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Review on the Assessment of Honey Production System, Constraints and Opportunities in Ethiopia

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Abstract: The paper assesses Ethiopia's honey production system, emphasizing its significant potential and rich beekeeping tradition. Many rural communities participate in beekeeping, primarily for honey and beeswax, which provide additional income. The honeybee species *Apis mellifera* is crucial to this practice, which encompasses traditional forest, traditional backyard, transitional and modern beekeeping methods. In the Oromia region, beekeeping contributes to cash income and nutrition for subsistence farmers. However, the sector faces multiple challenges, including a lack of knowledge, insufficient skilled labor and equipment, pest threats, poor infrastructure, limited forage and inadequate research and extension services. The paper advocates for initiatives to overcome these challenges and promote the development of beekeeping in Ethiopia.

Key words: Assessment · Beekeeping · Constraint · Opportunities · Ethiopia

INTRODUCTION

Beekeeping is an environmentally friendly and non-farm business activity that has an immense contribution to the economies of society and the national economy as a whole [1]. Beekeeping is a long-standing practice in the rural communities of Ethiopia and appears as an ancient history of the country [2]. Beekeeping in rural areas is an activity practised both by farmers and the landless rural population [1]. It is a non-farm income with specific importance to all those who do not have access to land, but some space in their backyard and communal areas [3]. In Ethiopia, beekeeping has been practiced for centuries and its potential is well documented [4]. Of all the countries in the world, no country has such a long tradition of beekeeping than Ethiopia [5].

Ethiopia boasts a long-standing and rich tradition of beekeeping that dates back to the reign of King Ezana in the 3rd century AD. At that time, beeswax was used for religious ceremonies, while honey was prized by the nobility and social elite for making traditional beverages. Over the years, honey has been considered a valuable commodity across different cultures, utilized for traditional rituals, medicinal purposes and as a food source [6].

Bees and their products are widely recognized and preferred by consumers in nearly every country. They play a crucial role in providing sustainable livelihoods for many small-scale farmers and individuals in both rural and non-rural areas [7].

In Ethiopia, ancient tradition for beekeeping stretches back into the millennia of the country's early history, which makes a difficult to establish a time reference when beekeeping was started [8].

Ethiopia has a longstanding beekeeping practice and endowed with huge apicultural resources and it has been an integral part of other agricultural activity, where about one million households keep honeybees [9].

Beekeeping directly contributes to the economy through the production of various outputs, including honey, beeswax, queen bees, bee colonies and additional

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products like pollen, royal jelly, bee venom and propolis, which are used in cosmetics and medicine [10, 11]. Ethiopia is a leading country in Africa and ninth in the world in honey production, respectively [9].

Similarly, it stands first in Africa and third in the world in beeswax production [12, 13]. Ethiopia has the potential to produce 500,000 tonnes of honey per year and 50,000 tonnes of beeswax per annual, but currently production is limited to 43,000 tonnes of honey and 3,000 tonnes of beeswax [14]. Honey and beeswax are primarily collected from October to December after the rainy season, with an additional minor harvesting period in May-June in the southern and eastern regions of Ethiopia [4]. In many regions of the country, beekeeping is considered as one of the income-generating activities for resource-poor farmers including women, youth and the unemployed sectors of the community [15].

The major honey and beeswax producing regions in Ethiopia are Oromia (41%), SNNPR (22%), Amhara (21%) and Tigray [16]. However, the country is suffering from the ecological degradation of its natural resources and this means the basis for any honey production is threatened and affected [4]. Ethiopia has a huge natural resource base for honey production and other hive products and beekeeping is traditionally a well-established household activity in almost all parts of the country [17]. Despite the favourable agro ecology for honey production and the number of bee colonies the country is endowed with, the level of honey production and productivity in the country remains low [18].

Despite Ethiopia's long tradition of beekeeping and its status as Africa's leading producer of honey and beeswax, the sector's contribution to GDP is disproportionately low compared to its potential. Productivity per bee colony and product quality remains inadequate, resulting in high domestic consumption and limited export earnings [19]. Hence, the beekeepers in particular and the country in general are not benefiting from the sub sector [20].

One of the prominent factors for this low honey and productivity is traditional hives [18]. Also, the other factor for low productivity is that the knowledge and skill of honey and beeswax production of Ethiopian farmers is still very traditional and 95% of beekeepers follow the traditional method of beekeeping practice with no improved techniques or technology [3]. Honey production from honeybees is very low, with an average of 5-6 kg per hive per year, while from the improved one average of 15-20 kg is even more possible [4]. These show that despite its long history, beekeeping in Ethiopia is still an undeveloped sector of agriculture [18].

Bee Keeping Production System in Ethiopia

Traditional Forest Beekeeping: Forest beekeeping entails placing hives in tall trees to attract swarms, often in regions with high honeybee populations. The advantages include reduced harm to domestic animals and ample forage for the bees. However, it poses challenges such as difficulties in hive monitoring, potential damage to colonies during honey harvesting and risks for beekeepers who must climb trees, especially at night. [21]. In Ethiopia, traditional beekeeping is the oldest and richest practice, which has been carried out by the people for thousands of years [8]. Several million bee colonies are managed with the same old traditional beekeeping methods in almost all parts of the country [22].

Traditional beekeeping in Ethiopia is primarily categorized into two types: forest beekeeping and backyard beekeeping. Forest beekeeping is common in the western and southern regions, where traditional hives are hung in trees. On the other hand, backyard beekeeping, which allows for better management practices, is more widely practiced in other parts of the country [23]. Traditional beekeeping primarily utilizes various types of traditional hives, with the simple cylindrical hive being the most common. These hives are known as fixed comb hives because the combs are securely attached to the hive's top and sides, making it difficult for beekeepers to remove or replace them [8].

Traditional Back Yard Beekeeping: It is undertaken in safeguarded area for honeybees mostly at homestead [8]. The advantages of traditional beekeeping practices include simple construction and the lack of need for advanced equipment or skilled labor. However, the disadvantages include challenges in conducting internal inspections and feeding, potential for swarming due to small hive size, inability to super and lack of partitions to separate brood and honey chambers [24].

Transitional System of Beekeeping: It is a type of beekeeping intermediate between traditional and modern beekeeping methods [8]. Transitional beekeeping methods, such as the Kenya Top Bar Hive (KTBH) and Tanzania Top Bar Hive (TTBH), utilize materials like timber and mud, featuring 27-30 top bars for comb attachment.

Benefits include easy management, guidance for parallel comb building, removable bars for efficient operation and reduced disturbance during honey harvests. These hives can also be suspended for pest protection. However, they come with higher costs than traditional hives and a greater risk of comb breakage [21].

The top-bar hive is designed as a single-story box with sloping sidewalls that form a 115-degree angle with the floor and includes fixed-width bars (32 mm) suitable for East African honeybees. Due to technical and economic limitations, many African countries are unable to use movable-frame hives, making the top-bar hive a viable alternative [25].

Modern (Frame-Hives) (Improved) System of Beekeeping: Modern beekeeping methods aim to obtain the maximum honey crop, season after season, without harming bees [25]. Ethiopia mainly uses Zandar and Langstroth hives for beekeeping, while Dadant, Modified Zandar and foam hives are less common. These hives differ in frame size and quantity, with Zandar being the most prevalent. Improved hives typically feature a brood chamber, honey chamber (super) and covers. Advantages of these improved hives include higher honey yield quality and better swarm control. However, they are relatively costly, require skilled labor and need specific maintenance precautions [21].

Modern movable-frame hives are made up of rectangular box hives stacked in tiers, with the number of boxes adjusted seasonally based on the bee population. This type of hive was invented by Lorenzo Lorraine Langstroth in 1851 in the USA [26, 27]. Various countries have developed their versions of movable-frame hives, such as Zander and Dadant, while Langstroth hives serve as the prototype. Langstroth hive boxes are widely recognized for their convenience in handling and management across many countries [8].

Economic Importance of Beekeeping in Ethiopia

Honey Production: Apiculture is a vital agricultural practice in Ethiopia, integrated into farming and providing additional income, especially for urban communities. It is prevalent in most villages and smallholder farms, except in areas with extreme climates. Honey, a key product, contains over 180 elements and has various uses [28].

About 1.8 million farmers are engaged in beekeeping activities with annual productivities of modern or box hives up to 50kg of honey [29]. There is a strong, local demand for honey, due to its use for the production of traditional beverage ‘Tej’ (honey mead) [8]. In Ethiopia, a significant portion of honey is used for the production of 'Tej,' a traditional fermented beverage, with 85% of honey brought to market allocated for this purpose. Only 15% of the total honey produced is consumed at home) [30].

Moreover, from the total honey produced in the country beekeepers are estimated to earn about 360-480 million Birr Per year [23]. The current annual honey production of Ethiopia is estimated to be about 43,373 tones [31]. This makes the country the leading honey producer in Africa and one of the ten largest honey-producing countries in the world [8].

Beeswax Production: In several regions of the country, beeswax collection is not significant and the beeswax produced by bees, which could be harvested by beekeepers, is wasted. The wax is mostly left or thrown away because beekeepers do not bother to collect it since it is of little practical value for beekeepers [32] and the people do not know the local beeswax is generating attractive money. Nevertheless, the annual beeswax production of the country is estimated at about 3,658 tones [31].

Ethiopia is the fourth largest producer of beeswax in the world, following China, Mexico and Turkey and is the third largest exporter in Africa. The beeswax industry significantly contributes to the national economy, generating approximately 125 million Birr in annual foreign exchange earnings [23].

Beeswax, similar to honey, is a versatile natural product used in the production of over 300 commodities. Both honey and beeswax hold significant cultural and religious importance in Ethiopian society [8]. The country sustains about 10 million bee colonies annually producing 50,000 and 3,500 tons of honey and beeswax, respectively [33].

Crop Pollination: Honeybees are crucial to agricultural systems, playing a significant yet often underestimated role in crop pollination, which enhances national food production and supports the regeneration of plant species. They are recognized as the primary pollinators globally [8]. Their service in pollination is estimated to be worth over 15 times the value of all hive products together, although it is much more difficult to quantify their benefit. The value of honeybee pollination to U.S. agriculture is estimated to be 14 billion U.S $ annually [24].

Honeybee is also believed to play a significant role in the economy of Ethiopia through pollination services. Pollination is one of the most important factors that affect seed production in crops [8]. In Ethiopia, an experiment

was conducted to determine the effect of pollination on Niger (Guizotia abyssinica) and the result showed that honeybees increased the seed yield of Niger by about 43% [34] and Onion (AllumeCepa) by two fold [35].

Source of Immediate Cash Income: Beekeeping is believed to play a significant role and one of the possible options to the smallholder farmers in order to sustain their livelihood [8]. In Tigray, the price of one established bee colony in a traditional hive ranged from 300-800 Birr, which was worth enough to buy about 3-5 sheep and goats or a heifer [23]. On the other hand, some beekeepers in Amhara region that are involved in beekeeping technology packages, were reported to earn up to 3000 birr annually from sale of honey making up for the large portion of their annual income [36].

Beekeeping has significant potential as a source of income diversification for rural communities. In the Jimma Zone of Oromia, beekeepers can earn up to 40,000 birr per year and in some tribes, the entire livelihood depends on honey sales [8].

Employment Opportunity: The exact number of people involved in Ethiopia's honey sub-sector is unclear, but it is estimated that approximately one million farm households practice beekeeping using various hive types. Additionally, many intermediaries and traders are engaged in honey collection and retailing at local levels [37]. Thousands of households are engaged in Tej-making in almost all urban areas, hundreds of processors are emerging and exporters are also flourishing [38].

Major Constraints of Beekeeping in Ethiopia

High Cost of Modern Bee Hives: In Ethiopia, many beekeeping tools, including modern hives, wax printers and honey extractors, are too expensive for farmers, with hives costing 900-1000 ETB, extractors ranging from 4,000-5,000 ETB and printers costing 5,000-6,000 ETB. This high cost results in a lack of proper technology for honey production and processing. Additionally, the absence of microfinance institutions restricts access to credit for farmers, preventing resource-poor beekeepers from improving their honey production capabilities [8].

Pests and Predators: The wax moth is a significant pest affecting honeybee colonies globally and is recognized as a serious local pest in Ethiopia. Investigations into its prevalence and impact on honeybees and their products have been conducted to better understand the problems it poses [39]. In Ethiopia, the ant species Dorylus fulvus is one of the most significant threats to honeybee colonies. It kills bees, steals their products and drives colonies away from their nests, leading to a decrease in honey production [39].

The small hive beetle, Aethina tumida Murray, a nest parasite of honeybees, (*Apis mellifera* L.) colonies native to sub-Saharan Africa [40]. Until 2006, there was no any report on its occurrences in association with local honeybees. The first hand report on the existences of this pest in the country came in 2006. The same source shows that external and internal inspections conducted on 427 bee colonies located in16 districts/places of South and Southwest parts of the country revealed six districts/places and 43 bee colonies positive to small hive beetle with the incidences ranging from 21%-66% [41].

Ethiopia, as one of the sub-tropical countries, the land is not only favourable to bees, but also for different kinds of honey bee pests and predators that are interacting with the life of honey bees [39]. Pests and predators cause serious, devastating damage to honey bee colonies within in short period and even overnight. The major bee pests and predators in the district were: wax moth, spider, ants, bee-eater birds, honey badger and beetles are the most serious problems to beekeeping development [8]. This result agrees with the report of, ants, honey badger, bee-eater birds, wax moth, spider and beetles were the most harmful pests and predators in order to decreasing importance of beekeeping in Amhara region [42].

Shortage of Flowering Plants: Deforestation in Ethiopia, caused by timber harvesting, construction, firewood collection and agricultural expansion, has led to a shortage of bee forage, particularly during the dry season. As a result, many beekeepers migrate their colonies to find better forage, which increases their costs due to labor and heightens the risk of colony loss from pests and predators [8].

The elimination of good nectar and pollen producing tree species in many areas make it difficult to maintain bee colonies without feeding [42]. Due to deforestation and poising of agro-chemicals, the honey bee population is in state of continues declining. As a result, it has become a serious challenge to get honey bee colonies to start and expand beekeeping [23]. Beekeeping sector is dependent on healthy flora and a healthy environment [8]. Recent years have seen environmental changes in Ethiopia in terms of erratic rain fall patterns and deforestation. If these problems worsen, the beekeeping sector could be affected [43].

Poisonous Plants: Several plant species are poisonous to honey bees. A recently emerged red color flower locally called Ababbo Diima [44] was reported to kill worker bees during their flowering stages. Plant species belonging to families of Ranunculaceae, Solanaceae, Acanthaceae, Euphorbiaceae and Phytolacaceae were reported to poisonous to bees [23].

Nectar and pollen from certain poisonous plants, including Cassia siamea, Croton macrostachyus, Aloe brahana, Zizyphus mucronata, Phytolacca dodecandra and Susbania species, are harmful to honeybees. Additionally, honey produced from these plants can be toxic to humans [45]. Similarly, honey from Datura arborea is reported to irritate human beings when eaten and Euphorbia cottinifolia is known to kill honeybees [46].

Diseases: In Ethiopia, the potential for beekeeping is significant, yet honey production and productivity remain low. One key factor contributing to this issue is the infestation of honeybee colonies by various diseases, which negatively impacts overall beekeeping productivity.

Chalk Brood Diseases: Chalkbrood is an infectious disease of honeybee larvae caused by a fungus Ascosphaera APIs, which causes death and mummification of sealed brood of honeybee with consequent weakness of the colony [47]. In Ethiopia the survey on chalkbrood diseases was started in the year of 2000 and the existence of the diseases was reported in 2001 around the Holeta research areas [39].

Survey on chalkbrood disease in Shoa and Arsi zones, reported an overall prevalence of 56.49%, with higher in west Shoa (24.5%) followed by Arsi (13.74) and lowest in East Shoa (7.63%) and North Shoa (9.92%) [21]. In Ethiopia the geographical distribution of chalkbrood diseases in honey bee were recorded [48].

The study found varying infection rates of chalkbrood disease in Ethiopia, with 37.12% in Amhara, 19.89% in Oromia and 17.93% in Benshangul-Gumuz. The research identified suitable ecological zones for these diseases as moist dega, moist weina-dega and wet weina-dega, while dry alpine, dry bereha and moist bereha areas are unsuitable. There is an unequal distribution of chalkbrood disease across the regions. Various bioclimatic factors, such as temperature and rainfall, were analyzed to understand the disease ecology [21].

Nosematosis: Nosema, caused by the fungi Nosema apis and Nosema ceranae, is a microsporidian disease that infects the intestinal tracts of adult bees. It has harmful effects on honey bees, negatively impacting colony development, queen performance and honey production [21]. In Ethiopia nosema was reported in low infestation rate in the survey conducted by the initiation of FAO [49].

Amoeba: Amoeba is a disease of the honey bee caused by a single-celled parasite called Malpighamoeba mellificae. The parasite affects the malpigian tubules of honey bees and shortens the life cycle of bees [21]. The diseases were reported in Ethiopia with a low infestation level in the survey made in the country initiated by FAO [49]. A survey conducted in the year of 2000, Amoeba was reported in South and South parts of the country [39].

The disease was also reported with a high prevalence rate in different regional states of Ethiopia, such as Oromia region with a prevalence rate (88%), Amhara region (95%) and 60 % in Benishangul-Gumuz [50]. A study from the Holeta research centre observed that amoeba cysts were present year-round in bee hives, irrespective of hive type. The highest intensity of cysts occurred in April and August, while the lowest was recorded in January [51].

Lack of Government Intervention: There is a widespread lack of knowledge about effective beekeeping practices among most beekeepers. This knowledge gap is worsened by the lack of higher educational institutions in the country that provide diploma or certificate programs specifically tailored to beekeeping. The only institution that offers any training is the Holeta Bee Research Center, which provides basic training to farmers, extension workers and experts. However, this training is inadequate to satisfy the growing demand for properly trained personnel in the region. As the economic potential of beekeeping becomes more recognized, it is essential to develop a well-trained workforce to enhance honey production and effectively manage beekeeping operations [8].

Lack of Skilled Man Power: Beekeeping in Ethiopia faces significant challenges due to a shortage of skilled manpower. Many beekeepers lack proper training in effective beekeeping techniques, which hinders their ability to manage hives effectively and maximize honey production. This lack of expertise is a persistent issue that continues to affect the beekeeping industry, limiting its growth and productivity. Adequate training in appropriate methods is necessary to improve the skills of beekeepers and enhance the overall performance of the sector [30].

Opportunities of Honey Bee Production: Owing to its varied ecological and climatic conditions, Ethiopia is home to some of the most diverse flora and fauna in Africa. Its forests and woodlands contain diverse plant species that provide surplus nectar and pollen to foraging bees [9].

Ethiopia's diverse climate and unique flowering plants make it highly suitable for beekeeping, supporting a large number of bee colonies and a long-established tradition of the practice [29]. The direct contribution of beekeeping includes the value of the outputs produced such as honey, bee wax, queen and bee colonies and other products such as pollen, royal jelly, bee venom and propolis in cosmetics and medicine [11]. Ethiopia's abundant forage and favorable agro-climatic conditions support over 7,000 species of flowering plants, facilitating the existence of more than two million local bee colonies in the country [8].

The density of hives occupied by the honeybees on the land may be the highest, at the present moment, of any country in the African continent [52]. In Ethiopia, beekeeping is an integral part of the life style of the farming communities and except for a few extreme areas, it is a common practice in every place where humankind has settled [8]. In addition, Ethiopia has probably the longest tradition of all the African countries in beeswax and honey marketing [38].

CONCLUSION AND RECOMMENDATIONS

Ethiopia has great potential for honey production, positioning beekeeping as a crucial component of its agricultural economy and a valuable income-generating activity for smallholder farmers. Various beekeeping systems, including traditional, backyard, transitional and modern methods, are employed, producing honey, beeswax, royal jelly and propolis, which enhance rural livelihoods. However, the sector faces significant challenges such as inadequate knowledge, a shortage of skilled labor, limited equipment, pest threats, poor infrastructure, lack of forage availability and insufficient research and extension services.

To address these issues, the paper recommends the following:

- Improving hive management
- Enhancing bee forage and nutrition
- Establishing collection centres and promoting strategies suitable for different production systems.
- Additionally, it emphasises the need to scientifically examine farmers' indigenous knowledge in beekeeping practices.

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