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Assessment of current status, nesting ecology and potential threats of stingless bees in selected districts of East Wollega Zone. Oromia Regional State, Ethiopia

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Abstract

The study was conducted in selected districts of east Wallega zone (Diga, Sasiga and WayuTuka) from December, 2018 to April, 2020 to determinecurrent status, nesting ecology and potential threats of stingless bees. Based on respondents and visual observation, the beekeeping activities have been practiced sideline with other agricultural activities. Majority of the respondents have been finding stingless bee nest during their farm practice.The technique to identify the natural nesting site of stingless bee were;Lay on the ground with their chest around the nest site, Searching the nest entrance whole and Searching the stingless bee during foraging. Most of the farmers harvested stingless bee honey from natural colonies in the forest and farmland by digging out the ground. Stingless bee colonies were decreasing with its products. In terms of Meliponiculture, some of respondents were shifting traditional ways of stingless bee keeping to adaptation of stingless bee in man-made box hive. The stingless bee honey production in farm land area was more decreasing than in forest area due to natural habitat losses. Based on respondents and visual observation, the stingless bee's colonies and nests were found in natural forests, in enclosure area, around the river, in communal grazing area and in farm area respectively. The more stingless bee colonies and its nest found in natural forest and protected area that provide them with a suitable cavities and nest preparation. The major opportunities for stingless bee keeping in in the study area was; non-aggressive and has no side effect of stingless bees, availability of bee forage and water, honey as medical value, available of stingless bee colonies and indigenous knowledge of farmers on stingless bee colonies. The major problems in Meliponiculture were; Habitat loss, lack of awareness and extension service, Poor indigenous knowledge sharing culture, agrochemical application.

Keywords: stingless bee, threats, ecology, Oromia,

1. Introduction

Stingless bees have populated tropical earth for over 65 million years – longer than Apis, the stinging honey bees (Michener, 2000). Stingless bees (Hymenoptera, Apidae, and Meliponini) are a group of small- to medium-sized bees with vestigial (non-functional) stings. They belong to the meliponinae, one of three subfamilies of the family Apidae and occur in recurrent colonies where they store honey, pollen, propolis and royal jelly. Social organization in stingless bees is highly developed and can be comparable to that of honeybees (Sakagami, 1982).

Stingless bees, like the honey bees of the genus Apis, live with many individuals in a nest where honey and pollen are stored. Although the amounts of honey are generally smaller than in the nests of honey bees, people have used stingless bee honey for many centuries. They are eusocial insects that play an important role in the pollination process of plant life, particularly plants in natural habitats in most tropical countries (Heard, 1999). The raising and farming of stingless bees, has been sparking interest for the past few years, not only in rural communities income generation, but also in the gourmet market, where professionals use the product, either for its medicinal properties or for its outstanding flavors. Honey produced by stingless bees have been widely relished in the past and besides their putative medicinal properties there are overbearing traditional reasons to harvest honey from pots, either from the forest or with the comfort of a well-establishedmeliponary (Vit*et al*., 2004).

Stingless bee honey is a valuable natural product from a diverse group of highly eusocial bees comprising the tribe Meliponini in the family Apidae. Stingless bees produce honey from nectar of flowering plants. It is stored in pots that are made of wax cerumen. Honey is mainly made up of glucose and fructose but contains minerals, vitamin and other nutrients. It is the main energy source for the bees and can serve as energy booster for humans (Peter K., 2010). Stingless bees store honey in pots rather than in combs. Their honey is also nectar or honeydew that has been concentrated and transformed. The honey from stingless bees is highly appreciated traditionally considered to be more powerful as a natural medicine for treating common diseases than honey of honey bee, (Lubertus B *et al*., 2006). One possible reason for such medicinal application is that the honey is usually kept in pots of cerumen. During storage, the honey may acquire some components of cerumen, known to have several medicinal effects (Drummond, 2013).

Unlike honey bees, which store honey in neat, regular combs, stingless bees fashion lumpy honey pots. Although their honey and other hive products are less abundant, it is more difficult to collect than those of honey bees. Their nests is 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. 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. One of the main issues for practical Meliponiculture is how to extract honey. When a beekeeper wanted to remove the honey, traditionally, they open at the rear 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 a high mortality of adult bees and the loss of a great percentage of the laid eggs. (Villanueva*et al*., 2005).

Stingless bees (Apidae: Meliponini) are major pollinators of many wild and cultivated plants, and both indigenous and non-indigenous populations use their products for diverse purposes including food, crafts, and medicine. However, many aspects of both stingless bee nesting ecology and traditional knowledge of these culturally significant bees by diverse human populations remain unknown or poorly documented. (Victor H *et.al*. 2018).In the studyarea the current status, nesting ecology and potential threats of stingless bees was not identified, well organized, documented and the study was focusto explore the nesting ecology, current status of stingless bee population, challenges and opportunities that affect stingless bee colony and its products.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted in East Wollega Zone, Oromia Regional state at about 332km away from Addis Ababa, and the capital city of Ethiopia. It is bordered on the southwest by BunoBedele Zone, on the west by the Didessa River, which separates it from West Wollega, on the northwest and north by

the BenishangulGumuz Region by the northeast by HoroGuduruWollega, on the east by West Shoa, and on the southeast by the Gibe River which separates it from Jimma Zone. The zone is located in the area stretching from 36 0 30'00" to 36 0 45'00''longitude and 9 0 05'00'' to 9 0 15'00'' latitude with elevation ranging from 1000m to 3207m. The range of annual rainfall of the zone is from 1500mm to 2200mm with mean annual temperature 15-20 degree centigrade (CSA 2005, 2007). The study was specifically conducted in three districts; Diga, Sasiga and WayuTuka.

Diga district is one of East Wollega Zone, Oromia Regional State. The Woreda is located at about 346 km away from Addis Ababa and 15km from Nekemte town to the West. Based on agro-climatically conditions namely: Highland altitude ranges 2100-2342m and Midland ranges 1200-2100m with annual rainfall of 2400mm (JoshaO,*et al;* 2010, CSA 2007).

Sasiga district is one of the wored in the Oromia Regional state and a part of the EastWalaga Zone. Sasiga is bordered on the south byDiga, on the west by the Benishangul-Gumuz Region, on the northwest by Limmu, on the north by an exclave of the Benishangul-Gumuz Region and on the east by GutoGidda. The administrative center of this woreda is Galo and 42 Km from Nekemte, the capital of East Walaga Zone.

WayuTuka district is located 324 km from the capital Addis Ababa at an altitude of 1700–2200 m above sea level and has an average annual rainfall of 2400 mm (CSA 2007).

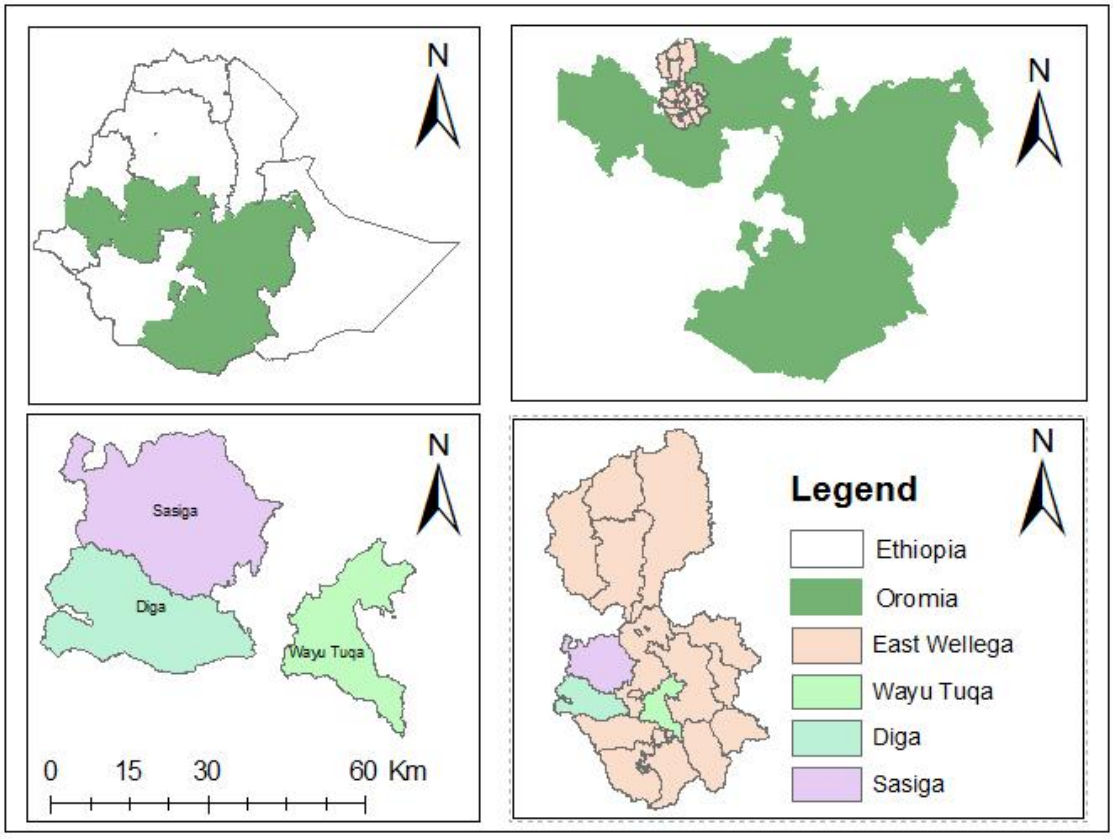

Figure 1 Map showing the location of the study area

2.2. Data sources and methods of collection

In this study, both primary and secondary sources of data were used. The primary data was collected from sample household beekeepers through a semi-structured questionnaire and by field examination of stingless bee nests. Secondary data was obtained from various sources through desk review.

2.3. Sampling methods

The study was purposively select three districts based on their intervention in stingless bee harvesting and domestication. The entire farmers who were involved in stingless bee honey harvesting were clustered in to those who were engaged in domestication and those who do not involve in domestication. Atotal 153 farmers and out of these 10 farmers who are involved in domestication were selected purposively and the rest of 143 farmers were selected using simple random sampling from those farmers who are not involved in the domestication of stingless bee but involving in harvesting of stingless bee honey.

2.4. Data Collection Methods

The study was based on qualitative and quantitative data collection methods. The qualitative approach was the dominant approach because it tends to give more attention to the subjective features of human knowledge and behavior (Powell and Connaway, 2007). Accordingly, interview, focus group discussions (FGD), and field observation were used.

2.5. Field Observation

Field observation was used to obtain information on farmers' indigenous knowledge that was not captured through interview and group discussions, to crosscheck the actual practices and to capture pictures.

2.6. Data management and statistical analysis

The collected data were stored in Microsoft Excel and SPSS software programs (SPSS @, version 20) for analysis. The statistical analysis used in the study varied depending on the type of variable and information obtained. Summarized data was presented in the form of tables and figures.

The data collected through semi structured questionnaires were analyzed using descriptive statistics and the ranking of the different types of beekeeping constraints, Common Cause of stingless bee colony and yield decrease obtained in the study were done by using the rank index formula as described by (Musa *et al.*, 2006):

Rank index*=sum of (5 * number of household ranked first + 4 *number of household ranked second + 3 *number of household ranked third + 2 *number of household ranked fourth + 1 * X number of household ranked fifth) for an individual reason divided by the sum of (5 * number of household ranked first + 4 *number of household ranked second + 3 * number of household ranked third + 2 * number of household ranked fourth + 1* number of household ranked fifth) for overall reasons.*

3. Results and Discussion

3.1. Beekeeping activities and potentials

Based on respondents and visual observation the beekeeping activities have been practiced sideline with other agricultural activities. There were no any respondents who depend only on beekeeping. Most beekeepers were started beekeeping before 2005(3.80%),2006-2010 (10.89%), 2011-2015 (18.41%)and after 2016(28.03%)in increasing respectively (table 1)and this indicate these beekeepers were related within age of between 31-42 years. Based on household respondents, beekeeping practice was increasing in the studyarea with beekeeping technology. Majority of beekeepers started after year 2016.

Table 1. Beekeeping starting time

Year	Frequency	Percent
Before 2005	9	5.88
2006-2010	26	16.99
2011-2015	42	27.45
After 2016	76	49.67

3.2. Indigenous Knowledge system in stingless bee honey production

The study interviewed 153house hold respondents who have been involved beekeeping and stingless bee production in order to extract the indigenous knowledge use and practices in stingless bee honey production.

3.2.1.Occasion of nest site location finding

Majority of the respondents have been finding stingless bee nest during arm practice since all respondents were farmers and some of respondents have been got stingless bee nests during keeping their livestock Table 2.

Table .2 Occasion of nest site location finding

Occasion of nest finding	Frequency	Percent
Keeping livestock	42	27.45
Farm practice	67	43.79
Fuel wood Collection	13	8.49
Only singles bee nest finding	31	20.26

3.2.2. Identification methods of the wild nesting site

According to the respondents, however, it is a difficult task to identify the wild nesting site of stingless bee. The technique to identify the natural nesting site stingless bee presence by ranks were Lay on the ground with their chest around the nest site (as 1st), Searching the nest entrance whole (as 2nd) and Searching the stingless bee during foraging (as 3rd) and others method of identifying the natural nesting site Table 3.

Table. 3 Identification methods of nest site

Identification methods of nest site	Relative degree of importance's					index	Rank
	1st	2nd	3rd	4th	5th		
Lay on the ground with their chest around the nest site	19	15	9	1	0	0.32	1
Searching the nest entrance whole	12	19	6	4	2	0.29	2
Searching the stingless bee during foraging	1	9	22	17	3	0.19	3
Searching the stingless bee during watering	0	3	7	8	27	0.071	5
Ting the stingless bee using thread	0	5	3	7	23	0.04	6
Using indicator insects or honey to attract the stingless bee	1	2	7	28	2	0.09	4

The farmers lie on the ground by their chest around the nest site to see the stingless bee while entering and leaving their nest/ observe bees flying in and out of the nest. The farmers used to search this tube in the areas around homestead, farmland and forest (Kwapong *et al*., 2010) and also other respondents stated that the stingless bee's nest can be identified by searching the entrance holes on trunks of trees and fallen logs. However, according to the respondents this method is time consuming and less effective compared to the other methods.

3.2.3. Domestication of stingless bee and colony transfer methods

The survey result shows that in the study area some farmers are starting to maintain stingless bee by artificial hives through domesticating these wild bees. The domesticators employ two ways of maintaining the stingless bee species in traditional hives made mud greased by cow dung (6.54) and most ofthe respondents maintain at their original nest site cavity (93.45%).

Figure 2. Domestication of stingless bee

3.2.4. Stingless bee honey harvesting methods

Stingless honey harvesting was take place in four ways, from the wild colony and from domesticated colony in their home. Honey harvesting in domesticated colony was more sustainable way compare to harvesting honey from the wild colony. The respondents clarify that honey harvesting from domesticated colony was easier, efficient and quicker compare to natural nest colony in the wild.

Table 4: Ways of stingless bee honey harvesting.

	Way of harvesting	Frequency	Percent
From wild colony	Without taking care of the colony	27	17.65
	With taking care of the colony	19	12.41
	By taking care of honey	71	46.40
	Taking care for colony and honey	36	23.53
From domesticated colony	Without taking care of the colony	0	0
	With taking care of the colony	0	0
	Only fir taking care of honey	1	0.65
	Taking care for colony and honey	9	5.88

Most of the farmers harvested in stingless bee honey from natural colonies in the forest, farmland and around homestead by digging out the ground. The ground-nesting stingless bees build their nests in the soil, with only the nest entrance visible.According to the respondent, the height of the excavated underground cavity varied from 0.5m up to 0.75mand also 0.75m up to 1m based on the property of the soil area. From this, it can be understand that how honey harvesting in wild colony is difficult. The result shows that, stingless bee honey was harvestedfrom the wild colony in two ways; harvesting the honey in their natural underground cavity without taking care of the colony and harvesting the honey with taking care of the colony by maintaining the nests in their natural underground cavity.

3.2.5.Stingless Bee Honey Yield status

According to respondents the amounts of stingless bee colony and their product was decreasing. In terms of Meliponiculture, some of respondents were shifting traditional ways of stingless bee keeping to adaptation of stingless bee in man-made box hive. The stingless bee honey production in farm land area was more decreasing than in forest area due to natural habitat losses.

The traditional way of clearing forests for agricultural farm disposes the ground to degradation agents, hence an environmental threat. It is a well demonstrated fact that stingless bee domestication and conservation would significantly impact on food security, besides increased household income.

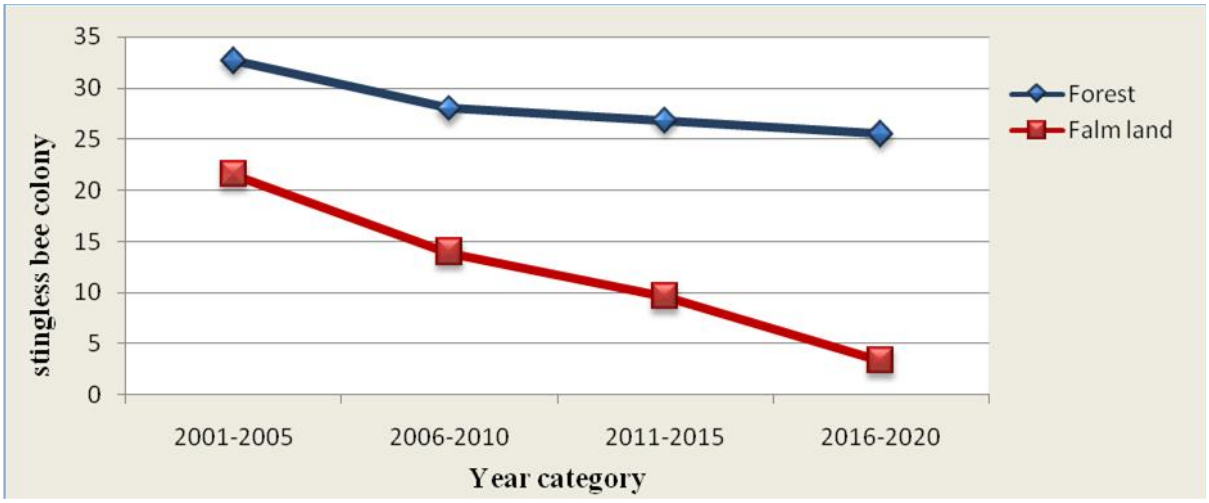

Figure 3.Stingless Bee colony Yield status

3.2.6. Stingless bee nesting area (ecology)

Based on respondents and visual observation, the stingless bee's colonies and nests were found in natural forests, in enclosure area, around the river, in communal grazing area and in farm area respectively. The more stingless bee colonies and its nest found in natural forest due to its availability of resources for survival or bets habitat.

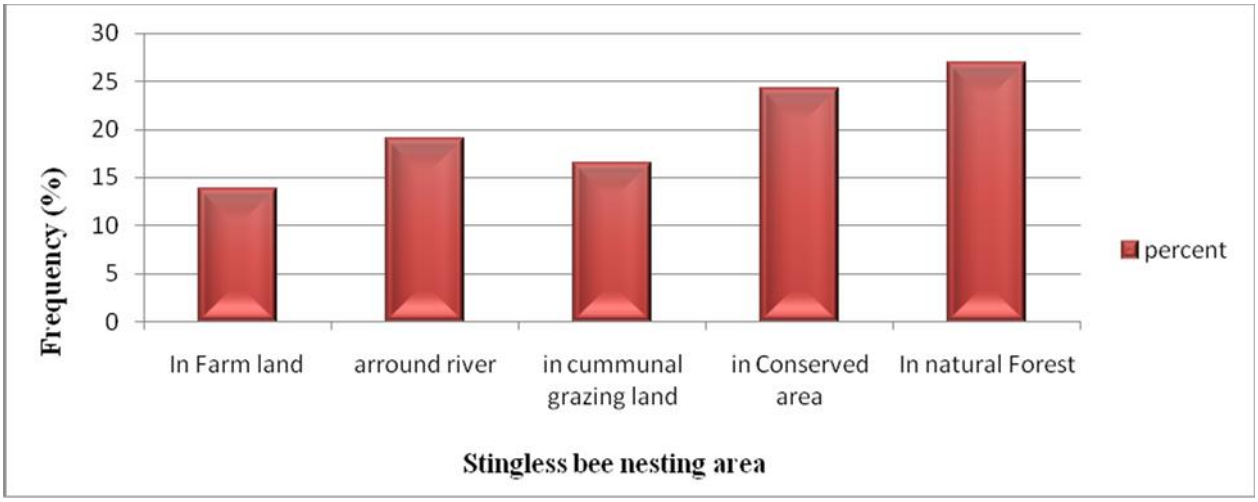

Figure 4.Stingless bee nesting area

Understanding the scale at which habitat influences species richness in ecosystems is central to ecology (Wettstein & Schmid, 1999) as both patch and landscape factors may contribute to the diversity of resident taxa (Collinge, *et al.*, 2003). Natural and anthropogenic disturbance affects the vegetation structure and composition. Due to anthropogenic ally mediated habitat, changes are taking place at multiple scales; science must distinguish between cover and landscape threats in order to develop effective conservation strategies. Community composition may be influenced by habitat variation from area to landscape-scale depending on body size, home range area, and dispersal distance of the taxa of interest (Haskell, *et al.*, 2002).

3.3. Opportunities and Challenges of Meliponiculture

Ethiopia has immense natural resource for beekeeping and Meliponiculture activity. However, like any other livestock, this sub sector has been ceased by complicated constraints. The main production constraints in stingless bee productivity would vary depending on the agro ecology of the areas where the activities is carried out.

3.3.1. Opportunities

According to the respondents, the major opportunities for stingless bee keeping in in the study area include: non-aggressive and has no side effect of stingless bees, availability of bee forage and water, stingless bee honey as medical value, available of number stingless bee colonies and indigenous knowledge of farmers on stingless bee colonies Table 5.

Table 5.Opportunity of Meliponiculture

Opportunity	Relative degree of importance									Rank Index	Rank
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th		
Non-aggressive and has no side effect	18	12	8	12	7	1	1	0	1	0.15	1
High demand and price value	15	12	8	12	7	1	1	0	1	0.14	2
Availability of bee forage and water	8	9	8	19	5	2	1	1	1	0.13	3
Hone as medical value	1	2	7	14	9	7	4	2	3	0.12	4
Available of number stingless bee colonies	1	2	7	18	4	2	3	0	5	0.11	5
Indigenous beekeepers knowledge	2	5	9	11	5	3	1	0	1	0.09	6
Existence of soil and water conservation and area enclosure	0	1	1	3	7	17	3	0	2	0.08	7
Meliponiculture experience of the farmer	0	1	1	1	9	5	12	2	1	0.07	8
Drought resistance	0	0	1	1	1	3		7	15	0.05	9

Stingless bees and honeybee colonies are also becoming important alternative pollinators to the honeybee, previously considered a universal pollinator, due to their abundance and adaptability, besides behavioral traits, which further enhance their suitability. Honeybees have emerged over the years, with great economic returns.Stingless bees do not sting humans or animals, making them easily acceptable to the bee farmer. They can be managed easily on pollen substitute and honey. Stingless bees honey hascollected for medicine to alleviate various ailments and discomforts such as constipation.

3.3.2. Major Constraints of Meliponiculture

According to the results of the study, the major problems in Meliponiculture arise from bee characteristics or environmental factors that are beyond the control of the stingless beekeepers, the others problems mentioned by the respondents were; Habitat loss, lack of awareness and extension service, Poor indigenous knowledge sharing culture, agrochemical application (Table 6). Moreover

it is also the lack of understanding on behalf of Meliponiculture combined with lack of regulations and enforcement that has enabled the increasingly rapid spread of pathogens during the past thirty years

Table 6.Challenges in Meliponiculture

Challenges	Relative degree of importance								Index	Rank
	1st	2nd	3rd	4th	5th	6th	7th	8th		
Habitat loss	17	13	9	11	5	3	1	0	0.25	1
Lack of awareness andextension service	10	21	6	4	2	0	0	0	0.21	2
Poor knowledge sharing culture	1	3	17	9	5	1	2	1	0.14	3
No attention and effort by government	1	2	7	18	4	2	3	0	0.12	4
Agrochemical application	0	5	3	7	15	2	0	1	0.11	5
Difficult to find nesting site	0	1	1	3	7	17	3	0	0.08	6
Lack of appropriate technology	0	0	1	1	9	5	13	2	0.06	7
Low productivity	0	0	1	1	2	5	9	10	0.04	8

The potential and levels of habitat loss due clearing forest for agricultural farm and grazing in the area has great effect on stingless colony. The rates of habitat degradation and destruction in tropical forests are almost greater than in any other biome in the world (Sala *et al*., 2000). Honey hunting for stingless bee honey had severe effects on stingless bees by killing bee colonies and leaving cavities unsuitable to be re-used by stingless bees.

4. Conclusion and Recommendation

From the result stingless bees prefer nest in forest and conserved land area that provide them with a suitable nest site. Landscapes and land uses can influence the nesting behavior of stingless bees due to their dependence on various substrates for nesting. From searching the stingless bee nest, lay on the ground was used as effective method with during farm practice as stingless bee nest finding. Harvesting the honey in the wild colony was only taking care for honey however from domesticated taking care for both colony and honey. According to respondents the amounts of stingless bee colony and their product was decreasing. Challenges in stingless bee include poor extension service, lack of awareness for farmers, low attention and effort by the government, lack of appropriate technology, and low productivity. The opportunity for stingless bee identified was high and price value of stingless bee honey, medical value of stingless honey, farmer's indigenous domestication and non-aggressive behavior of stingless bee. Awareness of stingless bee domestication and Meliponiculture equipment is important to support from agricultural Research, other experts and efforts should be made from concerning organizations as recommendation. These findings suggest that various landscapes and land uses can influence the nesting behavior of stingless bees due to their dependence on various substrates for nesting. For the reason of time restraint in this study area, awareness creation and attention to driving force of challenge and opportunity of stingless bee is suggested by monitoring throughout the year.

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