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Original Research

Opportunities and Challenges of apiculture development in Dembi Dollo Town, Western Ethiopia

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Abstract

The study aimed to assess beekeeping prospects and problems in Dembi Dollo town, using interviews, focus groups, and questionnaires. Four villages were selected based on beekeeping practices, and a cross-sectional research design was used to characterize beekeeper traits. Sixty-nine respondents were chosen proportionately from the four villages and Microsoft Office 2010 was used for data organization and analysis, with a one-way analysis of variance employed. Urban beekeeping is predominantly practiced by younger people, with 91.3% of 69 beekeepers being male and 8.7% female. 40.6% completed higher education, and 46.38% have been in the business for six to ten years. Advantages for urban beekeeping include suitable climate, availability of bee feed plants, adequate rainfall, water supply, and density of honey bees. Urban beekeeping faces challenges like beeswax, inappropriate agrochemical use, and high costs of modern hive equipment. Despite these, local communities and governments are promoting it. Governments should assist beekeepers, raise public awareness, and encourage hive provision. Further research is needed on urban honey bee productivity in western Oromia and the town.

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INTRODUCTION

The practice of raising, reproducing, and maintaining bee colonies in made-up nest boxes for commercial gain is known as apiculture (Akinmulewo et al., 2017). One of the most popular agricultural pursuits worldwide nowadays is beekeeping. Worldwide, there are about 56 million beehives and 1.2 million tonnes of honey produced by them (Ademuwagun, 2021). 54,000 metric tonnes of honey are produced annually in Ethiopia, making about 24% of the continent's total production at an estimated cost of 620 million Birr (Bareke & Addi, 2018). Ethiopia has a long history of beekeeping, and the country has abundant apicultural resources, especially in the west. Beekeeping may be one of the main areas of intervention to reduce food insecurity in the western region of Ethiopia, which is thought to have a varied range of cultivated crops and vegetation (Tadasse & Itefa, 2020).

Rural apiculture has been effectively used in projects aimed at reducing poverty, and it can be carried out by farmers in these areas as an extra source of revenue (Mazorodze, 2015). Because beekeeping helps impoverished households financially, nutritionally, and socially without requiring land ownership or significant capital outlays, it is frequently advocated in the context of rural development under such conditions (Kumar et al., 2018). However, rural areas are no longer the best places for pollinators, such honey bees, because of landscape homogeneity, habitat loss, and overuse of pesticides, all of which reduce the diversity of floral resources (Montagnana & de Oliveira, 2020).

Rehabilitating beekeeping resources in urban contexts has garnered interest. Globally, urban beekeeping is becoming more and more popular and is considered as one of the best ways to counteract the decline in bee populations. It is a well-known occurrence that is becoming more and more well-known. A long-term urban economy depends on beekeeping, which is supported by suitable development plans and policies in cities (Horst & Hoey, 2017). Moreover, because urban beekeepers have greater access to technology and medicine, they may be able to minimise the spread of diseases and pests by identifying them early and implementing appropriate best management practices (Bolshakova & Niño, 2018).

One of Ethiopia's major development priorities is apiculture development. The nation's rates of unemployment, poverty, and food insecurity have all gone up, especially in metropolitan areas. One potential remedy is beekeeping. The richness of urban bee flora and honey bee abundance, which are significant resource bases for prospective honey production in Ethiopia generally and in Dambi Dollo Town specifically, have not been documented in earlier studies on beekeeping in the nation. Investing in beekeeping is something that cities looking to prosper economically over the long run should think about. According to studies, urban bees outlive their rural counterparts in terms of longevity, honey production, and overall health. Research could not cover all aspects and areas to describe and document apiculture resources and associated constraints for proper intervention and utilisation, even though the Ethiopian government has given apiculture development due attention as a means of poverty reduction and national export diversification strategies (Chala et al., 2013). The amount of honey bees and the variety of flora in Dembi Dollo town have never been the subject of scientific study or documentation for the purpose of developing urban beekeeping. Thus, the goal of the current study was to evaluate Dembi Dollo town's urban apiculture prospects and challenges.

MATERIALS AND METHODS

The study area

The political and commercial hub of western Ethiopia, the Oromia Regional State, and the Kellem Wollega Zone is Dambi Dollo Town (Figure 1). The distance from Addis Ababa, the capital of Ethiopia, is roughly 642 kilometres. Sayo District and Kellem Wollega Zone both have their capital in this town. The town encompassed around 4350 hectares of land and had 37,339 residents, according to the CSA's 2007 population and housing

census (Dambi Dollo Municipal, 2011). Dambi Dollo Town is situated between latitudes 8˚ 30′ 07′ N and 8˚ 46′ 24′ N and longitudes 34˚ 50′ 00′ E and 34˚ 46′ 06’ E. The settlement of Dembi Dollo is encircled by many bodies of water. Laga Boorxaa to the west, Laga Loomee to the south, Laga Hidda to the east, and Laga Meexii to the north. The village of Dambi Dollo is suited for honey bee abundance and honey production capacity because of those sources of water. According to The Municipality of Dambi Dollo Town (2021), the town is bordered by Sayo District and a few peasant organisations, including Tabor in the south, Walgahi Gudina in the east, Ifa Tokuma, and Shogo in the west.

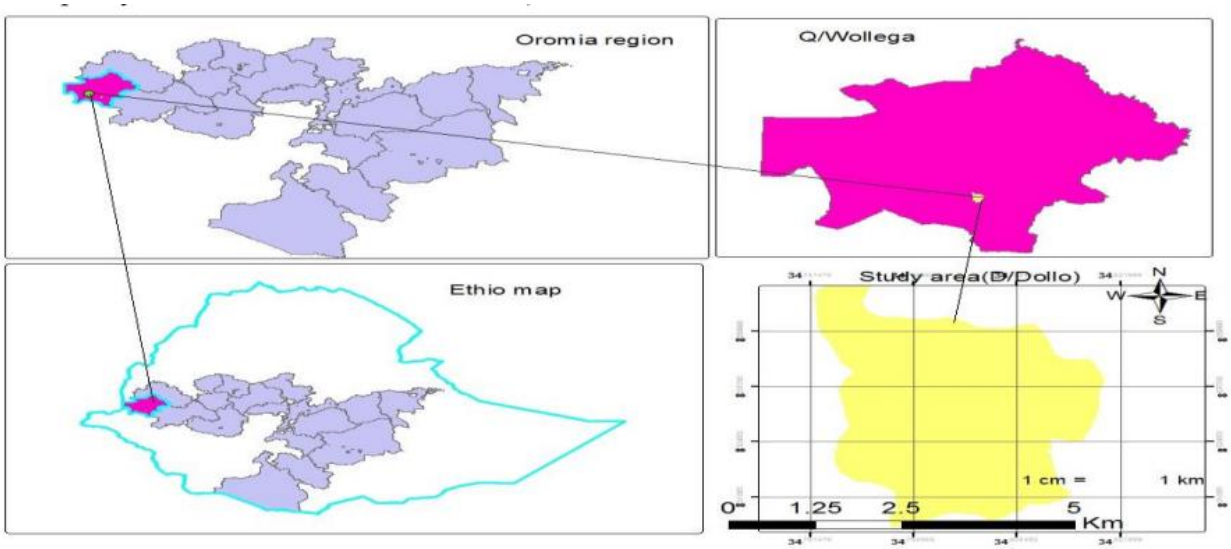

Figure 1 *Map of the study area and its location in Oromia and Ethiopia*

Study design and period

From June 2022 to December 2022, a community-based cross-sectional house-to-house survey was utilised to gather data during the busiest time for honey cropping. Pre-structured questioners and a visual inspection of the chosen apiaries were used in the survey. To determine the prospects and obstacles for urban beekeeping development in the research area, an interview and a pre-structured questionnaire were employed. Focus group discussions and key informants were also used.

Sample size determination and sampling technique

All four kebeles in the administration town were chosen for the study in order to gather information about the opportunities and difficulties of urban beekeeping in the area from beekeepers and all stakeholder groups present in Dambi Dollo town (Table 1). Out of the 83 beekeepers in the village of Dambi Dollo, 69 were chosen for this investigation. The beekeepers who were chosen were Ganda Biftu (21), Yabeloo (15), Dollo (20), and Lafto (13). Using the Yamane (1967) sampling formula with a 95 percent confidence level, the 69 beekeepers were chosen. Using the Yemane (1967) sampling

process, 69 apiculturists from four kebeles were chosen as the sample size from a total of 83 household apiculturists in the four kebeles.

To select sample size the following mathematical formula was used. $n = \frac{N}{1+N(e)^2}$

Where, N is the designates total number of beekeepers population household (hh) in Town, n represents the sample size, e is assumed to be represents maximum variability or margin of error 5% (0.05), 1 designates the probability of the event occurring.

$n = \frac{N}{1+N(e)^2} = n = \frac{N}{1+83\,(0.0025)} = n = \frac{83}{1.2075} =$ 68.73 ≈ 69 is the overall calculated sample size.

To select sample size from each Kebele the following mathematical formula was used:

$ni = \frac{nXNi}{N}$

N is the total apiculturists of selected four kebeles. Ni is the total bee keepers of each kebele. N is the total sample size of selected four kebele. Ni is the sample size selected from each kebele

Table 1

Number of beekeepers and sample size for the study

Kebele	Number of beekeepers	Sample size
Dollo	24	20
Laaftoo	16	13
Biiftuu	25	21
Yabeloo	18	15
Total	83	69

Method of Data Collection

A semi-structured questionnaire for beekeepers and key informant interviews (for other players) were used to gather primary data from the respondents. The town's Livestock and Fisheries department of the Urban Development Office provided secondary data, including restrictions, agro-ecology, topography, climate, and the kinds of hives that were available in the towns.

A group conversation involving apiculture professionals, developmental agents, and model beekeepers was convened to identify prospects for honeybee production in the research area.

Selected respondents were asked to participate in a household survey aimed at obtaining pertinent information regarding the study issues. The individuals that participated in beekeeping activities were the respondents. The first beekeeper households in the kebele were enumerated in order to choose the sample homes for the study. In light of this, 69 beekeeping homes in the community participated in the structured interview and questionnaire. The questionnaire, which was initially produced in English, translated into Afaan Oromoo, and then delivered, was semi-structured.

Key informant interviews were conducted with a number of individual beekeepers, development agents (DAs) in the study region, and beekeeping professionals in Dambi Dollo town. The data gathered from the household survey was cross-checked and supplemented with the qualitative information gathered during the interview. For this reason, participants in the key informant interview were chosen using the purposive sampling technique.

A conversation on beekeeping practices was held with a focus group of DAs, seasoned beekeepers, elders, and young and female village leaders in order to gather more information and improve the effectiveness and reliability of the main data collection. The main bee flora, beekeeping opportunities, potential, and constraints in each urban kebeles were all known. Each sampled kebele had a focus group with six individuals who were chosen by DAs in order to gather further information through conversation. Development agents assisted in the selection of the beekeepers who were known for their beekeeping performance and who were not included in the household survey for the focus group discussion. Therefore, the focus group discussion participants were chosen using the purposive sample method.

Data interpretation

For statistical analysis, the data were coded, input into a computer, verified, and executed in Microsoft Excel 2010 spreadsheets before being imported into SPSS version 21.0 software. The data were analysed using descriptive statistics like mean, standard deviation, frequency, percentage, and one-way ANOVA. Following the collection of the data, both qualitative (descriptive and reporting techniques) and quantitative (percentage, frequency, tabulation, and ratio) analysis and interpretation were performed. To compare the results, questionnaires were analysed using tables (frequency and percentage). Descriptive methods were used to analyse open-ended questions, observations, and interviews. The results of the study were then presented using words, tables, percentages, and graphs.

RESULTS

Socio-demographic characteristics

Of the 69 beekeepers that took part in the survey, 91.3% of the homes were headed by men and 8.7% by women. The mean age of the respondents was 47.7310.36, with the beekeepers ranging in age from 28 to 71 (Table 2). With 42.86% of the total, apiculturists in Biftu Kebele were mostly between the ages of 41 and 50. Nonetheless, 40% of beekeepers in the age range of 41 to 50 were from Dollo and Yabalo kebele; of these, 40% were more actively involved in beekeeping, and 38.6% were from Lafto kebele in the age range of 50 and above. With the exception of six respondents, every respondent claimed attending school, with Lafto Kebele topping the list with 61.54 percent of respondents reporting attending post-secondary education. In terms of urban beekeeping experience, Yabalo kebele ranked second with 73.33% within five to ten years, and Lafto kebele led with 76.92% with fewer than five years (Table 2).

Table 2

Socio-demographic characteristics of the respondents

Category	Variable	Study area								Overall (N=69)	
		Biftu (N = 21)		Dollo (N = 20)		Lafto (N = 13)		Yabalo (N= 15)			
		f	%	f	%	f	%	f	%	f	%
Sex	Male	21	100	19	95	13	100	10	66.67	63	91.3
	Female	0	0	1	5	0	0	5	33.33	6	8.7
	Total	21	100	20	100	13	100	15	100	69	100
Age (years)	20 to 30	1	4.76	0	0	2	15.38	0	0	3	4.35
	31 to 40	2	9.52	5	25	2	15.38	4	26.67	13	18.84
	41 to 50	9	42.86	8	40	4	30.77	6	40	27	39.13
	Above 50	9	42.86	7	35	5	38.46	5	33.33	26	37.68
	No formal education	1	4.76	2	10	0	0	3	20	6	8.7
Educational status	Elementary school	7	33.33	5	25	2	15.38	2	13.33	16	23.19
	Secondary school	4	19.05	6	30	3	23.08	5	33.33	18	26.09
	Above Secondary	9	42.86	7	35	8	61.54	5	33.33	29	42.03
Beekeeping experience (years)	<5	6	28.57	10	50	10	76.92	3	20	29	42.03
	6 to 10	11	52.38	8	40	2	15.38	11	73.33	32	46.38
	11 to 15	4	19.05	0	0	0	0	0	0	4	5.8
	>15	0	0	2	10	1	7.69	1	6.67	4	5.8

Major opportunities for urban apiculture development in Dambi Dollo town

The opportunities beekeepers reported for the development of urban apiculture in Dambi Dollo Town are depicted in Figure 2. These opportunities include adequate rainfall (92.75%), floral diversity of honey bees, water availability (78.26%), honey bee density (75.36%), access to modern bee equipment (72.46%), government support (69.57%), a suitable climate (66.67%), and skilled manpower (44.93%), in that order.

Additionally, the beekeepers stated that there was no local government organisation support.

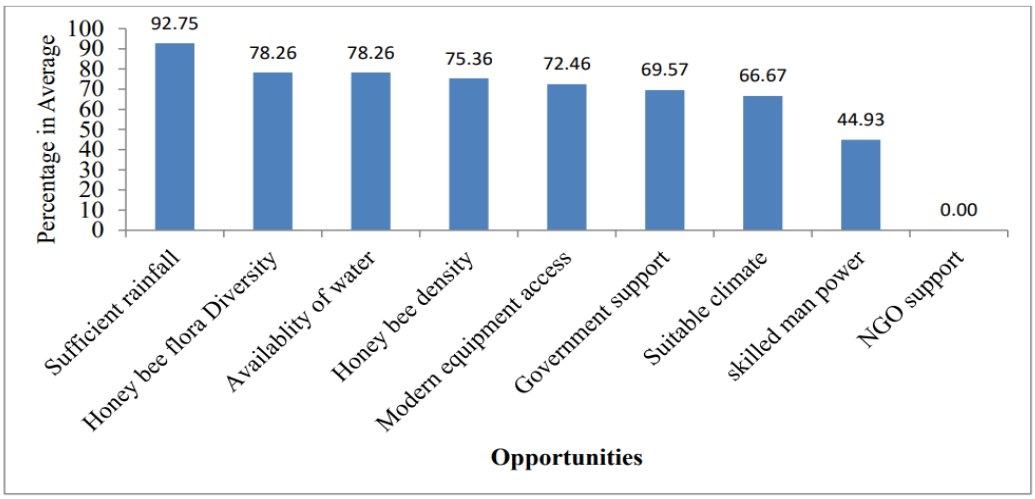

Figure 2 *The major opportunities of apiculture development in Dambi Dollo town*

Major challenges to urban apiculture development in Dambi Dollo Town

Numerous obstacles were impeding the advancement of metropolitan apiculture in the town of Dambi Dollo. Beekeepers cannot control environmental conditions, which are the main source of problems in beekeeping.

Consequently, every responder (100%) indicated that the primary obstacle preventing urban beekeeping from setting up new hives was beeswax.

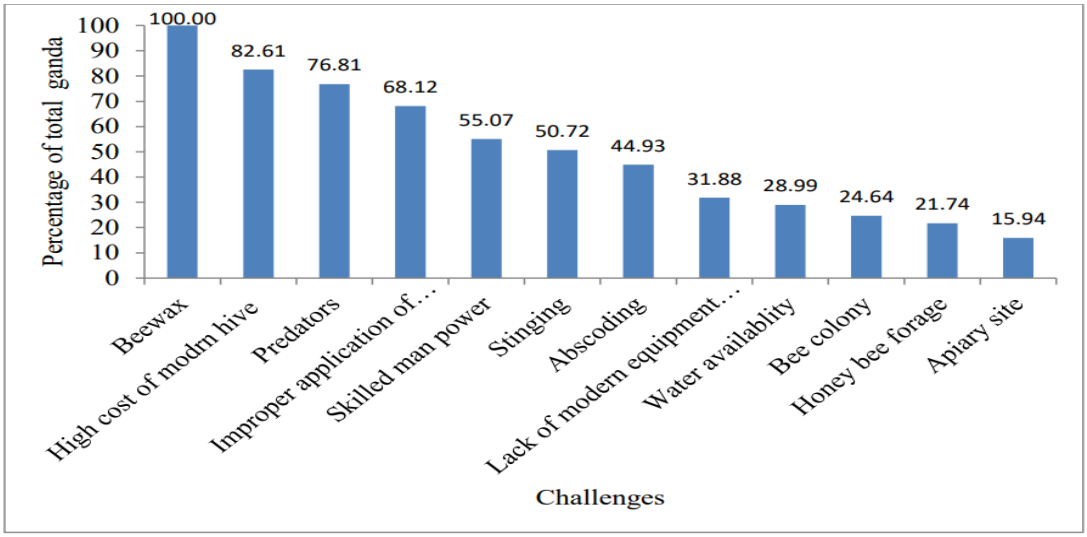

Figure 3 *The major challenges of apiculture development in Dambi Dollo Town*

Furthermore, over half of the participants indicated that finding competent workers posed an additional difficulty for beekeepers. In addition, the beekeepers faced difficulties related to predators (>60% each), incorrect pesticide application, and the high cost of contemporary hives and equipment (> 70%). Another difficulty was stinging, which was more common in Dolo (85%) than in Yabaloo (53.33%). Forage for honey bees and the availability of water, however, were not regarded as obstacles. However, the Laaftoo site posed the biggest impediment to absconding. Beeswax (100%), the high expense of contemporary hives (82.61%), predators (76.81%), incorrect agricultural application (68.12%), skilled labour (55.07%), and stinging (50.72%) were the main issues facing beekeepers (Figure 3).

DISCUSSION

Apiculture development opportunities in Dambi Dollo town

The findings highlight Dambi Dollo Town's abundance of opportunities and enormous potential for the growth of apiculture. The availability of rainfall, honeybee floral supplies, and a favourable environment are a few of the significant opportunities mentioned by the respondent. Due to the area's many potentials for the growth of urban beekeeping, there were numerous opportunities to raise the total production of beekeeping in Dambi Dollo Town. The following is a discussion of the main opportunities that the respondents reported.

Sufficient rainfall

About 94.20% of respondents in the study area reported that there was sufficient rain fall for urban beekeeping, and they raised it as a major opportunity for apiculture development in the area. These results would be expected because the western part of the country, including Dambi Dollo Town, is the evergreen and wettest part of the country and receives abundant annual rainfall (Tadasse & Itefa, 2020).

Honey bee flora diversity

It was found that one of the most significant indicators of the study area's potential for beekeeping was its vegetation. The study area's honeybee plants, which provide nectar and pollen, include trees, shrubs, herbs, and farmed crops, according to the survey's findings. A few significant honeybee plants in the research regions were identified using both common and scientific names along with their flowering times. There are many horticultural and field crops in the research region, such as avocado, mango, eucalyptus, coffee, and Vernonia spp. As a result, DDT contained a lot of bee flora.

Water availability

Honeybees require water to thin honey for feeding to larvae, cool the hive through evaporation, and indirectly obtain nectar and pollen from plants. Honeybees in the study region mostly drew their water from the neighbouring ponds and river, which they mostly used during the dry season. Along with the major streams and rivers in the area, the research area is also endowed with other smaller streams and rivers, such as Laga Borxa, Laga Hidda, and Laga Metti. Thus, bees always have access to enough drinking water. Beekeepers did not provide their bees access to water close to their apiaries.

Furthermore, 89.86% of respondents said that there was no shortage of water in the area, especially throughout the dry and wet seasons, which is one of the main times when beekeeping is allowed in Dambi Dollo Town. The results of Montagnana et al. (2020) on traditional management techniques and the production potential of beekeeping in the Erer Zone of Somali Regional State, Ethiopia, are in conflict with the results of this study.

Honey bee density

One of the main advantages of urban beekeeping for site assessments is the abundance of bee populations. In Dambi Dollo Town, there are roughly 980 hives, according to the Dambi Dollo Agriculture Livestock and Fisheries Resources Development Office (2022). Nonetheless, there is a good likelihood that 344 traditional, 100 transitional, and 312 modern bee colonies will become active beekeepers. The most obvious way for honey bees to reproduce is through swarming. About 75.36% of the 69 respondents in the study area had access to the density of honey bees.

Government support

According to key informants and focus group discussions, there was strong government backing in the research region for installing hives, installing honey extractors, and keeping an eye on the hives. In Dambi Dollo Town, beekeepers received a lot of counselling from agricultural office staff as well as developmental agents stationed in each kebele, with the goal of creating a conducive environment.

Suitable climate

One of the key elements influencing the honey bee and beekeeping businesses is the climate. Determining the ideal temperature is one of the most crucial steps towards making beekeeping and its products economically viable. It was not possible to create a uniform beekeeping calendar for the entire province because to the varying conditions. Furthermore, in order to raise their brood optimally and support the general fitness of the colony, these bees require significantly higher and consistent temperatures (90–95) and humidity levels (50–60). Anything outside of their ideal range will impede the proper upbringing of their brood. The results of Kassa et al. (2020) show that temperature and rainfall have the biggest effects on bees out of all the variables. It was also stated that the region's climate is favourable for the growth of apiculture.

Challenges hindering urban apiculture development in Dambi Dollo town

Abiotic and biotic variables abound that undermine the benefits of beekeeping. One of the most important abiotic elements is climate change. According to Bihonegn and Begna (2021), poor honeybee fodder availability, insufficient rainfall, pesticide poisoning, absconding, and a lack of honey storage facilities all had a negative impact on Ethiopia's honeybee productivity and production. Furthermore, according to Haftu (2015), the main obstacles to beekeeping in Ethiopia are a lack of trained labour, the high expense of bee hives, a lack of government support, a scarcity of bee feed, and pest and disease outbreaks among honey bees. In addition, it is clear that the main obstacles facing apiculture vary depending on the environment in which it is kept and the scale and kind of commercial ventures that are undertaken. Similar to the earlier-mentioned studies, beeswax, the high cost of

contemporary hives, bee predators, incorrect agricultural application, a shortage of qualified labour, and bee stinging were the main issues facing beekeepers in Dambi Dollo Town.

Shortage of bee wax in the study area

A hundred percent of the beekeepers who replied to the survey stated that there was not enough beeswax available in the study area to establish a new frame hive. Bee wax is another significant and vital product that honey bees can make in addition to honey. The growth of frame hive beekeeping in many Ethiopian locations has increased demand for wax, which is also greatly required by the global market. Because of the low trend in production, beeswax is substantially more expensive than honey, despite the huge demand. Because frame hive beekeepers in the research area have a high need for bee wax, they purchase it annually at a premium cost.

The high cost of a modern hive

The beekeepers who were interviewed frequently mentioned how expensive contemporary hives and their equipment are, making it unaffordable to purchase and operate this equipment. Furthermore, every apiculturist elucidated the limited availability of financing services that facilitate those beekeepers' investment in contemporary honey production. Due to their lack of resources, the majority of beekeepers were unable to purchase and implement contemporary bee technology to increase honey yield. They so mostly rely on beekeeping techniques that involve hanging on trees close to homesteads. This supports the findings of Taye and Marco (2014), who stated that one of the main obstacles to beekeeping is the high cost of contemporary hives. The interviewed beekeepers in Dambi Dollo Town responded that some bee equipment, such as modern bee hives, wax printers, and honey extractors, was very expensive, and thus beekeepers couldn't afford to buy and use this equipment. The current study is also consistent with Faji and Begna (2017), who reported that there is a scarcity of appropriate technologies for production, collection, processing, packing, and storage in the area. Because the majority of the beekeepers in the study area lacked resources, they were unable to purchase and implement modern bee technologies to increase honey yield. High cost and limited use of improved hive technological equipment are also two of the major challenges affecting urban apiculture promotion as well as potential production. As a result, small-scale urban beekeeper households were depending on traditional and backward beekeeping systems in the study area. Improved apiculture equipment's include box hives, casting molds, frame wires, queen excluders, honey extractors, and smokers are the major technological inputs. The high cost of beekeeping technologies and lack of access to finance were highly affecting the adoption of improved technologies for honey production in Ethiopia and warrant further research.

Pathogens, parasites, and predators

Viruses, bacteria, and fungi are just a few of the pathogens and parasites that can affect honeybee colonies and the products they produce. The dynamics of pollinator populations, both in the wild and under

control, are significantly influenced by natural enemies such as diseases, predators, and parasites. Numerous viral, fungal, and bacterial illnesses as well as infestations by different insect and mite parasites can damage bee species, particularly A. mellifera colonies. The natural enemies that pollinator populations have co-evolved with do not pose a threat to them. On the other hand, when wild populations are under stress due to environmental degradation, climate change, or a monoculture diet, negative consequences of natural enemies may occur. Yirga et al. (2012), who noted that bee pests, predators, and absconding are key restrictions affecting the beekeeping sub-sector in Ethiopia, provide support for the current study.

Improper use of agrochemicals

Exposure to agrochemicals hampered beekeeping and its output. By interfering with their neural activity—their moulting process or another particular metabolism—the agrochemicals are killing honeybees. Not only do deadly agrochemical occurrences impact pests, but they also have an impact on beneficial insects such as honeybees and their products. Farmers in Dambi Dollo town mostly grow maize, sorghum, potatoes, beans, and various horticulture crops. To control weeds and insect pests, they apply chemical sprays such herbicides and insecticides. The current study found that the majority of beekeepers in the mixed crop-livestock production system experienced a problem with pesticides and herbicides, which led to the death of honeybees and significant loss. This result is consistent with Kerealem's (2005) result. Apart from the careless application of agrochemicals, employing herbicides instead of manual weeding can also have detrimental effects on honeybee populations by destroying their food source.

Shortage of skilled manpower

Given the high population density of metropolitan areas and the sound of bees moving about apiaries in search of food and water to produce honey, human capital is an extremely important component of urban beekeeping. Twelve (17.39) urban beekeepers who are using antiquated management approaches or lack comprehensive skills are among the survey respondents. In particular, 44.93% (31) of beekeepers were monitoring their own hives for internal management (production and inspection), although the majority of them had professional assistance. The remaining 55.07% (38) beekeeping households relied on paid professionals to manage their hives because they lacked any skill at all. In terms of the source and accessibility of training for urban beekeeper households, 97.1% (67) said that neither government agencies nor non-governmental organisations have provided suitable training access to urban beekeeper households. Only two of the beekeepers who were chosen for interviews had access to proper beekeeping management training while pursuing their veterinary medicine degrees at a university.

CONCLUSIONS

According to reports, Dambi Dollo Town has significant potential for the development of urban beekeeping due to its favourable environment; abundant bee feed plants, ample rainfall, water supply, and high density of honey bees. The main obstacles were beeswax and honey bee diseases, parasites, and

predators; the high cost of contemporary hive equipment inputs; and inappropriate pesticide use. Urban beekeeping is receiving attention from the local community and government, despite its challenges. Thus, it is advised that the government help beekeepers obtain finance, raise public knowledge of the value of beekeeping, and encourage both governmental and non-governmental organisations to provide hives for beekeepers. Additionally, more investigation is needed into the productivity of urban honey bees in the town and throughout western Oromia.

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DECLARATION

There is no competing interest.

DATA AVAILABILITY

All necessary data are found from the corresponding author on request.

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