

The Current Constraints and Opportunities of Beekeeping in Ethiopia: A Review

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Abstract: The goal of this article was to summarize beekeeping's constraints and potential in Ethiopia. Beekeeping techniques and some of the roles of this sector in Ethiopia's economy will be covered in this article. Ethiopia is one of the countries with a large honey-producing potential in Africa. Currently, there are three main classifications of the honey production system in Ethiopia; these are traditional (forest and backyard), transitional (intermediate) and modern (frame honeycomb) systems. Despite the challenges and limitations, Ethiopia has the largest bee population in Africa with more than 10 million bee colonies, of which 5-7.5 million are clustered together while the rest exist in a state of disrepair. wild Thai. The country has the potential to produce up to 500,000 tonnes of honey annually. But currently, the production is limited to 53,000 to 58,000 tons of honey. Ethiopia has an even greater potential than the current honey production due to its many bee sources such as natural forests with a complete bee system, water resources and a high number of existing bee colonies. Lack of a well-trained workforce, honey bee pests and diseases, high cost and limited availability of modern beekeeping equipment and inappropriate use of pesticides are some of the main constraints hindering the profession. Ethiopian beekeeping reaches its full production potential. Beekeeping plays an important role in increasing and diversifying the income of smallholder farmers in Ethiopia, especially those who have small plots of land and landless. To significantly improve the beekeeping sub-sector, the government and relevant development partners must collaborate to organize and promote forums on how to improve this industry and realize its full potential.

Keywords: Beekeeping, Honey, Hive, Constraints and Opportunity, Ethiopia

1. Introduction

Ethiopia is one of the African countries with a high potential for honey production. The country is home to a rich flora and has Africa's greatest honeybee population due to its unique ecological and climatic circumstances [1]. The country's large and diversified botanical resources, together with favorable weather conditions, make it ideal for beekeeping. Approximately 10 million honeybee colonies are there in the country, with roughly 7 million kept in beehives by farmers and the remainder living in the wild in the forests [2]. Because of its large number of colonies, it is Africa's biggest honey and beeswax producer [3].

Beekeeping is an important part of Ethiopia's agriculture and rural development programs. It helps to ensure nutritional, economic, and environmental security for rural populations at the household level. Honey can be used as a food, medicine, and a cash crop in both domestic and international markets [4]. According to this author, around 620,101 kg of honey was exported in 2010/2011, and the sale of honey generates an average of 420 million Ethiopian Birr per year. Beekeeping is a common activity among smallholder farmers and landless people since it does not require cultivated land, involves little investment, and yields immediate financial returns [5]. This sector has the potential to produce jobs for smallholders in both rural and urban parts of the country, by government strategy. According to

Teshome and Megerssa [6], beekeeping employs two million Ethiopians. As a result, the development of beekeeping techniques is now widely recognized as one of the best ways to improve society's livelihood.

According to various reports, Ethiopia has the potential to produce 500,000 tons of honey and 50,000 tons of beeswax. Nega and Eshete [7] reported Ethiopia's annual total honey output reached 53,000 tons, representing less than 10% of the potential, while the country produces 3,800 tons of beeswax annually. According to these sources, around 80% of the total honey produced is used for local brewing known as Tej (honey wine), with the remainder being marketed as table honey in the domestic market or exported. Michael [8] reported the country produces about 54,000 tons of honey each year. CSA [9] also reported that the current production is estimated to be 58,000 tons however, FAO [10] data shows, honey and beeswax output reached 53782 and 5,742 tons, respectively.

As various literature shows, even though the country has favorable environmental conditions for beekeeping, more opportunities, and a high potential for honey production, there are significant constraints that impede and keep this sector from realizing its potential for honey and beeswax production, earning foreign exchange, and providing income to smallholder beekeepers. As a result, there is a need to assess the constraints that are preventing this sector from reaching its full potential in the country. This document will aid in the development of a topic for improving honey production on a national or local level in general. Based on this, the objective of this paper is to determine the constraint and potential of beekeeping in Ethiopia.

2. Materials and Methods

This paper included a detailed evaluation of relevant information on beekeeping practices, as well as the constraints and opportunities that beekeeping presents in Ethiopia. Twenty-five more relevant papers were chosen

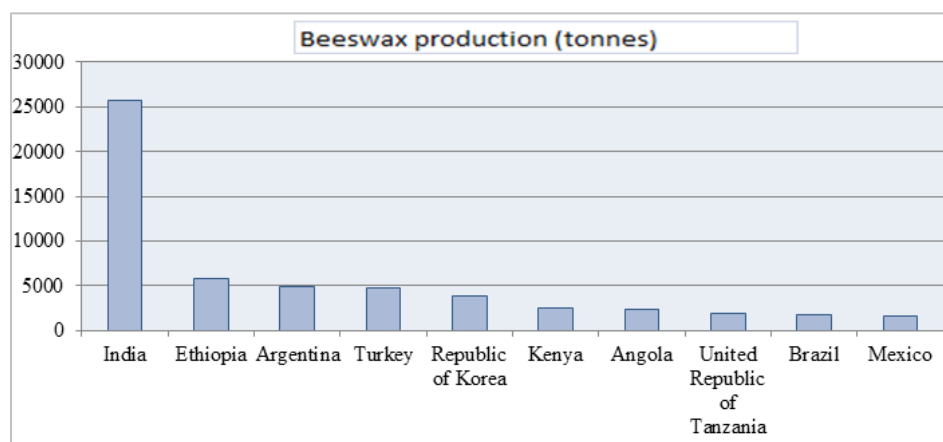
based on relevant information from over thirty-two publishes papers. International journals, study reports, and reviews on honey production were included in the literature review. Honey and beeswax production data was obtained from the Federal Democratic Republic of Ethiopia's Central Statistical Agency (CSA, 2018/19) and the UN's Food and Agriculture Organization database (FOA, 2019).

3. Literature Review

3.1. Economic Importance of Beekeeping in Ethiopia

Beekeeping has long been a part of Ethiopia's farming systems [11]. It is a tradition long before other farming systems. It's been a tradition for a long time before other farming systems existed. Around one million farmers are expected to maintain bees, which is a long-standing and widely held activity in rural areas across the country. Beekeeping has played and continues to play, an important part in both the country's national economy and the subsistence smallholder farmers' livelihoods [12]. The socio-economic impact of beekeeping and the main hive products and importance of beekeeping are summarized as follows:

Honey production: Honey, a natural product of the honeybee, is a good source of energy because it includes simple sugars that are ready for digestion as soon as they enter the intestine. Honey is in high demand on the local market since it is used to make the traditional beverage 'Tej' (honey mead). Much honey has traditionally been fermented in Ethiopia to make 'Tej.' According to Sahle et al. [1], 85% of the total honey estimated to be brought for the market is used for 'Tej' manufacture, with 15% of the total honey consumed at home. Furthermore, beekeepers are estimated to earn around 360-480 million Birr per year from the total honey produced in the country [4]. According to the report of FAO [10], from the 187 tons of honey exported about a 133 million ET Birr Per year was earned at a national level.



Source: FAO [9]

Figure 1. Top 10 beeswax production countries in the World 2019.

Beeswax production: Wax is largely used in the production of comb foundations, cosmetics, candles, ointment and cream,

varnishes and polishes, unique forms and surfaces for creative sculptures, and the fabrication of queen cups for the development and reproduction of bee colonies. In Ethiopia, traditional hives are used to collect wax rather than moving frame hives. Traditional hives' wax yield is estimated to be 8-10% of the honey yield, compared to 0.5- 2 percent for frame hives [13]. Nonetheless, it is estimated that a significant amount of beeswax is lost at various stages due to a lack of awareness of its marketability. The annual beeswax production of the country is estimated at 5790 tonnes and this makes the country is the second- largest beeswax producing country in the world after India [10]. According to this data, the yearly average value of beeswax exported is estimated to be over 325 tones, with a profit of around 560 million ETB (Figure 1).

Crop pollination: In the agricultural system, bees play a critical function. Although the importance of honeybees in agricultural pollination is underestimated, they play an important role in enhancing the national food supply and plant species regeneration. Honeybees are also thought to play an important part in Ethiopia's economy by providing pollination services. An experiment was done in Ethiopia to investigate the effect of pollination on Niger (*Guizotia abyssinica*), and the results revealed that honeybees increased Niger seed yield by about 43%. 37 and the onion (*Allume Cepa*) by a factor of two [3].

In addition to its economic relevance, beekeeping makes a major contribution to annual income supplementation. Farmers make money by selling hives or colonies, as well as honeybee products. Honey production and value addition to

honey products are essential to poor people's long-term survival. It also plays a role in providing employment opportunities for landless men and women, as it requires little cash to get started. It's also important to note that a large number of people (intermediaries and traders) are involved in honey harvesting and distribution (at the village, district, and zonal levels).

3.2. Beekeeping Practices in Ethiopia

Honey is produced in practically every region of Ethiopia, with different types of honey produced in different areas. The majority of honey produced in the country (92.80% of total honey produced) is produced by traditional beehives, which provide low yields and poor-quality honey. According to the result of the survey of CSA [9] revealed, from a total of 7.08 million hives estimated to be found in the country, the greater part (96.03%) is reported to be traditional.

Ethiopia has a vast natural resource base that allows for the production of honey and other hive products, and beekeeping is still practiced in most parts of the country by beekeeper households [5]. According to Kassa and Megerssa [6], bees are currently handled using three unique beekeeping practices: traditional, transitional, and modern hive systems. Each production system is classified according to the technologies used and the system's productivity potential. A brief explanation below indicates different productivity statuses, types of inputs used, and manageability of each system (Table 1).

Table 1. Number of beehives, honey production, and average frequency of honey harvests per year in Ethiopia.

Type of beehive	No. of Beehives	Amount of honey produced (kg)	The average frequency of harvests/year
Traditional bee- hives (Forest and backyard)	6794424.00	54367925.00	1.59
Intermediate/ transitional beehives	80164.00	951706.00	1.62
Modern bee- hives	200600.00	3268521.00	1.76
Total	7075188.00	58588152.00	1.60

Source: CSA [8].

3.2.1. Traditional (Forest and Backyard) System

Traditional beekeeping in Ethiopia's oldest and richest practice, having been practiced by the Ethiopian people for thousands of years. In every parts of the country, several million bee colonies are handled using the same old traditional beekeeping practices [14]. Hive is made of locally available materials such as tree logs, bamboo, woven grasses, and other natural elements. Beekeepers that are knowledgeable and skilled in using these hives could perform many operations with less equipment [13]. Forest beekeeping and backyard beekeeping are the two forms of traditional beekeeping practices. Forest beekeeping, in which some traditional beehives are hung from trees, is popular in different parts of the country, especially in the west and south. In most other parts of the country, backyard beekeeping is popular, with relatively better management.

The productivity of these hives is exceedingly poor, with an average yield of only 5-8 kg per colony per year, compared to 18-30 kg per year for improved hives (including

transitional hives) [14]. Traditional beehives are relatively difficult to manage than transitional and modern hives because of colony inspection for brood status (e.g., for infectious diseases), opening hives at night, not suitable for managed queen rearing, higher risk for a variety of bees, and a queen being killed during operations, and honey harvesting is more difficult. Furthermore, colony feeding during times of food scarcity is challenging, and determining the maturity of honey before harvesting is pretty difficult.

3.2.2. Transitional Beekeeping

Transitional beekeeping practice was first introduced into Ethiopia in 1976. It's a form of beekeeping activity that falls somewhere between traditional and modern beekeeping, and it's one of the better methods of beekeeping when compared to traditional methods [5]. Kenya Top Bar Hive (KTBH), Tanzania Top Bar Hive (TTBH), and mud-block hives are the three types of hives used in this method [2]. Because of its low cost and ease of construction, the KTBH has shown to be the most ideal. KTBH is well-known and widely used in

different parts of the country among these hives. An ideal condition, a top-bar hive can produce approximately 50 kg of honey per year, but in Ethiopia, the average amount of crude honey produced per hive per year is 9-13 kg [3].

Transitional (intermediate) beekeeping has several advantages, including the fact that it can be opened quickly and easily, that bees are guided into building parallel combs by following the line of the top bars, that the top bars are easily removable, allowing beekeepers to work quickly, that it is easier to construct than frames, and that honeycombs can be removed from the hive for harvesting without separating themselves from the hive [5]. This practice has its own set of drawbacks, such as the fact that top bar hives are more expensive than traditional hives, and that combs suspended from top bars are more likely to break off than combs built within frames [14].

3.2.3. Improved Beekeeping Practices

To provide optimal honey yield for a long time without damaging bees, modern beekeeping procedures are essential. The modern movable-frame hive is made up of properly built rectangular box hives placed one on top of the other in a tier, with the number of boxes varying depending on the size of the bee population and the season. Since 1970, around five different types of mobile frame hives have been introduced in Ethiopia [5]. The improved box hive has an advantage over the others in that it produces a high quality and quantity of honey and it is easy to manage the swarm by supervising the bees as they look for honeybee flowers and pollination services [11]. The downsides, on the other hand, are that the equipment is somewhat expensive, it requires experienced labor, and that it requires very specific precautions.

3.3. Constraints and Opportunity of Beekeeping in Ethiopia

3.3.1. Constraints of Beekeeping

In Ethiopia, the beekeeping sub-sector has some key challenges and constraints that must be solved if the full potential of apiculture is to be realized.

Honeybee pests, predators and disease: With the life of bees, the number of pests and predators is remarkable. According to a study conducted by Malede et al. [15] ants, insects, spiders, snakes, and lizards, wax moth (*Galleria mellonella*), bee-eater birds, bee lice (*Braula coecal*), honey badger (*Mellivora capensis*), monkey, and small hive beetles (*Aethina tumida*) cause devastating damage to honey bee colonies and products in a short time. Honey bees, on the other hand, can become affected by the disease, posing a major threat to honey bee production and productivity. Different authors investigated and reported on the existence of two adult honeybee illnesses, *Melipaphomoeba mellificae* and *Nosematosis*, as well as their distribution [12]. The most famous bee diseases in Ethiopia are *nosemosis*, *amoeba* and *chalk* [14].

Improper application of agrochemical inputs: The major three challenges affecting the beekeeping industry have been identified as pesticide poisoning, a lack of equipment, pests, and predators, with roughly three-quarters of beekeepers

losing their colonies owing to sprayed agrochemicals [16]. Improper pesticide use in crop production is a source of socio-economic conflict among farmers, and poisoning of honeybees by these chemicals has increased over time, with some beekeepers losing all of their colonies as a result of agrochemical use. According to a study conducted by Bizuayehu in the east and west Gojjam Zones of the Amhara Region, on average, 1,736, 4036, and 1,890 honeybee colonies die, abscond, and dwindle each year [17]. This suggests that the application of various insecticides on crops has a significant impact on beekeepers' bottom lines.

High cost and limited availability of improved technologies: The key issues influencing the promotion and development of honey production and marketing are reliance on traditional and low-technology input, poor pre- and post-harvest management, insufficient extension services, and a lack of marketing infrastructure. According to Seid and Solomon [13], introducing upgraded hives and working tools to the rural population is out of reach for most farmers and even for those who can afford it, it is not readily available. Some beekeepers, for example, have modern beehives (only boxes) but lack the instruments needed to properly manage them (such as a smoker, queen excluder, or honey extractor) [18]. In some parts of the country, modern beehives built by some private companies and co-operatives were built with the wrong dimensions and poor quality wood. As a result, honeybee migration in modern hives is extremely high [1].

Limited technical capacity: Limited technical capacity, such as a shortage of materials and the ability to construct improved beehives, inadequate hive management skills, limited know-how in regards to hive colonization, insufficient capacity for monitoring beehives for pests and illnesses, and limited capacity for developing solutions to problems such as additional feed and disease management, are all important challenges to the sector's development. One of the biggest concerns has been the occurrence of infections such as parasites, bacterial, and viral diseases. Furthermore, predators and the unrestricted use of pesticides and herbicides are two important difficulties that have an impact on the quality and wholesomeness of honey bee products. Moreover, understanding is scarce about how to mitigate and reduce the primary risks associated with apiculture, as well as how to manage them when they arise. Beekeepers that do have modern beehives lack the necessary skills and knowledge to effectively manage them, and training is not widely available. As a result, they frequently use poor extractive harvesting methods and tools that are inappropriate for this kind of hive. Moreover, during droughts, they rarely offer supplementary feed (water, sugar syrup, or flour) and have little awareness of existing honey-quality requirements in export markets [18].

Lack of financial resources (access to financial service): Access to financial services is one of the primary obstacles to increasing honey production. Poor financial access has been a major barrier to the development of industrial-scale production and the establishment of honey processing and packaging operations [19]. Beekeepers have limited access to

financial services that would allow them to upgrade from traditional beehives to better versions, making it difficult for them to buy modern beehives and other tools necessary to increase honey production. Most beekeepers do not have the financial means to upgrade to transitional and modern beehives; therefore they continue to produce honey using traditional methods [18].

Lack of standardization and quality management system: On the farm, there is a lack of standardization and quality management systems, which contributes to poor production, processing, packaging, and labeling. This is due to a lack of adequate laboratories and facilities for quality assessment. This has an impact on access to international markets, as well as the production and sale of honey on the domestic market and along the value chain [20]. In absence of support to address proper handling, packaging, and labeling, locally produced honey fails to command good market prices even though it is organic and free from human interferences, making it inherently a premium product attract to niche markets. Locally produced honey fails to attract excellent market pricing in the absence of support to meet proper handling, packaging, and labeling, although it is organic and lacks human interferences, making it naturally a premium commodity attracting to niche markets.

Limitation in business management: Most beekeepers consider beekeeping as a part-time business with low work requirements. One of the biggest issues that beekeepers face is managing and growing their businesses. The majority of profits are not re-invested in the business to increase production and improve quality standards. Processors, particularly large marketing agencies, demand an assured supply of a specific quantity and quality. As a result, beekeepers are unable to compete in competitive markets where their products could command a higher price. Beekeepers lack established commercial procedures, and there are few connections between smallholder, medium-scale, and large-scale producers and processors. Low production, poor yield, limited market access, low incomes, and under-utilization of beekeeping for wealth generation are the overall effects of the above issues [21].

3.3.2. Opportunities of Beekeeping in Ethiopia

There are tremendous opportunities in the honey industry for the improvement of the livelihoods of people in the country.

Diverse Agro-ecological conditions and flowering plants: The country's current various agro-ecological conditions are ideal for honey production. The favorable environmental conditions encourage the establishment of dense forests such as rainforests, dry deciduous forests, spiny woods, and other forms of flora that are conducive to beekeeping and honey production. There are also a lot of marginal lands, such as dry and semi-arid places, that can't support permanent or intense agriculture without a lot of money invested inland. Beehives could be placed in this area because the bees will not be relying on the land directly, but rather on the nectar flowers found in the marginal regions [11]. Ethiopia has

beekeeping potential due to the abundance of diverse plants and crops that provide nectar and pollen for honey bees. There are around 7000 varieties of flowering plants in the country that the bees feed on and collect crucial raw materials for making honey and other hive products [14].

Existence of strong bee colonies: Ethiopia's favorable climatic conditions and diversified floral resources support approximately 10 million honeybee colonies, of which 7 million are kept in local beehives by farmers and the rest remain in the wild in the forests [1]. Similarly, data on beehives acquired during the CSA [9] livestock survey revealed that there are an estimated 7.08 million hives in the country's rural areas. As a result, the country has the largest number of bee colonies in Africa.

Demand for the bee products and honeybee: The demand for bee products is expanding at an alarming rate both in the domestic and international markets. According to the healthy state of bees and the production of organic honey are in great demand [11]. Beekeeping is a low-impact activity that can be combined with other agricultural practices like crop production, animal husbandry, horticultural crops, and natural resource conservation [21]. As a result, it would be one of the most critical intervention areas for long-term growth.

Bee products are in high demand, and this trend is expected to continue. Honey has a lot of health benefits, so it's in great demand. Honey and its derivatives are commonly used inputs for cosmetics and medicine production and formulation; widely used inputs for cosmetics and drug manufacturing and formulation. Currently, approximately all of these industries' supplies come from imports because local suppliers do not meet the industry's quality standards. Import substitution presents a significant potential.

Presence of Indigenous knowledge and skills: The main areas of indigenous beekeeping knowledge are hive construction from locally available materials, swarm catching, hive fumigation, honey and swarming season identification, different medicinal values of honey, identification of important honeybee floras, and identification of adulterated honey [14]. This experience and pride in beekeeping may help to speed up adoption among new beneficiaries. According to research conducted by Dinku and Bereket in Hawassa city and Tsegayet in Wolaita and Dawro Zone beekeepers in Southeastern Ethiopia have good indigenous knowledge of traditional beekeeping [20, 22].

The presence of supporting organization: Various governmental and non-governmental organizations (NGOs) were active in beekeeping practice, for example, they provided financial credit, beehives, and bee equipment, and they gave short-term beekeeping training. Training has resulted in significant improvements in apiculture production. For the past ten years, new technologies, equipment production, and distribution, and institutional capacity building have been deployed. Training of extension workers and farmers in apiculture has also been prioritized for them to get better beekeeping knowledge and develop skills, allowing them to improve traditional beekeeping practices and increase honey and beeswax production [23].

By connecting them with local carpenters who make modern honeycombs, the government has intensified its focus on expanding the beekeeping sub-sector as one of its measures to alleviate poverty and diversify export products and establish commercial ties with end users, including international markets [24]. The government is currently promoting a self-governing basin development initiative that includes beekeeping. Modern, low-cost beehives are built using locally accessible materials, while an effort is made to organize farmers into groups and connect them with local carpenters who build modern hive. Recent public and private sector initiatives, as well as non-governmental organizations (NGOs), are pointing in the correct direction for developing the beekeeping sub-sector in order to maximize its potential and competitiveness. Introduction and promotion of innovative honeycomb methods for obtaining high quality honey for industrial processing [25].

4. Conclusion and Recommendations

The beekeeping sub-sector plays an important role in increasing and diversifying the income of subsistence Ethiopian smallholder farmers, particularly those with small plots of land and those who are landless. It also contributes a lot to the country's national economy. Apiculture has a lot of room for expansion; increases output to fulfill the ever-increasing demand for the product. The country's diversified agro ecological characteristics are ideal for honey production. However, other issues are impeding the sector's growth. Bees and other commercial insects have been killed as a result of the indiscriminate use of pesticides and insecticides. Bee mortality would have a significant impact not just on honey production, but also on crop yields and plant life that rely on pollination by bees. Production and processing equipment, as well as infrastructures such as transportation, clean water, communication systems, and buildings, are all required for a successful beekeeping business. However, the sector faces significant difficulties due to a shortage of or insufficient supply of these resources. Therefore;

1. It is important to harmonize policy and supportive structures at the regional and national levels to guide the development of the beekeeping sector.
2. To improve the productivity of this sector in the country, there is a need for effective and efficient organization, funding, research and development, extension program that are market-focused.
3. Conservation, protection, and maintaining the existing honey bee colonies for the future are very important.
4. Policy and regulations that are specifically designed for the beekeeping sub-sector, to regulate the use of pesticides and insecticides should be there and applicable.
5. Agrochemicals should be used in ways that do not harm bees.
6. The existing production techniques need to be diversified and improved to ensure proper beekeeping husbandry to reach optimal production capacity.

7. Training on beekeeping and its management (including pests and diseases management, bee forage development, colony management, honey harvesting, extraction, processing, etc should be undertaken.

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