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Pre-extension Demonstration of Stingless Beekeeping *(Meliponiculture)* Through Participatory Approaches

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Abstract: This study was conducted in Toke Kutaye and Wolmera districts of West Shoa zone in 2018 and 2019. The two districts were selected purposively based on the stingless bee (meliponiculture) abundance. The objective was to evaluate and demonstrate stingless beekeeping practice (domestication) with farmers participation. Three Farmers research and extension groups (FREG) with 10 beekeepers each (6 male and 4 female) were established at Toke Kutaye and Wolmera districts. Three stingless bee apiaries were selected at each FREG for stingless bee (Meliponiculture) domestication. Both practical and theoretical Training was given for 41 beekeepers, 6 Woreda experts, and 3 DAs. Out of the training participants, 19 were female. A total of 31 pot hives were constructed by local potteries following the appropriate design. 20 queen right stingless bee nests from Toke Kutaye and 9 from Wolmera agro-ecologies were collected and domesticated at each apiary site. One shade was constructed at each apiary and pot hives were constructed for all FREG members. FREG members participated in all works (colony hunting from the forest and transferring, shade construction, feeding, and other management). The transferred colony (31 pot hives) were domesticated/persisted at all FREG site. About 620 mL of pure honey per pot per period was harvested from Toke Kutaye site. FREG members and other neighboring farmers appreciate the technology particularly for honey quality, simple inspection, colony not absconded, etc. Therefore, the technology should be further promoted in stingless bee production potential areas.

Keywords: Demonstration, Nest, Pot Hives, Stingless Bee

1. Introduction

Worldwide about 20,000 different bee species, varying in size form and lifestyle were found [15]. Michener, C. D. [11] choses 28 characteristic probably related to social level and coded these for 18 species in 12 genera and 3 families. There are two groups of highly eusocial insects in the world. Apinae bee and Meliponinae bees. More species of both groups have been used in the beekeeping industry, apiculture, and meliponiculture, owing to the specific characteristics of eusocial insects.

Stingless bees (Hymenoptera; Apidae; Meliponini) are living in tropical and subtropical regions of the world where they are abundant in species and numbers. Because of their biodiversity and co-evolved with vegetation, they are among potential pollinators in various tropical ecosystems. Stingless bees are of economic importance as key contributors in ecosystem support services vital to the survival of several forest plant species as well as crop through pollination [17-19, 14].

Several hundred species of stingless bees are assumed to exist worldwide [1], where about six genera comprising twenty species, are known to occur in Africa [9, 12]. Stingless bee studies were conducted by [6] who studied Hypotrigona, studied several species. Only the existence of 5 species is recently identified in Ethiopia using a population survey and its taxonomic work of which *Meliponula baccarii* was the most frequent specimens [12]. In a few years worldwide decline/absence of bee populations and species diversity has raised global environmental and economic concerns, as pollinator loss will negatively affect global human diet and health and crop market economies, as well as the livelihood of farmers and beekeepers (e.g.) [7, 8, 13].

M.baccarii ("Daamuu") bees live by harboring underground soil in perennial colonies composed of a few hundred to several thousand workers and utilize the resins of

more than one hundred different plant species for food, nest construction, and chemical defenses [2-4] *M. baccarii* species are very docile and their non- stinging behavior helps for easy management and adaptation around home gardens.

The honey produced by stingless bees (*M.baccarii*) is a valuable bee product with a long consumption tradition, to which several medicinal uses are attributed. Stingless bee products are considered better than honeybee products, for example, the antioxidant properties in the honey of stingless bees are higher than those of honeybees [10]. Honey produced by stingless bees is aromatic, sweet-sour in taste with a fruity. It contains more water (about 20-35%) and is more liquid than the honey produced by honeybees [16]. In Ethiopia, honey produced by stingless bees is considered to be important in traditional treatments of the wound, respiratory ailments, surface infection, diarrheal, and various other diseases in line with other treatments [20]. As a result, stingless bee honey has been known as a product with high market demand, achieving higher prices than the honey produced by bees of the Apis genus, commercialized in different regions of Ethiopia.

Despite their ecological value and highly demanded honey, less attention has been given to these valuable bee species in Africa in general, and in Ethiopia in specific. As a result, the honey harvesting system from feral colonies, for example, is traditional and destructive that endangered species diversity and reduces the honey quality standard. Few attempts have been initiated in meliponiculture as a new opportunity for the source of income generation in African countries like Ghana, Kenya, Botswana, and South Africa [21]. It is the first successful stage that domestication and management of stingless bees in pot hives have been done at the HBRC apiary site in Ethiopia.

Therefore, taking this domestication and management practice of stingless bees to the small scale farmers is very important for the production of improved honey quality, income generation, and species conservation. This study was conducted to evaluate and demonstrate stingless beekeeping practice (domestication) at farmer's level, awareness creation on stingless beekeeping technologies, to produce improved honey quality/quantity for income generation, medicinal value, and nutrition and to generate sustainable species conservation strategies.

2. Materials and Methods

2.1. Description of Study Area

The pre-extension demonstration was conducted in two districts West Showa Zone of Oromia regional state namely, Toke Kutaye and Wol Mara.

Toke Kutaye district: is one of the West Shewa Zone districts, is bordered on the east by the Ambo Zuria, on the north by Midakegn, on the west by Cheliya, the largest town is Guder. It is found at a distance of about 137 Km away from Finfinne on the Finfinne –Nekemte main road.

Wol Mara district: Is one of Oromia special Zone surrounding Finfinne, its bordered on the South by the Sebeta Hawas, on the west by West Shewa Zone, on the north by Mulo, on the northeast by the Sululta, and on the east by the city of Addis Ababa.

2.2. Selection of Target PAs and Farmers

Two districts were purposively selected based on the potential for stingless bees (*M.baccarii*) abundance and three representatives PAs, one from Wol-Mara and two from Toke-Kutaye were selected.

The activity was carried out using Farmers' Research Extension Groups (FREG) formed of smallholder farmers. Experienced farmers with indigenous knowledge on nets finding and interested were selected by DA and Woreda experts. Three farmers' research Extension Groups (FREGs) with 30 (6 male and 4 female at each site) were established at Toke Kutaye and Wol Mara districts. The groups contain 40% of women and they assign the leader and they can talk together on different issues and work in close relationships with researchers and technical assistance.

2.3. Farmers Training

Theoretical and practical training was given for FREG members, Woreda experts, and DAs on stingless bee (*M. baccarii*) demonstration technology. Three apiary sites were selected from two districts of three PAs. After the organization of FREG, training was provided on the stingless beekeeping (Meliponiculture) from colony hunting up to honey harvesting and finally, all necessary input was delivered to the farmers from the Holeta Bee research center (tin for shade construction, pots, sugar, etc.) and farmers transferred colonies in their apiaries and follow-ups and essential advice from respective researchers has been taken place. The training also includes the decline of stingless bees because of different factors and the species of Stingless bees kept around the home by this technology. Farmers have evaluated the demonstration apiaries three times (i.e., at transferring, feeding, and honey harvesting).

Table 1. *List of training participants (by gender) before the demonstration. Source: Own Data, 2019.*

No.	District	Demonstration site	Participants						Total Participants
			Beekeeper		Experts		DA		
			Male	Female	Male	Female	Male	Female	
1	Toke Kutaye	Group one	9	5	1	1	1	1	18
		Group two	5	3	2	0	0	0	10
2	Wol Mara	Group one	6	4	1	1	0	1	13
Total			20	12	4	2	1	1	41

Figure 1. *Theoretical training for stingless beekeepers, experts, and Das.*

Figure 2. *Shade construction.*

2.4. Colony Transfer and Establishment

After investigation, the nest of stingless bees were excavated with great care and transferred into the new pot hives. After removing the lids, brood combs with bees and the queen were placed in the hive and covered by the lids, and then all the gaps were sealed by plasters and/by mud. Accordingly, queen right colonies of the commonly available species (*M. baccarii*) were transferred to new hives with in order not to squeeze and damage the broods. A total of 31 queen right colonies were established at all apiary sites of FREGs groups. All the colonies were kept under the shades of each apiary. All necessary managements such as feeding, controlling hive temperature/shade, and protecting against the attack of enemies (pests) were regularly performed.

Figure 3. *Established stingless bee colonies.*

2.5. Method of Data Collection and Analysis

2.5.1. Data Collection

Both qualitative data (farmers' opinions, challenges) and numeric data were collected. Number of colonies transferred to pots, shade construction, number of absconded colonies, number of colonies successful, number of farmers participated in training, farmers' opinion, honey harvested were collected during pre -extension demonstration.

2.5.2. Statistical Analysis of Data

The collected data were statistically analyzed using descriptive statistics such as percentages, mean. Some information that could not be taken through quantitative analysis was analyzed qualitatively based upon Key Informant Interview and group discussion with extension workers, and farmers.

Colony adaptation success per hive type was calculated by the following formula:

$$Colony\ adaptation\ rate = \frac{number\ of\ colonies\ lived\ in\ the\ hive\ for\ one\ year}{all\ the\ number\ of\ colonies\ transfered\ in\ to\ the\ hive\ type} X\ 100$$

3. Results and Discussions

3.1. Stingless Beekeeping Production System

In beekeeping production system before other honey bee production system technologies adapted and demonstrated back yard honey bee production system is known under farmer's beekeepers level. Then in a stingless beekeeping system no backyard or around home-keeping of the colonies in the study area except, honey harvesting with destructive nest and destroying colonies was practiced. For this reason, the number of nests and colonies decreased when compared with the ancient time.

3.2. Characteristics of Modern Stingless Bee (M. baccarii) Pot Hives

Modern stingless bee pot hives are the pot that can assist singles bee colonies. Stingless bee colonies (*M. baccarii) spp* by nature live underground so this pot is made as to the behavior of their nests. It provides all essential living facilities for colonies. It simple for management (inspection, cleaning in and around the pot), close, open, feed the colony, and cheap which was verified during demonstration evaluation.

3.3. Training

Training is an important knowledge and develops the skill of farmers to adopt new practices. Therefore, to utilize the technology successfully, farmers, DAs, and experts need training. A total of 38 target individuals participated during training. Among them, 17 farmers, 3 DAs, and 6 experts were involved. Out of trained participants 12 females were involved to keep the gender balance in the activity. Of the total trainers, 39.4% were female and 60.5% were male farmers. The training has been given on stingless beekeeping technology (management, shade construction, colony hunting from the environment, transferring to pots, feeding colonies, inspection, and honey harvesting method) as well as its information exchange. Unless weak participation was present among them, all the beekeepers in FREG members participated until the final work.

Table 2. *List of training participants (by gender), after the demonstration. Source: Own Data, 2019.*

No.	District	Demonstration site	Participants						Total Participants
			Beekeeper		Experts		DA		
			Male	Female	Male	Female	Male	Female	
1	Toke Kutaye	Group one	6	5	1	1	1	1	15
		Group two	5	3	2	0	0	0	10
2	Wal Mara	Group one	6	4	1	1	0	1	13
Total			17	12	4	2	1	2	38

3.4. Shade Construction

Stingless bee colonies nest holes most of the time found in the forest. The collected bee colonies were kept under the shade/roof / of the constructed house from the tin established by the Holeta Bee Research center team, although attempt has been made to maintain colonies indoors in colder climates, using temperature-controlled rooms and/or hives [5]. The arrangements between the pot hives under the shade were not specific. Partially the wall of the shade inters the sunlight gently.

3.5. Colony Establishment and Survived

FREG members and the HBR team were found the nest in the forest and collected the stingless bee colonies from the forest to establish the initial colony to demonstrate and conserve the species. Farmers use different methods to find the bee colony traditionally, after locating any colonies in the ground. They simply dig around the nest safely and bring the colony to the prepared pot hives. More of stingless bee colonies were survived in three apiary sites. Only some colonies were absconded. 95% and 80% of colonies were survived from Toke Kutaye and Wol-Mara sites respectively.

Table 3. *Number of stingless bee colonies transferred and survived by pot, source own data 2018 & 2019.*

Apiary	Number of colonies transferred	Number of colonies survived	Number of colonies absconded
Toke group one	10	9	1
Toke group two	11	11	0
Wal-Mara	10	8	8
Total	31	28	9

3.6. Honey Yield

Although the colony sizes of these bees are much smaller than those of the (*Apis mellifera*) honey bee the per-bee productivity can be quite high. Honey harvesting is done only once in a year, after the establishments of the initial colony. In a stingless bee, colony honey is stored in spherical pots made by "cerumen" which are distributed surrounding the brood combs. The amount of honey produced by the stingless bee colony depends on the strength of colonies and the availability of resources (flowers). We simply open the pot and collect the honey in pots by syringe without damaging the broods, but a little portion is left as the food for bees, during the dearth period. From the demonstration average of 620mL of honey per pot /period was harvested at Toke Kutaye. On the other hand, one FREG site (Wol Mara) was failed after the stingless bee colonies were adapted in a good performance and stayed for one year, due to unknown reasons. All data were collected except honey yield data.

Figure 4. *Honey harvesting system.*

Table 4. *Honey yield per pot, by one season.*

Pots	Site	Honey harvested per pot/period	
		Ml	Average
Pot 1		730	
Pot 2		400	
Pot 3	Toke Kutaye Group 1FREG	600	
Pot 4		650	620
Pot 5		716	
Pot 6		625	
Total		3721	

3.7. Occurrence of Pest and Predators

Due to the lack of a functional stinger and characteristic non-aggressive behavior they can be reared without problems in densely populated environments, around the home. Stingless bees like all other animals are attacked by various parasites, pests, predators, and enemies. Different factor's Human being was one of the enemies of stingless bees as you were distractive its nest and colony when harvesting honey. After the domestication of stingless bee (*M. baccarii*) in pot hives, some pest and predators were reported. Wasps reported from Toke Kutaye and, mice/rat/ were reported from Wol Mara site farmer beekeepers group. Wasps hunted by sitting on pot lid in the day, the worker of stingless bees.

3.8. Participant's Feedback on the Technology

From stingless bee colony nest finding up to honey harvesting time, FREG members suggested different feedback like: - if we transferred the colony at any time when the nest is available what problem argue against. For this idea, the researchers suggested that colony transferring only possible at active season (availability the resource) of the area.

Figure 5. *Mice/rats in pot hives.*

4. Conclusions and Recommendation

4.1. Conclusion

Domesticating and managing colonies of ground-nesting bees using artificial (pot) hives is simple because the pot hive prepared from clay soil, so colonies obtained heat from under naturally and for this reason adapted to pot hives. The adeptness of stingless beekeeping in pot hives at farmers' level depends on the availability of the stingless bee nests in the forest, the known time of the transferring from the natural nest to pot hives, the strength of the colony, and a full package of management. It is not unexpected that the local people have somewhat important indigenous knowledge about stingless bees nesting in their local forests. Farmers hunting the nest of stingless bees in their environment and harvested honey by destructive the nest, colony, and not quality honey in the study area. This process declines the stingless bee species in the natural environment and decreases the production of agricultural products which pollinated by those insects. But by this technology (with pot hives) stingless bee colony species which are declined from the environment were saved and transferred to a new generation, both species conservation and the advantage obtained by this bee (hive products, pollination of agricultural and other flowering plants were) survived for the future generation. The ownership of the apiaries of the stingless bee agrees the management obtain knowledge of the biodiversity of the area.

4.2. Recommendation

Demonstration of stingless beekeeping and management in pot hives was accepted at FREG members. Due to their docile colonies and safety for beekeepers and guests, they can be used in areas where stinging insects/honey bee/ are not desirable, as in greenhouses, cities, etc. So this technology should be more demonstrated for farmers at were this stingless bee species found in different parts of the country.

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