs     | ----- | Households                                      |
| MoARD   | ----- | Ministry of Agriculture and Rural Development   |
| SPSS    | ----- | Statistical Package for Social Science          |
| TLU     | ----- | Tropical Livestock Unit                         |

## **ABSTRACT**

Beekeeping is a long-standing practice in the rural communities of Ethiopia and appears as ancient history of the country. Despite the long tradition of beekeeping in Ethiopia and having potential for beekeeping, the beekeepers in particular and the country in general are not well benefited from the sub-sector. Moreover, the study area is covered with natural vegetations, shrubs and man-made forest, annual and perennial crops which create conducive environment for beekeeping. However, beekeeping activities are still at low level and could not exploit the existing potential. The main objective of this research was to assess the factors that affect development of beekeeping and honey production in the study area. Household survey and key informant interview were used to collect primary data. To conduct the household survey structured questionnaire was prepared in English language first and translated to mother tongue. In order to collect primary data multiple stage technique of sampling was employed. Accordingly, three sample kebeles were selected purposively and 90 sample beekeepers were selected using simple random sampling technique. Households' survey data was analyzed using descriptive statistics; percentages, frequencies. It was found that shortages of bee forages, application of pesticides and herbicides, pests and predators, previously unknown and recently emerged red color flower, farmers inclination to traditional beekeeping method, lack of extension services, expensiveness of improved hives and lack of allocation of budget for beekeeping activities, absence of man-power who have specialized in apiculture are the major factors that hindered the development of beekeeping in the study area. Based on the findings of the study the researcher recommends: Education for beekeepers how to prevent enemies of bees, mobilizing the community to destroy the recently arriving poisonous plant, an arrangement to make improved hives, strong extension services, sustainable awareness creation activities among the farmers with respect to beekeeping activities, recruitment of man-power specialized in beekeeping, budget allocation specific to beekeeping activities, attention in producing professionals who have specialized in apiculture and adoption of policy specific to beekeeping sub-sector.

**Key Words:** Beekeeping, honey, beehive, households, beeswax

## CHAPTER ONE

### INTRODUCTION

#### 1.1 Background of the study

Beekeeping is a long-standing practice in the rural communities of Ethiopia and appears as ancient history of the country. Beekeeping is a very ancient and deep-rooted household activity for the rural communities of Ethiopia that stretches back into the millennia of the country's early history. It seems as old as the history of the country and it is an integral of the life style of the farming communities (Adebabay *et al.*, 2008).

Ethiopia has huge potential for beekeeping production because of its endowment with diversity in climate and vegetation resources offer potentially favourable conditions for beekeeping. These have enabled Ethiopia to take the total share of honey production around 23.58% and 2.13% of the African and world's respectively (Workneh and Puskur, 2011). In Ethiopia, there are about 10 million bee colonies and over 800 identified honey source plants (Kebede *et al.*, 2011). Out of the total colonies, about 5 million are hived.

Currently, most of the honey produced in Ethiopia comes from traditional beehives. There are an estimated 5.15 million hives in Ethiopia, which are almost all entirely maintained according to traditional methods. These hives are managed by approximately 1.4-1.7 million farm households, who are keeping bees as a means of additional income generation (Paulos, 2012). Traditional beehives make up 95.57% of the total quantity of beehives in Ethiopia, while the percentage of transitional (Kenya top bar) and modern beehives are 1.63 % ( 81,596) and 2.8% (139,682), respectively (CSA 2012a).

Ethiopia is one of the top 10 producers of honey in the world, and it is the largest one in Africa (USAID, AGP-AMD, 2012). It is estimated that the country has a potential to produce 500,000 tons of honey per annual. The recent production, however, is only 53,675 tons of honey. This shows that the country is producing less than 10% of its potential (CSA 2012a). Beekeeping and honey production in Ethiopia form an ancient tradition that has been incorporated into Ethiopian

culture and even the country's religious customs. Ethiopia is also the country with the longest history of marketing honey and beeswax in Africa. The average household in Ethiopia is composed of six people, and annual honey consumption is estimated to be 10 kg per household. Honey in Ethiopia is generally produced as a cash crop, with yearly sales amounting to 90 to 95 percent of total production. Currently, the majority of honey produced (about 70% of the 90 to 95% designated for sale) is sold to "Tej" houses. The remaining portion is marketed as table honey for general consumption (Tadasse and Philips, 2007).

The total volume of honey production in Ethiopia in 2007-2011 was 163,257.42 tons, of which 99.2% was consumed domestically and 0.8% was exported. The total volume of Ethiopian honey exports in 2007-2011 was 1,297,716 kg, with a total value of US\$4,066,528. There is a large unmet demand for an organic honey in European countries and, according to the international trade centre; East Africa has good potential for organic beekeeping (Oxfam GB, 2011). So far, Ethiopia has not succeeded in exploiting its natural capacity for honey production, nor has it been able to fully benefit from its comparative advantage in the honey sector. Several factors have kept Ethiopian honey production from reaching its full market potential (USAID, AGP-MADE, 2012). The beekeeping products and their usage in the world are honey for food, medicine and nutrition value; wax for medicine and industrial value; royal jelly for health, food and medicinal value; pollen for health bee food and medicinal value; propolis and bee venoms for medicinal value (BSCIC, 2010).

The study area considered in this research is grouped under high potential for beekeeping. It is covered with natural vegetation, shrubs and man-made forest annual and perennial crops. Moreover, it has adequate water resources and large bee colonies which create conducive environment for beekeeping. However, in the study area could not harness the existing potential. Therefore, this study investigates the factors that hampered to utilize the existing potential

## **1.2. Statement of the Problem**

Beekeeping in Ethiopia is an important seasonal activity that predominantly remained rudimentary and unexploited, but it has tremendous potential for widening Ethiopian export base. Honey production in Ethiopia has recently attracted the attention of various agencies because of

its potential to help regenerate the Ethiopian economy, reduce poverty, and conserve forests (FAOSTAT, 2012). The honey produced in Ethiopia is expected to become a major commodity for acquiring foreign currency to improve the Ethiopian economy. Although, Ethiopia does not have sufficient infra structure for transporting and storing goods, the long shelf life of honey makes it an attractive export for the country (Gidey and Kibrom, 2010).

Beekeeping in Ethiopia has been considered as a supplementary activity and traditionally managed. Whilst it's a potential source of small holder income it has been under utilized for many years (Melaku *et al.*, 2008; Kerealem *et al.*, 2009). The supplementary role of beekeeping to house hold economy had even been declining. Beekeeping activities in Ethiopia mainly constrained by inability in the transformation, promotion, scaling up to rapid growth, lack of commercial beekeeping development and beekeeping technology, limited credit supply, quality issue, lack of market access and information transformations (Ayalew Kassaye, 2008). These related and interrelated problems limit the country from getting the potential benefit from the sub-sector.

Beekeeping by its nature doesn't need huge investment (financial asset), large size of land complicated technical knowledge. The outcome of beekeeping is real; some of its outcomes include income, material goods, wellbeing and satisfaction (Nicola, 2009). Beekeeping strengthens rural community livelihoods and helps rural people to become less vulnerable to different shocks and reduces the danger that they will fall into crisis. There are 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 easy beekeeping products from the local market of the study area for home consumption and other purposes to the required quantity and quality. Majority of the farmers don't engage in processing and preparing beeswax in required manner for home consumption and other purposes.

According to the researcher's long observation, the local producers do not provide significant quantity of beekeeping products to the near town and there is no experience of providing beekeeping products to the central market by local farmers and local traders which could play role in the national economy in general and increasing the income of the producers and traders in particular. Furthermore, according to the information obtained from Sayo district agriculture and

rural development office, the rural households of the study area secure income for their livelihood from selling of coffee, cereals, animal husbandry, selling of “chat” and other products from non-farming activities. Therefore, from this we understand that the role of beekeeping in the livelihoods of the rural community is insignificant. In this connection, the research focuses on exploring the factor that affect beekeeping in the study area. In order to achieve the objective of this research the following research question are prepared.

### **Research questions**

What are the beekeeping practices used by beekeeper in the area?

What are the factors that affect beekeeping and honey production in the study area?

What are the market constraints that influence honey production and beeswax?

### **1.3 Objectives of the study**

#### **1.3.1 General objectives**

This study was intended to investigate factors that affect beekeeping and honey production practices in Sayo district.

#### **1.3.2 Specific objectives**

- ❖ To identify the beekeeping practices and their roles in the economic activities of the society.
- ❖ To investigate factors that affects beekeeping practices, honey and beeswax production in the study area.
- ❖ To determine market constraints that may influence honey and beeswax production in the study area.

### **1.4. Significance of the study**

Beekeeping activity does not need huge capital and large land size and doesn't depend on importable inputs. It has significant contribution in strengthening livelihood and maintaining ecosystem through cross pollination of plants. Moreover, the country can earn significant foreign

currency by exporting beekeeping products to different countries which have a role in the national economy of the country. But, the country still didn't utilize its potential of producing beekeeping products for more gains due to various factors. The study area is one of the potential areas for production of honey and other beekeeping products. However, beekeeping activities are still at low level in the study area which leads the local farmers not to benefit from it in particular and decrease its role in the national economy in general.

Therefore, this research investigated some factors that contributed beekeeping activities to be low at the study area and recommended possible solutions to enhance beekeeping activities and increase its role in the livelihood of the local community in particular and for the national economy in general.

Governmental and non-governmental organizations which might be interested in beekeeping activities in the study area and in other neighboring districts can utilize the research findings. Furthermore, the findings can be used as inputs to researchers who are interested in such studies.

### **1.5 Scope and limitation of the study**

This study aimed at assessing the factors that affect development of beekeeping and honey production practices. Majority of the districts in Kelem Wollega zone have conducive environment to undertake beekeeping activities. However, the scope of the study was limited to Sayo district of Kelem Wollega Zone. This is mainly because of limited availability of resources and time to undertake the study on a wider scale.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Origin, evolution and distribution of honey bees

There is very little information about the ancestor of bees as the fossil record is extremely scarce. However, it is supposed that the first bees have developed from wasp like ancestor known as spheciod about 100 million years ago in Gandawana during mid-cretaceous period. This was the time when the evolution of angiosperms had taken place (HBRC, 2004). But, honey bees and humans have been crossing paths for millions of years. Indeed, our early ancestor likely raided wild bee colonies for honey, much as Chimpanzees do today (Hicks et al., 2005). Both humans and honey bees originated in Africa, each species migrating out of the continent on several occasions. It was one of these migrations when honey bees left their tropical ancestral home for the higher northern latitudes that resulted in the honey bees evolving large colony sizes and building up excessive stores of honey to survive the colder winters, opportunistic humans noticed and manipulated.

The honey bee *Apis mellifera* in Africa has three sub species with slightly different morphometrics (Crewe et al., 1994). High altitude areas at about 2500 m and above are inhabited by the sub-species, *Apis mellifera monticola* mountain honey bee. Low altitudes, such as coastal areas of east Africa, are populated by small sized honeybee sub-species *Apis mellifera litorea* (Smith, 1961). Mid-altitude areas are populated by *Apis mellifera scutellata*, which is morphometrically similar to *Apis mellifera litorea* (Radloff and Hepburn, 1997).

As it moved from its original homeland to different parts of the world, *Apis mellifera* faced new environment with different flora, climates and other factors that affected its existence. To cope with these new changes in environment in which they were to live, *Apis mellifera* underwent rapid changes in morphology, behavior and biochemical processes (Ruttner, 1988)

Geographical races of honeybees are the result of natural selection and they are not the result of breeding but raw material for breeding. Geographical races are distinct unit, representing different genotypes adapted to different environments. Recent studies indicated that there are

about 23 *Apis mellifera* honeybee races of which 12 of these found in Africa. Climate is a major isolating factor for honeybee races in Africa (Ruttner, 1975).

## **2.2 Life cycle of Honeybee**

The life cycle of all insects, including honey bees, begins with eggs. During the winter season, a queen forms a new colony by laying eggs within each cell inside a honeycomb. Fertilized eggs will hatch into female worker bees, while unfertilized eggs will become drones or honey bee males. In order for one colony to survive, the queen must lay fertilized eggs to create worker bees, which forage for food and take care of the colony. Each colony contains only one queen, which mates at an early age and collects more than 5 million sperm. A honey bee queen has one mating flight and stores enough sperm during the mating flight to lay eggs throughout her life. When a queen can no longer lay eggs, new queens become responsible for mating and laying honey bee eggs.

Honey bee eggs measure 1 to 1.5 mm long, about half the size of a single grain of rice. When the queen lays her eggs, she moves through the comb, closely examining each cell before laying her eggs. The process of laying one egg takes only a few seconds, and a queen is capable of laying up to 2,000 honey bee eggs within a single day. A young queen lays her eggs using an organized pattern, placing each egg next to others within a cell. Queens begin laying their eggs in the center of the cell frame, so workers can place honey, royal jelly and other foods for larvae on the outer edges. However, as the queen ages, she lays fewer eggs in a less organized pattern.

When the queen lays a honey bee egg, it becomes attached to the cell by a mucous strand. During the first stage of development, the digestive system, nervous system and outer covering are formed. After three days, the eggs will hatch into larvae, which will be fed by worker honey bees with honey, royal jelly and other liquids from plants. These honey bee larvae have no legs, eyes, antennae or wings; they resemble a grain of rice with a small mouth. They will eat and grow into adult workers, queens or drones.

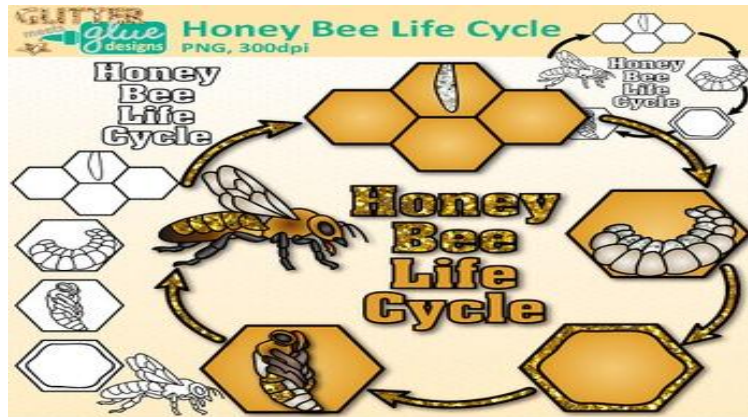


Figure 4. 1life cycle of honeybee

### 2.3 Honeybee Species in Ethiopia

The most important and available insect in the world today is the honeybee. *Apis mellifera* is very famous in the country among several existing species of honeybees. It is wonderful and popular bee type for its honey and beeswax production besides the major value as plant pollinator (Ayalew, 2001).

Different scholars/researchers have studied the identification of honeybee races of Ethiopia. *Apis mellifera monticola* was the first honeybee race reported to exist in the Ethiopian plateau as noted by Smith (1961, cited in Nuru, 2002). Ayalew (1990) identified the existence of five honeybee races in Ethiopia. These are *Apis mellifera adasanit* exists in south and western part of the country, *Apis mellifera jementica* founds in the low land areas of the eastern Ethiopia, *Apis mellifera monticola* exists in South east Mountain of bale Dinsho, *Apis mellifera litorea* exists in the South west low lands, *Apis mellifera abyssinica* exists in high land area of central, west and southern parts of the country.

According to recent study of the multivariate morphometric analysis of Ethiopian honeybee population indicates the occurrence of five statically separable morphometric clusters occupying different ecological areas: *A.m. monticola*, in northern mountainous high land, *A.m. jementica*, in eastern, north eastern and north western arid and semi-arid lowlands, *A.m. bandasii*, in central moist highlands, *A.m. scutellata* in western, southern southwest humid midlands (tropical forest) and *A.m. wayi-gambellain* south western sem-arid to subhumid low lands (Amsalu *et al.*, 2004).

However, the recently published work of (Meixner *et al*, 2011) reported as if only one honeybee race exists in the country, requiring further study to reconciling the dispute in between these literatures

## **2.4 Beekeeping production in Ethiopia**

According to (HBRC, 2004), there are four different types of beekeeping practices in Ethiopia namely, traditional forest, traditional backyard, transitional and improved beekeeping.

### **2. 4. 1 Traditional forest beekeeping**

It is placing of hives in the forest on very tall trees for catching swarms. It is commonly exercised in forest-covered areas of the country where the population of honeybees are abundant. The advantage of forest beekeeping is that the bees do not cause harm to the domestic animals and humans and the bees can get access to abundant forage plants in their vicinity. Its disadvantages are lack of close follow up during honey harvesting period as the beekeeper drops down the hive from the tree, it damages the honeybee colony. It is also dangerous for the beekeeper to climb tall tree in night (HBRC, 2004). Beekeeping using bark and basket hives have long been part of the subsistence economy of people in Sayo.

### **2.4.2 Traditional backyard beekeeping**

It is undertaken in safe guarded area for honeybees mostly at homestead. The advantages of such practices are; construction is very simple; it does not require improved beekeeping equipment; it does not also require skilled manpower, where as its disadvantages are inconvenience to undertake internal inspection and feeding, in some places the size is too small and cause swarming, it has no possibilities of supering, there is no partition to differentiate brood chamber and honey chamber (HBRC, 2004).

### **2.4.3 Transitional Beekeeping**

It is one of improved methods of beekeeping practices. The hives can be constructed from timber, mud or locally available materials. Each hive carries 27-30 top bars on which honeybees attach their comps. The top bars have 3.2cm and 48.3cm width and length, respectively.

Transitional beekeeping practice has different advantages such as, it can be opened easily and quickly the bees are guided into building parallel combs by following the line of the top bars, the top bars are easily removable and this enables beekeepers to work fast, the top bars are easier to construct than frames, honeycombs can be removed from the hive for harvesting without disturbing combs containing broods, the hive can be suspended with wires or ropes and this gives protection against pests. Transitional beekeeping has its own disadvantages such as, top bar hives are relatively more expensive than traditional hives, combs suspended from the top bars are more appropriate to break off than combs which are building within frames (HBRC, 2004).

#### **2.4.4 Frame beehive beekeeping practices**

It uses different types of frame hives. Zandar and Langstroth hives are the most common that exist in the country. Dadant Modified Zandar, and Foam hive are found rarely these hives differ in number and size of frames. The most commonly used hive type in Ethiopia is Zandar type. Frame beehives have components like chamber, super (honey chamber), inner and outer cover. Frame or box beehives have advantages over the others in that it gives honey yield both in quality and quantity. The other advantages of improved box hives is its possibilities of swarming control by easily giving additional space (supering) to the bee colony and it allows easy movements from place to place for searching high potential honeybee flower and pollination services. On the other hand, its disadvantages are the equipments are relatively expensive, requires skilled manpower and the equipment needs to maintain precision while constructing (HBRC, 2004).

#### **2.5 Beekeeping Production in Sayo**

Beekeeping production practices in Sayo are similar as elsewhere in Ethiopia. It is an ancient farming activity which is practiced by the beekeepers as side line activities with other farm practices. Beekeeping using basket hives have long been part of the subsistence economy of people in the area. On the other hand, beekeeping can be described as a way of life initially practiced by small group of people and the skill passed on from generation to generation within families. The traditional beekeepers work within a framework set by the subsistence need of the household.

Similar with rest part of the country, there are three types of beekeeping practices under way in Sayo namely: traditional, transitional and modern beehives based on the type of beehives used. Traditional production system is practiced in forms of, traditional forest beekeeping which is dominantly practiced in forest by hanging beehives on long trees and with no management care given for bees and the other traditional beekeeping is practiced around homestead with little management given to this type beekeeping production system.

## **2.6 Beehive Products**

Bee products have been put to a wide variety of uses from time immemorial but today, with rising costs and perhaps some disillusionment with and synthetic products, there is resurgence (reappearance) in interest into what the hive can offer (Sarah L Jones *et al.*, 2011). While honey and bees wax are the best known primary products from beekeeping pollen, propolis, royal jelly and bee venom are also marketable primary products. Some of these products can be consumed directly or in the case which they were produced by bees, other can only be consumed as ingredients of secondary products. Due to favorable characteristics and quality of bee products they enhance value of these secondary products when added to them. Therefore, these secondary products, which can be made up of primary products are referred to value added products from beekeeping (Osman Mwebe, 2012).

Apiculture is practiced on a near global scale, in both developed and developing countries. In most countries, honey and beeswax are the most well-known apicultural products, but bee pollen, royal jelly, and propolis are also marketable primary products. Some regions may have markets for bee venom, queens, the bees and their larva (FAO, 1996). While most hive products can be used or consumed in their original state, each has additional uses and economic potential as ingredients of another product. The profitability of most primary beekeeping products increases significantly as value-added products (FAO, 1996).

### **2.6.1. Honey**

Honey is one of the oldest sweetening agents and is defined as the natural substance produced by *Apis mellifera* bees from the plant nectar, from secretions of living parts of the plants, or from excretions of plant sucking insects on the living part of plants. Honeybees collect, transform and

combine this with specific substance of their own, and then store it and leave it in the honeycomb to ripen and mature (Codex Alimentarius, 2001). Honey is composed, primarily of the sugars, acids and minerals. The sugars found in honey can be classified as monosaccharide (glucose), sucrose and oligosaccharides (White, 1980).

There is a strong, local demand for honey, due to its use for the production of traditional beverage 'Tej'. In Ethiopia, much honey has traditionally been fermented to make 'Tej' and according to (Edessa Negera, 2005) 85% of the total honey estimated to be brought for market is used for 'Tej' production and 15 % of the total honey produced is consumed at home. Moreover, from the total honey produced in the country beekeepers are estimated to earn about 360-480 million Birr per year (Nuru, 2002). Of the total honey production in Ethiopia, about 41.22% was used for household consumption, about 54.68% for sale, about 0.34% used as payment for wage in kind and the rest (3.75%) used for other purposes (CSA,2013). This makes Ethiopia leading in Africa and ninth in the world in honey production.

### **2.6.2. Beeswax**

Beeswax is a substance produced by the worker bees of fully developed in 12 to 18 days old and recovered primarily from honey and cull combs. They use it as construction material for their combs. In older bees the wax glands diminish their activity. However in emergency situations wax-synthesis can be reactivated (Hepburn, HR, 1986, FAO, 2012). Beeswax is valued according to its purity and color. Light colored wax is more highly valued than dark colored wax, because dark is likely to have been contaminated or overheated. The finest beeswax is from wax capping, which are the wax seals with which bees cover ripe honey combs. This new wax is pure and white (FAO, 2003). The composition of beeswax depends to some extent on the subspecies of the bees the age of the wax, and the climatic circumstances of its production. However, this variation in composition occurs mainly in the relative amounts of the different components present, rather than in their chemical identity (Aichholz and Lorbeer, 1996). More than 300 individual components have been reported in beeswax from various species of honeybees (Tulloch, 1980). Although their concentrations may vary depending upon the honeybee species and the geographical origin, only small differences are observed in the concentration of

individual components and substance and classes (Aichholz and Lorbeer, 1999; Wolfmeier *et al.*, 1996).

Most of the beeswax of the world comes from developing countries and mainly used for export purpose. In developing countries exportation of beeswax has been considered as inflation proof against local currencies (Roberts, 19700).

Research report indicates that Ethiopia has got potential for production of beeswax because of huge number of honey bee colonies being kept in traditional hives (Gemechis, 2014). The beeswax production in traditional beehives is 8-10% of the honey yield (Crane, 1990). In Ethiopia the annual beeswax production is expected to be more than 5000 tones and out of which, 44.13% produced in the country was used as household consumption while 25.22 percent was used for sale and the rest 0.84% and 29.81% is used for wage in kind and other purposes respectively (MoARD, 2013; CSA, 2015). This makes Ethiopia a leading in Africa and third in the world in beeswax production (MoARD, 2013). Beeswax supports the national economy through foreign exchange earnings. Presently, beeswax is one of the major exportable agricultural products (Nuru), 2002).

### **2.6.3. Propolis**

Propolis, also known as been glue, is a resin-like product collected and elaborated by bees from vegetable exudates to maintain and repair the beehives. It is complex resinous mixture which contains approximately 50% resin and balsam, 30% wax, 10% essential and aromatic oils, 5% pollen, and 5% impurities (Thomson, 1990). Propolis is used by honeybees to weather proof the hive and for other sanitation purposes; including sealing cracks to prevent the growth of bacteria and fungi (FAO, 2003). For commercial production, a slotted plastic frame the placed over the top super in the hive. Propolis is scrapped from the frame once bees have filled in the screen. Its recent global price was approximately US\$10.00 perkilogram (FAO, 2003). Threeounce bottles of organically certified propolis extract (12% propolis) retails for nearly \$ 13.00 in the United States (Wild Bee, 2007).

Research conducted at Holeta Bee Research center show that simple induction of colonies for more propolis production is possible in both basket and box hives. It is also reported that

propolis have antimicrobial activity against *S. aureus* *S. pyogenes* pathogens (Gemechiset *al.*, 2012). The chemical composition of propolis highly variable mainly due to the variability of plant species growing around the hive, from which the bees collect the exudates (Bankova *et al.*, 1999; Katircioglu Mercan, 2006). Consequently, some important biological compounds such as flavonoids, derivatives from aromatic acids and esters, terpenoids, and waxy acids can be present in different concentrations (Bankova *et al.*, 1999; Katircioglu Mercan, 2006).

Additionally, propolis composition can vary depending on the seasonality, illumination, altitude, collector type, and food availability and activity developed during propolis exploitation (Bankova *et al.*, 1998; Souza *et al.* 2010). Therefore, controlling the production, collection and improvement of the ethanolic extracts of propolis (EEP) is ensuring quality for the commercialization of propolis.

#### **2.6.4. Pollen**

Pollen is the male reproductive portion of a flower and is rich in proteins, vitamins and minerals (FAO, 1996). It is collected by honeybees during foraging trips and transported back to the hive in the form of small pellets, carried in pollen baskets found on each hind leg of honeybee. Pollen is stored and used as a proteins source by a segment of the colony, in a partially fermented form known as beebread. Young worker (nurse) bees consume beebread for the adult queen. Bee pollen differs qualitatively from the fine powdery pollen on flowers. For better adhesion during transport the honeybee mixes a small amount of nectar or honey in with the pollen. Therefore, bee pollen collected during hive management differs slightly in nutritional value from flora pollen and is typically sweet in taste.

Bee pollen is harvested by a beekeeper through the use of a ‘pollen trap’ installed periodically over the entrance of the hive. The trap’s perforated openings dislodge pollen pellets from the hind legs of returning field bees, where they subsequently fall into a secure storage tray. Pollen traps typically have an efficiency rate of 50% and the pellets should be gathered daily (FAO, 1996). Bee pollen must be properly dried and stored as soon as possible after harvesting. Moisture content can be reduced through simple drying techniques and should be below 10 % but preferably between 5 to 8 % for commercialization (FAO, 1996). Due to the high floral

fidelity of the honeybee pollen pellets typically contain pollen grains from only one or several species (FAO, 1996). Botanical origin influences the nutritional value and color of bee pollen. Bee pollen color is most frequently yellow but may also occur in red, purple, green, orange, or other colors; nutritional benefits increase with pollen source diversity (FAO, 1996). On average, bee pollen contains over ten times the level of thiamin and riboflavin found in beans and beef and most varieties contain about 30% protein (FAO, 1996). These characteristics are easily lost however with improper processing and storage. Bee pollen is a useful source of nutrition and typically bottled and sold in health food stores in urban centers (FAO, 1996; FAO, 2003). The main issue with using bee pollen as a food ingredient is the allergic reaction many people have with pollen from a wide of floral species (FAO, 1996). The price of bee pollen is highest in East Asia and Europe (FAO, 2003).

In Ethiopia research report from HBRC show average pollen yield obtained per colony is about 98.9gm per month during flowering periods. It is also indicated that the performances honeybee colonies is not affected by pollen trapping and length of trapping periods (Gamechis *et al.*, 2012).

### **2.6.5 Royal Jelly**

Royal jelly is a pasty substance produced in the hypo pharyngeal gland of young worker bees. It is extremely rich in proteins and fatty acids and fed directly to the queen or young larva as it is secreted (FAO, 1996). The amount of royal jelly fed during the early larval stage determines whether the larva will develop into a queen or worker bee. The high fertility and long life span of the queen bee is attributed to a diet of royal jelly. The principles constituents of royal jelly are water, protein, sugars, lipids and mineral salts. Protein and sugars account for the largest fraction of dry weight. Protein represents nearly 75% of nitrogenous substances and all amino acids essential to human health are present (FAO, 1996). Glucose and fructose account for nearly 90% of sugar contents in most royal jelly and are found in similar proportion as that of honey (FAO, 1996). Only relatively recently has royal jelly been considered a commercial hive product (FAO, 1996). Under normally hive conditions, royal jelly is only stored in the few cells containing larva destined for queen development and is not present commercially viable amounts. The commercial harvesting royal jelly is possible only through a fairly technical management

technique known as queen rearing. In this practice several dozen newly hatched larva are transferred from their original cells on onto a grafted panel of queen-cell sized base cups. The young worker bees construct the partial queen cups, with newly deposited larva, to the appropriated dimensions of a normal queen cell and secrete less than 200 milligrams of royal jelly into each. The developing queen is removed from the cell three days later and the royal jelly extracted. Fresh royal jelly can be sold in an unprocessed state but must remain frozen or refrigerated to extent shelf life (FAO, 3003). The extraction process must take place under hygienic working conditions, out of direct sunlight, and with good organization. Any enterprise capable of meeting the above demands can commercially produce royal jelly. On an industrial scale royal jelly is typically distributed in a freeze-dried form or as a tincture (FAO, 2003). It is also dehydrated and sold powdered. Unaccounted of royal jelly's nutritional composition and association with queen bee vitality it is sold as a dietary supplement, medicine, and aphrodisiac.

#### **2.6.6 Venom**

Honeybee venom is synthesized by the venom glands of workers and queens, stored in the venom reservoir, and injected through the sting apparatus during the stinging process. The sting apparatus of bees is in fact a modified egg-laying organ (ovipositor), which is present in many other female insects. Venom is a bitter hydrolytic blend of proteins with basic PH, and it has long been used for treating various human ailments in many cultures, particularly for its alleged anti-inflammatory and anti arthritic effects. The venom gland is located in a chamber at the end of the abdomen, and is completely separate from all other glands and organs of the bee. Bee venom is commercially collected by means of special apparatus that uses electrical current to force worker bees to sting a rubber mat or synthetic membrane and the venom is collected on a glass plate positioned below the membrane. The device is inserted into each hive and operated for only a few minutes (Schmidt and Buchman, 1992).

#### **2.6.7 Bee Brood**

Brood refers to the immature developmental stages of the honey bee, eggs, larvae, and pupae. The larvae, pupae, and adult bees can be harvested from the hive for several purposes. Adult bees are collected to be sold as packaged bees. The larval and pupal stages are sold for animal

feed and for human consumption. They are removed from uncapped cells by shaking the frame or gently flushing the cells with water. The larvae and pupae can be consumed fresh, dried, or frozen as a protein-rich food (Lorna H. Tsutsumi and Darcy E. Oishi, 2010).

## **2.7. Factors Affecting Honeybee productions**

Low productivity and poor quality of bee products are the major economic impediments for rural beekeepers (Nuru, 1999). Also, limited availability of bee forage (due to deforestation), shortage of honey bee colonies, backward technology, poor pre and post harvesting managements has been reported affecting the supply of honeybee's products (FAO, 2012). Furthermore, in adequate government support and poor extension services, lack of improved technologies, shortage of trained human power, and lack of access to credit services and weak road and market infrastructures in production areas. The present increasing use of pesticides and herbicides is severely threatening bee colonies implying conflicts of crop and honey production (FAO, 2012).

### **2.7.1 Botanical origin of Honeybee's Flowers**

Honey production and composition is tightly associated to its botanical origin, which is closely related to the geographical area from which the honey originated (KaskonieneV, and P. R. Veskutonis, 2010). The volatile composition of honey is very dependent on the geographical location even for the same plant species, as accumulation of phytochemicals depends on climatic conditions (sunlight and moisture), soil characteristics, and the presence of different minerals arising from soil. This suggests that the chemical composition of the honeys even if of the same floral origin may be quite different (Castro L. M Varquez *al.*, 2010). Due to the botanical origin given by the particular flora and the ecosystem diversity conditioned by the given territory, honey may have unique characteristics. Indeed, the estimation of honey quality by consumers depends on its organoleptic characteristics, which are strongly dependent on botanical origin of the honey and to some extent on its geographical origin (Camina J. M *et al.* 2012; Ruoff K. *et al.*, 2006).

There are about eight mono-floral honeys which are originated from eight plant types, local names are given in Oromifa: “Haada” (*Guizotia spp*), “Baargamoo”( *Eucalyptus globules*), “Qilxuu” (*Sheffleria abyssinica*), “Hiqamuu” (*Vernonia spp*), “Baddeessaa” (*Syziuneense*), “Laaftoo” (*Acacia spp*), “Bakkanniisa” (*Croton machrostachys*), “Saattoo” (*Erica arborea*) in Ethiopia (Gemechis *et al.*, 2012). The chemical analysis of this mono-floral honeys indicated that they are in the ranges of standards set for honey quality of national and world. Generally, Ethiopia has been a potential to produce and supply varieties of specially honey to national and world markets (Gemechis *et al.*, 2012).

### **2.7.2. Types of Beehives Used**

The ability to increase the supply and quality of honey is determined primarily by the beehive type in which it is produced. The beekeepers play an important role in improving the types of beehives used for better quality and quantity bee products production. The quality of the 16 products can scarcely be improved once they have been removed from the hive, but their quality can be diminished during harvesting extraction, further processing and storage (Mutsaer *et al.*, 2005). Durability can be improved by further processing but this also diminishes the quality in certain ways: the product loses its freshness and its therapeutic value is reduced. The edible products (honey, pollen, bee bread, bee milk, and bee brood) all contain biologically active ingredients that can lose some of their effectiveness. Beeswax, propolis and bee venom, on the other hand, retain their original qualities much better after extraction and further processing.

Beehive construction varies from one area to the other (Olagunju, 2000). The traditional beehives were initiated in an attempt to utilize the cheap and plentiful local materials for hive construction. Modern beehives on the other hand adopt the principle of having a box-like enclosure with removable top or frames, which facilitate routine inspection of the established colonies. The increasing awareness about honey consumption viz a viz other hive products in the world have called for a concerted effort on boosting honey production and its quality (Olagunju, 2000). Moreover, beekeeping is an appropriate and well-adapted farming practice to extensive range of ecosystems of the country. To date, over 10 million of bee colonies are found in the country, which include both feral and hived ones (Ayalew, 2001).

### **2.7.3. Harvesting and processing methods**

At farm household level basic processing of bee products may traditionally managed. However, such methods may not be proficient in supporting yields and quality and hence will need support from advisors. For example, in many countries when honey is capped from comb, the wax is disregarded or used for other purposes that do not have any market value. Awareness creation and training should be provided that builds on traditional skills and improves them (FAO, 2012).

Many tropical countries have successfully processed and marketed crude honeys using producers, cooperatives and small-scale processors (Crane, 1990). Processing crude honey has been also proved in improving honey quality and better utilization of resources. It is possible, even honey properly harvested from traditional and transitional hive, to process and market to produce a better quality table honey, since a traditional hive honey is a good quality as far as its in the hive (Townsend, 1976). The inferior quality of honey comes from only mishandling of the product starting from harvesting through storage to marketing. Yet another challenge arises when equipment is required, one option is the creation of honey collection centers where such equipment can be brought collectively and/or the formation of producer and marketing groups. However, appropriate training and an appraisal of the ‘spare parts’ supply chain to maintain such equipment in operation is required (FAO, 2012). As value is added to be products, not only is training is required in improved processing methods for value adding, but quality control and quality maintenance training are required (FAO, 2012).

In Ethiopia manual processing methods of honey and beeswax is the most common and affordable way for small holder farmers. However, research result showed that the mechanical jack presser is 50% more efficient in recovering pure beeswax than manual method (Gemechis *et al.*, 2012). Moreover, the efficiency of traditional beeswax rendering method is very low with an average Yield of 3.42kg of pure beeswax per 10 kg of crude beeswax compared to mechanical rendering method which is 6.47 kg of pure beeswax. It is reported that there was significant difference between different sources (comb, sefef and crude honey) and methods of processing (manual, submerged and solar) on but no difference in quality (Gemechis *et al.*, 2012).

#### **2.7.4. Packaging and Packaging Materials**

Packaging can be a major constraint to bee product as mostly this is carried out in rural and remote areas using recycled drinking bottles and other packaging materials sourced locally. However, very often these types of packaging materials are unsuitable for wider distribution of bee products to town, city and export to markets. Improved packaging materials, for example new glass jars with lids for honey, are not commonly available in many areas and their cost high (FAO, 2012). Yet again honey collection centers and /or producer organizations can provide the needed funds to buy packaging in bulk and hence reduce its unit costs as well as offering packaging services for its members.

#### **2.7.5 Honeybee Diseases, Pests and predators**

Honeybees are subject to many diseases and pests like any other livestock. The major problem in many countries is that honeybee diseases and pests that do not affect *Apis mellifera* are not fully understood and researched adequately. Moreover, it is also the lack of understanding on behalf of beekeepers combined with lack of regulations and enforcement that has enabled the increasingly rapid spread of pathogens during the past thirty years (FAO, 2009). The bees and their products are vulnerable to various diseases, parasites and pests. The existences of two adult honeybee diseases namely *Nosemaapis* and *Melipighhamoe bamellificae* and their distribution was studied and reported (Gezahegn and Amsalu, 1991; Desalegn and Amssalu, 1999). Some major types of honeybee pests and predators, magnitude of their damage, and some possible solution to minimize the damage they cause on bees and their products were discussed (Desalegn, 2001).

Moreover, the occurrence of small hive beetle (*Aethinatumida murray*; *Coleptera:Nitidulidae*) in honeybees was assessed (Desalegn and Amssalu, 2006) and recently the effect of ant (*Ddorylusfulvus*) on honeybee colony and their products in west southwest shewa zones was examined (Desalegn, 2006). The most commonly known honeybee diseases reported to exist in Ethiopia are Nosema, Amoeba and Chalk brood diseases (Desalegn and Amssalu, 1991; Desalegn and Amssalu, 1999; Desalegn, 2006). Furthermore, research review of different times in Ethiopia indicates that investigations of about 16 different types of pests and three microbial diseases are found in the country (Desalegn, 2015).

### 2.7.6. Seasonal Management

Like many other agricultural enterprises bees follow a seasonal cycle. Bees will respond to the nectar flow and that of pollen. The nectar and pollen flow are defined by weather and seasons. If there is a good flow of both nectar and pollen then the colony will increase its brood (egg laying). As colonies grow in size, the ratio of brood to adult's decreases hence enabling more adults to go out and forage and not look after brood. The essence of good management is to obtain a large adult population to coincide with the major nectar flow in an area allowing for a resulting maximum honey flow (FAO, 2012).

In tropical and sub-tropical regions there is often one major flow of nectar followed by several lesser flows. This is a challenge as it is difficult to ascertain exactly when the major nectar flows occurs. This usually occurs after the rainy season or may come after initial rains following a long dry period. A healthy colony that is increasing in population requires a queen that has a good capacity to lay eggs, availability of nectar and pollen, space in the hive as well as honey storage for the dearth period, along with a good worker bee population that can look after and feed the brood, forage and maintain temperature control (FAO,2012). Good management of these factors in terms of enhancing and improving them are important. Labor is one of the most important management factors. Labor needs to ensure that bees have good stores of honey and pollen for the dearth period. Labor also needs to increase and reduce space in the colony when and where it is needed. Extra space is needed in the nectar flow season so more honey storage is possible as well as for more brood. In the dearth period less space is required and hence unused comb needs to be removed (FAO, 2012).

It is important that management interventions occur at the appropriate time and this requires understanding the yearly colony cycle. Management is required in all three phases of the cycle, but is most important in the death period (FAO, 2012). As many tropical countries, past efforts have shown that in Ethiopia there are numerous practices of seasonal bee colonies management was under take to improve the performance of local honeybee colonies. Like feeding system, supering method, swarming and migration control, pests and predator control, and also other practices are under way. However, the annual movement of honeybee is common phenomenon in Ethiopia (Gemechis *et al.*, 2012).

Experiences beekeepers in Ethiopia had colony management practices like Borena, South Wello of Amahara region move their hives once a year to an outstanding honey flow area and 2 to 3 times honey harvest is possible. For maximization of honey production and efficient utilization of resources, migratory beekeeping can be exercise in areas where honey forages provide rich honey flows in succession (Keralealem, 2005).

### **2.7.7. Use of Agro-chemicals (Herbicides and Pesticides)**

The promotion of some agricultural inputs such as pesticides and herbicides for cereal crops production as well as the use of deadly chemicals for malaria eradication program has substantially reduced honey production (Gezahagn, 2001). As a result, bee products marketing has retrogressively promoted to petty trading. The use of chemicals and pesticides for crop pests, weeds, *Tsetse fly*, Mosquitoes and household pests control brings in to focus the real possibility of damaging the delicate equilibrium in the colony, as well as the contamination of hive products. Of the various kinds of chemicals only insecticides and herbicides are now major problems to the beekeepers. The chemicals used for crop protection are the main pesticides that kill the bees. Moreover, there are two other circumstances in which bees are killed on plants by chemicals. These are by insecticides applied to non-crop pests such as Mosquitoes and *Tsetse* flies and by herbicides applied to plants on which the bees are foraging. Insecticides have a much more dramatic effect on population of bees, thus, the important contribution made by bees to the production of food and human nourishment is being jeopardized. On the other hand, herbicides, which are commonly not toxic to bees, destroy many plants that are valuable to bees as source of pollen and nectar. The types of chemicals used include Malathion, Sevin, DDT, 2-4 D and Acetone. As it was seen from the beekeeper point of view, poisoning of honeybees by agrochemical has been increased from time to time. Some beekeepers lost totally their colonies due to agrochemical (Kerealem *et al.*, 2009). Desalegn (2014) recently reported that there is a growing pesticides grievance on honeybee population and their products decline with considerable economic impacts on beekeepers and he also reported that indiscriminate uses of pesticides caused fatalities on 22987 honeybee colonies and incurred economic loss amounting USD 819291.37 in districts of Amhara Region of Ethiopia.

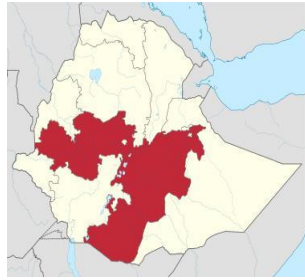
## **CHAPTER THREE**

### **MATERIALS AND METHODS**

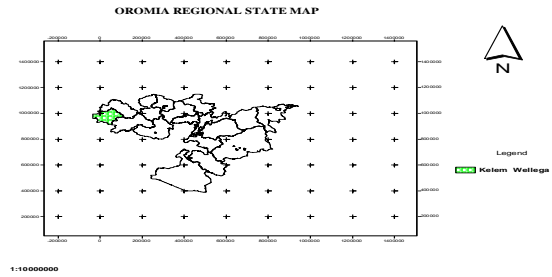
#### **3.1. Description of the study area**

##### **3.1.1. Location**

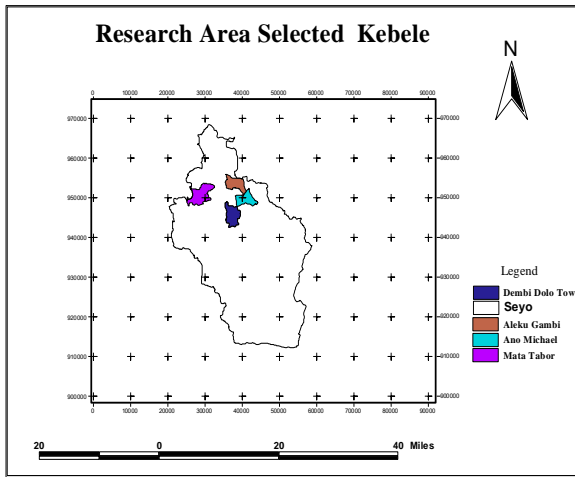
The study was conducted in Sayo district which is one of the twelve districts of Kelem Wollega Zone, Oromia regional state. Dambi Dollo is a capital (town) of Kelem Wollega Zone. It is located at 652 km from the Addis Ababa in western part of Ethiopia. The study site has Latitude  $8^{\circ} 32'N$  and longitude  $34^{\circ} 48'E$  with an elevation of between 1701 and 1827 meters above sea level. Sayo is bordered on the south by the Gambela region, on West by Anfilo district, on North by Yemalogi Welal, on North West by Hawa Galan, on East by the Birbir River which separates it from the Illubabor Zone. The district was twenty six kebeles and Dambi Dollo town is the centre of Sayo district administration. A survey of the land in Sayo shows that 55.2% is cultivated or arable, 4.45% grazing land, 26.51% forest, and 13.83% infrastructure or other uses. Coffee is an important cash crop of this district. Over 50 square kilometers of the land are planted with crops. The study focuses on high, mid and low altitude. The study area kebeles were Mata, Aleku Gambi and Ano Mikael were purposively selected for the study to represent agro-ecologies of Sayo district that is high mid and low altitude respectively.



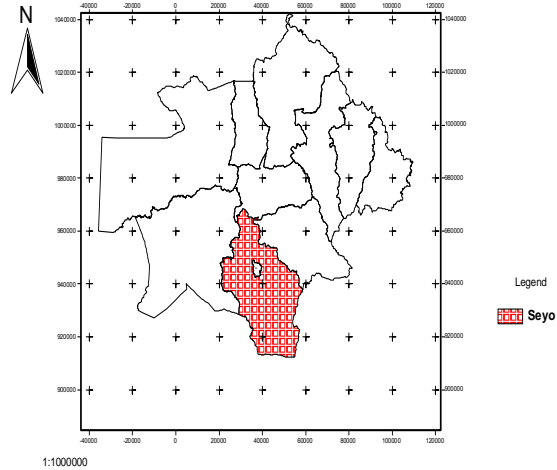
A) MAP OF ETHIOPIA



B) MAP OF OROMIA REGIONAL STATE



C) MAP OF STUDY AREA



D) MAP OF KELEM WOLLEGA ZONE

Figure 5. Map of the study area

### 3.1.2. Demographic structure

Based on the 2007 National Census reported by the CSA, the total population of the district was 116,631 out of this 58,268 were Men and 58,363 were Women. The total number of households was 22,268 out of this 21,512 were men and 756 were women were living in Sayo district. None of its population was urban dwellers. The majority of the populations were Protestants, with 56.1% reporting that as their religion, while 25.72% observed Ethiopian Orthodox Christianity, 10.83% observed Islam, and 5.84% were Catholic.

### **3.1.3. Topography, Altitude and Climate**

The Sayo district has varied topographic and climate characteristics, which influences the vegetation cover, the soil and the weather characteristics. Its altitude ranges between 900 - 2300 m. above sea level, it gently slopes to the east, and its western parts consist of high plateau, mountain peaks and rugged terrain. The climate is a hot and humid type. The annual maximum rainfall of the area reaches 600 -1500 mm. it is during the wet season (May – October) that 80 – 90% of the total precipitation occurs. The average annual temperature of the area is 19<sup>0</sup>C. The mean monthly temperature varies significantly throughout the year, that is from 10<sup>0</sup>C to 28 <sup>0</sup>C (Sayo district Agricultural and rural development Office, 2016)

### **3.2. Research Design**

In this study, two experimental designs were employed. The first design is a cross-sectional research design based on collecting information from across section of beekeeper at one point in time. The information was collected at one shot, then organized and analyzed. The second design is case study based on collecting, organizing and analyzing information from selected cases. Therefore, the research design is a case study and cross sectional research design.

### **3.3 Types and Sources of Data**

For this research both qualitative and quantitative data was gathered. Primary data related to the research questions were gathered from the study area .The sources of primary data were beekeeper farmers, district agricultural experts, development agents. Moreover, secondary data was collected from district agriculture and rural development office, previous research, books, journals and internet in order to supplement primary data.

### **3.4 Methods of Data Collection**

#### **3.4.1 Household Survey**

In order to get relevant data related to the research questions, household survey was conducted on selected respondents. The respondents were those who engaged in beekeeping activities. The selected respondents were interviewed through structured questionnaire which is prepared in

English language first and translated to mother tongue and administered to the selected respondents to collect the data. Interviewing the sample households through questionnaire is important, as the sample households may not read write to fill the questionnaire. To conduct the household survey enumerators were recruited from the study area and awareness was given for the enumerators on how to conduct the household survey with the help of the development agents.

### **3.4.2. Key Informant Interview**

In order to get primary data with respect to research questions and related issues key informant interviews were conducted with selected kebeles resident development agents, district agriculture, rural development head and experts.

### **3.5 Sampling Procedure and Sampling Size**

In order to collect data related to the research problems and research objectives the researcher followed different stage technique of sampling. Accordingly, in the study area there were twenty six kebeles exist in the district, at first stage, three kebeles were purposively selected out of the twenty six kebeles with the criteria of having relatively large number of participants in beekeeping and potential for beekeeping with the help of district agriculture and rural development experts. The purposively selected kebeles were Mata, Aleku Gambi and Ano Mikael. Accordingly, in Mata there were 120 beekeepers in which the numbers of traditional, transitional and modern beekeepers were 98, 2, and 20 respectively. In Aleku Gambi there were 114 beekeepers in which the numbers of traditional, transitional and modern beekeepers were 84, 18, and 12 respectively. In Ano Mikael there were 143 beekeepers in which the numbers of traditional, transitional and modern beekeepers were 120, 12, and 11 respectively. In the second stage, using the population list of beekeepers in the sample kebeles 90 beekeepers (households) were randomly selected for the household survey. The list of beekeepers households obtained from Development agents in each kebeles were used as a sampling frame.

### **3.6 Methods of Data Analysis**

All collected data were coded and tabulated for analysis. The statistical analysis used in the study was very depending on the type of variable and information required. However, since the survey study was based on formal survey method, descriptive statistics using SPSS and Microsoft Excel software was mainly be applied such as mean, mean comparison, frequency, percentages, and ranges.

## CHAPTER FOUR

### RESULTS AND DISCUSSIONS

#### 4.1. Scio-economic characteristics of the respondents

##### 4.1.1 House Hold Characters

All of the total 90 beekeeper respondents participated in the survey, (100%) were male headed beekeepers. This is because of the traditional belief that beekeeping is men's activity and the women are therefore not allowed to undertake beekeeping activity in the study area. It is a cultural taboo to involve women to harvest honey, hive construction, hanging of hives on trees and succeeding bee product harvesting. Similarly, Hartmann (2004) reported that in Ethiopia traditionally beekeeping is men's job and Workineh Abebe (2006) who also reported beekeeping as male headed households dominated activity in Atsbi Wemberta District of eastern Zone of Tigray region.

Survey results showed that the beekeepers' age ranges from 23 – 70 years old with mean age of 43.7. Out of which more than 75% of the respondents' age was less than 55 years old. The results indicated that there was no significant deference in age between the studied kebeles. That's the total age group of the respondents in the three kebeles in the interval of 15 – 24, 25 – 34, 35 – 44, 45 – 54 and above 55 were 3, 29, 22, 20 and 16 respectively (Table 1).

This result showed that beekeeping can be performed by younger age groups. Similarly (Chala, 2010) reported the most productive age are actively involved, accommodating experiences from elders and family became independent beekeepers.

Table 1. Age Distribution of the Respondents

| Age group | Mata | Aleku Gambi | Ano Mikael | Total |
|-----------|------|-------------|------------|-------|
| 15 – 24   | -    | 1           | 2          | 3     |
| 25 – 34   | 12   | 9           | 8          | 29    |
| 35 – 44   | 9    | 7           | 6          | 22    |
| 45 – 54   | 5    | 8           | 7          | 20    |
| Above 55  | 4    | 5           | 7          | 16    |

Survey results revealed that the average family size per HHs during the study time were no significance differences between the studied kebeles, that's Mata (4.13), Aleku Gambi (6.57) and Ano Mikael ( 5.35). The overall mean family sizes of the respondents were 5.35 and ranges from 2 to 9 persons per beekeepers. Workineh Abebe (2006) stated that family sizes of 6.6 and 5.9 for beekeepers technology adopters and non adopters, respectively in Atsbi Wemberta District of eastern Zone of Tigray region. Showing high beekeepers HHs which might suggest adopting beekeeping somehow improve the problem of food and competition for others resources arisen from high HH members.

Survey results showed that there was significant difference in beekeeper's experience between Mata and Ano Mikael kebeles with no significant difference between Ano Mikael and Aleku Gambi , Mata and Aleku Gambi (Table 2) the total mean of the three location were ( 17.5) years' experience with range of 3 to 40 years.

Table 2. Socio- economic characters of the sample HHs

| Variables                      | Mean value | Minimum value | Maximum value |
|--------------------------------|------------|---------------|---------------|
| Age                            | 43.7       | 23            | 70            |
| Average household size         | 5.35       | 2             | 9             |
| Bee farming experience in year | 17.5       | 3             | 40            |
| Honey income in Birr           | 1990       | 200           | 7800          |

It is also revealing in (Table 2) the beekeepers earned between 200 – 7800 ETB annual incomes from honey produce with an average 1990 ETB per annual. This indicates that a reasonable

income can be earned from them in study area. This supports the finding by Tijani (2007) that annual farm income of a farmer determines the farmer ability to purchase improved technology which may bring about increase in productivity and subsequently leads to higher income. Thus, the higher the annual income of a farmer, the greater the scale of agricultural production he can undertake and the higher the profit in farming.

#### 4.1.2. Educational Level of the respondents.

The educational level of sample respondents showed only 6.7% were illiterate but the remaining respondents had got at least basic education but, they cannot read and write with their mother tongue (Table 3) and more specifically 15.31, 69.57, and 9.42 basic education, elementary school (grade 1 – 8) and high school (grade 9 – 12) level attended, respectively. In addition correlation analysis indicated that there were good association between educational level and beekeeping experience, number of bee colony holding and adoption of improved beehives. From this it is easy to note that education has significant importance to improve technology utilization and improvement of production and quality products. Educational level of farming system may have great importance in identifying and determining the type of development and extension service approaches in order to improve the livelihoods of small holder farmers (beekeepers). Similar reports were noted by (Gichora, 2003. Workneh Abebe, 2006). It is also observed that education had significant effect on adoption of improved beekeeping technology, beekeeping experience and number of bee colony holding between illiterate and educated beekeepers.

Table 3. Proportion of Educational level of respondents

| <b>Total sample size (90)</b> |                        |                               |                              |                           |
|-------------------------------|------------------------|-------------------------------|------------------------------|---------------------------|
| <b>Variables</b>              | <b>Mata<br/>% ages</b> | <b>Aleku Gambi<br/>% ages</b> | <b>Ano Mikael<br/>% ages</b> | <b>Overall<br/>% ages</b> |
| Illiterate                    | 4.87                   | 6.29                          | 8.94                         | 6.7                       |
| Basic education               | 16.56                  | 18.75                         | 10.62                        | 15.31                     |
| Grade 1- 8                    | 71.35                  | 67.43                         | 69.93                        | 69.57                     |
| Grade 9 – 12                  | 7.79                   | 11.51                         | 8.96                         | 9.42                      |

## 4.2. Beekeeping Practices and Production Potential

### 4.2.1. Sources of honeybee colony and Apiary sites

The study indicated existences of huge indigenous knowledge on practicing beekeeping which might differ from a beekeeper to beekeeper and also from one location to another location mostly depending on the beekeepers experience. The survey result indicated that 88.75% of the beekeepers started beekeeping by catching bee swarms, while the remaining by getting bee colonies through gift from family, through inheritance from their parents and both catching swarm and gift from family 1.54% , 7.18% and 2.53%, respectively (Table 4). This finding agree with Tessega (2009) and Chala (2010) reports that majority of beekeepers initiated beekeeping through swarm catching in Burie district of Amahara region and Gomma district of Oromia Region, respectively. But it also showed that bee colony selling is uncommon as there were no single respondent beekeepers that started beekeeping by buying bee colony.

Table 4. Sources of honeybee colonies in the study area.

| Sources of honeybee colony                | No of respondents | % of respondents |
|---|-------------------|------------------|
| Through inheritance from their parents    | 7                 | 7.78             |
| Gift from family                          | 1                 | 1.11             |
| Catching swarms                           | 80                | 88.89            |
| Both gift from family and catching swarms | 2                 | 2.22             |
| <b>Total (N= 90)</b>                      | <b>90</b>         | <b>100</b>       |

Majority of the beekeepers in the area, 75.78%, had 1 to 5 honeybee's colony whenever they started beekeeping. About 24.57% of the beekeepers place traditional beehive on trees in forest, 18.86%, 37.71%, and 11.43%, 7% places backyard, hanging on trees near homestead, both backyard and hanging on trees near homestead, and both hanging on trees near homestead and hanging in the forest respectively (Table 5). However, most of the beekeepers that started beekeeping in transitional (56.56%) and movable-frame hives (60.37%) placed bee colonies at backyard with the remaining locate their bee colonies inside the house and under the shed near home (Table 4).

Table 5. Arrangements (placement) of different beehives after getting colony.

| <b>Total Sample size (90)</b>                                   |                    |                     |                      |
|---|--------------------|---------------------|----------------------|
| <b>Placement of Hive</b>  | <b>Traditional</b> | <b>Transitional</b> | <b>Movable frame</b> |
|   | <b>%</b>           | <b>%</b>            | <b>%</b>             |
| -Backyard   | 18.86              | 56.56               | 60.37                |
| -under the shed near home                                       | -                  | 37.28               | 36.67                |
| -Inside the house   | -                  | 6.16                | 2.96                 |
| -Hanging on trees near homestead                                | 37.71              |                     |                      |
| -Hanging on trees in the forest                                 | 24.57              |                     |                      |
| -Both hanging on trees near homestead and hanging in the forest | 7.43               |                     |                      |
| -Both backyard and hanging on trees near homestead              | 11.43              |                     |                      |

#### 4.2.2. Honeybee colony holding in the study area

The mean honeybee colony holdings in Ano Mikael (14.41) were significantly higher than that of Aleku Gambi (10.23) and Mata (9.53). But, there were no significant difference between Aleku Gambi and Mata (Table 6). However, the overall mean of the study area was 11.39 honeybee colonies per HHs in all beekeeping production system. These results agree with Tessega (2009) who reported mean honeybee's colony holding in traditional hive 7.75 per household. The high colony owning at Ano Mikael Kebeles might be attributed to abundant honeybee flora and favorable environment of the kebeles.

Table 6. The Average honeybee colony holding per HH in the study area

| <b>Kebeles</b>      | <b>Number of honeybee colony owning (90)</b> |                                     |
|---------------------|--|-------------------------------------|
|                     | <b>Range</b>                                 | <b>Mean <math>\pm</math> SE</b>     |
| Mata                | 1 – 47                                       | 9.53 $\pm$ 1.485                    |
| Aleku Gambi         | 1 – 51                                       | 10.23 $\pm$ 1.82                    |
| Ano Mikael          | 1 – 78                                       | 14.41 $\pm$ 2.632                   |
| <b>Overall mean</b> | <b>1 – 78</b>                                | <b>11.39 <math>\pm</math> 1.979</b> |

From the total 90 beekeepers interviewed, 75.56% have only traditional type of hive, and 6.67%, 5.56%, 5.55%, 2.22% and 4.44% had only movable-frame, combinations of traditional and transitional, traditional and movable-frame, transitional and movable frame, traditional, transitional and movable-frame hives, respectively (Table 7), indicating low adoption of improved beekeeping technology in the area. This low adoption rate of technology might be due to poor beekeeping extension services, high costs of beekeeping equipment, lack of know how about improved beekeeping and others made.

Table 7. Distribution and composition of bee hive types

| Types of bee hive used                      | Total sample size (N =90) |                 |
|---|---------------------------|-----------------|
|   | Frequency                 | Percentages (%) |
| Only Traditional                            | 68                        | 75.56           |
| Only Transitional                           | -                         | -               |
| Only movable-frame                          | 6                         | 6.67            |
| Traditional and transitional                | 5                         | 5.56            |
| Traditional and movable-frame               | 5                         | 5.55            |
| Transitional and movable-frame              | 2                         | 2.22            |
| Traditional, transitional and movable-frame | 4                         | 4.44            |

#### 4.2.3. Beekeeping practices and trends in Study Area

##### 4.2.3.1. Beekeeping practices in Study Area

Beekeeping is not new idea in Sayo district and generally in Ethiopia; it is an ancient farming activity which is practiced as a sideline with other farm activities. Yet in Sayo there are three types of beekeeping which include: traditional, transitional and movable-frame based on the types of beehives used.

##### a. Traditional bee hives

The data collected from the study area showed that traditional beehives was categorized in to three different categories; this includes: *Bidiru (Log)*, *Mud (Dogogo)* and Basket hive type, but

all were oval in shape with the dimension of around 90-100cm in length and a diameter of approximately 30cm. As information gathered from the respondents, they were plastering interior of hive by mud and cow dung to protect bees from cold weather conditions and external part were covered with grass and bamboo sheath to protect from rain and sun. According to the survey result, the mean bee colony owning of traditional hive beekeepers in Ano Mikael (11.41) was significantly higher than that of Aleku Gambi (7.23) and Mata (5.53) kebeles. But, there were no significant difference between Aleku Gambi and Mata (Table 8) in owning bee colonies in traditional beehives. The HHs overall mean of bee colony holding in traditional was 11.39 and the minimum and maximum were 2 to 78 per household, respectively. These results agree with Tessega (2009) who reported mean honeybee's colony holding in traditional hive 7.75 per household.

Table 8. Averages Traditional Hive per HHs

| <b>Kebeles</b> | <b>Minimum</b> | <b>Maximum</b> | <b>Mean <math>\pm</math> SE</b> |
|----------------|----------------|----------------|---------------------------------|
| Mata           | 2              | 47             | 5.53+1.485                      |
| Aleku Gambi    | 5              | 51             | 7.23+1.82                       |
| Ano Mikael     | 7              | 78             | 12.41+2.623                     |
| Overall mean   | 2              | 78             | 8.39+1.976                      |

According the survey result until now traditional beekeeping is practiced in two forms traditional forest beekeeping which is practiced in forest by hanging beehives on long trees and with no management care for bees and bee products. This way of beekeeping is the dominant ways of honey and beeswax production system in the study area. The second form is traditional backyard beekeeping which is practiced around homestead with relatively better management provided to bee colonies as compared to forest beekeeping (Figure 2)



Figure 6. Traditional beekeeping practices at near home stead and in the forest.

### **b. Transitional beehive**

It is one of the improved methods (technology) of beekeeping practiced in the study area. However, it is very limited and this might be due to poor beekeeping extension services in the study area. The study showed the average transitional bee owning per HH was 1.75 which is insignificant as compared to traditional beekeeping practice. However, there is a recent effort by GO in introducing transitional beehives as well as providing training to framers. The training was focused on hand on practices that equip the beekeepers with skill to prepare their own transitional from locally available material to overcome the high cost of investment.



Figure 7. Transitional beekeeping practices at backyard and under the shade.

### C. Moveable-frame hive beekeeping practice

The quantity and quality of hive products production primary depend on the type of beehive used. According to the result of this study, the applications of movable-frame hive was very low as compared to traditional beehive with overall mean holdings of 3.57 and maximum 10 and minimum 1 hives per HH. This is probably because of poor beekeeping extension services and weak intervention on beekeeping by Government and there is no non-government organization in the study area. Currently, the costs of movable frame hive ranges from 1500 to 2000 Ethiopian birr which is not affordable by small holder farmers as an information gathered from Sayo district agricultural and rural development office. Moreover, movable-frame hives allow appropriate colony management and use of a higher level technology, with larger colonies, and can give higher yield and quality honey but, are likely to require high investment cost and trained man power (Crane, 1990).



Figure 8 Movable frame beekeeping practices at backyard and under the shade.

#### 4.2.3.2. Types of Beekeeping in Sayo

The majority (more than 86.76%) of the respondents follow traditional production system with only few beekeepers started using transitional (4.79%) and movable-frame (8.45%) beekeeping production system. Tesfaye and Tesfaye (2007) also reported similar figures for the beekeepers in the mid rift valley of Ethiopia, Adami Tullu Jido Kombolcha i.e., 98% traditional and 2% modern production system.

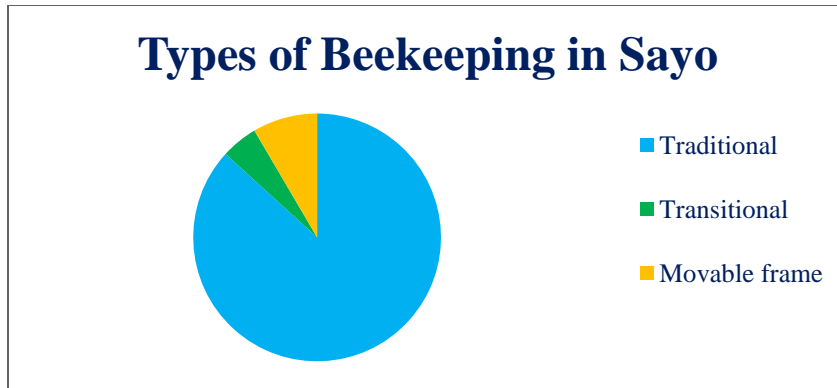


Figure 9 Beekeeping trends in Sayo district

Out of the 90 interviewed beekeepers the majority (64.23%) agree on the decreasing trends in the yields and the number of honeybee populations due to the effects of absconding, application of pesticides and herbicides, climatic change from time to time and shortage of bee forage (Table 9) and this finding agree with Tessega (2009) and Haftu and Gezu (2014) who reported shortage of bee forages, drought, pesticides and herbicides application, lack of water, decreasing in number of bee colony, lack of improved beehives and poor management as reasons for the products and honeybee population decline, Whereas, 33.04% and 2.73% of the rest respondents agree with increasing and unchanged way of production system trends, respectively. However, those categorized as increasing production system asked what the reason for increasing production system and they were given responses as availability of good honeybee’s floras, added more bee colonies, good market price for bee products, awareness of beekeeping production system and use of new beekeeping technologies in the area.

Table 9 Causes of decreasing trend of beekeeping in Sayo

| Causes of decreasing trend of beekeeping | Total sample size (N= 90) |                 |
|--|---------------------------|-----------------|
|  | Ages (%)                  | Ranking         |
| Lack of bee forages                      | 39.23                     | 2 <sup>nd</sup> |
| Migration                                | 49.54                     | 7 <sup>th</sup> |
| Absconding                               | 51.76                     | 1 <sup>st</sup> |
| Pests and predators                      | 33.41                     | 3 <sup>rd</sup> |
| Bee diseases                             | 7.98                      | 8 <sup>th</sup> |
| Pesticides and herbicides application    | 43.84                     | 4 <sup>th</sup> |
| Deforestation                            | 23.62                     | 6 <sup>th</sup> |
| Climate change                           | 18.71                     | 5 <sup>th</sup> |

Notice: For each rank, the causes of absconding trend can be evaluated out of 100% by multiple response analysis method and the winner take its age (%).

#### 4.2.4. Occurrence of Absconding

Honeybee colonies abscond from their hives at any season of the year when the hives affected by their enemies (Ayalew, 2006; Nuru, 2007). According to this study about 82.8% of the respondent reported absconding of their honeybee colonies with the absconding frequency occurred 37.1%, 25.6%, 12.8%, 8.3% and 16.1% in March to May, September to November, December to February, June to August and no response or they don't know about absconding, respectively. Bee enemies are rated number one initiator of bee colony absconding with the other reported reasons for absconding of bee colonies are indicated in table 10. Also different mechanisms are used to control bee colony absconding which includes: queen wing clip, providing additional feeds, queen caging (that made from *shimal*, *kerka*), leaving honey combs during harvesting and cleaning and smoking the beehives.

Table 10 Factors responsible for absconding of honeybee

| Reason of absconding                         | Total sample size (N=90) |                 |
|--|--------------------------|-----------------|
|  | Ages (%)                 | Ranking         |
| Honeybee enemies                             | 57.47                    | 1 <sup>st</sup> |
| Lack of bee forages                          | 34.56                    | 2 <sup>nd</sup> |
| Indiscriminate application of agro-chemicals | 48.21                    | 3 <sup>rd</sup> |
| Poor management system of beekeeping         | 52.39                    | 4 <sup>th</sup> |
| Lack of protection against bad weather       | 11.81                    | 5 <sup>th</sup> |

Notice: For each rank, the factors responsible for absconding can be evaluated out of 100% by multiple response analysis method and the winner take its %age.

#### 4.2.5. Honeybee colony Swarming and Means of control

It is obvious that swarming is a means of reproduction in honeybee. From the total 90 respondents in this study, about 97% reacted occurrences of reproductive swarming in their apiary with the remaining about 3% had no knowhow about swarming. The respondents mentioned that frequency of swarming depends on the availability of honeybees flower and season of the swarming occurrences (Table 11). About, 88.75% of the sample respondents had experience of catching the issued swarm and this result agrees with report of (Tessega, 2009) who recorded 85.80% experience in catching swarm for beekeepers in Burie District of Amhara Region. Also in this study about 68.7 % of the sample respondents agree that swarming had advantage to increase their number of colony and replace non-productive colony with only 31.3% responded swarm has no advantage. Further, most of the beekeepers reported to use many ways of controlling reproductive swarming among which removal of queen cell, returning back the issued swarm to mother colony, use large volume of hive and harvesting or cut comb

Table 11. Frequency of reproductive swarming occurs

| Season of occurrence | Frequency | Ages (%)   |
|----------------------|-----------|------------|
| Every season         | 55        | 61.1       |
| Every year           | 21        | 23.3       |
| Once in two year     | 3         | 3.4        |
| Twice in a year      | 9         | 10         |
| No know how          | 2         | 2.2        |
| <b>Total</b>         | <b>90</b> | <b>100</b> |

#### 4.2.6. Inspection of honeybee colonies

With regards to collecting information on the inspection of bee colonies by the beekeepers, about 92% of the respondents do undertake inspection of their bee colonies with only about 8% not. This indicates that most of beekeepers visit and inspect their beehives both externally and internally at varied frequency to check either the hive was save or filled with honey (Table 12). However, internal hive inspection was limited to those honeybee colonies placed at backyard and under the shade near the house. Different researcher (Kerealem, 2005; Tesfaye and Tesfaye, 2007; Chala, 2010) reported that farmers in Ethiopia do not commonly practice internal hive inspection due to the difficulty of the traditional hives for internal inspection i.e., fixed combs attached to the body of traditional beehive.

Table 12. External and internal hive inspection frequency

|                 | External  |            | Internal  |            |
|-----------------|-----------|------------|-----------|------------|
|                 | Frequency | %          | Frequency | %          |
| Every day       | 8         | 8.9        | 0         | 1.11       |
| Every three day | 11        | 12.2       | 3         | 3.33       |
| Every week      | 7         | 7.8        | 4         | 4.44       |
| Every two week  | 9         | 10         | 2         | 2.2        |
| Every month     | 31        | 34.44      | 7         | 7.78       |
| If necessary    | 14        | 15.56      | 14        | 15.55      |
| Not at all      | 10        | 11.1       | 60        | 66.7       |
| <b>Total</b>    | <b>90</b> | <b>100</b> | <b>90</b> | <b>100</b> |

#### **4.2.7. Hive products (Honey and wax) harvesting season**

Survey result revealed that there were two major hive products harvesting season in the study area which ranges from December to February (87.54%) (Peak periods), the second harvesting time was from May to June (11.32%) (Second peak time) and few respondents (1.14%) said as they were harvesting March to May. Within these major harvesting periods, there were many harvesting frequency which depend on the availability of flowering plants, length of flowering time and rainfall patterns at different ecologies in the study area as the information gathered indicated. Sample respondents have been asked “what type of product you produce in your locality?” and most of them (97.78%) responded as they were producing only honey. Haftu and Gezu (2014) reported the same issue. But few respondents (2.22%) reported as they were using both honey and beeswax. Among the total 90 respondents 65.36 % of them harvest honey twice, whereas only 31.12%, and 3.52% of the sample farmers respond that they harvest once and three times, respectively. It was also reported that none of the respondents can remove all honey combs found in the hives; at least they could leave one or two combs depending on the colony strength and availability of flowers on the field. It was reported by the beekeepers that any production obtained in the remaining periods of the year would be left as a source of food for the colony to strengthen it for the next harvesting season.

#### **4.2.8. Honey and Beeswax yields from different types of beehive**

The amount of any hive products differ from place to place and from hive to hive type depending on different factors (like the availability of flora, colony strength and management given) exists. The overall mean of honey yield harvested in the study area during study time was 6.86 kg with minimum 1kg and maximum 17 kg was recorded from traditional hives. There were significant difference ( $P < 0.05$ ) between Aleku Gambi ( $6.96 \pm 0.33$ ), Mata ( $4.89 \pm 0.28$ ) and Ano Mikael ( $8.73 \pm 0.39$ ) (Table 13) kebeles in honey yields per hive from traditional hives. This was probably because of the fact that the variability of flora and whether condition differences exists between kebeles and also difference in management practices of beekeepers. The lowest honey yield per hive was recorded at Mata this was also because the most cold weather condition and the highest yields were reported at Ano Mikael which is the low land area and relatively higher flora could found at Ano Mikael. From this study, it is realized that lowland area is more

conducive for beekeeping than high land areas. The current result was similar with Ethiopian national average and Workneh Abebe (2006) that states the average amount of honey harvested per traditional hive in West, South West and North Shewa zones to be 6.2 kg. In this study, hive products from transitional and movable frame was not compared with each other and with traditional hive types because of there was no product records on all Kebeles. In addition there were also product of beeswax yield presented gained from beekeepers. This is two of the beekeepers in the study area was started to use beeswax and even have know how about this product.

Table 13. Mean and Range Comparison of honey yields in kg per traditional hive

| Kebeles        | Total Sample size (N =90) |           |             |
|----------------|---------------------------|-----------|-------------|
|                | Minimum                   | Maximum   | Mean        |
| Aleku Gambi    | 1                         | 14        | 6.96        |
| Mata           | 2                         | 15        | 4.89        |
| Ano Mikael     | 1                         | 17        | 8.73        |
| <b>Overall</b> | <b>1</b>                  | <b>17</b> | <b>6.86</b> |



Figure 10. Beeswax productions in the study area.

### 4.3. Factors Affecting Beekeeping and Production of Honey and Beeswax

#### 4.3.1. Extension Services

Access to extension services is essential for the farmers in adopting and transferring of improved technologies to improve production and productivity. More specifically access to extension

contact and market information is the most important factors that promote production and marketing of honey and other bee products and thereby increase income of the producer (farmers). It is expected that extension service widen the beekeepers knowledge with regard to the use of improved beekeeping technologies and have positive impact on the income of the framers. Survey result showed that only 30.6% of the respondents had participated in extension package services of beekeeping. This result indicated that there was poor beekeeping extension services delivery of improved beekeeping technologies to the beekeepers. However, it was observed that beekeepers that have more frequently contact with development agents (DA) and expert have better information about improved beekeeping technologies and could also adopt better improved technology than those who have no contact with extension services. Workneh (2006) reported as the beekeepers that had got direct technical assistance from the bee expert and DA; know more about the technology, which in turn help them to utilize the technology effectively.

#### **4.3.2. Lack of Improved Beekeeping Equipment**

According to respondents suggestion, most of beekeeping equipments used in their area were locally available materials like traditional hives, smokers (made from clay), knife, bee brush (made of grass and feather), honey container and etc. This agrees with Tesfaye and Tesfaye, (2007); Haftu and Gezu (2014) that stated farmers did not have any type of improved beekeeping equipment in Adami Tullu Jidu Kombolcha and Hadya Zone, respectively. This indicated that very low familiarity of the beekeepers with improved beekeeping technologies. Due to this reason, they were not benefited from the potentiality of resource available and even their product quality also not in good manner as information gathered showed. Therefore, one can realized that lack of access to improved beekeeping equipment as one of the factors affecting both the quantity and quality of bee products.

#### **4.3.3. Lack of beekeeping training**

Sample respondents were asked whether they receive training with regard to techniques of beekeeping and its management. Accordingly, majority 58.9% of the interviewed beekeepers had not get any beekeeping advice and training with respect to method of beekeeping and

management, but only 41.1% had got training on beekeeping from researches, livestock experts and NGO's. It is obvious that lack of provision of trainings for beekeepers also has its own adverse impact on the quantity and quality of hive products (especially honey and wax). Moreover, beekeeping training develops the beekeepers' self-confidence in the technology adoption and utilization system of the available resources. It also increases the productivity of the beekeeping. Generally, training is a back bone to equip the beekeepers with basic knowledge on how to operate improved beekeeping technologies, basic bee biology, manipulate honeybee colonies, record keeping, appropriate bee forage planting, processing hive product techniques of high quantity and quality of bee products and its marketing. Therefore, it is important to organize especially practical training for beekeepers in order to improve the livelihoods of small holder beekeepers and benefit them from the unexploited potential of beekeeping in Sayo.

#### **4.3.4. Methods of Processing and Storage Materials**

In Sayo most commonly beekeepers deal with crude honey, which is obtained by breaking honey combs into smaller pieces by hand or stirring with a stick. According to the survey of results majority of the respondents 48.9% did not store honey, they use it for home consumption or sold immediately after harvesting. They reason out that if it was stored for long time it could be granulated/ crystallized and fermented. This is most probability because of manual processed and not separated with beeswax. As reported by the sample respondents the most commonly used traditional storage containers were: plastic containers, clay pot, fertilizer bag, tin (*tasa*), material made from hide and skin of animal (*Kelkelo*). Nuru (1999) reports indicated that as honey was also stored in traditional containers such as clay pot, hide, and tin and he also reported that honey quality is reduced when stored in traditional containers. Such traditional containers will absorb moistures or may change the flavor of honey and deteriorate the quality of their honey during storages. Therefore, awareness creation is very important for these beekeepers to advise what type of containers they use and how to keep the quality of their honey. But still now, processing and storages methods of beeswax and other hive products were not presented, this is because interviewed beekeepers were not started using of other hive products including beeswax. In general the reason of not using of wax and other hive products is lack of awareness (know how) and poor extension services.

### 4.3.5. Major beekeeping constraints

The major beekeeping constraints are technical and institutional which come from honeybee's characteristics or environmental factors that are beyond the control of the beekeepers, whereas others have arisen with poor marketing infrastructure and storage facilities. Based on the information of the sample respondents, there were a number of difficulties and challenges that are hostile to achieve the success of desired honey production. The identified and prioritized major problems facing the beekeeping activities as indicated in table 14

Table 14. Major Constraints identified by respondent beekeepers in the study area.

| Major beekeeping constraints             | Total sample size (N =90) |                  |
|--|---------------------------|------------------|
|  | Ages (%)                  | Ranking          |
| Shortages of bee forages                 | 53.74                     | 1 <sup>st</sup>  |
| Pests and predators                      | 39.46                     | 2 <sup>nd</sup>  |
| lack of beekeeping equipments            | 31.43                     | 3 <sup>rd</sup>  |
| Application of herbicides and pesticides | 48.37                     | 4 <sup>th</sup>  |
| Lack of improved bee hive                | 27.13                     | 5 <sup>th</sup>  |
| Absconding                               | 43.87                     | 6 <sup>th</sup>  |
| Migration                                | 21.43                     | 7 <sup>th</sup>  |
| Lack of extension services               | 22.35                     | 8 <sup>th</sup>  |
| Swarming                                 | 19.35                     | 9 <sup>th</sup>  |
| Drought                                  | 14.21                     | 10 <sup>th</sup> |

Notice: For each rank, the constraints can be evaluated (competed) out of 100% by multiple response analysis method and the winner take its %age.

#### 4.3.5.1. Honeybee pests and predator

According to the result of the current study, presences of pests are major challenge to honeybees and destroy their products. The ranks of the top ten harmful pests were indicted in table 13. Shunkute *et al.*, (2012) reported that great loss of total honey production per annual can be caused by honeybee enemies (40.7%) mainly by pest. According to this study, a shortage of bee

forages was a serious problem in the dry season of the study area. About 53.74% the transitional and the modern honey production system is vulnerable and easily influenced by this factors. There is also the honey badger which attacks the traditional honey production practiced in the forest. As a result of the shortages of bee forages and honey badger attack a considerable amount of honey and other hive products was lost and bees absconded. Following honey bee forages and badger, ants, spider and bee-eating birds with 39.46% took the second most serious bee enemies' position presented in the area (Table 13).

#### **4.3.5.2. Unsafe use of agrochemicals**

Chemicals poisoning honeybees are agricultural inputs that used to control weeds, pests and fungus in order to boost yield of crops or used to control ecto-parasites of animal. Farmers in Sayo primarily produce Teff, Maize, Sorghum, wheat, Coffee, Barely, Bean, Field Pea and horticultural crops. They use various types of agrochemical without any consideration to damage it can cause to honeybee colonies. Beekeepers indicated that a number of bee colonies either die or abscond from their hives due to the extensive and unsafe use of agro-chemicals to mainly control crop pests. Sample respondents have been requested to mention presence of agro-chemicals that poison to honeybees in their locality. The main agricultural chemicals reported to be used in the study area were 2,4D (two four D), Round up, Malethine, DDT and other Fungicides types. Kerealem *et al.*, (2009) and Taye and Marco (2014) reported similar issues about effect of agro-chemicals. These chemicals are directly or indirectly affect the life of honeybees or honeybee's production.

Information gathered from respondents revealed that due to agro-chemicals application a number of honeybee's colony and honeybee production decreasing from time to time. The chemicals affect honeybees in two main ways, first by direct killing number honeybees on field and when bring nectars and pollen sacking to the hive a number of broods and adult honeybees in the hive were died. And the second way is by killing honeybee's flowers on the field which otherwise used to serve as major food sources of honeybees. In short, these problems are technical, management and policy issues and can affect the production and productivity of beekeeping in the study area and in general in Ethiopia. Therefore, much focus has to be given to

alleviate the effects of poisoning from agrochemicals to ensure productivity, quality and safety of beekeeping in the study area and in the country as a whole.

#### 4.3.5.3. Poisoness plants to honey bee

Sample respondents were interviewed if they know toxic/poisonous plants in their localities. Accordingly, few 13.3% experienced beekeepers replied positively as they know toxic plants to honeybee that they were considered to be toxic to honeybees and humans or suspected in the study areas. This plants were include “Abaaboo diimaa”, “Quncee Qararoo”, “Omborii (Aajjaa)”, “Tamboo” (*Nicotiana rustica*), and their local name, scientific name, These plants can be whose nectar or pollen is toxic to the bees, and those in which the honey produced from their nectar are toxic to humans. Similarly (Nuru, 2002) reported that some poisonous bee plants from Northern regions of Ethiopia, and pollen grains of nine poisonous species of bee plants from the families *Ranunculaceae*, *Solanaceae*, *Acanthaceae*, *Euphorbiaceae* and *Phytolacaceae* were analyzed and documented. Kerealem (2005) also mentioned that Gumero, Yeferenj Digit (*Cassia siamea*), Bisan (*Croton macrostachyus*), Iret (*Aloe brahana*), Foch (*Zizyphus mucronata*), Endod (*Phytolacca dodecandra*) and *Susbania* spp are suspected bee poisonous plant in Amhara Region. However, further research works are required to confirm if the plants are truly bee poisoning and which resources (nectar and/or pollen) is responsible to the act, before recommending eradication control.



Figure 11. “Abaaboo Diimaa” Poison Plant to bees and humans.

#### **4.4. Honey and Beeswax Marketing and market constraints**

According to (Mendoza, 1995), marketing channel is the sequence through which the whole of honey passes from farmers to consumers. The analysis of marketing channel is intended to provide a systematic knowledge of the flow of the goods and services from their origin (produce) to the final consumer. During the survey, the majority of the respondents replied positively for the question a few of them replied negatively. This indicated that most of the beekeepers in the study area undertake beekeeping to generate cash income from selling honey.

During the study period the average price of crude honey per kilogram were 68.18 Ethiopian birr with minimum 35 and maximum 90 Ethiopian birr per kilogram. It was also understood that there were price variations which based on honey quality mainly on the color of honey, tastes, season and distance from market point. Honey price was low during the peak production season and high during the slack season. Also honey with light color and good tastes get better price. According to the opinion obtained through this study, honey with orangey (golden) color and clear honey is highly preferred on the market, whereas, dark color is regarded as low quality for which not preferred by consumers. In this study, lack of market information, lack of transportation, low price and price fluctuation during harvesting time, lack of cooperatives, were identified as the main bee products market problems.

In the study areas, about most of the sample respondents sold their honey to the nearest Town market and only few sold at their home. In the market the main customers of honey were ‘Tej’ houses, whole sellers and beekeepers co-operative. Tessega (2009) reported the same idea.

In the study area as a whole, collecting and selling of beeswax and other hive products by beekeepers was not known or started. Even in the area the beekeepers awareness about other hive products is very low. Therefore, future beekeeping intervention is very crucial in the area on bee products diversification to contribute to improved livelihoods of the community.

## **5. CONCLUSION AND RECOMMENDATIONS**

### **5.1 Conclusion**

Beekeeping practices in Sayo is an ancient farming activity which was practiced as a side line activity with other farming activities. It is a potential with full available resources but, its development is still at very low rate due to different factors. Based on the finding of this study, it can be concluded that beekeeping in the study areas is dominantly defined as men's job. But, women play important role in the marketing of honeybee products. Survey data indicated that beekeepers in the area had deep indigenous knowledge of traditional production system. Most of beekeepers were engaged in beekeeping from their younger age and about 88.75% of them had got source of colony through catching swarm. In the area three beekeeping practicing systems are identified, with traditional beekeeping dominating up to 86.76%. Transitional and movable frame beehive beekeeping account 4.79% and 8.45% of the production system, respectively. Based on this, a conclusion can be drawn that beekeepers did not fully benefited from this sub-sector. But, still there are good opportunities and potential to improve the production situation and quality of hive products.

This study characterized some beekeeping systems and bee products of Sayo district and identified many challenges and opportunities for fostering beekeeping and honey production. The major factors affecting beekeeping and honeybee production in the study area are poor extension services, lack of beekeeping equipments, lack of beekeeping training, shortages of bee forages, pests and predator, application of herbicides and pesticides, lack of improved beehives, absconding and migration, deforestation, lack of processing methods and storage facilities and beekeeping constraints. During the study period the main bee products marketing challenge identified were lack of market information, lack of transportation, low price and price fluctuation during harvesting time, and distance from market.

## 5.2 Recommendations

- Production of honey and beeswax should be enhanced by improving the traditional production system and also introducing modern beekeeping methods.
- Awareness should be given to households through training programs for the community focusing on the practical aspects of beekeeping and involvement of women and youth on improved beekeeping technologies to raise awareness and promotion of beekeeping.
- Education should be given for beekeepers on how to prevent pests, birds and wild animals, honeybee poisoning plants, from beehives.
- Awareness should be given to farmers in the use different agro-chemicals for the increments of crop yield, but which have side effects on beekeeping.
- There should be sustainable awareness creation activities among the farmers with respect to beekeeping activities in general and improved beekeeping method in particular.
- The district agriculture and rural development office should also assign trained personnel who specialized in beekeeping and budget should be allocated specific to beekeeping activities.
- District administration and Agricultural office should establish good market networks and developing market information delivery system for bee products is important to make the work attractive to the farmers.

## REFERENCES

- Ayalew Kassaye. 2001. Promotion of beekeeping in rural sector of Ethiopia: *Proceedings of the third National Annual Conference of Ethiopian Beekeepers Association (EBA)*, Addis Ababa, Ethiopia, pp.52-58.
- Aburime, I.L.; Omotesho, O.A. and Ibrahim, H., (2006). An Analysis of Technical Efficiency of Beekeeping Farms in Oyo State, Nigeria. *European Journal of Social Sciences*,4 (1): 1 – 8.
- Adebabay Kebede, Kerealem Ejigu, Tesema Aynalem, Abebe Jenberie (2008). Beekeeping in the Amhara Region, Amhara Regional Agriculture Research Institute, Bahirdar, Ethiopia.
- Aichholz, R., Lorbeer, E. 1999. Investigation of comb wax of honey bees with high-temperature gas chromatography-chemical ionization mass spectrometry. *High-temperature gas chromatography, Journal of Chromatogr*, 855: 601-615.
- Amssalu Bezabeh, Nuru Adgaba, Sarah E. Radloff, H. Randall Hepburn. 2004. Multivariate morphometric analysis of Honeybees (*Apis mellifera* L.) in the Ethiopian region. *Apidologie*, 35: 71-84.
- Amssalu Bezabeh, Nuru Adgaba, Sarah E. Radloff, H. Randall Hepburn. 2004. Multivariate morphometric analysis of Honeybees (*Apis mellifera* L.) in the Ethiopian region. *Apidologie*, 35: 71-84.
- Ayalew Kassaye. 1990. The honeybees (*Apis mellifera*) of Ethiopia. Approaches, Methods and Processes for Innovative Apiculture Development:
- Ayalew Kassaye (2008). Establishment of Apiculture Data Base in Ethiopia, Addis Ababa, Ethiopia.
- Bangladesh Small and Cottage Industries Corporation (2010). Beekeeping, Bangladesh.
- Bankova V, Boudourova-Krasteva G, Popov S, Sforcin JM and Funari SRC. 1998. Seasonal variations of the chemical composition of Brazilian propolis. *Apidologie*, 29: 361– 367.

- Bankova, V.S., Boudourova-Krasteva, G., Sforcin, J.M., Frete, X. Kujumgiev, A., Maimoni Rodella, R. and Popov, S. 1999. Physico- chemical evidence for the plant origin of Brazilian propolis from Sao Paulo State. *Zeitschrift f̃ Naturforschung*, 54C: 401–405.
- Castro L. M. Várquez, M. C. Díaz-Maroto, C. De Tores, M. S. Pérez-Coello. 2010. *Food Res. Int.* 43 (2335).
- Codex Alimentarius. 2001. Revised Codex Standard for Honey, Codex STAN 12–1981, *Rev. 1* (1987), *Rev. 2*.
- Crane, E. 1990. *Bees and Beekeeping: Science, Practice and World Resources*. Comstock Publishing Associates (Cornell University Press), Ithaca, New York.
- Crewe RM, Hepburn HR, Moritz RFA. 1994. Morphometric analysis of two southern African races of honeybee. *Apidologie*, 25: 61-70.
- CSA. 2012. *Statistical Abstracts*. Central Statistical Agency. Addis Ababa, Ethiopia.
- CSA. 2015. *The Federal Democratic Republic of Ethiopia Central Statistical Agency*
- Desalegn Begna and Amsalu Bezabeh. 2006. Occurrence of small hive beetle (*Aethina tumida* Murray; *Coleoptera: Nitidulidae*) in honeybee (*A.mellifera* L.) in Ethiopia. *Ethiopian veterinary journal*, 10(2): 101-110. Addis Ababa, Ethiopia.
- Desalegn Begna and Amssalu Bezabeh. 1999. Distribution of honeybee diseases *Nosema apis* and *Melpighamoeba mellificae* in Ethiopia. Holeta Bee Research Center. Annual Report
- Edessa Negera. 2005. Survey of honey production system in West Shewa Zone: *Proceedings of the 4th Ethiopian Beekeepers Association (EBA)*.
- FAO STAT. 2005. *Statistical Database Livestock* <http://faostat.fao.org/default.aspx>.
- Food and Agriculture Organization (FAO). 1996. Value added products from beekeeping (FAO Agricultural Services Bulletin No., 124). Rome, Italy.
- Food and Agriculture Organization (FAO). 2003. *Beekeeping and sustainable livelihoods*. Rome.

- Food and Agriculture Organization (FAO). 2009. Bees and their role in forest livelihoods, by N. Bradbear, Non-wood forest products No. 19, Rome Food and Agriculture Organization (FAO). 2012. Beekeeping and Sustainable Livelihoods by Martin Hilmi, Nicola Bradbear and Danilo Mejia, FAO Diversification booklet number 1, second edition, Rome
- Food and Agriculture Organization (FAO). 2012. Beekeeping and Sustainable Livelihoods by Martin Hilmi, Nicola Bradbear and Danilo Mejia, *FAO Diversification booklet number 1, second edition*, Rome
- Gemechis Legesse Yedeta. 2014. Review of progress in Ethiopian honey production and marketing. Holeta Bee Research Center (HBRC), Holeta. P.O. Box 22 Ethiopia.
- Gemechis Legesse, Kibebew Wakjira, Amssalu Bezabeh, Desalegn Begna, Admassu Addi (eds). 2012. Apiculture research achievements in Ethiopia, Oromia Agricultural Research Institute, Holeta Bee Research Center, Holeta, Ethiopia.
- Gezahegn Tadesse and Amssalu Bezabeh. 1991. Identifying and Diagnosing Honeybee Diseases at Holeta Bee Research and Training Center. Proceedings of the fourth National Livestock Improvement Conference, pp. 263 – 265.
- Gichora. M. 2003. Towards Realization of Kenya’s Full Beekeeping Potential: A Case Study of Baringo district. Ecology and Development series No.6, 2003. Cuvillier Verlag Gottingen, Gottingen, Germany. 157p.
- Gidey Yirga and Kibrom Ftwi (2010). Beekeeping for Rural Development: Its Potentiality Constraints in Eastern Tigray, Northern Ethiopia, Agricultural Journal, Volume 5, Issue 3, Medwell Publishing.
- Hicks, T. C., R. S. Fouts, and D. H. Fouts. 2005. Chimpanzee (*Pan troglodytes*) tool use in the Holeta Bee Research Center (HBRC), 2004. Beekeeping Training Manual. Holeta, Ethiopia.
- (White J.W.JR, 1980). Honey composition and Properties. Beekeeping in United States Agriculture hand book Number 335, p.82-91.

- Kaškoniene V, P. R. Veskutonis. 2010. *Compr. Rev. Food Sci. Food Saf*, 9 (620)
- Kerealem Ejigu Haile. 2005. Honeybee Production Systems, Opportunities and Challenges in Enebse Sar Midir Wereda (Amhara Region) And Amaro Special Wereda (Southern Nations, Nationalities and Peoples Region), Ethiopia. M.Sc. Thesis.
- Lorna H. Tsutsumi and Darcy E. Oishi. 2010. Farm and Forestry production and marketing profile for honeybee (*Apis mellifera*), Web <http://www.uhh.hawaii.edu/academics/cafnrm/faculty/arita-tsutsumi.php>
- Melaku Girma, Shifa Ballo, Azage Tegegne, Negatu Alemayehu and Lulseged Belayhun (2008).
- MoARD. 2013. Ministry of Agriculture and rural development annual report.
- Nicola, Bradbear (2009). Bees and their Role in Forest Livelihoods A guide to the Services Provided by Bees and The Sustainable Harvesting Processing and Marketing of Their Products, Food and Agriculture Organization of The United Nations, Rome.
- Nuru Adigaba. 2002. Geographical races of the honeybees (*Apismellifera*L) of the northern regions of Ethiopia. PhD Dissertation, Rhodes University, South Africa.
- Olagunju, D. 2000. Alleviating Poverty through Beekeeping,. Cahrli-Tonia publisher Osogbo Nigeria. pp: 189
- Osman Mwebe. 2012. The Beekeepers Manual, A practical guide to modern beekeeping and the use of the six bee products, Kampala, Uganda.
- Oxfam GB, 2011. Engaging Small Holders in Value Chains, Programmed Insights, in Small Farmers, Big Change: Achieving scale in the development of small holder agriculture. ISBN 978-1-84814-842-0.
- Paulos, Desalegn, 2011. Ethiopian Honey: Accessing International Markets with Inclusive Business and Sector Development. Online. [http://seasofchange.net/downloads/SoC-120404Ethiopiahoney-case\\_FINAL.pdf](http://seasofchange.net/downloads/SoC-120404Ethiopiahoney-case_FINAL.pdf) (Accesed February 13, 2013)

- Radloff, S.E. & Hepburn, H.R. 1997. Multivariate Analysis of Honeybees, *Apis mellifera* L., of the Horn of Africa. *African Entomology (in press)*.
- Roberts. E. 1970. Memorandum on the Beekeeping Industry in Uganda and its potential for development. Makerere University College, Kampala, Uganda.
- Ruttner, F. 1988. Biogeography and taxonomy of honeybees. Springer-Verlag, New York, New York, USA.
- Sarah L Jones, H Richard Jones and Andreas Thrasyvoulou. 2011. Disseminating Research about Bee Products. A review of articles published in the Journal of Apicultural Product and Apicultural Medical Science, 3 (3): 105 - 116.
- Schmidt JO, Buchmann SL. 1992. Other products of the hive. In: Graham JM (ed) The Hive and the Honeybee. Revised edition, p 927-988. Hamilton, Illinois, Dadant and Sons Inc.
- Smith, F.G. 1961. Races of honeybees in East Africa. *Bee World* 42: 255-260.
- Tadesse, B., and Phillips, D. (2007). Ensuring Small Scale Producers in Ethiopia to Achieve Sustainable and Fair Access to Honey Markets. International Development Enterprises (IDE) and Ethiopian Society for Appropriate Technology (ESAT).
- Tessega Belie. 2009. Honeybee Production and Marketing Systems, Constraints and Opportunities in Burie District of Amahara Region, Ethiopia. M.Sc. Thesis.
- Tesfaye Kebede and Tesfaye Lemma. 2007. Study of honey production systems in Adami Tulu Jido Kombolcha district in mid rift valley of Ethiopia. Livestock Research for Rural Development. Volume 19, Article # 11. <http://www.lrrd.org/lrrd19/11/kebe19162.htm>.
- Thomson, W. 1990. Propolis. Medical Journal of Australia, 153, p. 654.
- Tijani, B.A., 2007. Comparative Economic Analysis of Weed Control Methods for Selected Crops in Marte Local Government Area of Borno State, Nigeria. Unpublished. M,Sc. Dissertation, Department of Agricultural Economics and Extension University of Maiduguri, Nigeria. 93pp.

USAID (United States Agency for International Development), 2012. Agricultural Growth Program-Agribusiness and Market Development (AGP-AMDe) Project. Submitted by ACDI/VOCA to Contracting Officer's Representative Tewodros Yeshiwork, USAID Ethiopia. Wild Bee. 2007. Propolina Extract. *www.thewildbee.com*

Workneh Abebe. 2006. Identification and documentation of indigenous knowledge of beekeeping practice. Proceedings of the 14th Ethiopian Society of Animal Production, ESAP. Addis Ababa.

Workneh, Abebe, and Ranjitha, P., 2011. Beekeeping Subsector Challenges and Constraints in Atsbi Wemberta District of Eastern Zone, Tigray Region, Ethiopia. Journal of Agricultural Extension and Rural Development, 3(1): Z8-12 .