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Research Article

Assessment of Stingless Bee Production Potentials, Distribution, and Constraints in West Hararghe Zone, Oromia, Ethiopia

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Abstract

The study was proposed to assess the stingless bee production potentials, distribution, and constraints in West Hararghe Zone Oromia Regional State Ethiopia. A cross-sectional study design was used. A structured and semi-structured questionnaire was prepared and data were collected by using the purposive sampling method. A total of 80 respondents were interviewed and practical field investigations were conducted. According to the study results, about 59.26%, 100%, 77.78%, and 21.05% of respondents in Sire Gudo, Sire Qallo, Sire Qallo Gato, and Sire Qallo Haro Xaxe respectively get stingless bees suddenly without searching. As per the study's findings about 74.07%, 0%, 44.44% and 68.42% of respondents in Sire Gudo, Sire Qallo, Sire Qallo Gato and Sire Qallo Haro Xaxe kebeles reported that no management was given for stingless bee. According to the present findings about 51.85%, 0%, 22.22%, and 21.05% of respondents in Sire Gudo, Sire Qallo, Sire Qallo Gato and Sire Qallo Haro Xaxe kebeles reported that honey harvesting is the challenge of stingless bee production. In Gemechis district there was indigenous knowledge regarding stingless bee production, the searching method of stingless bees, honey harvesting from stingless bees, the use of stingless bees, and constraints/challenges of stingless bee production. The main challenge of stingless bee production in the study district was nest destruction during honey harvesting. In general, the overall stingless bee production in the study area was hopeful and to establish a sustainable stingless bee production, proper management and adaptation of stingless bees in artificial hive is essential. Once more, further study is required to study the production potential, of this bee in the rest part of the West Hararghe Zone.

Keywords

Indigenous Knowledge, Meliponini, Nest, Stingless Bee, Trigonini

1. Introduction

Stingless bees (Apidae: Meliponini) are one of the most diverse, attractive, appealing, conspicuous, and useful of all the insect groups of the tropical world [31]. Longer than Apis, the stinging honey bees, they have been on tropical earth for approximately 65 million years [14]. Stingless bees are the largest group of eusocial bees containing about 56 genera and more than 600 species are known to occur in various nesting ecological areas of the world [26]. The African stingless bee species comprises six genera. On the other hand, in Ethiopia, only six species of stingless bees have been

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identified [18]. Only Meliponula beccarii, among the species found in Ethiopia, is known to construct its nests underground [5]. Progress is hampered by our ignorance of the taxonomy and biology of stingless bees [18]. Stingless bee social organization is well-developed and equivalent to that of honeybees. They are 50 times more species-rich than the honey bees, the other tribe of highly eusocial bees. Similar to honey bees of the genus Apis, stingless bees live in colonies in a nest that stores honey and pollen. However, stingless bees have also been found in wall cavities, old trash cans, water meters, and storage drums [20]. Again, stingless bee species are typically found in Ethiopia's low to medium highlands. In central and western Oromia, stingless bees nest in a wide range of habitat types, particularly in cultivated lands next to protected woods, grasslands, and woody shrubs along field boundaries [6]. On the other hand, Stingless bees typically nest in hollow tree trunks, tree branches, underground cavities, or cracks in rocks. They are eusocial insects that are crucial to the pollination of plants, especially those in their native environments in the majority of tropical nations. Stingless bees are an ancient source of sweetness and medicine for many indigenous people in the tropics, from the nomadic hunters and gatherers [17].

Meliponiculture had issues with habitat destruction, a lack of expertise and extension services, a poor indigenous knowledge-sharing culture, and the use of agrochemicals. Honey badgers (Mellivora capensis) and birds posed a serious threat to unprotected nests as a result of honey hunting [11]. Several significant nesting tree species utilized by stingless bees are impacted by selective logging [15]. Many commercially harvested trees provide crucial nesting grounds for stingless bees and other pollinator insects in their natural environments. As a result, nests are commonly destroyed when trees are cut down for their timber, although less research has been done to estimate the damage brought on by logging [24]. Logging methods are endangering the existence of stingless bees by removing huge trees, which threatens many of the stingless bees' natural nests [10]. Stingless bee honey is a valuable natural product from a diverse group of highly eusocial bees. Honey is made by stingless bees using the nectar of flowering plants. Stingless bees make lumpy honey pots instead of the tidy, regular combs that honey bees use to store their honey. It is more difficult to harvest honey and other hive products than honey bees, even though they are less common. Their nests are typically in hollow trees or other cavities, the bees stockpile both honey and pollen in lumpy little pots fashioned from cerumen which is a mixture of beeswax and plant resins [33]. Honey is frequently collected from natural colonies in the forest. This often leads to the destruction of the nests, and often to that of the tree as well. When a beekeeper wants to remove the honey, traditionally, they open at the rear of the log or chamber and then perforate all honey pots, to allow the honey to drain and be collected. Here the honey passes through the garbage area of the colony and is contaminated. Also, this procedure causes a lot of damage to the colony, which loses several food pots and causes high mortality of adult bees and the loss of a great percentage of the laid eggs [9]. In Ethiopian farming communities, the practice of hunting honey from stingless bee colonies has a long history. Local hunters look for natural stingless bee nests, which is a common activity throughout the nation in general and in Oromia in particular [5]. The West Hararghe Zone is one of the country's areas that is stingless bee exist. However, the production potentials, distribution, constraints, local knowledge and management technique of this bee are not identified. Therefore, the current study was carried out to illustrate the information gap/farmer knowledge and put the general information for further studies.

So, the study was designed as followed to address the following objective:

Objective of the study

1. Identifying stingless bee (Meliponula sp) production potentials and their constraints in the study area.
2. To document local knowledge and management techniques of stingless bees (Meliponula sp) in the study area.

2. Literature Review

2.1. An Overview of the Stingless Bees

Stingless bees are by far the most diverse, morphologically and behaviorally, of the eusocial corbiculate bees (Apini, Bombini, and Meliponini). They are members of the Apidae family, which also includes bumble bees, carpenter bees, orchid bees, and common honey bees. The sting of stingless bees is atrophied and does not sting, in contrast to the ordinary honey bee Apis mellifera [29]. Meliponini and Trigonini are the two tribes of stingless bees (Subfamily Meliponinae) [30]. Trigona species, which do not have stings, are included in the Order Hymenoptera and Class Insecta. They are members of the Meliponini Tribe of the Family Aphidae. The Trigona genus of Stingless bees is the biggest and most common. Meliponini are widely distributed throughout the world's tropical and subtropical climates [26].

2.2. Description of Types of Stingless Bees and Their Habitats

The stingless bees have above- and below-ground nests. The stingless bees that build their nests above ground do so mostly in hollow tree trunks, other cavities, under the roofs of houses, and in abandoned log hives [18]. Stingless bees that build their nests underground with only the entrance visible do so. Therefore, we restricted our research to stingless bees that nest on the ground. According to the responses, ground-nesting stingless bees were widespread, and they routinely harvested their honey.

2.3. Distribution of Stingless Bees

The stingless honeybees (Apis mellifera), in contrast to honeybees (Apis mellifera), which are primarily domesticated, are wild. They store their honey in cerumen-based containers in the ground (for "Tazma" honey) or in tree trunks (for "Tinign" honey). By their inclinations, Tazma and Tinign honeybees, like stingless bees, could build their nests in the ground or tree trunks. Australia, Africa, Southeast Asia, South and Central America, and other tropical and subtropical regions of the planet are home to stingless bees [7].

They typically make their homes in hollow tree trunks, tree branches, subterranean chambers, or rock fissures. The world's tropical and southern subtropical regions are home to stingless bees [32]. Their nesting locations can include cracks in the ground, hollow trees, orifices in rocks, walls, or man-made structures, as well as the undersides of branches. Different stingless bee species, which are renowned for producing stingless bee honey annually, have a great chance of existing in Ethiopia. Stingless bees are widespread throughout Ethiopia at middle elevations up to 2300 meters above sea level. Stingless bees (Trigona spp.) are reported to nest in the ground and inside hollow trees in the Gedeo zone. The area's stingless bee population, which makes up 30% of the total, is noted for its higher productivity. Around 50% of the beekeepers in the Kaffa, Sheka, and Bench-Maji zones of Ethiopia have the opportunity to gather stingless bee honey each year, with an average harvest of 2 liters of honey per nest. Additionally, numerous Gojjam and Tigray regions are the primary habitats for these stingless bees [6].

2.4. Stingless Bee Species Diversity

The community structure parameter of species diversity includes species richness and abundance for taxa. There are six genera among the stingless bee species found in Africa: Cleptotrigona, Liotrigona, Hypotrigona, Dactylurina, Meliponula, and Plebeina. And it's conceivable that more species will be found in the nations of Sub-Saharan Africa [15]. The genus Meliponula, which has 9 species, has been found to have the highest species diversity among African stingless bees [17]. However, habitat loss for nesting and foraging for food is the main cause of the stingless bee population, and diversity declines globally [15]. Only six species of stingless bees have been identified in Ethiopia, which is most likely a significant undercount. These species include Meliponula beccarii, Liotrigona bottegoi, L. baleensis sp. nov., Hypotrigona gribodoi, H. ruspolii, and Plebeina armata [18]. Future studies are required to describe the diversity and distribution of stingless bee species in the study region, which includes Ethiopia and Africa. These discoveries are crucial for conservation efforts as well. Habitat degradation decreased the variety of stingless bees in a tropical rainforest in Kenya [22].

2.5. Significance of Stingless Bee

2.5.1. Medicinal Uses of Stingless Bee Honey

Small amounts of highly valued medicinal honey are generated by stingless bees, along with wax and propolis that are used for both domestic and therapeutic purposes. Apitherapy, a branch of traditional medicine that has recently emerged, provides treatments for numerous ailments based on honey and other bee products [4]. Stingless bee honey has a higher market demand and is 20 times more expensive than regular honey in India since it is thought to have medicinal potential [20]. In the treatment of diabetes, metabolic and neurological disorders, cancer, cardiovascular disease-related problems, hypercholesterolemia, and wound healing, stingless bee honey has biological and pharmacological activity [25]. Stingless bee honey has statistically resulted in a significant reduction in the number of episodes of oral mucositis, and bacterial and fungal infections [21]. In addition to curing asthma, arthritis, and hepatitis, it also treats bladder infection, improves brain function, treats cough, stomach disturbance, sore throats, and tonsillitis, and can be used in wound dressing. Numerous researchers have recently examined the use of this substance in the treatment of burns, gastrointestinal problems, respiratory ailments, infections and chronic wounds, skin ulcers, and cancer [30].

2.5.2. The Use of Products from Stingless Bees

The stingless bee honey was primarily consumed at home. In addition to being regarded as a nutritional supplement, honey was also used to treat a variety of illnesses, including tonsillitis, oral thrush, malaria, coughing, asthma, and (TB) Tuber Colossi [19]. To seal or fix fractured clay pots, plastic containers, and other household items, propolis was utilized. Stingless bee honey costs three times as much as honey from honey bees due to its medicinal and nutritional benefits and can be purchased for 150–200 (ETB) Ethiopian Birr as opposed to 60–78 ETB.

2.6. Threats to Stingless Bee

It is critical to comprehend how bee communities are being impacted by changes in land use. Anthropogenic influences and other natural forces such as climatic changes, are contributing to the current changes in diversity around the world [15]. The documented decline in bee species variety is largely attributed to habitat degradation. For example, beekeeping practices and honey hunting are significant contributors to habitat loss and forest fragmentation [23]. Grazing has been employed as a useful method for managing shrub and tree succession to promote the growth of nectar-rich plants and provide possible nesting sites. Grazing is prohibited in IFR. However, grazing can be harmful to the environment, destroying many bee nesting sites and reducing the amount of food available to stingless bees and other pollinators [19]. The ecosystem as a whole is badly impacted by this alternation that grazing animals might bring about for both plants and stingless bees [16]. Honey extraction from stingless bees is mostly harmful, as is the situation in many African nations [1]. In natural woods, many stingless bee nests are destroyed, resulting in the loss of numerous bee colonies [12]. Only a small number of tree species are thought to be impacted by hunting when it comes to nested trees. Stingless bee nest density and abundance in natural settings are impacted by the removal of possible nesting substrates [15]. Several significant nesting tree species utilized by stingless bees are impacted by selective logging [28]. Many commercially harvested trees provide crucial nesting grounds for stingless bees and other pollinator insects in their natural environments. As a result, nests are commonly destroyed when trees are cut down for their timber, even though less research has been done to estimate the damage brought on by logging. Logging methods are endangering the existence of stingless bees by removing huge trees, which threatens many of the stingless bees' natural nests [10]. Special habitats for nesting and bee foraging that are not given by the young trees are also disappearing. Commercialization of wood for timber led to a decrease in stingless bee nesting cavities in the South American Amazonian region [24]. Additionally, it has been observed to have an impact on colony reproductive division, and colony dispersal due to habitat fragmentation, and loss of suitable nesting areas [15]. Human disturbances in Malaysia's tropical rainforest had a favorable impact on stingless bee numbers as well as the density of huge trees [27].

3. Materials and Methods

3.1. Description of Study Area

The study was conducted in the Gemechis district of West Hararghe Zone, which was located in the eastern part of Ethiopia (figure 1).

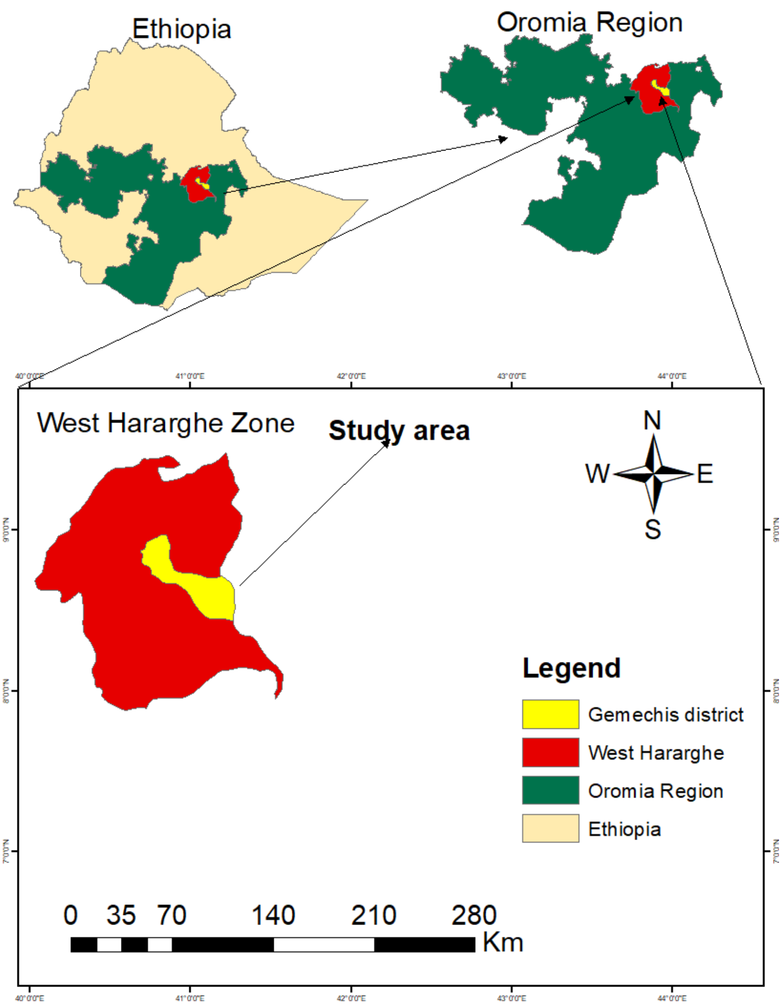

Figure 1. *Map of the study area.*

Gemechis district: -is one of the districts in West Hararghe Zone, Oromia National Regional State, Ethiopia. According to basic data from the West Hararghe Zone of Agriculture Office (2021), Gemechis district is one of the 14 districts in

West Hararghe Zone which is located 343 km east of Addis Ababa and about 17 km south of Chiro. Gemechis district covers an area of 77,785 hectares. The geographical location of the district lies between 8°10′N latitude and 40° 45′E longitude. The minimum and maximum temperatures of the district are 20–30 ℃, respectively with rainfall of 850–1000 mm. The agroecology of the district is 15% highland, 45% midland, and 40% lowland. The district is found at an altitude of 1300 to 2400 m above sea level with an average annual rainfall of 850 mm. It receives a bimodal rainfall where the short rain season is between March and April while the main rain is between July and September. The farming system of the district is categorized as a crop-livestock farming system.

3.2. Study Population and Design

The study population was represented by stingless bee owners in the study kebeles. The indigenous knowledge of the West Hararghe Zone regarding stingless bees' production potential was documented using a cross-sectional study design. In 2021, the study was carried out in the Gemechis district. Based on information previously obtained from district experts, development agents, and senior community members on the suitable locations for the production of stingless bees, we chose four (PAs) Peasant Associations from the district.

3.3. Sample Size Determination

The study involved 80 farmers who used stingless bees in their agricultural activities. Then, in each Peasant Association (PA), we discussed with elders and local authorities to find out who knew about the stingless bee. We then explained the study's objectives and got approval to speak with each of the 80 respondents. Before performing the actual survey, we gathered data from the Zonal and District of Agriculture offices. Finally, relevant data were collected from respondents.

3.4. Data Collection Techniques

A structured, semi-structured, and field inspection was utilized to gather information from stingless bee owners and experts. Four kebeles were selected by purposive sampling method based on having a stingless bee. The selected kebeles were Sire Gudo, Sire Qallo, Sire Qallo Gato, and Sire Qallo Haro Xaxe. On the same method, stingless bee owners were selected purposively. Before starting the activities, every respondent included in the study was briefed about the objective of the study. Then, information was collected from selected stingless bee owners using pre-test questionnaires. Finally, data like searching method, habitat, nesting status, indigenous knowledge and management technique, challenge/constraint of stingless bee raring, and honey harvesting during honey flow season were collected from respective kebeles.

3.5. Data Management and Analysis

The collected data were entered in the Ms-Excel spread worksheet, edited, cleaned, and imported into *the JMP* 17 version software package for analysis. Analyzed, categorical data were summarized with descriptive statistics such as percentages and the (X^2) Chi-square test.

4. Results and Discussions

The results of the present findings are discussed in the below table.

4.1. Methods of Searching Stingless Bee Nests

Table 1. *Methods of searching stingless bee nests.*

Searching stingless bee nests	Kebeles				Overall	X^2	P-value
	Sire Gudo	Sire Qallo	Sire Qallo Gato	Sire Qallo Haro Xaxe			
Suddenly without searching	16 (59.26)	7 (100)	21 (77.78)	4 (21.05)	48 (64.52)		
When the queen moves from place to place	3 (11.11)	0 (00)	2 (7.41)	1 (5.26)	6 (5.95)		
Suddenly & when the Queen moves from place to place	7 (25.93)	0 (00)	3 (11.11)	1 (5.26)	11 (10.58)	47.056	0.0001
Morning when it gets out & afternoon when it gets in	1 (3.7)	0 (00)	1 (3.7)	13 (68.42)	15 (18.96)		

Values before brackets are frequencies while those in brackets are percentages; X^2 = chi-square.

Table 1 Provides the searching methods of stingless bees nests in the study kebeles.

According to the present study, about 59.26%, 100%, 77.78%, and 21.05% of respondents in Sire Gudo, Sire Qallo, Sire Qallo Gato, and Sire Qallo Haro Xaxe kebeles respectively get stingless bee suddenly without searching. Stingless bees by accident when a farmer strolls through a forest, farm, or cornfield, and grazing [6]. Stingless bee owners in Sire Gudo, Sire Qallo, Sire Qallo Gato, and Sire Qallo Haro Xaxe respectively reported that, 11.11%, 0%, 7.41% and 5.26% get stingless bees when the queen moves from place to place. In the same ways about 25.93%, 0%, 11.11%, and 5.26% of respondents in Sire Gudo, Sire Qallo, Sire Qallo Gato, and Sire Qallo Haro Xaxe kebeles respectively get suddenly and when Queen move from place to place whereas 3.7%, 0%, 3.7%, and 68.42% of respondents explained that stingless bee gains in the morning when it get out and afternoon when it get in. Underground nests in the field, honey collectors used several methods, including directly observing nest entrances and worker bee movement, attaching a thread to the worker bee, and listening for the humming sound of the bee's natural enemy (wasp) [2]. The chi-square test indicated that the differences in getting stingless bees across kebeles were statistically significant (47.056), p-value = 0.0001).

4.2. Habitat of Stingless Bee

***Table 2**. Habitat of stingless bee.*

Kebeles							
Stingless bee habitat	**Sire Gudo**	**Sire Qallo**	**Sire Qallo Gato**	**Sire Qallo Haro Xaxe**	**Overall**	**X^2**	**P-value**
Farmland	24 (88.89)	7 (100)	21 (77.78)	12 (63.16)	64 (82.46)		
Farmland & rocky place	0 (00)	0 (00)	3 (11.11)	0 (00)	3 (2.78)		
Forest	0 (00)	0 (00)	0 (00)	4 (21.05)	4 (5.26)	32.558	0.0011
Forest and farmland	0 (00)	0 (00)	0 (00)	3 (15.79)	3 (3.95)		
Grazing land	3 (11.11)	0 (00)	3 (11.11)	0 (00)	6 (5.56)		

Table 2 illustrates the various habitats of stingless bees in all four kebeles.

A notable percentage of respondents in Sire Gudo, Sire Qallo, Sire Qallo Gato, and Sire Qallo Haro Xaxe kebeles reported that about 88.89%, 100%, 77.78%, and 63.16% respectively confirmed that, farmland is the main habitat of stingless bee. Stingless bee honey production in farmland areas was decreasing than in forest areas due to natural habitat losses [3]. On the other hand, stingless bee owners from Sire Gudo, Sire Qallo, Sire Qallo Gato, and Sire Qallo Haro Xaxe kebeles identified that around 11.11%, 0%, 11.11%, and 0% respectively reported that grazing land is the second habitat of stingless bee in all four study kebeles. Threats to stingless bees and honeybee species in African savanna ecosystems are mainly from habitat loss and predation [13]. The chi-square test indicated that the differences in the habitat of stingless bees across kebeles were statistically significant (32.558), p-value =0.0011).

4.3. Nesting Status of Stingless Bees

***Table 3**. Nesting status of stingless bees.*

Kebeles							
Nesting status	**Sire Gudo**	**Sire Qallo**	**Sire Qallo Gato**	**Sire Qallo Haro Xaxe**	**Overall**	**X^2**	**P-value**
Decreasing	10 (52.63)	7 (100)	11 (55.00)	7 (50.00)	28 (64.41)		
Increasing	9 (47.37)	0 (00)	0 (0.00)	7 (50.00)	16 (24.34)	33.506	0.001
Stable	0 (00)	0 (00)	9 (45.00)	0 (0.00)	9 (11.25)		

Table 3 presents the nesting status of stingless bees across four kebeles of the study areas.

Respondents in Sire Gudo, Sire Qallo, Sire Qallo Gato, and Sire Qallo Haro Xaxe kebeles confirmed that the nesting status of stingless bee decrease from 52.63%, 100%, 55.00%, and 50.00% respectively. According to respondents in Sire Gudo, Sire Qallo, Sire Qallo Gato and Sire Qallo Haro Xaxe kebeles the nesting status of stingless bee were increased by 47.37%, 0%, 0%, and 50% respectively. On the other hand, the nesting status of stingless bees in Sire Gudo, Sire Qallo, Sire Qallo Gato, and Sire Qallo Haro Xaxe kebeles were stable by the percentage of 0%, 0%, 45.00%, and 0% respectively. The chi-square test indicated that the nesting status of stingless bees across kebeles were statistically significant (33.506), p-value =0.001).

4.4. Management Technique of Stingless Bee

Table 4*. Management technique of stingless bee.*

Kebeles							
Management technique	**Sire Gudo**	**Sire Qallo**	**Sire Qallo Gato**	**Sire Qallo Haro Xaxe**	**Overall**	**X^2**	**P-value**
Clean around and keep human urine from it	1 (3.7)	7 (100)	10 (37.04)	1 (5.26)	19 (36.5)	34.983	0.001
Give feed and water	1 (3.7)	0 (00)	1 (3.7)	1 (5.26)	3 (3.17)		
Keep from flood, herbicide, and predator	5 (18.52)	0 (00)	4 (14.81)	4 (21.05)	13 (13.60)		
No management	20 (74.07)	0 (00)	12 (44.44)	13 (68.42)	45 (46.73)		

Table 4 presents the management technique of stingless bees across four study kebeles.

According to respondents in Sire Gudo, Sire Qallo, Sire Qallo Gato, and Sire Qallo Haro Xaxe kebeles, about 3.7%, 100%, 37.04%, and 5.26% percentages clean around and keep human urine from the stingless bee. About 3.7%, 0%, 3.7%, and 5.26% of respondents in Sire Gudo, Sire Qallo, Sire Qallo Gato, and Sire Qallo Haro Xaxe kebeles respectively give feed and water to stingless bees. In the same way, around 18.52%, 0%, 14.81%, and 21.05% of respondents in Sire Gudo, Sire Qallo, Sire Qallo Gato, and Sire Qallo Haro Xaxe kebeles, keep stingless bee from flood, herbicide, and predator. On the other hand, around 74.07%, 0%, 44.44%, and 68.42% did not give any management for stingless bees. The chi-square test indicated that the differences in the management technique of stingless bees across kebeles were statistically significant (34.983), p-value =0.001).

4.5. The Difference Between Stingless Bee and Honey Bee

Table 5*. Stingless bee differs from honey bee.*

Kebeles							
Stingless bee differs from honey bee	**Sire Gudo**	**Sire Qallo**	**Sire Qallo Gato**	**Sire Qallo Haro Xaxe**	**Overall**	**X^2**	**P-value**
It does not sting	17 (62.96)	0 (00)	7 (25.93)	3 (15.79)	27 (26.17)	25.647	0.0023
It's honey is so much smell	1 (3.7)	0 (00)	3 (11.11)	2 (10.53)	6 (6.34)		
Small in size	2 (7.41)	0 (00)	2 (7.41)	5 (26.32)	9 (10.29)		
It does not sting, small in size	7 (25.93)	7 (100)	15 (55.56)	9 (47.37)	38 (57.22)		

Table 5 Outlines the difference between stingless bees and honey bees across four study kebeles.

According to the present study about 62.96%, 0%, 25.93%, and 15.79% of respondents in Sire Gudo, Sire Qallo, Sire Qallo Gato and Sire Qallo Haro Xaxe kebeles explained that stingless bees did not sting. Stingless bee owners in Sire Gudo, Sire Qallo, Sire Qallo Gato, and Sire Qallo Haro Xaxe kebeles identified that, around 7.41%, 0%, 7.41%, and 26.32% respectively confirmed that stingless bees differ from the honey bee by having a small size. On the other hand, about 25.93%, 100%, 55.56%, and 47.37% respectively explained that stingless bees did not sting and were small in size relative to honey bees. The chi-square test indicated that there are significant (25.647), p-value = 0.0023) differences among stingless bees and honey bees across study kebeles.

4.6. Advantage of Stingless Bee

Table 6. *Advantage of stingless bee honey in the study area.*

Kebeles							
Advantage of stingless bee	**Sire Gudo**	**Sire Qallo**	**Sire Qallo Gato**	**Sire Qallo Haro Xaxe**	**Overall**	**X^2**	**P-value**
For medicine	24 (88.89)	7 (100)	21 (77.78)	13 (68.42)	65 (83.78)	4.916	0.1781
Medicine and food	3 (11.11)	0 (00)	6 (22.22)	6 (31.58)	15 (16.23)		

Table 6 presents the Advantages of stingless bees across four study kebeles.

According to the responses of the farmers interviewed, in Sire Gudo, Sire Qallo, Sire Qallo Gato, and Sire Qallo Haro Xaxe kebeles about 88.89%, 100%, 77.78%, and 68.42% respectively use stingless bee honey for medicinal purpose whereas around 11.11%, 0%, 22.22%, and 31.58% of respondents in Sire Gudo, Sire Qallo, Sire Qallo Gato and Sire Qallo Haro Xaxe kebeles respectively uses both for medicine and food purpose. Stingless bee honey was valued as a food supplement and also used for the treatment of different types of diseases like tuberculosis, coughing, malaria, constipation, asthma, tonsillitis, and oral thrush [2]. The results indicate that there is no statistically significant difference in the advantage of stingless bees among the surveyed kebeles (x^2=4.916, p=0.1781).

4.7. Challenge/Constraint of Stingless Bee

Table 7. *Challenge of stingless bees in the study area.*

Kebeles							
Challenge of stingless bee	**Sire Gudo**	**Sire Qallo**	**Sire Qallo Gato**	**Sire Qallo Haro Xaxe**	**Overall**	**X^2**	**P-value**
Honey harvesting	14 (51.85)	0 (00)	6 (22.22)	4 (21.05)	24 (23.78)	25.130	0.0028
Human Urine	2 (7.41)	0 (00)	8 (29.63)	0 (0.00)	10 (10.85)		
It is difficult to move from one place to another	4 (14.81)	1 (14.29)	5 (18.52)	5 (26.32)	15 (18.49)		
Predator, honey harvesting, and flooding	7 (25.93)	6 (85.71)	8 (29.63)	10 (52.63)	31 (48.475)		

Table 7 provides challenges of stingless bees across four study kebeles.

The present finding showed that about 51.85%, 0%, 22.22%, and 21.05% of respondents in Sire Gudo, Sire Qallo, Sire Qallo Gato, and Sire Qallo Haro Xaxe kebeles reported that honey harvesting is the challenge of stingless bee production. About 7.41%, 0%, 29.63%, and 0% of respondents in Sire Gudo, Sire Qallo, Sire Qallo Gato, and Sire Qallo Haro Xaxe kebeles explained that human urine is one of the challenges that affects stingless bee production. On the other hand, around 14.81%, 14.29%, 18.52%, and 26.32% of respondents in Sire Gudo, Sire Qallo, Sire Qallo Gato and Sire Qallo Haro Xaxe kebeles respectively confirmed that moving from place to place was the constraint of stingless bee production whereas around 25.93%, 85.71%, 29.63%, and 52.63% were predator, honey harvesting and flooding. The chi-square test indicated that there are significant (25.130), p-value = 0.0028) differences among challenges of stingless bees across study kebeles.

4.8. Tolerant to Disease and Pathogen

Table 8. *Tolerant to disease and pathogen.*

Kebeles							
Tolerant to disease and pathogen	**Sire Gudo**	**Sire Qallo**	**Sire Qallo Gato**	**Sire Qallo Haro Xaxe**	**Overall**	**X^2**	**P-value**
Stingless bee	25 (92.59)	6 (85.71)	21 (77.78)	17 (89.47)	69 (86.40)	2.72	0.4371
Honey bee	2 (7.41)	1 (14.29)	6 (22.22)	2 (10.53)	11 (13.61)		

Table 8 provides tolerant to disease and pathogen among stingless bees and honey bees across four study kebeles.

The results from the present findings showed that about 92.59%, 85.71%, 77.78%, and 89.47% of respondents in Sire Gudo, Sire Qallo, Sire Qallo Gato, and Sire Qallo Haro Xaxe kebeles reported that, stingless bee was more tolerant to disease and pathogen while, around 7.41%, 14.29%, 22.22%, and 10.53% reported honey bee was more tolerant to disease and pathogen. The results indicate that there is no statistically significant difference in tolerance to disease and pathogen between stingless bees and honey bees among the surveyed kebeles (x^2=2.72, p=0.4371). Therefore, from this study, the stingless bee has a good ability to be rare in the study area, and farmers/stingless beekeepers are rare without being afraid of disease and pathogens when compared with honey bees.

4.9. Field Investigation

To gather information on farmers' innate knowledge that was missed during interviews, field investigations were used. During field supervision we observed nest structure, stingless bee status in the farm land, in the forest, grazing land and in the rocky place. Again, we watched how stingless bee honey were harvested while conducting a field investigation. At the time of honey harvesting a lot of bee hive were destruction due to stingless bee construct its nest under the ground and its difficult for honey harvesting. On the other hand, we count the number of bee guards at the entrance to the bee nest during the investigation. As per as interview report the number of bee guards on the nest entrances showed the years of bee/individual nests.

Figure 2. *Field investigation.*

5. Indigenous Knowledge of Stingless Bee Owners in the Study Area

Stingless bee owners in the research area had access to a wealth of knowledge for a long time regarding to searching methods, honey harvesting, challenges/constraints of stingless bees, and benefits of stingless bee honey. The primary product that was used in the research region for a variety of purposes was honey from stingless bees. However, there was a lot of nest destruction during the honey harvest. Similar to this, it was noted that meliponiculture is comparatively infrequent in Africa and that meliponine honey harvesting is primarily harmful [8]. In the research area, ground-nesting stingless bee honey has been obtained by their ancestors for many years in this manner, passing down the knowledge of stingless bee hunting and gathering from generation to generation. Traditional classifications for stingless bees in the region include daamu (stingless bees that nest underground; Meliponula spp.) and bookee (stingless bees that nest in tree trunk cavities; Trigona spp.). However, because underground nesting stingless bees were well recognized and their honey was used for many purposes in society for a long time, we chose to focus on Meliponula spp. for our recent study.

6. Opportunities and Limitations of Meliponiculture in the Study Area

The high medicinal value of stingless bee honey, the high demand and high price of the honey, the non-stinging nature, disease tolerant ability of stingless bees, and the indigenous knowledge of farmers on stingless bee locating are among the study areas' major opportunities for stingless beekeeping, according to respondents and our observation. The Meliponini rarely engage in resource-inducing behavior or abscond, thus they must develop alternative coping mechanisms to maintain their permanent colonies over the prolonged times of scarcity they encounter in tropical dry woods [6].

The respondents pointed out several obstacles that were limiting the development of meliponiculture. Among these were the lack of extension services and training, as well as the fact that stingless bees had not yet been domesticated. As a result, stingless beekeeping, honey harvesting, processing, handling, and other management techniques were not well-known or supported by technology. The fact that stingless bees frequently only yield small amounts of honey was another factor.

7. Summary and Conclusions

The study was carried out in the selected districts of the West Hararghe Zone of Oromia, a Regional State, Ethiopia to assess the stingless bee production potentials, distribution, and constraints. Cross-sectional study design was used and data was collected by using the Purposive sampling method. A total of 80 respondents participated. Simultaneously practical field observations were conducted. Then after data were collected intensively, it was entered in the Ms-Excel spread worksheet, edited, utilized, and imported into *the JMP* 17 version software package for analysis. Analyzed categorical data were summarized with descriptive statistics such as percentages and, the Chi-square (X^2) test.

The study indicates that the majority of respondents in the study area found stingless bees suddenly without searching and there is a significant difference among study kebeles in founding of Stingless bee. These findings suggest the majority of stingless bees exist on the farmland with evidence of significant differences among study kebeles. According to the present finding, there is a significant difference in the nesting status of Stingless bees in study kebeles. The findings suggest that there are significant differences in the management technique of Stingless bees among study kebeles. Even though, there are significant differences between Stingless bees and honey bees the main differences among them in study districts were, that stingless bees had small sizes and didn’t sting. As per as study findings there are significant differences in constraints of Stingless bees among study kebeles. Even though there is variation tolerant to disease and pathogens among Stingless bees and honey bees across the study kebeles, the chi-square test indicates that these differences are not statistically significant. According to field investigation results, stingless bee exists in Sire Gudo, Sire Qallo, Sire Qallo Gato, and Sire Qallo Haro Xaxe kebeles of Gemechis district and there are bee guards at the entrance of stingless bees and the number of bee guards on the entrance indicates that, the year of stingless bee. The results from the study indicate that there is indigenous knowledge of Stingless bee searching, honey collecting, and product use in the societies in the Gemechis district of West Hararghe Zone.

Generally, to enhance stingless bee (Meliponula spp.) production in the Gemechis district solving constraints of production is the most important thing. Further study was required to domesticate stingless bees into artificial hives to simplify honey harvesting and reduce stingless bee nest destruction.

Abbreviations

ETB	Ethiopian Birr
PAs	Peasant Associations
TB	Tuber Colossi
X^2	Chi- square Test

Author Contributions

Segni Giza: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

Sudi Dawud: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Resources, Supervision, Visualization

Dema Dugda: Conceptualization, Funding acquisition, Methodology, Resources, Supervision

Conflicts of Interest

The authors declare no conflicts of interest.

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