



WALLAGA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

COLLEGE OF NATURAL AND COMPUTITIONAL SCIENCES

DEPARTMENT OF BIOLOGY

**ETHNOBOTANICAL STUDY OF HONEYBEE FLORA DIVERSITY
AND USES IN HARO LIMU DISTRICT, EAST WALLAGA ZONE,
OROMIA NATIONAL REGIONAL STATE, ETHIOPIA**

MSC THESIS

BY: AMSALU TEMESGEN GUDURA

APRIL, 2026

NEKEMTE, ETHIOPIA



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MSC THESIS,

**SUBMITTED TO BIOLOGY DEPARTMENT IN PARTIAL
FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE IN BIOLOGY**

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APRIL, 2026

NEKEMTE, ETHIOPIA

DEDICATION

This thesis is dedicated to my father Temesgen Gudura and my mother Walalo Gosu for love and their dedicated partnership in the success of my life.

LIST OF ABBREVIATIONS / ACRONYMS

AFB ----- American Foulbrood

BMPHH -----Best Management Practices for Hive Health

DA-----Development Agents

DMR-----Direct matrix rank

FAO ----- Food and Agricultural Organization of the United Nations

HLDADO -----Haro Limu district's Agricultural Development Office

ICF----- Informant consent factor

MP-----Multiple purposes

NUC -----Number of use Citations

WHO-----World health organization

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ABSTRACT

The study was conducted to investigate the ethnobotany, diversity, and uses of honeybee flora in Haro Limu District, East Wallaga Zone, Oromia National Regional State, Ethiopia. A total of 389 respondents were purposively selected, along with district experts, for data collection, and specimens of honeybee flora were collected from three Kebeles. Socio-demographic analysis showed that 52.8% of respondents were men, 33.6% had completed primary education, 65.15% were aged between 24 and 35, and 80.9% had a medium life status. Using interviews, visual observations, and field surveys, 65 plant species were documented, of which 48 were classified as major and 17 as minor honeybee flora sources across different agro-ecological zones. Most species flower during the first (September–November) and second (December–February) seasons, highlighting two major periods for nectar and pollen availability, when beekeepers can optimally manage hives, divide colonies, add supers, and harvest honey. Beekeepers commonly positioned traditional hives in backyards, while key challenges to apiculture included natural enemies of bees, agrochemical poisoning, lack of knowledge in bee management, scarcity of colonies, and plant-related toxicity. The study underscores the importance of further ethnobotanical research on honeybee flora to enhance productivity and income for local beekeepers.

Keywords: Apiculture, Honeybee flora, Honey, Major flower, Minor flower

1. INTRODUCTION

1.1. Background of the Study

Apiculture, the study and management of honey bees, often begins as a hobby until beekeepers turn their interest into small-scale enterprises. Beekeeping not only provides valuable honey and other bee products but also supports agricultural pollination. The production of honey and related products depends on the availability of floral resources, or bee forage (Amsalu Bezabeh *et al.*, 2003). Most studies on the utilization of local plants rely on field observations of honeybee foraging behavior. Beekeeping, or apiculture, involves the management of honeybee colonies for agricultural pollination and the exploitation of their products, including honey, pollen, wax, propolis, and brood.

Bees are small animals, and individual consumption of honey is minimal; consequently, the ecological and economic importance of their services is often underestimated. The domestic honey bee (*Apis mellifera* L., Hymenoptera: Apidae) is the primary species used for honey production. Honeybee societies are among the most complex invertebrate social systems due to advanced communication skills and a strict caste system, which makes identifying the queen bee straightforward. Africa, including Ethiopia, has a large indigenous wild population of honey bees (Dietemann *et al.*, 2009).

Ethiopia is estimated to host around 6,000 species of flowering plants, which serve as sources of nectar and pollen for honeybees (Equar Gebru *et al.*, 2016). The country's diverse environmental conditions and abundant floral resources contribute to the highest bee density and honey production in Africa. Beekeeping is one of Ethiopia's oldest agricultural practices, preserved across generations (Fichtl & Admasu Addi, 1994). Flowering plants bloom at different times and locations, allowing for numerous beehive colonies across the country (Admasu Addi, 1996). Ethiopia has the longest beekeeping heritage globally, making it a deeply rooted cultural practice (Ayalew Kassaye & Gezahegn Tadesse, 1991). Beekeeping contributes to the economy, society, culture, nutrition, and agricultural productivity (Kumari & Kumar, 2019).

Due to Ethiopia's diverse biological and climatic conditions, it hosts some of Africa's most varied flora, providing abundant forage for bees. Consequently, the country maintains the largest honeybee population and generates the highest quantities of honey and beeswax. According to CSA reports, Oromia (41%), SNNPR (22%), Amhara (21%), and Tigray (5%) are the leading honey and beeswax-producing regions. However, ecological degradation threatens honey production across many areas. The abundance and seasonal availability of floral resources strongly influence honey and other bee product yields (Rucker *et al.*, 2002; Crane, 1990). Major and minor honey flow periods are determined by nectar and pollen availability (Atwal, 2001). Bees secrete wax from four pairs of abdominal glands, with wax production influenced by pollen consumption by young bees after emergence; wax secretion peaks around day 10.

Despite Ethiopia's long history of beekeeping, favorable agro-ecology, and numerous bee colonies, honey productivity remains low. Key reasons include the use of traditional hives and other structural and ecological limitations (Gebretsadik Solomon, 2016; Ayalew Kassaye, 1994; Eddesa Negera, 2002).

In Haro Limu District, beekeeping is a primary income source. However, information on plants used for beekeeping in the district is limited. Bee flora and associated traditional knowledge are being affected by deforestation, lack of beekeeping knowledge, shortage of skilled labor and equipment, pests, pesticide threats, poor infrastructure, limited bee forage, and lack of research extension services. Therefore, documenting the diversity and uses of plant species for beekeeping in Haro Limu District is essential. The present study aims to investigate and record this ethnobotanical knowledge to support sustainable apiculture development in the area.

1.2. Statement of the Problem

Ethiopia's natural resources, particularly forests, are under increasing pressure due to overexploitation and improper utilization, resulting in environmental degradation (Bedru Babulo *et al.*, 2006). This degradation has significantly affected the biodiversity of honeybee forage plants, commonly referred to as bee flora, through deforestation and the reduction of vegetation cover (Eqvar Gebru *et al.*, 2016). Studies, such as Tessega Belie (2009) in the Burie District of the Amhara Region, have shown that beekeepers attempt to cultivate native plants near apiary sites to mitigate the decline in honeybee populations. However, despite such local initiatives, Ethiopia's national beekeeping resource base continues to deteriorate at an alarming rate, highlighting the need for sustainable interventions (Melaku Girma *et al.*, 2008).

In Haro Limu District, East Wallaga Zone, Oromia National Regional State, the diversity and traditional knowledge of honeybee flora are rapidly changing. This shift is driven by multiple factors, including deforestation, lack of skilled labor, inadequate beekeeping equipment, pests and predators, exposure to agrochemicals, poor infrastructure, scarcity of bee forage, and limited research and extension services. The decline in bee flora diversity threatens honeybee productivity, the availability of bee products such as honey and wax, and the livelihoods of local beekeepers. Despite its critical importance, there is limited documented information on the diversity and uses of honeybee flora in Haro Limu District.

Therefore, this study seeks to investigate and document the ethnobotany of honeybee flora in Haro Limu District, providing vital information for sustainable beekeeping practices and conservation of floral resources to enhance productivity and local incomes.

1.3. Research questions

1. What is the diversity of honeybee flora (bee forage plants) in Haro Limu District, East Wallaga Zone, Oromia National Regional State, Ethiopia?
2. What are the major and minor honeybee flora species, and how do their flowering periods influence honey and other bee product availability?
3. What are the traditional uses and ethnobotanical knowledge associated with honeybee flora among local beekeepers?
4. What socio-demographic factors (age, education, gender, and livelihood status) influence beekeepers' knowledge and utilization of honeybee flora?
5. What are the major challenges and threats affecting honeybee flora and beekeeping productivity in the study area?
6. How can documentation and conservation of honeybee flora contribute to sustainable beekeeping and improved livelihoods in Haro Limu District?

1.4. Objectives of the Study

1.4.1. General Objective

The general objective of this study was to investigate and document the ethnobotany, diversity, and uses of honeybee flora in Haro Limu District, East Wallaga Zone, Oromia National Regional State, Ethiopia, to support sustainable beekeeping and enhance local livelihoods.

1.4.2. Specific Objectives

1. To identify and document the diversity of honeybee flora (bee forage plants) in Haro Limu District.
2. To classify major and minor honeybee flora species and determine their flowering periods relevant to honey and other bee product availability
3. To record the traditional knowledge and ethnobotanical uses of honeybee flora among local beekeepers.
4. To assess socio-demographic characteristics of beekeepers and their influence on knowledge and use of honeybee flora.
5. To identify major challenges and threats affecting honeybee flora and beekeeping productivity in the study area.
6. To provide recommendations for the conservation of honeybee flora and sustainable beekeeping practices in Haro Limu District.

1.5. Significance of the study

The study aimed to assess and document the diversity and management of plant species used in beekeeping, as well as the practices related to honey production in Haro Limu District. It focused on the management of honeybee forage plants and the local knowledge and customs associated with honey production. Additionally, the study evaluated the challenges faced by beekeepers and examined the current honey production practices in the district.

The findings of this study provide valuable information on indigenous knowledge and practices that can be used to address beekeeping challenges and develop sustainable solutions. The documented information can guide improvements in the management of honeybee flora and enhance honey production. Furthermore, the application of indigenous knowledge contributes significantly to the livelihoods of the community and to the national economy through increased honey production. The data generated from this research also serve as baseline information for future studies and provide a foundation for further research in the field of apiculture and ethnobotany in the region.

1.6. Scope/delimitation of the study

This study was conducted in the Haro Limu district of the East Wallaga Zone, Ethiopia. The study was conducted in a bee honey-producing area by collecting important and necessary information from sample household's respondents and other chain actors operating in the Haro Limu district. Therefore, this study was coverage three kebeles (Birbo, Tutine and Oda gudina) of Haro limu district.

1.7. Limitation of the study

The main limitation of this study was mainly related to coverage of the study area. The topography of the land and peace condition was the limitation to collecting data through field observation. Also in the study area, more than seventeen kebeles are present. Hence, this investigation was conducted only on three kebeles. Due to plotical crisis three kebeles was selected.

2. LITERATURE REVIEW

2.1 Origin and Evolution of Bees and Beekeeping

Beekeeping has been practiced since ancient times, and honey has been regarded as a valuable substance used for food, medicine, and traditional rituals (Lietaer, 2009). Bees and their products provide small-scale farmers and rural households with a stable source of income, while requiring relatively low financial input (FAO, 2012). Beekeeping can be established with locally available tools and equipment, and the skills required are often embedded in local traditions (FAO, 2012). Globally, approximately 1.3 million tons of honey are produced annually, with Russia producing 193,000 tons, China 161,000 tons, the United States 75,000 tons, and Mexico 67,000 tons. Nearly 47% of honey production occurs in developing countries.

2.1.1. Beekeeping in Africa

Traditional beekeeping in tropical Africa persisted using crude hives until around 1500 AD (FAO, 1986). From 1650 to 1850 AD, top-bar and frame hives were introduced, but the basic design remained flawed because bees attached comb to hive walls, making it difficult to remove combs without destruction (Crane, 1976). In 1853, Lorenzo Lorraine Langstroth developed movable-frame hives with a correct “bee space,” establishing the modern principles of beekeeping. Africa, particularly Egypt, has historical records of beekeeping dating back to 1500 BC, making it the continent with the oldest documented beekeeping practices (Crane, 1990).

2.1.2 Beekeeping in Ethiopia

Beekeeping is a traditional agricultural practice in Ethiopia, and it is one of the most important sectors for rural livelihoods (Nuru Adgaba, 2007). Ethiopia’s rich biodiversity and diverse agro-climatic conditions support numerous honeybee colonies and a wide variety of honeybee flora. Approximately 10 million feral colonies and 6 million managed colonies exist in the country (Brodschneider, 2020). Among honeybees, *Apis mellifera* is the most common species, providing significant pollination services and producing honey and beeswax. Various subspecies of *Apis mellifera* are distributed throughout Ethiopia, including *A. m. adansanii*, *A. m. rajemenitica*, *A. m. monticola*, *A. m. litorea*, and *A. m. abyssinica* (Sos Sahle et al., 2018).

Ethiopia’s Oromia region is the leading honey and beeswax producer, contributing 41% of national production, followed by SNNPR (22%), Amhara (21%), and Tigray (5%) (CSA, 2003). The region

has favorable conditions, including diverse flowering plants, large bee colonies, adequate water supply, and suitable agro-ecology, which enhance honeybee survival, reproduction, and product yield. Haro Limu district relies on honey production alongside crops, livestock, and cash crops (coffee and chat) as major sources of household income.

2.2 Honeybee Products

2.2.1 Honey

Honey production depends heavily on the availability of floral resources (Rucker *et al.*, 2002). Honey is a viscous, sweet substance produced by bees using nectar collected from flowers and processed within the hive (Saralay *et al.*, 2021).

2.2.2 Royal Jelly

Royal jelly is secreted by the hypopharyngeal and mandibular glands of young nurse bees aged 5–15 days (Chauvin & Chauvin, 1968). It is fed to larvae and the queen, supporting growth and development. Peak production occurs around one week after larvae emerge.

2.2.3 Pollen

Honeybees collect pollen from flower stamens, roll it into pellets with saliva, and transport it in pollen baskets on their hind legs. House bees process it into bee bread, which is rich in micronutrients and has dietary and medicinal uses.

2.2.4 Pollinators

Bees are vital pollinators, supporting both cultivated and wild plants and contributing to ecosystem stability (Potts *et al.*, 2010; Faita, 2018; Malerbo-Souza & Halak, 2009). They enhance crop yields by approximately one-third globally (Aizen & Harder, 2009; Morse & Calderone, 2000).

2.2.5 Bee Bread

Bee bread is made by mixing pollen with honey and enzymes, then fermenting it in honeycomb cells. It is nutrient-dense and essential for colony growth.

2.2.6 Brood

Bee brood consists of eggs, larvae, and pupae. Drone brood is often harvested for consumption but may reduce colony growth if mismanaged.

2.2.7 Health and Nutritional Value of Honey

Honey and other bee products provide essential micronutrients, energy, and therapeutic benefits. Honey has antibacterial properties and promotes wound healing (Farn *et al.*, 2004; Layflurrie, 2008). Bee pollen and bee bread are nutrient-rich and support immune function and general health (Villanueva *et al.*, 2002; Lietaer, 2007).

2.3 Honeybee Flora

Beekeeping depends entirely on flowering plants. Worldwide, approximately 40,000 plant species serve as significant honey sources (Crane, 1990). Ethiopia has 6,500–7,000 flowering plants, with about 500 species providing abundant nectar and pollen (Fichl & Admasu Addi, 1994; Edwards, 1976). Honeybee flora includes crops, trees, shrubs, and weeds (Abrol, 1997; Kumar, 2015). Plant species, season, and time of day strongly affect nectar and pollen availability, which determines major and minor honey flow periods (Crane, 1990; Atwal, 2001).

2.4 Plant Habit Classification

Local communities categorize plants based on growth habit: Biqiltu (Herbs): Small, non-woody plants <1 m tall. Hidda (Climbers): Plants that rely on others for support to bear flowers or fruits. Micire (Shrubs): Woody plants shorter than trees, present in most fields. Muka (Trees): Woody plants that grow tall, varying by agro-climatic zone. Marga (Grasses): Herbaceous, non-woody plants important for bees.

2.5 Floral Calendar of Honeybee Plants

A floral calendar indicates flowering times and durations of honey and pollen plants, which guides hive placement and honey harvesting (Diver, 2002; Tessega Bellie, 2009; Bista & Shivakoti, 2001). For example, in Ethiopia, honey trees bloom during short rains (April–May), while shrubs and herbs bloom after the main rains (September–November) (Admasu Addi, 2002).

2.6 Beehives

2.6.1 Traditional Hives

Traditional beekeeping uses fixed-comb cylindrical hives, which are still widespread in Ethiopia. Backyard and forest hives are common, with honey production averaging 5–6 kg per hive annually (Edessa Negera, 2005; Gezahegne Tadese, 2001).

2.6.2 Transitional Hives

Top-bar hives, including the Kenyan Top-Bar (KTB), are used as intermediate technology between traditional and modern hives, producing 7–8 kg honey per hive annually in Ethiopia (Segeren, 1995; Gezahegne Tadese, 2001).

2.6.3 Modern Hives

Movable-frame hives, such as Langstroth and Zander, allow higher honey yields (15–20 kg per hive annually) and improved management, but require higher investment and skilled labor (Crane, 1976; HBRC, 1997).

2.7 Effects of Deforestation on Bees

Human activities, particularly deforestation and bush burning, reduce floral resources, degrade habitats, and negatively impact bee populations (Adekola et al., 2006; Adegbola et al., 1998). Forest conservation is essential to sustain honeybee populations and honey production (Mustafa *et al.*, 2015; FAO, 2009).

2.8 Pests of Honeybees

Rodents, honey badgers, birds, and other mammals are major predators of bees and hive products (MAAREC, 2004; BMPHH, 2019; Mayer, 2019).

2.9 Management of Honeybee Production Constraints

2.9.1 Cultural Practices

Cultural methods include removing infected combs, maintaining hygienic hives, and controlling pests using ant barriers and sticky traps (FAO, 2006; HPMSP, 2008).

2.9.2 Biological Agents

Biological control using disease-resistant strains and beneficial microbes is an environmentally safe method to manage honeybee diseases (Arbia & Babbay, 2011; Rondeau *et al.*, 2019).

2.9.3 Chemical Control

Chemotherapeutics, including antibiotics, may control bacterial diseases, but excessive use can harm bees and the ecosystem. Pesticide use should be minimized (Bogdanov *et al.*, 2004; Frazier *et al.*, 2008).

3. MATERIAL AND METHODS

3.1. Description of the Study area

The current investigation was carried out in Ethiopia's Oromia regional states in the Haro Limu area of the East Wallaga Zone. Haro Limu is 491 kilometers from Addis Ababa and is situated in the western portion of the East Wallaga Zone of the Oromia National Regional State of Ethiopia. The district, which occupies just 2% of the zonal area, is located between latitudes 8° 28'N and 8° 47'N and longitudes 38° 17.5' E and 38° 29'E. It lies at an altitude of approximately 1,500–2,500 meters above sea level. The district comprises two major agro-climatic zones: Dega (temperate), accounting for about 35% of the area, and Woina Dega (sub-tropical), covering approximately 65% (HLDADO, 2018/19). Its total area is 124,591.467 hectares. There are two urban towns and fifteen rural kebeles that make up the district. The Beneshangul-Gumuz National Regional State in the west, Ebantu district in the north, Limu district in the east and Sasiga district in the south make up the Haro Limu district's vicinal boundary (HLDADO, 2018/19).

Three kebeles from the Haro Limu District in the East Wollega Zone of Oromia Regional State, Ethiopia, were purposefully chosen for this study: Birbo, Tutine, and Oda Gudina. The selection criteria were accessibility for fieldwork, the availability of a variety of honey bee plants, and the existence of active beekeeping methods. Comprehensive information on beekeeping techniques, honey bee food species, and related environmental and socioeconomic aspects was gathered from these kebeles through a combination of household surveys, key informant interviews, field observations, and guided field walks. By using a purposive method, the study was able to collect accurate and pertinent data that reflected the district's beekeeping operations.

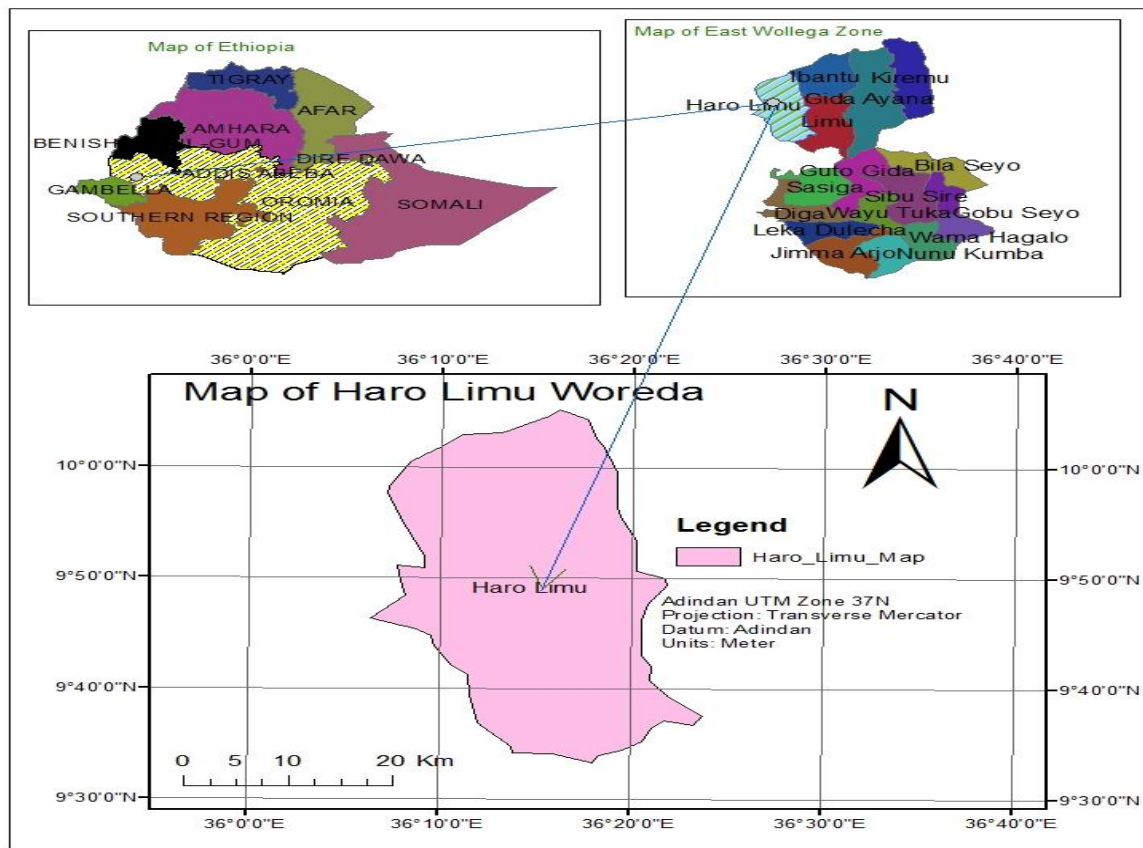


Figure 1 Study area Map of Haro limu

3.1.1. Climate and Soil of the Study Area

Haro Limu district's Agricultural Development Office (HLDADO, 2018/9) states that only two agro climatic zones—Dega, which has a temperate climate, and Woina Dega, which has a sub-

tropical temperature account for 35% and 65% of the district's, respectively. The district's has an average annual rainfall of 1200 mm to 2400 mm and an average temperature range of 15⁰c to 27⁰c. Nitsols (red-basaltic soils), Vertisols (black basaltic soils), and Cambisols (shallow, sandy soils with coarse texture) make up 45%, 35%, and 20% of the district's soil composition, respectively. The climatic diagram provided for the Haro Limu district (located in the East Wollega Zone of the Oromia Region) depicts the projected long-term average monthly temperature and precipitation levels.

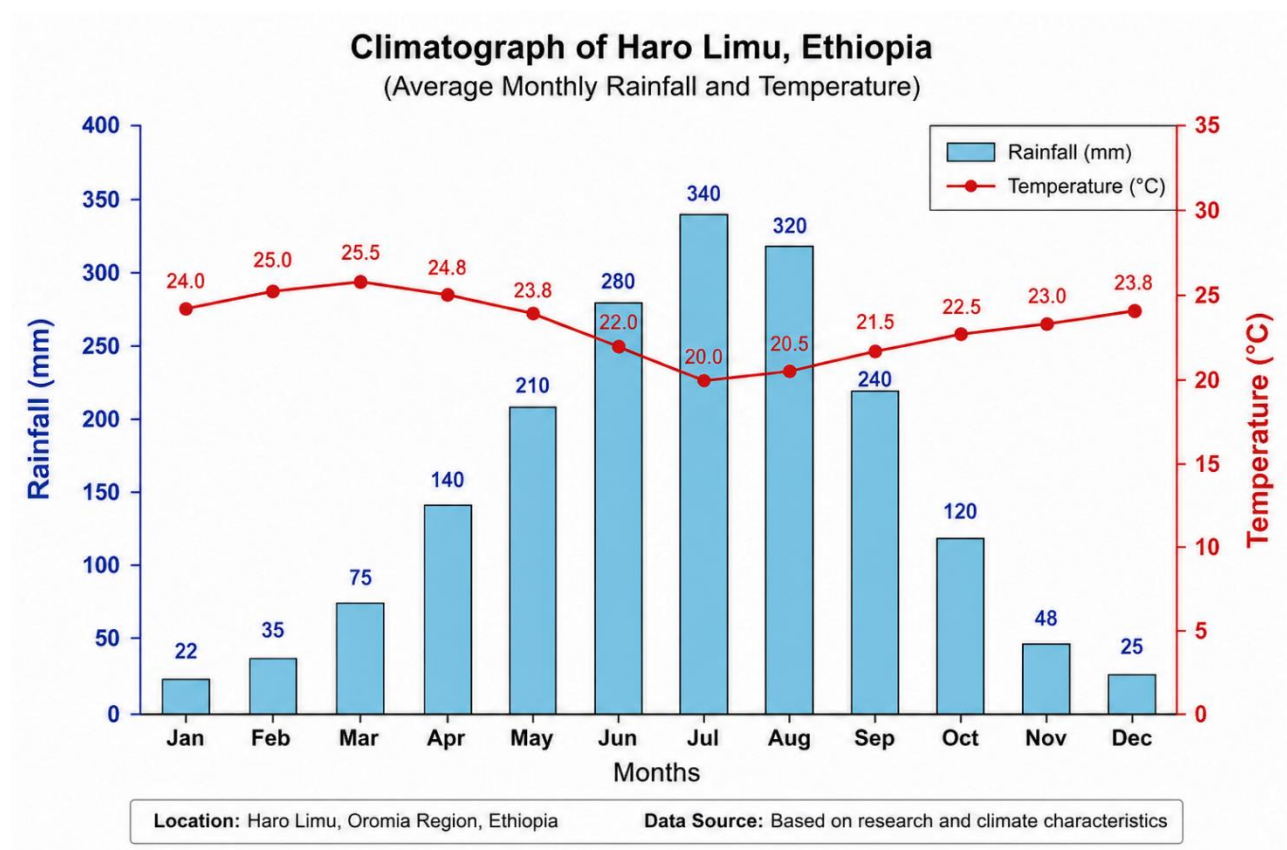


Figure 2 Average monthly temperature and rainfall (Climatic diagram) at Haro Limu district.

3.1.2. Vegetation type of study area

The most common type of natural vegetation is the high forest, which covers 15791 hectares and is located in Kello, Walga'i Soruma, Birbirs dabetan, and the Lalisa Peasant Association. The remaining natural vegetation types found in the area are riverine, which makes up 371 hectares in Kekero, woodland, which makes up 17732 hectares, and shrub land, which makes up 1200 hectares in the Ebantu district. The Agricultural Development Office of Haro Limu Woreda (2018/9) estimates that the total area of the Woreda is 123589.50 hectares. Agriculture occupies 38.36% of the total land area, followed by forests (23.67%), grazing (11.59%), other social activities (1.8%), and other uses (such as minerals, swamp regions, and rocky vast areas) (24.38%) (HLDADO, 2019).

The study area in Haro Limu is distinguished by a variety of flora types, including trees, bushes, herbs, and farmed crops that are crucial sources of food for honey bees. Native multipurpose trees and shrubs including *Eucalyptus camaldulensis*, *Cordia africana*, *Croton macrostachyus*, and *Vernonia amygdalina* are part of the natural vegetation and offer honey bees nectar, pollen, shade, and places to nest (Nuru Adgaba, 2007).

While developed crops like *Citrus aurantifolia*, *Coffee arabica*, and *Cucurbita pepo* provide additional nectar and pollen sources, herbaceous plants and wild flowering species contribute to seasonal forage (FAO, 2010). The vegetation, which reflects a fragmented yet varied terrain, is primarily found in private gardens, farmlands, and remnant natural forests. By offering consistent flowering seasons and other ecological advantages like soil conservation and microclimate regulation, this diversity of vegetation promotes sustainable beekeeping (Jose, 2009; Young, 1997).

3.1.3. Demographic Characteristics of the Study Area

32412 males and 32875 women make up the woreda's total population of 65,287, according to the Agricultural and Developmental Office of Haro Limu Woreda (HLWADO, 2018/19). According to the man-land ratio, which is calculated by dividing the total population by the woreda's total area,

the population distribution of the Woredas is 1p/km² (HLWADO, 2018/19). Islam and Christianity are the two most prevalent religions in the Woreda (HLWADO, 2019).

3.1.4. Socio-Economic Characteristics

The majority of the population in the district makes their living from agriculture, which is the leading economic activity in the area. The majority of farmers engaged in mixed farming systems, which involve raising livestock and crops for both commercial and domestic use. Cereals, oil seeds, and pulse crops are the main crops grown in the district. The most common livestock species include chickens, sheep, goats, donkeys, oxen, and cows. It is distinguished, nevertheless, by a lack of access to contemporary technologies, a poor productivity level, a reliance on rainfall, and irrigated farming. In addition to farming, the district was involved in medium- and small-scale business and retail trade. Additionally, there are tourist attractions that will continue to operate in the future, such as woods, natural caverns, and waters (HLWADO, 2019).

The socio-economic characteristics of respondents in Haro Limu revealed that beekeeping is predominantly practiced by economically active adults, mostly in the age group of 24–35 years. The majority of beekeepers were male, while females were mainly involved in honey processing and marketing. Household sizes were moderate, providing adequate labor for both farming and apiculture activities. Most respondents were mixed crop-livestock farmers, with farming experience spanning several years, indicating substantial indigenous knowledge in agriculture and beekeeping. Landholding sizes and access to natural resources such as water and bee forage plants significantly affected beekeeping activities. Overall, these socio-economic factors play an important role in shaping the practices, productivity, and sustainability of beekeeping in the study area.

3.1.4.1. Animals and Honey Bees Resources of the Area

The Haro Limu district is currently facing considerable strain on its forest resources as a result of population growth. Debel (2014) identified that the increase in agricultural land, the collection of wood for fuel, and the rising demands for agricultural inputs are significant contributors to deforestation in the region, which in turn diminishes the habitat available for both wildlife and plants that provide forage for bees. Regarding wildlife, a study on human–wildlife conflict in the

forested areas of Haro Limu reported several species that cause damage to crops: Anubis baboon (*Papio anubis*), Vervet monkey, wild pig, warthog, porcupine, and civet cat. This research indicated that approximately 66.1% of respondents experienced crop damage, while 12.4% reported livestock predation, with habitat disturbance, deforestation, and the expansion of subsistence farming being the primary causes of these conflicts.

On the plant-resource side, traditional medicinal plants continue to hold significance in the study area. In a study conducted by Tafesse & Amenu (2022), the authors identified around 18 plant families utilized by local communities for the treatment of various human ailments. These plants are predominantly wild (as opposed to cultivated), indicating their role as part of the native flora that may also supply nectar or pollen for bees. Furthermore, ethno-veterinary practices in Haro Limu demonstrate that local populations depend on medicinal plants not only for human health but also for the health of livestock. Tena Regasa & Gedefa Guteta (2023) documented numerous such practices, underscoring a crucial intersection between plant utilization, animal health, and ecosystem services.

3.1.4.2. Food Security and Uses(Production) of Honey in the Area

In the study area, honey production significantly contributes to local food security and the livelihoods of residents. Beekeeping serves as a supplementary income-generating activity for numerous households, with the honey produced fulfilling both nutritional requirements and enhancing economic resilience (Temesgen Tafesse and Desalegn Amenu, 2022). Research conducted in Haro Limu revealed that beekeepers encounter various challenges, such as traditional production techniques, restricted market access, and pests that hinder their capacity to fully utilize honey as a food and income source.

Furthermore, honey from the study area possesses notable antibacterial properties: samples analyzed in Haro Limu demonstrated considerable antimicrobial activity against multiple pathogens, highlighting its importance not only as a food source but also for health benefits. On both national and regional scales, agriculture is acknowledged as a vital element in strategies aimed at poverty alleviation and food security, as it requires minimal land, can be incorporated into smallholder farms, and yields a highly nutritious food product.

3.2. METHODOLOGIES

3.2.1. Selection of study sites and informants

The study was conducted in the district of Haro Limu. Haro Limu district was selected due to its representativeness and honey bee foraging availability. The district of Haro Limu has seventeen kebeles and two administrative Towns. Among the 17 kebeles of the district three kebeles were selected for an ethnobotanical data collection. These kebeles were selected purposively based on honey production potential available area from Haro Limu district. Three kebeles (Birbo, Tutine and Oda gudina) were selected and data were collected. Therefore, nine key informants—beekeepers, development agents (DAs), and managers were purposefully selected, and general informants or households were chosen at random to offer representative data on honeybee flora.

3.2.2. Sampling techniques and sample size determination

To collect the required social data for the research area, focus groups, individual interviews, and one-on-one interviews with key informants were conducted. The Kothora (2004) formula was used to determine the sample size of household respondents these for the Ethnobotanical bee flora was study included and three DA, three manager, and three honey bee keepers were chosen from each three kebeles. A total of 380 households were arbitrarily chosen to participate in surveys and interviews. The Formula for sample size: $n = N/1 + N(e)^2$

Where: n = Sample size to be studied N = Population size e = margin of error

$N= 7920$

$n = 7920/1 + 7920(0.05)^2$, $n=380$ (household respondents)

As a result, 380 families were chosen to participate in the Beeflora survey. There were 389 interviewees in all for the study after the addition of 9 key informants, including managers, development agents, and beekeepers.

Table 1. Informant Sampling Design for Ethnobotanical Bee Flora Study

Name of Kebele	Number of Households	Regular Informants	Key Informants	Total Sample Size

Birbo	2,640	127	3	130
Tutine	2,780	133	3	136
Oda Gudina	2,500	120	3	123
Total	7,920	380	9	389

3.2.3 Data collection methods

3.2.3.1. Semi structured interview

From the three kebeles (Birbo, Tutine, and Oda Gudina) in the Haro Limu area, 380 homes were selected at random. In order to collect information about honey bee forage plants and related parameters (e.g., identification of common bee flora with their flowering time, importance, seasonal forage availability in relation to colony strength and honey production, etc.), the sample beekeepers are interviewed one-on-one using a semi-structured questionnaire.

3.2.3.2 Key informant interview

Nine (9) key informants were purposefully selected for interviews out of 389 informants in the study region. Beekeepers, development agents (DAs), and managers were selected as informants based on their expertise and understanding of beekeeping techniques, honey bee flora, and honey output. The purpose of the key informant interviews was to collect detailed information on the following topics: major and minor honey bee flora and their uses; flowering period; beekeeping challenges and limits; traditional and modern management practices; and conservation of bee flora.

3.2.3.3 Focus Group Discussions

Focus groups with members of the community, who were specifically chosen for the study, including DAs and some people thought to be knowledgeable about bee flora plants, were held in the study area. Therefore, focus group discussion participants were chosen using the purposive sampling technique. One group in each kebeles were formed and during the discussion ideas were

allowed to flow and exchange among discussant's about the existing indigenous knowledge on honey bee flora, uses of honey bee flora.

3.2.3.4. Field Observation (guided field walk)

Field observation was made on the study sites with help of beekeepers, development agents (DAs) and managers. During that observation important points like conservation action of bee flora species, cultivation practice of bee flora species and vegetation of an area were observed. Bee flora plant parts like flowers, leaves, fruits and barks were collected based on plant habit.

3.2.4. Plant specimens collection and identification

To estimate the composition and diversity of bee flora in the study area, samples were collected from rainy-fed and irrigated cultivated land, closed forest areas, pasture land, and homesteads during the two main rainy seasons, known as "Kiremt" (end of June to mid-September) and "Bega" (end of December to mid-March). A plant press was used to press the gathered plant materials into a flat sheet, which was subsequently put in a dryer to expedite the drying process. The specimens' wetness was absorbed using blotters and newspapers, and any leftover moisture was wiped off with corrugated card board. To eradicate the fungus, the specimens were placed in a deep freezer after they had dried (Tesfaye Abebe, 2006). A plant taxonomist, my adviser Dr. Getachew W/michael from the Department of Biology's Nekemte campus made the identification. The Wallaga University Herbarium received the conserved voucher specimens.

3.2.5. Data Analysis Methods

The collected ethnobotanical data was examined using the survey and analytical methods for ethnobotanical approaches, as recommended by the WHO (2003). The data was analyzed using descriptive statistics, fidelity level, informant consent factor, preference ranking and direct matrix rank.

3.2.5.1. Descriptive statistics methods

The data collected from respondents were analyzed and summarized using descriptive statistics such as frequency and percentage.

3.2.5.2. Preference Ranking

The best forage types for honey bees in the research district were chosen using preference ranking. Using chosen key informants, preference ranking was carried out for the most preferred bee forage plants based on two factors: the quantity of blooms per plant and the degree of honey bee attraction (Martin, 1995). These plants were presented to ten of key informants to identify most preferred honey bee flora. They were oriented to give the highest number to the most preferred plants. In this case 5 was given to the best preferred species. Scores given by all informants were added and the value sum up then ranked.

3.2.5.3. Informant consent factor

Using the formula $ICF = (nuc - ns) / (nuc - 1)$, where nuc = number of use citations and ns = number of species utilized for each use citation, the ICF was computed to determine the agreement of informants for a plant species in treating a certain ailment in accordance with Heinrich et al (1998).

3.2.5.4. Fidelity Level (FL)

The Fidelity Level (FL) index was calculated based on the formula recommended by Friedman *et al.* (1986) which is used to quantify the importance of a given species for a particular purpose in a given cultural group or to determine the most preferred plants for a treatment of a particular disease and calculated as $FL = TS / TF * 100$. Where, TS: Number of use-reports cited for a given species for a particular ailment TF: Total number of use-reports cited for any given species

3.2.5.5. Direct Matrix Ranking

Direct matrix ranking was done according to Martin (1995) to compare plant species for their multipurpose use. Ten multipurpose plant species were selected based on their highest use reported from the community and Ten use attributes were identified including Soil conservation, Soil Fertility Management, Shade, Fire Wood, Charcoal, hive building, Timber, Livestock Feed, smoke fuels and Food were listed. Key informants were told to give values or scores for the different uses

of a given plant species. The given values or scores were sum up and ranked. The values used for rank were: 5-best, 4-very good, 3-good, 2-less used, 1-least used and 0-no value.

4. RESULT AND DISCUSSION

4.1. RESULT

4.1.1. Honeybee flora species diversities

According to the study's findings, 65 plant species with a variety of habit and families were identified in Haro Limu district (5 Climbers, 14 Shrubs, 16 Herbs, and 30 Trees) (Table 2).

Table 2 List of Honeybee flora species recorded in the study area

Vernacular Name	Correct Scientific Name with Author	Family Name	Plant Habit	Flowering Time	Category
Abayii	<i>Maesa lanceolata</i> Forssk.	Myrsinaceae	Tree	Jan–Mar	Major
Ancabbii	<i>Ocimum lamiifolium</i> Hochst. ex Benth.	Lamiaceae	Herb	Sep–Nov	Major
Ancootee	<i>Coccinia abyssinica</i> (Lam.) Cogn.	Cucurbitaceae	Climber	Jun–Aug	Major
Andoodee	<i>Phytolacca dodecandra</i> L'Hér.	Phytolaccaceae	Climber	Sep–Nov	Minor
Anfaarree	<i>Buddleja polystachya</i> Fresen.	Loganiaceae	Tree	Jan–Mar	Major
Arbuu	<i>Ficus sur</i> Forssk.	Moraceae	Tree	Sep–Dec	Major
Atara	<i>Pisum sativum</i> L.	Fabaceae	Herb	Aug–Oct	Minor
Avokaadoo	<i>Persea americana</i> Mill.	Lauraceae	Tree	Sep–Dec	Major
Baaqelaa	<i>Vicia faba</i> L.	Fabaceae	Herb	Aug–Nov	Minor
Baargamoo adii	<i>Eucalyptus globulus</i> Labill.	Myrtaceae	Tree	Mar–Apr	Major
Baargamoo diimaa	<i>Eucalyptus camaldulensis</i> Dehnh.	Myrtaceae	Tree	Mar–Apr	Major
Baddeessaa	<i>Syzygium guineense</i> (Willd.) DC.	Myrtaceae	Tree	Aug–Dec	Major
Baggii	<i>Combretum paniculatum</i>	Combretaceae	Shrub	Sep–Nov	Major

	Vent.				
Bakkaniisa	<i>Croton macrostachyus</i> Hochst. ex Delile	Euphorbiaceae	Tree	Jun–Aug	Major
Birbirsa	<i>Podocarpus falcatus</i> (Thunb.) Mirb.	Podocarpaceae	Tree	Sep–Dec	Major
Boqqolloo	<i>Zea mays</i> L.	Poaceae	Herb	Jul–Oct	Minor
Buna	<i>Coffea arabica</i> L.	Rubiaceae	Tree	Mar–May	Major
Burtukaana	<i>Citrus aurantiifolia</i> (Christm.) Swingle	Rutaceae	Tree	Sep–Dec	Major
Ceekaaa	<i>Calpurnia aurea</i> (Aiton) Benth.	Fabaceae	Tree	Jul–Oct	Major
Cilaaddama	<i>Satureja paradoxa</i> Vahl	Lamiaceae	Herb	Sep–Oct	Minor
Dabaaqula	<i>Cucurbita pepo</i> L.	Cucurbitaceae	Climber	Sep–Nov	Minor
Dannisa	<i>Dombeya torrida</i> (J.F.Gmel.) P.Bamps	Sterculiaceae	Tree	Mar–May	Major
Dhummugaa	<i>Justicia schimperiana</i> (Hochst. ex Nees) T.Anderson	Acanthaceae	Shrub	Sep–Nov	Major
Dinnicha	<i>Solanum tuberosum</i> L.	Solanaceae	Herb	Sep–Oct	Minor
Ebicha	<i>Vernonia amygdalina</i> Delile	Asteraceae	Shrub	Dec–Feb	Major
Geeshoo	<i>Rhamnus prinoides</i> L’Hér.	Rhamnaceae	Tree	Sep–Nov	Major
Gatamaa	<i>Schefflera abyssinica</i> (Hochst. ex A.Rich.)	Araliaceae	Tree	Mar–May	Major

	Harms				
Giraaviliyaa	<i>Grevillea robusta</i> A.Cunn. ex R.Br.	Proteaceae	Tree	Mar–May	Minor
Goraa	<i>Rubus apetalus</i> Poir.	Rosaceae	Shrub	Sep–Nov	Major
Gurra hantuutaa	<i>Vigna vexillata</i> (L.) A.Rich.	Fabaceae	Climber	Mar–May	Minor
Hadaa	<i>Guizotia scabra</i> (Vis.) Chiov.	Asteraceae	Herb	Sep–Nov	Major
Hadheessa	<i>Teclea nobilis</i> Delile	Rutaceae	Tree	Mar–May	Major
Hagamsa	<i>Carissa spinarum</i> L.	Apocynaceae	Shrub	Dec–Feb	Major
Hanquu	<i>Embelia schimperi</i> Vatke	Myrsinaceae	Shrub	Mar–May	Major
Harangamaa	<i>Pterolobium stellatum</i> (Forssk.) Brenan	Fabaceae	Shrub	Sep–Dec	Major
Hidda fiitii	<i>Clematis simensis</i> Fresen.	Ranunculaceae	Climber	Jan–Mar	Major
Keelloo	<i>Bidens pachyloma</i> O.Hoffm.	Asteraceae	Herb	Oct–Nov	Major
Kombolcha	<i>Maytenus arbutifolia</i> (A.Rich.) Wilczek	Celastraceae	Tree	Mar–May	Major
Kosorruu	<i>Acanthus sennii</i> Chiov.	Acanthaceae	Shrub	Sep–Nov	Minor
Kusayee	<i>Lippia javanica</i> (Burm.f.) Spreng.	Verbenaceae	Herb	Sep–Nov	Major
Laaftoo	<i>Acacia abyssinica</i> Hochst. ex Benth.	Fabaceae	Tree	Mar–May	Major

Lolchisaa	<i>Bersama abyssinica</i> Fresen.	Francoaceae	Tree	Nov–Dec	Major
Maangoo	<i>Mangifera indica</i> L.	Anacardiaceae	Tree	Sep–Dec	Major
Meexxii	<i>Phoenix reclinata</i> Jacq.	Arecaceae	Shrub	Mar–Aug	Major
Misingaa	<i>Sorghum bicolor</i> (L.) Moench	Poaceae	Herb	Sep–Dec	Minor
Mossobila	<i>Ocimum sanctum</i> L.	Lamiaceae	Herb	Sep–Nov	Minor
Mukaarbaa	<i>Albizia gummifera</i> (J.F.Gmel.) C.A.Sm.	Fabaceae	Tree	Mar–May	Major
Muuzii	<i>Musa paradisiaca</i> L.	Musaceae	Shrub	Sep–Oct	Minor
Niimii	<i>Azadirachta indica</i> A.Juss.	Meliaceae	Tree	Dec–Jan	Major
Nuugii	<i>Guizotia abyssinica</i> (L.f.) Cass.	Asteraceae	Herb	Sep–Nov	Minor
Qilxuu	<i>Ficus vasta</i> Forssk.	Moraceae	Tree	Sep–Dec	Major
Qomonyoo	<i>Brucea antidysenterica</i> J.F.Mill.	Simaroubaceae	Tree	Jan–Mar	Major
Raafuu	<i>Brassica carinata</i> A.Braun	Brassicaceae	Herb	Jun–Nov	Minor
Reejjii	<i>Vernonia auriculifera</i> Hiern	Asteraceae	Shrub	Dec–Jan	Major
Saspaaniyaa	<i>Sesbania sesban</i> (L.) Merr.	Fabaceae	Tree	Jun–Aug	Minor
Somboo	<i>Ekebergia capensis</i> Sparrm.	Meliaceae	Tree	Sep–Nov	Major
Sookokkee	<i>Drynaria volkensii</i> Hieron.	Polypodiaceae	Shrub	Jan–Mar	Minor

Sooyoma	<i>Vernonia leopoldii</i> (Sch.Bip. ex Walp.) Vatke	Asteraceae	Herb	Jan–Mar	Major
Suufii	<i>Helianthus annuus</i> L.	Asteraceae	Herb	Sep–Nov	Minor
Tuufoo	<i>Guizotia scabra</i> (Vis.) Chiov.	Asteraceae	Herb	Nov–Dec	Major
Ulumayii	<i>Clausena anisata</i> (Willd.) Hook.f. ex Benth.	Rutaceae	Tree	Mar	Major
Urgeessaa	<i>Premna schimperi</i> Engl.	Lamiaceae	Shrub	Jan–Mar	Major
Waddeessa	<i>Cordia africana</i> Lam.	Boraginaceae	Tree	Jun–Nov	Major
Waleensuu	<i>Erythrina brucei</i> Schweinf.	Fabaceae	Tree	Mar–May	Minor
Zayituunaa	<i>Psidium guajava</i> L.	Myrtaceae	Shrub	Mar–Apr	Major

4.1.2.Honeybee Flora Composition

Table 3 indicates that the identified honeybee flora were distributed among several plant families with different levels of representation. Fabaceae was the dominant family, accounting for 9 species (14.1%), followed by Asteraceae with 7 species (10.9%). Lamiaceae and Myrtaceae each contributed 4 species (6.2%), while Rutaceae accounted for 3 species (4.7%). The remaining 38 species (57.9%) belonged to other plant families. The result shows that the study area has diverse honeybee flora composition with a wide distribution of plant families.

Table 3 Plant family Composition

Family Name	Frequency	Percentage (%)
Fabaceae	9	14.1
Asteraceae	7	10.9
Lamiaceae	4	6.2

Myrtaceae	4	6.2
Rutaceae	3	4.7
Others	38	58.5

4.1.3.Plant Habit Composition of Honeybee Flora in Haro Limu District

Table 4 presents the growth habits of honeybee flora species in Haro Limu District. The results show that trees were the most dominant plant habit, comprising 30 species (46.1%). Herbs followed with 16 species (24.6%), while shrubs accounted for 14 species (21.3%). Climbers were the least represented growth form, with 5 species (7%). Overall, the findings indicate that the honeybee flora of the study area is mainly composed of woody plants, particularly trees, suggesting their major importance in providing forage resources for honeybees in the district.

Table 4.The Habit of honey bee flora species in Haro limu District

Plant Habit	Number of Species	Percentage
Trees	30	46.1%
Herbs	16	24.6%
Shrubs	14	21.3%
Climbers	5	7%

4.1.4. Preference ranking of Major Honey Bee flora

The sample household responses indicate that honey bees visit almost all types of flowering plants in the vicinity of their colonies.

A variety of plants are used as food for bees. In these cases, local household respondents suggest which plant species they prefer depending on the number of flowers and the area flora's ability to attract honey bees. The study used preference ranking for ten chosen plants to examine the species value for bee foraging. The length of flowering periods, flower biomass, number of branches per

plant, number of flowers per branch, and honey bee attraction were also taken into consideration when selecting the plant species. At each study site, 10 of the sixteen primary bee floras that were discovered were placed in the top ten (Table 5).

Table 5 Preference ranking of Major Honey bee floras

Plant species	Rank per respondents											
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	Total	Rank
<i>Syzygium guineense</i>	7	7	7	6	6	7	5	4	7	6	69	1 st
<i>Albizia gummifera</i>	7	6	5	6	7	4	6	5	7	7	60	4 th
<i>Croton macrostachyus</i>	7	6	6	7	7	7	5	4	7	6	62	3 rd
<i>Guzotia scabra</i>	6	6	7	4	7	7	7	5	4	5	58	5 th
<i>Coffee Arabica</i>	5	3	4	3	5	5	4	4	5	2	44	7 th
<i>Vernonia amygedalina</i>	7	7	7	5	6	5	6	6	7	7	63	2 nd
<i>Schefflera abyssinica</i>	3	5	4	4	5	6	5	6	6	4	48	6 th
<i>Buddle japolystachya</i>	4	3	2	3	3	4	3	3	5	3	33	9 th
<i>Premna schimperi</i>	4	3	3	4	3	3	5	3	3	3	34	8 th
<i>Eucalyptus globulus</i>	3	2	3	1	3	1	2	3	3	2	23	10 th

4.1.5. Preference ranking of minor honey bee flora

Through group discussion, the preference ranking of minor bee flora for honey production was also identified. Ten of the thirty minor bee floras were ranked in the top ten (Table 6).

Table 6 Preference ranking of minor Honey bee floras

Plant species	Rank per respondents											
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	Total	Rank
<i>Brucea antidysenterica</i>	5	7	6	5	7	6	6	7	7	6	62	1 st
<i>Guitozia abyssinica</i>	7	6	2	5	3	4	4	7	7	5	50	6 th

<i>Zea mays</i>	6	7	7	7	3	6	6	7	7	4	60	2 nd
<i>Pisum sativum</i>	3	7	4	2	7	3	3	7	7	5	48	7 th
<i>Sorghum bicolor</i>	4	6	5	3	6	1	2	4	5	6	42	9 th
<i>Saturejaparadoxa</i>	5	7	6	4	7	6	5	7	7	5	59	3 rd
<i>Ficus vasta</i>	5	5	4	4	3	7	6	7	7	5	53	4 th
<i>Brassica Carinata</i>	2	4	3	5	2	2	1	2	1	5	27	10 th
<i>Ekebergia capensis</i>	4	6	2	4	3	6	5	7	7	5	47	8 th
<i>Helianthus annus</i>	5	7	4	3	4	6	3	7	7	5	51	5 th

4.1.5. Beekeeping activities in Haro Limu District area

Three types of beehives were used to generate honey by farmers in the research region; the majority of these hives were set up in backyards (Table 7).

Table 7 Type of beehives owned by sample respondents

Beehive types	Frequency	Percentage (%)
Traditional hive	203	52.2
Transitional hive	115	29.5
movable frame hives(Modern	71	18.3

4.1.7 Disease treatments by Honey Bee Flora

Focus group talks revealed 14 disease kinds that are treated with medicinal herbs related with honey bees. The Informant Consensus Factor (ICF), which shows the degree of agreement among informants on plant use, is displayed in Table 8 for each illness category. Values nearer 1 imply higher agreement to honey beeflora treat disease.

Table 8. Informant consensus factors (ICF) values of honey bee flora used to treat disease

Disease categories	Number of Species (ns)	Number of use reports (Nuc)	ICF
Skin cuts and wounds	8	84	0.09
Headache	5	57	0.03

Intestinal parasites	4	91	0.04
Constipation	4	36	0.1
Respiratory disease	2	22	0.09
Evil spirit	2	11	0.18
Bites	1	13	0.07

N.B: ICF= Informant consensus factors, Nuc = Number of use reports and Number of Species
Ns=Number of Species.

The degree of informant agreement regarding the medicinal significance of honey bee flora species in the Haro limu varied significantly, according to the fidelity level (FL) analysis. A number of species showed extremely high fidelity levels (FL = 100%), suggesting that responders were strongly in agreement regarding their particular therapeutic applications.

These include *Croton macrostachyus* (skin scrapes, wounds, and ringworm), *Vernonia amygdalina* (intestinal worms), *Eucalyptus camaldulensis* (cough), and *Ruta chalepensis* (abdominal pain), emphasising their cultural relevance and dependability in conventional medicine. The FL results show that while some species have strong, well-established medicinal value in the community, others are used more inconsistently, which reflects variations in local knowledge, accessibility, and perceived efficacy.

Table 9 Fidelity level (FL) values for some MPs function of Honey bee flora species

Plant species	Diseases	TF	TS	FL
<i>Acanthospermum hispidum</i>	Skin cuts and wounds	18	7	38.8
<i>numu sitatissimum L</i>	Wounds	12	5	41.6

<i>Musa paradisiac L</i>	Headache	21	11	19
<i>Ruta chalepensis L</i>	Abdominal pain	78	78	100
<i>Vernonia amygdalina</i>	Intestinal worms	52	52	100
<i>Phytolacca dodocandra</i>	Rabies	15	2	13
<i>Guitozia abyssinica</i>	Diarrhea& Cough	11	6	54
<i>Eucalyptus camaldulensi</i>	Cough	45	45	100
<i>Croton macrostachyus</i>	Skin cuts an, wounds& Ring worm	15	13	100
<i>Carica papaya</i>	Malaria	5	2	40
<i>Citrus aurantifolia</i>	Tonsil, measles	8	6	75
<i>Coffee Arabica</i>	Skin cuts , Diarrhea and wounds	22	17	77.2
<i>Cordia africana Lam</i>	Jaundices	13	11	84.6
<i>Cucurbita pepo L</i>	Tape worm	8	3	37.5
<i>Melia azedarach L</i>	Malaria	15	12	0.8
<i>Rhamnus prinoides L'Herit</i>	Scabies	16	11	68.7
<i>Vicia faba L</i>	Swell& headache	4	3	75

N.B: FL= Fidelity Level, SF= is the number of informants who independently cited the importance of a species for treating a particular disease, and TF= total number of citations.

4.1.8. Direct Matrix ranking of Honey bee flora uses

The results of the direct matrix ranking (DMR) exercise on seven multipurpose (MP) plants were used in this study to determine the type of multipurpose plant species that were under stress in the region as well as the associated cause endangering the base of resources. According to Table 10, *Cordia africana* was the most endangered MP honey bee flora species, followed by *Podocarpus falcatus*. According to the socioeconomic study participants, the community utilized the MP species in the study region for a variety of uses, such as Soil conservation, Soil Fertility Management, Shade, Fire Wood, Charcoal, hive building, Timber, Livestock Feed, smoke fuels and Food.

Table 10 Average DMR of Multipurpose functions of Honey Bee flora

Multipurpose	functions of Honey Bee flora
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honey bee flora Species	SF	F	C	SH	S	FW	TI	LF	HB	T	R
	H										
<i>Croton macrostachyus</i>	1	0	3	4	1	4	4	1	1	19	7 th
<i>Cordia Africana</i>	2	3	4	5	0	5	5	0	1	25	1 st
<i>Albizia gummifera</i>	3	0	1	2	0	4	3	0	1	14	10 th
<i>Podocarpus falcatus</i>	2	0	5	5	5	5	2	0	0	24	2 nd
<i>Acacia abyssinica</i>	3	4	2	2	0	4	2	0	1	18	8 th
<i>Calpurnia aurea</i>	2	0	1	3	1	5	0	0	1	13	9 th
<i>Eucalyptus globulus</i>	3	1	4	4	1	5	3	0	1	22	4 th
<i>Ekebergia capensis</i>	1	0	3	4	2	5	4	0	2	21	5 th
<i>Ficus sur</i>	2	0	4	4	0	5	4	0	1	20	6 th
<i>Syzygium guineense</i>	2	0	5	5	0	5	5	0	1	23	3 rd
Total	23	8	34	38	10	47	32	1	10	203	

Note: SC= Soil conservation, SF= Soil Fertility Management, Sh=Shade, FW=Fire Wood, T =total, R= Rank, CH= Charcoal, HB = hive building, Ti=Timber, LF= Livestock Feed and S=smoke fuels, F= Food , (5 = best, 4 = very good, 3 = good, 2 = less used, 1 = least used and 0 = no value)

4.1.9 Beekeeping constraints

Based on research area responses, the study found a number of significant environmental and management-related restrictions limiting honeybee productivity in the study region. According to the consensus, the two main limiting factors are exposure to agrochemicals and natural enemies (Table 11).

Table 11 The major constraints of beekeeping

Beekeeping constraints	Rank
Un-wise use of pesticides and herbicides	1 st
Natural enemies of Honeybees	2 nd
Lack of knowledge to manages honeybees and bees products	3 rd
Lack of bee colonies	4 th
Bee poisoning from plants	5 th

4.1.10. Honeybees' pests and predators and controlling mechanisms

4.1.10.1. Honeybees' pests and predators

The current study findings indicate that one of the biggest problems facing the honeybees and beekeepers in the study area was the presence of pests and predators. The most dangerous pests and predators that the beekeepers reported being present in their area include in Table 12.

Table 12 Pests and predators founds in Haro Limu district based on their importance.

pest and predator	frequency	Percentage (%)	Rank
Honey badger	151	40.1	1 st
Spider	123	31.6	2 nd
Birds	78	20	3 rd
Wax moth	18	4.6	5 th
Wasp	12	3.08	6 th
Lizard	5	1	7 th
Ant	20	5	4 th
Mice	2	0.5	8 th

4.1.10.2. Indigenous knowledge of beekeepers practiced on pests and predators controlling mechanisms

In the past, beekeepers employed various preventative techniques, but these methods were ineffective in completely eliminating these pests and predators; therefore, efficient preventive techniques must be developed in order to avoid them (Table 13).

Table 13 Pests and predators founds in Haro Limu& their traditional control mechanisms

pest and predator	Traditional controlling mechanisms
Honey badger	Utilizing "wormed" to kill, chasing dogs, enclosing the apiary site with a sturdy fence, and suspending hives from tall trees with rope
Spider	Keeping the hive stand clean at all times, taking down spider webs, and adding ash

Birds	Distancing the bee-eating birds by covering the hive entrance with plastic, mastic, or tallow.
Moth	Increasing colony strength, providing extra food, blocking hive entrance, and fumigating or smoking the hive.
Wasp	Tightening the hive entrance, clearing up wasp nests, and cleaning the apiary site
Mice	Cleaning apiary site, killing using cats,
Lizard	Extending the hive stand, attaching a smooth iron sheet on it, cleaning the apiary, and applying motor oil to the hives' legs.
Ant	Using materials such as tobacco, manure, grass, etc. to smoke or fumigate the hive strengthens the colonies and provides more food for the weaker ones.

4.1.11. Conservation practice and threats of honey bee flora

Deforestation has led to a decline in flowering plants, honeybee variety, and honeybee value. Because of this, the forest provides excellent supplies for beekeeping and honeybees throughout ecosystems. The study discovered that the of honey bee flora in the study area were under threat from a number of sources.

According to Table 14, the biggest threats are firewood (13.3%), deforestation (20.01%), and agricultural expansion (67.1%). The preservation of honey bee flora encompasses a range of practices designed to safeguard their populations and habitats. These practices consist of reducing pesticide application, encouraging community involvement, reforestation, and pest management.

Table 14 Priority ranking of factors perceived as threats to bee flora on the level of destructive effects

Threats of bee flora	No of Respondents n=389)	Percentage (%)	Rank
Agricultural expansion	261	67.1	1 st

deforestation	78	20.1	2 nd
Fire wood	52	13.3	3 rd
Timber wood	31	7.9	5 th
Charcoal	25	6.4	6 th
Over grazing	36	9.3	4 th
Pesticides	11	2.8	7 th

4.2. DISCUSSION

4.2.1. Honey Bee flora species diversities

The present study in Haro Limu District revealed a considerable diversity of honey bee forage plants, with a total of 65 species belonging to 40 families(Table 2). This high plant diversity indicates that the area provides a favorable ecological environment for apiculture and supports honey bee colonies throughout different seasons. Similar findings have been reported in other Ethiopian regions, where rich floral diversity has been associated with strong colony performance and improved honey production (Fichtl & Abebe Admasu, 1994; Befekadu Desalegn , 2001). The presence of both major and minor honey bee flora further suggests continuous availability of nectar and pollen sources, which is essential for sustaining colony growth and productivity. According to Amsalu Bezabeh (2004) and Admasu Addi *et al.* (2004), bee keepers who are familiar with the floral calendar find it easier to pick between different beekeeping tasks. There is a lot of potential for honey production in the study area.

November and December are the busiest months for honey collection, followed by March and April.

The strength of the bee colony is strongly correlated with the availability of bee flora, according to the beekeepers. Colonies that are blossoming in large quantities are less vulnerable to honey bee enemies. The availability and management of honey bee flora are important determinants of honey bee colony strength and honey production; claim (Bista and Shivakoti, 2001). According to Table 1, the majority of the bee floras in the study bloom mostly in September, October, and March. This indicates the peak of the honey flow in the Haro Limu district. Our analysis agreed with a previous study conducted in Ethiopia by (Fichtl and Admasu Addi, 1994). Furthermore, the blooming calendar helps identify periods of low forage for bees. As a result, the beekeepers mostly supply extra feed from mid-December to mid-January and then again from April to May (Table 2).

The dominance of Asteraceae and Fabaceae families, each contributing the highest number of species, highlights their ecological and apicultural importance in the study area. These plant families are widely recognized as key honey bee forage sources due to their high nectar and pollen productivity and extended flowering periods. Fabaceae species are particularly important for their nitrogen-fixing ability and prolonged blooming, while Asteraceae members are abundant and easily accessible to pollinators (Abrol, 2012). Their dominance in Haro Limu District therefore ensures reliable forage availability, contributing significantly to honey bee nutrition and honey yield potential.

Regarding growth form, trees constituted the largest proportion of bee forage plants, followed by herbs, shrubs, and climbers. The dominance of trees indicates their critical role in providing long-term and stable nectar and pollen resources, especially during dry seasons when herbaceous plants are scarce. Herbs and shrubs, on the other hand, contribute significantly during rainy seasons, ensuring seasonal continuity of floral resources. This complementary structure of vegetation supports uninterrupted bee foraging activity, which is essential for colony survival and honey

production stability. However, ongoing land-use change and deforestation could threaten this floral diversity, making conservation of key bee forage species necessary for sustainable apiculture development (Table 3).

According to the beekeepers, the number and frequency of bee visits to the blooms allow them to differentiate between the major and minor honey bee flora. When a large number of bees visited the blossoms, particularly in the morning and afternoon, significant honey bee flora was seen. On the other hand, flowers that are visited less frequently by honey bees are categorized as tiny (Table 4). It is easier for beekeepers to maintain their hives and decide when to harvest honey when they are aware of the names of the various kinds of bee flora .

4.2.2. Preference ranking of Major Honey Bee flora

The ranking of honeybee flora species in the study area was mainly based on beekeepers' indigenous knowledge and long-term observation of floral resource availability, which supports the argument that local ecological knowledge is a reliable approach for identifying important bee forage plants. This finding is consistent with Gichora (2003), who reported that native plant species often provide more stable, diverse, and continuous nectar and pollen sources compared to exotic species, thereby playing a crucial role in sustaining honeybee colonies. In the present study, highly ranked species such as *Syzygium guineense*, *Vernonia amygdalina*, and *Croton macrostachyus* were identified as key honey forage plants, which agrees with previous research indicating that these indigenous trees and shrubs are important contributors to honey production due to their extended flowering periods and high nectar availability in Ethiopian ecosystems. The dominance of native species further suggests that maintaining and conserving natural vegetation is essential for improving apicultural potential, as habitat loss and replacement of indigenous plants may directly reduce forage diversity and honey yield. Therefore, promoting the conservation and planting of high-ranked bee forage species is crucial for sustaining honeybee productivity and enhancing the overall apicultural development of the study area (Gichora, 2003).

4.2.3. Preference ranking of minor honey bee flora

The preference ranking of minor honeybee flora in the study area provides important insight into the proportional contribution of different plant species to honey production and colony maintenance. Although these species are categorized as minor sources of nectar and pollen, their cumulative ecological value is significant, particularly during periods when major forage plants are scarce. The variation in rankings among the ten respondents reflects differences in beekeepers' experiences and perceptions regarding the foraging importance of these plants, indicating that local ecological knowledge plays a key role in identifying functionally important bee forage species. This aligns with findings that minor floral resources, despite producing limited nectar individually, collectively support colony survival and productivity during dearth or transitional flowering periods (Gichora, 2003). Therefore, the ranking is grounded in beekeepers' firsthand knowledge of each plant's feeding potential and its contribution to sustaining honeybee colonies under variable environmental conditions. The results further emphasize the necessity of conserving and promoting highly ranked minor honeybee flora as part of a broader strategy to enhance forage diversity, stabilize colony performance, and improve apicultural productivity in the study area.

4.2.4. Beekeeping activities in Haro Limu District area

Three types of beehives traditional, transitional, and movable (modern) hives were commonly used by farmers in the study area, with most beekeepers placing their colonies in backyard apiaries. The findings indicate that traditional hives were the most widely used, followed by transitional and then movable hives, showing that beekeeping in the area is still largely dependent on outdated production systems. This reliance on traditional technology is associated with relatively low honey yield and limited colony management practices, which ultimately reduce overall apicultural productivity. The result is consistent with earlier studies conducted in different parts of Ethiopia, including central, southwestern, and northern regions, which also reported dominance of traditional beekeeping systems and gradual adoption of improved technologies (Kebede Debele, 2007; Nuru Adagba, 2007). These similarities suggest that despite the presence of improved hive technologies, adoption remains limited due to factors such as cost, lack of training, and management constraints, highlighting the need for targeted extension services and capacity building to enhance modern beekeeping practices and increase honey production.

4.2.5 Disease treatments by Honey Bee Flora

In Haro Limu, many traditional medicinal plants are used to heal a variety of human ailments, such as skin cuts and wounds, headaches, intestinal parasites, constipation, respiratory disease, evil spirits and bites, as Table 8 shows. However, there are no research studies for Haro Limu that explicitly establish the usage of "disease treatments by honeybee flora", which refers to the application of honey, bee pollen, or other bee products produced from local floral sources. There is probably some overlap if the term "honeybee flora" is used to refer to therapeutic plants that also serve as bee fodder, although there is still no detailed research article on this relationship (Table 8).

-FEDILITY----- TABLE 9

4.2.6. Direct Matrix ranking of Honey bee flora uses

The results of the current study showed that trees, shrubs, and herbs are important components of the agroforestry system in the study region. They perform several tasks in the systems (Table10). In addition to giving bees food, trees and shrubs help beekeepers by producing wood products and maintaining and improving the physical features of the study area, which is crucial for encouraging the growth of agricultural crops. This is consistent with previous research showing that multipurpose agroforestry species frequently play a key role in supporting family needs, agriculture, and beekeeping in smallholder farming systems (Gichora, 2003). The multipurpose trees listed by the respondents provide a variety of purposes, including medicinal purposes, charcoal production, hive construction, soil conservation, soil fertility management, shade, firewood, lumber, and animal feed. Certain species are highly ranked because of their dual significance to beekeepers and the larger community. Because they provide honey bees with an abundance of nectar and pollen, trees and shrubs have a major impact on colony productivity and honey supply. Nuru Adgaba (2007) revealed similar findings, emphasising that honeybee foraging behaviour and honey production capacity are strongly impacted by vegetative diversity and the availability of flowering plants.

4.2.7. Beekeeping constraints

The study's conclusions indicate those bee enemies, agrochemical-related bee poisoning, a lack of knowledge about managing bees and their products, a lack of bee colonies, and plant-related bee poisoning are the primary environmental barriers to beekeeping (Table 11). Each participant in the study was asked to rate the worth of their labor. Therefore, the most significant threat to beekeeping in the region is the inappropriate use of pesticides and herbicides, which is followed by honeybee adversaries (predators and pests). The results are fully broken down in Table 8. As mentioned before, these restrictions had a major impact on honeybees and hive products, as well as the financial health of the beekeeping business. According to Awraris Shunkute *et al.* (2012), in Ethiopia's Kaffa, Sheka, and Bench-Maji zones, the same result.

4.2.8.1. Honeybees' pests and predators and controlling mechanisms

The results of the current study show that the presence of pests and predators was one of the main issues that the honeybees and beekeepers in the study area had to deal with. The beekeepers identified the most threatening animals and pests in the area. The honey badger (*M. capensis*), spider (*Latrodectus mactan*), birds, lice (*Braulacoeca*), wax moth (*Galleria mellonella*), wasps (*Polistes fuscatus*), mice, and lizards were the most dangerous pests and predators, in order of importance (Table 10). Similar findings were found in reports from different parts of the country (Desalegn Begna, 2001; Kebede Debele, 2007; Belie, 2009; Chala Kinatiet *al.*, 2012; Awraris Shunkute *et al.*, 2012). According to this survey, 40.1% of respondents said they have seen honey badgers in the vicinity of their apiaries. Attacks by honey badgers were a notable problem in the region that led to the collapse of honeybee colonies. A large amount of honey and other hive products are lost or vanished as a result of this predator's attack. Although certain seldom found pests and predators in particular places were also listed, Table 12 covers the most prevalent pests and predators in the study area. The second and third most significant bee adversaries in the region, according to the respondents, were spider-eating birds (31.6 and 20%, respectively).

4.2.8.2 Indigenous knowledge of beekeepers practiced on pests and predators controlling mechanisms

Many preventative measures were used by beekeepers in the past, but they were not successful in getting rid of pests and predators entirely; consequently, effective preventative measures must be

created to stay clear of them. According to Table 13, most respondents who were asked how they traditionally dealt with pests and predators in their area stated that they tied thorny branches, used dogs, killed badgers with wotmad, hung hives on long trees with smooth bark that honey badgers cannot climb, fixed smooth iron sheets to the trunks of trees where hives are hung, and used ash to keep most common pests away from their hives. To protect their honeybees from pests and predators, beekeepers in the Oromia Region's Haro limu district used a variety of tactics. Similar results were corroborated by Abera Belay (2015).

Thus, the indigenous knowledge used by beekeepers in the research area is compiled in Table 10. Researchers must, however, validate this result scientifically if beekeepers are to benefit completely from this apiculture subsector.

4.2.9. Conservation practice and threats of honey bee flora

Because of agriculture, firewood, charcoal, harvesting methods, and construction, honeybee diversity, honeybee value, and flowering plants have all declined. Abebe Demissie (2001) asserts that both natural and man-made factors impact Ethiopia's biodiversity. In the Haro Limu District, the research region, this was accurate. Because of this, the forest provides excellent supplies for beekeeping and Thus, the sustainability of beekeeping and the value of its products depend on the forest being maintained (Mustafa Musiliyu *et al.*, 2015) honeybees throughout ecosystems. (Table 14) In the research area, farmers' agricultural fields are subject to certain conservation practices for a variety of uses, including firewood, building, medicine, and the trading of charcoal. In the *Coffea arabica* plantation, plants like *Croton macrostachyus* and *Accacia abyssinica* were preserved as coffee shade (Bahailu Etana, 2010). Additionally; some therapeutic plants are being conserved in private gardens. However, not every research location observes the action in the same way. In the house garden, *Coffea Arabica* and other plants were preserved.

5. CONCLUSION AND RECOMMENDATIONS

5.1 conclusion

The purpose of this study was to assess the flora that bees use as a honey source during major and minor honey harvesting seasons in the East Wallaga zone of the Harolimu districts in west Ethiopia. In each of the three kebeles, beekeepers cited common honey source floras such as *Vernonia Spp.*, *Coffee arabica*, and *Croton macrostachyus*. Ethiopia usually offers a diverse range of vegetation and honey bee habitats. Honey production, or beekeeping, is also seen as a resource-conserving and environmentally beneficial endeavor. It does not require more land. If frame hives, strict hive management, and regular hive inspections are used, honey can be produced year-round in an area with good apicultural practices. In order to establish carrying capacity, select the ideal location for their colony, and establish a suitable calendar for colony management, beekeepers must have a thorough understanding of bee forages and plants that yield honey.

5.2. Recommendations

- To take advantage of the area's potential for honey production in the Haro Limu district, beekeepers should adhere to the floral calendar of honeybee plants. It is necessary to use pollen analysis techniques to ascertain the botanical origin of honey.

- Because forests and protected areas have a good diversity of flora, beekeepers should use them for their operations.
- It is strongly advised that more research be done on the establishment of an ethnobotanical honey bee flora in the Haro Limu district for beekeeping.
- Both governmental and non-governmental organizations should educate the public about the elements that affect beekeeping.
- All members of the community must safeguard the deforestation of forests located across the Haro Limu District from human factors such as firewood gathering, overgrazing, and charcoal trading.
- The protection of Ethinobotanicals district Honey beeflora and all plants in their natural habitat must be supported and encouraged by the Haro Limu Woreda Administration Office.
- The primary threats to Ethinobotanicals Honeybee flora in the study area were found to be agricultural expansion, firewood collection, construction, overgrazing, overharvesting, and the trading of charcoal. As a result, the Woreda administration of Haro Limu should preserve the remaining deforestation forest in the study area.
- The local community must safeguard the indigenous knowledge from threats by passing it on to the following generation.
- The community of the study area must support and preserve the indigenous knowledge of the local peoples and the knowledge of traditional healers.

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APPENDICIES
APPENDIXI:
WALLAGA UNIVERSITY

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES,
DEPARTMENT OF BIOLOGY

Dear respondents;

This question prepared for Households of Haro limu district, Eastern Wollega Zone, Western Ethiopia. This questionnaire is designed for the purpose of research study. It's maintained is to gather data on Ethinobotanical study of Honey bee Flora diversity and uses at Haro limu district, and eastern Wallaga zone. The success of the study depends on your genuine response to those questions. Please, read carefully and respond to the questions honest and frankly. The help received from you were greatly acknowledged in the study.

Thank you in advance

PART I

General instruction:

➤ Please, do not write your name on the questionnaire

➤ Therefore tick for each question in the choice

Socio-economic characteristics of the respondent

1. Sex: Female ☐ Male ☐
2. Age: <30 ☐ 30 – 40 ☐ 41 – 50 ☐ >51 ☐
3. Educational level: Illiterate ☐ Read & Write ☐ 1-4 grades ☐
- 5 -8 grades ☐ 9-12 grade ☐

PART II: QUESTION PART

1. What is the level of deforestation on bee flora?

High ☐ medium ☐ low ☐

2. Is live stock contribution of bee flora deforestation?

Yes ☐ No ☐

3. What are the main commons for bee flora deforestation?

Ploughing ☐ over grazing ☐ charcoal ☐

4. Are there any constraints that affecting bee flora and its conservation?

Yes ☐ No ☐

5. If answer of Q4 yes list which constraints that affecting bee flora

6. Is there any bee flora conservation practices?

Yes ☐ No ☐

If answer of Q6 yes list which method of bee flora conservation practices are

PART III :CHECK LIST OF QUESTIONS FOR INFORMANTS

1. In your opinion what are the farmers' perceptions on bee flora deforestations and conservation practices?
2. In your opinion what are the factors that Affecting bee flora and Conservation Practices?
3. In your opinion what was the Major bee flora Conservation Practice Implemented by Farmers in the Study Area?
4. The purpose of 1 In Haro limu districts are there bee keeping management and its production in all kebele(area)? Yes_____ No_____
5. For question no.1 if your answer is yes what is important for favorable of availability?

6. Without any other additional job, is there a person who lives with only beekeeping and its production? Yes No
- 7 If your answer for question no.3 is yes how many of them are there? M_____ F_____ T_____
8. Beekeepers are what kind of hive they used? A) Traditional B) Modern C Both of them D) Transitional E) All
9. The hive they used serves for how many durations of time? A) If not full one year for how many months? _____ B) if full a year for how many years serves? _____
10. Their production averagely how many K.Gs got from each hives?
Traditional hive_____ Modern hive_____ If others _____
11. From these hives which one they used mostly? _____
12. They know which hive gives more and low production. Why they used a hive which gives lowest production? _____
13. In Haro limu districts the kind of honey produced is single or different kinds? Single different

PART IV QUESTION PART: SOCIO DEMOGRAPHIC RESPONDENTS

Table 15. Socio demographic respondents on Honey bee flora

Variable		Frequency (n)	Percentage (%)
Sex	Male	203	52.8
	Female	186	47.2
Age	15-23	39	10.02
	24-35	254	65.15
	> 36	96	24.6
Educational level	No primary	112	28.7
	completed primary	131	33.6
	Completed secondary	87	21.53
	Completed degree	59	15.1
Religion	Orthodox	93	23.9
	Protestant	212	54.4
	Muslim	84	4.6
Wealthy	Rich	18	2.604
	Medium	315	80.9
	Poor	56	14.3

PART V: HONEY BEEFLORA IMAGE







Figure 3. image of Honeybee flora in Haro limu District