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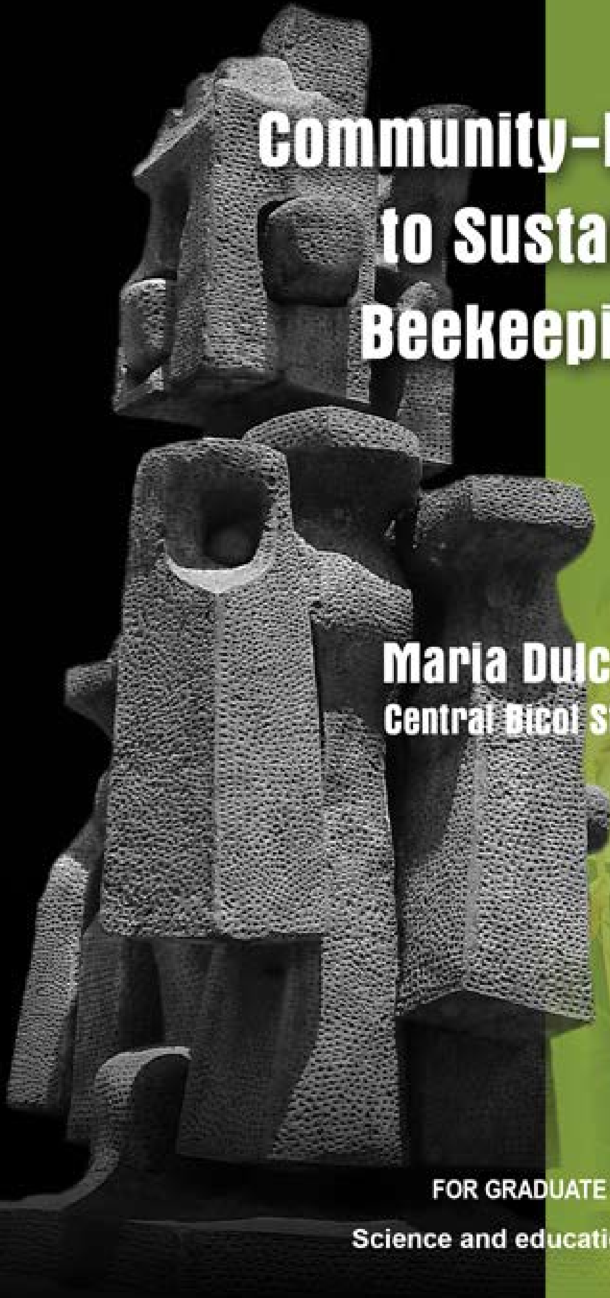
Community-Based Approach to Sustainable Stingless Beekeeping in Sorsogon, Philippines



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FOR GRADUATE STUDY AND RESEARCH IN AGRICULTURE

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ABSTRACT

Stingless beekeeping technology as an alternative livelihood in the Bicol region involves hunters, beekeepers, and assemblers of bee products. However, development and adoption of the technology could lead to overexploitation of feral colonies by hunters, imperiling the population of this endemic species. This project mainly aimed to help communities in Sorsogon province to adopt beekeeping as a livelihood through sustainable utilization, management, and development approach for the conservation of the species. The specific objectives were to (1) document ethnological/meliponicultural practices of Sorsogon, (2) determine the diversity and abundance of the stingless bee population in two municipalities in Sorsogon, (3) facilitate knowledge transfer of stingless beekeeping technology, (4) facilitate meliponary establishment at the community level, and (5) develop a policy on conserving wild populations of stingless bees. The project was carried out in the municipalities of Casiguran and Bulusan in Sorsogon from February 2013 to January 2016.

A survey of the ethnomeliponicultural practices of 29 community members (25 bee hunters and 4 beekeepers) in Casiguran and Bulusan showed a slight difference in bee hunting and keeping practices. Most respondents were hunters and were untrained in beekeeping. They learned hunting skills from their parents and grandparents. The respondents differed in their time of the hunt, species of bees hunted (*Apis dorsata* and *Apis cerana*), and bee products collected. Only a few of them hunted stingless bees. Regarding bee products, they were mostly familiar with honey, but only a few of them were aware that pollen is also an important bee product. Most of them just fed the pollen to their animals. Low-quality honey was sold in the market. The hunters encountered the following common problems and risks: stings of bees and ants, bites of snakes, and attacks by wild pigs; injury due to trees with spines and falling debris from tall trees; bad weather conditions; lack of paraphernalia for use in climbing tall trees heavily surrounded by parasitic plants/vines; lack of skills in hunting and collecting honey from the wild (resulting in damage to the colony); lack of knowledge and technology on how to transfer hunted colonies; and encountering hostile community members or outsiders in the hunting area.

The distribution and abundance of stingless bee were determined with participation of the hunters; this was conducted in one barangay per municipality. Nest trees were coconut, santol, mango, cacao, pili, guava, and narra. Hive structures of extracted colonies were spherical, hive entrances varied in shape and size, and pollen and honey pots were found within the periphery of

the brood. Maps on the distribution of stingless bees in the two municipalities were generated. Colonies in the sampling sites were not abundant. Marked nest trees were visited after three months and onwards to monitor the regrowth of reproductive propagules in the area. Regrowth occurred from 9 to 18 months after nest extraction. The species of stingless bees was identified as *Tetragonula biroi* based on morphological characteristics and through gene sequencing.

Capacity enhancement of the beneficiaries via training in stingless beekeeping focused on value of stewardship, beekeeping benefits and potentials, biology and behavior of bees, and stingless bee culture. After the training, community meliponaries were established in the two municipalities. Initial stocks of bee colonies were provided and monitored monthly. Biotic and abiotic factors greatly influenced the outcomes of the project.

The proposed policy for the conservation of stingless bees includes education of the general public on stingless bees, generation of public interest in stingless bees, establishment of a suitable environment for bee survival, creation of beekeepers' organizations/societies, and implementation of similar or supporting conservation policies.

INTRODUCTION

Rationale and Objectives

Beekeeping using stingless bees, known as meliponiculture, has gained widespread interest among people in all walks of life. Meliponiculture has been successfully adopted, especially in Bicol, since its introduction in 2003. The proponent, together with another researcher and a local beekeeper, introduced this technology to Bicolanos, particularly those in marginal communities, as a means of livelihood. Because it uses an indigenous species, *Tetragonula* sp., meliponiculture can be an alternative livelihood among rural folk without sacrificing biodiversity conservation.

With beekeeping becoming a fast-emerging industry, traders of stingless bee products and colonies now abound. However, unregulated transport of colonies could affect the population of wild stingless bees in the Bicol region. Hence, the development of new approaches to conserve the stingless bee population in the region, along with proper utilization and management of the ecosystem, is a potential area for research, development, and extension in meliponiculture.

In order to come up with a policy on conservation of the stingless bee population in the region, it is helpful to develop a community-based model meliponary to demonstrate sustainability via proper use of resources, careful management of colonies, and development of environment-friendly techniques. This undertaking would involve benchmarking indigenous knowledge and apicultural practices of the local communities, including honey production and apitherapy (medicinal use of bees, honey, and other bee products), as well as current techniques in handling and managing bees and bee products. Estimating the wild bee populations in the project sites would entail environmental scanning of bee habitat to determine colony density, supplemented with available Google earth images. Information from the benchmarking and environmental scanning is essential input in the development of conservation measures for the stingless bee species.

Background of the Study/Review of Related Literature

Beekeeping uses two groups of highly eusocial insects: Apinae (honeybees) and Meliponinae (stingless bees). There are at least 10 species of honeybees, among them the Asian honeybee, *Apis cerana*, and giant honeybee, *Apis dorsata*, which are beekeeping species in the Philippines and in other Asian countries.

Stingless bees have more than 400 species in tropical and subtropical areas; the genus *Tetragonula* is indigenous and abundantly found in the Bicol region.

Mostoles et al. (2010b) conducted studies from 1999 to 2003 to identify native bees in Bicol. They found *A. cerana, A. dorsata,* and *Trigona biroi* (now known as *Tetragonula*) in different landscapes. The presence of these species indicates the abundance of bee resources and favorable environmental conditions in the region. In the Bicol region, five species of *Tetragonula* have been classified in the following species groups: *laeviceps, iridipennis,* and *carbonaria* (Nicolas 2008). It is worth noting that eight species of stingless bees have been newly discovered in the Philippines—further evidence of the diversity and endemicity of the species in the country.

Mostoles and Ruiz (2010) have developed new techniques in stingless beekeeping in collaboration with a local beekeeper from Guinobatan, Albay as early as 2003. The resulting technology, meliponiculture, has been promoted and disseminated in various national and international forums. Numerous research studies have been conducted also, geared toward technology packaging.

With support from the Regional Apiculture Center (RAC), apiaries/meliponaries were established in various parts of the region. Palconitin's Apiary (now TOP-A Farm), which was the beekeepers' major source of colonies not only for the region but for other beekeepers across the country, was devastated by Typhoon Reming in 2006, but it was able to recover. According to Floreza Broqueza, proprietor of TOP-A Farm, her farm was instrumental in the inclusion of stingless bees in Balay Buhay sa Uma in Bulusan, Sorsogon. Other beekeepers put up meliponaries in Sorsogon, particularly in the municipalities of Bulusan, Donsol, and Casiguran, such as Grajo's Bee Farm, Father Barcelona's Farm, and PHI Farm. These were either individually managed or NGO-supported. Meliponaries were also found in the other provinces, such as Balmadrid's, Bees and U, Quiapo, Borromeo, MTB Meliponaries, and a number of small meliponaries managed by the graduating entomology students of Central Bicol State University of Agriculture (CBSUA) (Mostoles et al. 2014a).

The technology has been shared also with numerous individuals and institutions outside the region, who have gained interest in the importance and novelty of stingless bee culture. As a result, the demand for colonies has increased, resulting in massive collection of feral colonies to populate the adopters' meliponaries. Moreover, traders from outside of the region get wild bee colonies from Bicol and sell them in other parts of the country. All this could disrupt the stingless bee population in the region. The situation underscores the need for conservation measures and standardization procedures.

Using the Japanese hive design, Mostoles et al. (2010b) determined the productivity and adaptability of stingless bee colonies in seven meliponaries in Bicol by comparing the resulting number of brood layers and pollen and honey pots in cocoshell hives and those in the OATH/Box/Rafael's[1] hives in varying ecosystems. The cocoshell hives had more brood, honey, and pollen than the OATH/Box/Rafael's hives. Varying amounts of brood layers and honey and pollen pots were produced in the different meliponaries. Pollen sources and bloom pattern in each meliponary were also identified. Significant differences in meliponaries' performance were observed in the following top factors: terms of adaptability to the culture of stingless bees, technical know-how, and environmental concerns. Adaptability of meliponiculture was influenced by the beekeeper's technical know-how and environmental conditions. The performance of meliponaries found in agroecosystem, forest, mangrove, and coastal ecosystems also differed significantly. For instance, Abad's forest ecosystem compared to Servilla's mangrove ecosystem, MTB's agroecosystem compared to Barcelona's forest ecosystem. Other influencing factors include abundance of pollen and nectar sources, presence of canopies as barriers and bee shelter; and absence of pollutants, human disturbance, and pests (Mostoles et al. 2015).

The goal of meliponiculture is to maximize the use of stingless bee species for the production of honey, pollen, wax, royal jelly, and propolis, as well as to increase crop production through pollinations. Honeybees are among the most effective agents of crop pollination because they can easily cross-pollinate plants, ensuring higher fruit yield, and thus, provide higher income for farmers. Using stingless bees as pollinators have many advantages, too: they are harmless to farmers, active throughout the year, polylectic (visit a wide variety of crops), tolerant to high temperatures, can be transported easily, and hardly pose an environmental risk (e.g., invading natural habitats).

Several pollination studies had been conducted in the Philippines using native bees. Salazar (2007) determined the pollination efficiency of stingless bees on cucumber and pepper using open- and closed-pollination setups. Closed pollination using a colony of stingless bees improved the yield of both crops.

Mostoles et al. (2010, 2014a) reported that *Tetragonula* was found to be a common floral visitor of *Musa* spp., coconut, jackfruit, mango, and pigeon pea at Bernales' Farm. The stingless bees prefer these plant species due to their

1 OATH refers to original australian trigona hive, Rafael's box is two layered using plywood. maybe we can use just boxes which could either be OATH or Rafael's design. pls change OATH (Original Australian Trigona Hive)/Rafael's Box

abundance of nectar and pollen. They forage for pollen, nectar, and resin early in the morning, coinciding with the opening of the bracts.

Studies are ongoing to establish the pollination efficiency of stingless bees on various crops. Likewise, pollen, nectar, and propolis sources, as well as the bloom patterns in meliponaries are being studied, results of which could be useful input in the proper management of stingless bees under different ecosystems, with the bees' conservation in view.

Description of the Project Areas

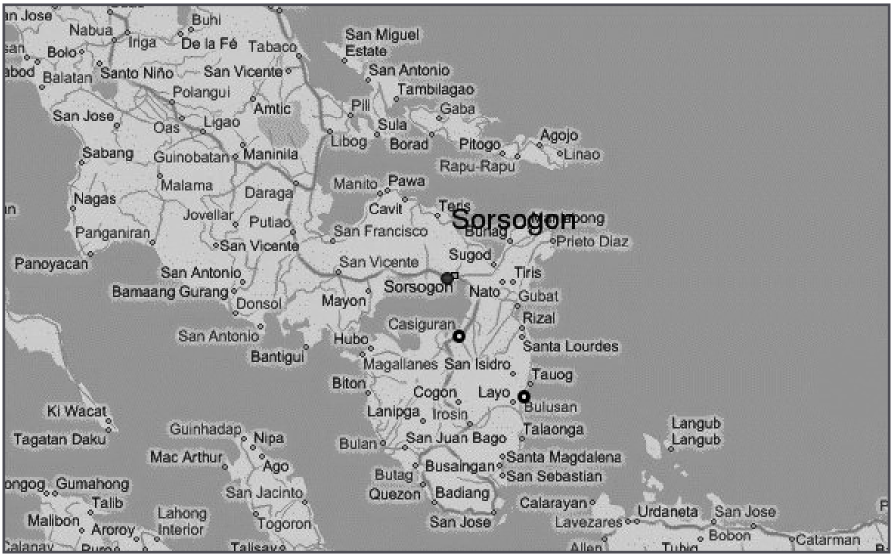
Based on preliminary data derived from RAC's research and monitoring, the following criteria were used to select the project sites: (1) presence of natural barriers (e.g., bodies of water and mountain ranges); (2) human (e.g., traders) transfer of colonies from one island to another; (3) existence of beekeepers, commercial bee farms/meliponaries; (4) abundance of wild/feral colonies; (5) rich vegetation serving as bee habitat and food sources; (6) presence of hunters and occurrence of destructive hunting practices; (7) accessibility of the target sites; and (8) peace and order situation.

Bulusan and Casiguran, both municipalities in Sorsogon province, were chosen as project sites (Figure 1). The presence of Balay Buhay in Bulusan and Grajo's Bee Farm in Casiguran was a determining factor in selecting the barangays.

Bulusan, a fourth-class municipality, is bordered by the towns of Barcelona, Casiguran, Juban, Irosin, and Santa Magdalena. Barangay San Roque in Bulusan has a dominant vegetation of coconut with a few betel nut, santol, gumamela, mango, rice, cacao, and other crops in an agroecosystem landscape. Its geographical position is 12°45'05.14" N and 124°08'08.97" E, with an eye altitude of 1,727 m and an elevation of 12.8 m above sea level (masl). San Roque is located in the mountain area and surrounded by coastal, forest, residential, grassland, and mangrove areas, having a slope level to nearly level, gently sloping to undulating, rolling to moderately steep, steep, undulating to rolling, and very steep.

Casiguran, also a fourth-class municipality, is on the coast of Sorsogon Bay. Among its 25 barangays, Barangay Inlagadian was chosen as project site for the distribution and abundance study due to sightings of stingless bees in the area by bee hunters. The barangay is also closest to Grajo's Bee Farm where the community apiary was located.

Figure 1. Map of project sites



Source: weather-forecast.com (2019)

METHODOLOGY

Ethnological/Meliponicultural Survey

The target barangays were appraised to (1) describe and evaluate the biophysical and socioeconomic characteristics of the area; (2) identify problems, opportunities, and constraints in the agro-farming systems; (3) design instruments for a detailed baseline survey; and (4) identify research gaps and possible interventions. The two barangays were described in terms of the parameters indicated.

Preliminary visits to the barangays, requests for meetings with local executives/officials and barangay leaders to present the project, and secure clearances to conduct the research were undertaken. Key informants who were identified by the municipal agriculture office and barangay officials were interviewed to identify indigenous apiculture activities in the project sites. Market information and other information were also used to help identify bee product gatherers as well as bee farms in the areas. Apiculture enthusiasts and practitioners were also noted.

Moreover, a focus group discussion (FGD) was done to gather information from bee hunters and other respondents of the study. It was conducted in areas where bee farms and hunters were identified during site reconnaissance. Nine hunters, two beekeepers, and two stakeholders from the local government unit (LGU) in Casiguran and one beekeeper, two stakeholders (LGU), and 14 farmers in Bulusan wre identified.

Activities and important events related to apiculture were documented, especially those on ethno-apidology practices in harnessing bee and bee products, from raising to product collection, processing, and utilization. Indigenous knowledge was documented specifically in established meliponaries in the project sites regarding production, harvesting, utilization, sustainable management, as well as handling of bees and bee products by conventional beekeepers. Colonies marketed within and outside of the region were documented also to determine the extent of human transfer of colonies.

Stingless Bee Distribution and Abundance in Casiguran and Bulusan

Stingless bee *(Tetragonula* sp.*)* colonies in the wild were mapped out and inventoried using the participatory research approach. Bee hunters in the project sites identified from the ethnological survey were involved. Nest sites were located through visual search. The Point Center Quarter Method (PCQM) was used to determine the abundance of colonies in each area. Each nest position was registered as a geographical coordinate using the Garmin global positioning systems (GPS) 12 XL. The intersection of these coordinates resulted in a panbiogeographic node that represents the area of occurrence of the species. The trees used for nesting, source, and habitat were described and recorded.

Nests found during the first visit (month 1) were marked. Three months later, the area was evaluated again for possible additional nests. The resulting information was used to determine the rate of colony division in the area. This information was useful for determining policies on the manner and frequency of feral colony hunting to conserve the stingless bees' population.

Sampling points in San Roque, Bulusan were identified at an interval of 50 m per point; transect lines had a mean distance of 150 m. Using a GPS and with assistance of bee hunters in the area, the exact locations (elevation and latitude) of the stingless bee colonies were marked. Equally spaced points along the area were then determined using nylon strings as transect lines. The diameter at the breast height was measured. Each transect line had a minimum of three points, and the trees near the point were also taken into consideration. The distance of the colony in reference to the tree(s) was measured.

A sample of 20 stingless bees was randomly collected from each colony. Adult bees were captured on the hive entrance using a sweep net, placed in vials with 95 percent ethanol, and properly labeled according to source and nesting habit. Their species was identified using a taxonomic key and confirmed through gene sequencing.

Two colonies were extracted from each nest site and brought to the laboratory for further examination. The colonies were characterized by analyzing the hive structure, hive entrance, brood construction, and honey and pollen storage pots.

The exact location (i.e., coordinates) and elevation of the stingless bees were encoded into a GIS software from digital data collection systems. The following survey instruments were used to plot the data: GARMIN GPS 12 XL GADM-BiogeMancer Project, WorldClim, and Philgis.com. The data were used to construct the distribution map of the stingless bees in the two municipalities using Quantum GIS Software (QGIS) version 1.8-0-Lisboa and DIVA-GIS software version 7.5 for precipitation and temperature ranges.

Community-Based Meliponary Establishment in Bulusan and Casiguran

The project's community-based approach to sustainable stingless beekeeping involved strengthening of human resource through training; strengthening of regulatory activities through policy review and development, accreditation, and quarantine measures; business ethics through social responsibility; and infrastructure development.

As mentioned earlier, the major project beneficiaries include bee hunters and selected members of the community. These hunters supplied the feral colonies needed by existing meliponaries; they were involved in a previous distribution and abundance study. Keeping them involved in the project and educating them on the risk of overexploiting wild colonies can help promote stingless bee conservation.

Through the LGUs, specifically the Municipal Agriculture Office (MAO), beneficiaries such as bee hunters and bee enthusiasts were shortlisted then trained on stewardship or values formation, benefits and potential of stingless beekeeping, biology and behavior of the bees, and the package of technology (POT) for stingless bees, which includes facilities, equipment, and conservation strategies. The training was followed by apiary development. The project assisted in establishing two meliponaries in each municipality. To comply with the requirements for starting meliponiculture, an environmental scanning was conducted.

Pro-biodiversity activities were encouraged among the community members, such as support for pollination and reduced use of chemicals in farming. Community members were taught about the role of bees as main pollinators of agricultural crops, mangrove, forest trees, and other multipurpose tree species. The role of bees in viable seed formation of wild plants, fruit trees, vine and vegetables was also highlighted. The community was also taught that establishing vegetation in marginal and barren areas contributes to biodiversity conservation.

Changes in rainfall pattern, temperature, and other climatic factors could greatly affect the floral pattern of bee forage plants, which in turn results in low honey and crop yield as well as increasing meliponary maintenance costs. Thus, the communities will have to continuously determine the pollen, nectar, and propolis sources of the stingless bees as well as bloom pattern, biotic, and abiotic factors to ensure the success and sustainability of their meliponaries. Once the meliponary becomes productive, it also needs to monitor the sales of colonies and where these are marketed or distributed to.

Crafting Policies on the Conservation of Stingless Bees

Republic Act 9151 established the National Apiculture Research, Training and Development Institute (NARTDI) as the lead institution in the development and promotion of the beekeeping industry, in coordination with the Department of Agriculture (DA), Department of Science and Technology (DOST), Department of Environment and Natural Resources (DENR), and state universities and colleges (SUCs), among others. In addition, the DA has issued an administrative order that integrates beekeeping development programs in the National Livestock Program. These pieces of legislation are important in the formulation of appropriate regulations and quarantine measures in the Philippines, which should be at par with the standards of international bodies.

Conservation of native bees is a major thrust in the Bee Industry Roadmap. In order to have an effective operational and regulatory environment, beekeeping policies must be carefully formulated, reviewed, and implemented. The Bee Industry Roadmap includes programs that strengthen and build on institutional capabilities.

Information gathered from previous studies was used in crafting conservation policies and strategies for stingless bees in the province. These will be submitted to appropriate bodies for adoption and implementation.

Limitations of the Study

Limitations included abiotic and biotic factors. The first constraint was the distance of the project sites to the base agency of the proponent. Thus, monitoring frequency was reduced from monthly to once in two months. Moreover, in lieu of the proponent, a staff member from the MAO conducted the monitoring activities.

Typhoon Glenda disrupted the establishment of meliponaries and other beekeeping activities. It destroyed vegetations, which provide the bees' sources of nectar and pollen. This delayed the project activities.

Another limitation of the study was the low attendance of hunters during training activities, and their negative work attitude toward collaboration.

RESULTS AND DISCUSSION

Ethnological/Meliponicultural Survey

Sociodemographic profile of the respondents

The project had a total of 29 respondents: 14 in Casiguran and 15 in Bulusan. They were engaged through training and acquisition of initial stock for their respective meliponaries. The Casiguran respondents came from five barangays: San Juan, Mabini, Inlagadian, Escuala, and Tigbao. The Bulusan respondents came from six barangays: San Rafael, San Roque, San Jose, San Francisco, San Bernardo, and Bulusan Proper. Table 1 presents the respondents' profile.

Age. More than half (57.14%) of the Casiguran respondents belonged to the 21-40 years old group and more than a third (35.72%) to the 41–60 years old group. Only one respondent was more than 60 years old. This means that the majority of potential beekeepers and hunters in Casiguran belonged to the middle-aged groups 1 to 3. A similar trend was observed in Bulusan, although there were more respondents belonging to the 41–60 years old group and two respondents were younger than 21 years old. Those between 21 and 60 years of age were more active and interested in beekeeping.

Sex. All respondents—the hunters and associates—were male. Purposive sampling was done by the MAO to identify the respondents. Males are more likely to be involved in beekeeping activities due to risks involved, such as climbing trees, trekking mountains, and extracting colonies from nest trees. Women preferred to take care of the bees in the farmstead.

Civil Status. All the respondents in Casiguran were married. Among the Bulusan respondents, 60 percent were married, 20 percent were single, and 20 percent were separated from their spouses. All respondents engaged in beekeeping and hunting as a livelihood to sustain their families.

Number of Children. The number of children per family ranged 4–6 (64.29%) and 1–3 (35.71%) in Casiguran; and 1–3 (40%) and 4–6 (27%) in Bulusan. It was inferred that because the Casiguran respondents had more children, there was a bigger need for them to have other means of livelihood to augment their basic source of income.

Educational Attainment. More than half of all respondents completed their elementary education. Sixty-four percent of the Casiguran respondents and 58 percent of the Bulusan respondents did not pursue high school education. Only about one-fifth (21.4%) of respondents in Casiguran and about one-third (33.3%) in Bulusan obtained a high school diploma. Among the 29 respondents, only four (13.8%) were able to pursue college education. A respondent from Casiguran was employed at the MAO and another was a farm owner. Two respondents from Bulusan finished college and were self-employed.

Table 1. Sociodemographic profile of beekeepers/bee hunters in Casiguran and Bulusan, Sorsogon (April 2014)

Profile	Casiguran		Bulusan		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Age						
>21	0	0	2	13.33	2	6.9
21-40	8	57.14	4	26.67	12	41.4
41-60	5	35.72	8	53.33	13	44.7
>60	1	7.14	0	0	1	3.5
No Answer	0	0	1	6.67	1	3.5
Total	14	100	15	100	29	100
Sex						
Male	14	100	15	100	29	100
Female	0	0	0	0	0	0
Total	14	100	15	100	29	100
Civil status						
Single	0	0	3	20	3	10.3
Married	14	100	9	60	23	79.4
Separated	0	0	3	20	3	10.3
Widow/er	0	0	0	0	0	0
Total	14	100	15	100	29	100
Number of children						
None	0	0	3	20	3	10.34
1-3	5	35.71	6	40	11	37.93
4-6	9	64.29	4	27	13	44.83
7 above	0	0	2	13	2	6.9
Total	14	100	15	100	29	100
Educational attainment						
Elementary	9	64.3	8	53.4	17	58.6
High school	3	21.4	5	33.3	8	27.6
Vocational	0	0	0	0	0	0
College	2	14.3	2	13.3	4	13.8
Total	14	100	15			
Religion						
Roman Catholic	14	100	10	66.6	24	82.75
Aglipayan	0	0	1	6.7	1	3.45
Born Again	0	0	0	0	0	

Continued on next page

Table 1. Continued

Profile	Casiguran		Bulusan		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
INC	0	0	3	20.0	3	10.35
Others	0	0	1	6.7	1	3.45
Total	14	100	15	100	29	100
Average family income (PHP)						
<1001	3	21.43	2	13.33	5	17.24
1001-5000	5	35.71	8	53.33	13	44.83
5001-10000	3	21.43	2	13.33	5	17.24
10,001-15,000	2	14.29	1	6.68	3	10.34
15,001-20,000	0	0	2	13.33	2	6.90
20,001-25,000	1	7.14	0	0	1	3.45
Total	14	100	15		29	100
Income derived from apiculture (PHP)						
<1001	5	35.71	6	40.00	11	37.93
1001-5000	2	14.29	2	13.33	4	13.79
5001-10000	2	14.29	3	20.0	5	17.24
10,001-15,000	1	7.14	0	0	1	3.45
No answer	4	28.57	4	26.67	8	27.59
Total	14	100	15	100		
Main source of income (multiple responses)						
Farming	13	38.2	9	25.8	22	31.9
Employment	2	5.9	3	8.6	5	7.2
Labor	5	14.7	4	11.4	9	13.0
Apiculture	14	41.2	15	42.8	29	42.12
Others	0	0	4	11.4	4	5.8
Total	34	100	35	100	69	100

Religious Affiliation. The majority (82.75%) of respondents were Roman Catholic, while the rest belonged to religious groups such as Aglipayan, Iglesia ni Cristo, and others (not specified). While no link was observed between religion and success in beekeeping, religion could be a factor for effective community involvement.

Average Household Size and Involvement in Beekeeping. The average household size was five for Casiguran and six for Bulusan. In Casiguran, two household members (the head of family, usually the father, and another family member) were involved in beekeeping, This is best exemplified in Grajo's Farm, wherein the son took up the beekeeping initiatives started by his father. However, when the son left for an overseas job, the father re-assumed the responsibility along with his daughters. Meanwhile in Bulusan, only one family member (usually the father) was involved in beekeeping. Respondents in the area said it was difficult to involve other family members due to the risks involved in bee hunting.

Main Source of Income and Average Income. The respondents' work occupations were: hunters/beekeepers (42.1%), farming (31.9%), laborers (13.0%), government employment (7.2%), and buy-and-sell business (5.8%). Several respondents continued with beekeeping activities despite getting employed in the government. Others worked as laborers, construction workers, and farmers at the same time. During dearth periods (non-honey flow season), the respondents sought other jobs.

Thirteen of the respondents (44.83% of the farmers) declared an average family income of PHP 1,000–5,000/month. Five respondents earned below PHP 1,000 and the rest had more than PHP 5,000/month; none exceeded PhP 25,000/month. The farmers were paid on contractual basis. The income of respondents who worked primarily as hunters depended on the number of acquired colonies and honey. The income of respondents who doubled as laborers depended on the availability of work in their immediate vicinity. Respondents who were government employees had monthly incomes ranging from PHP 15,000 to PHP 25,000.

Apiculture involvement

The respondents were classified as hunters, beekeepers, and hunters-beekeepers. Among the 29 respondents, 25 (86.21%) were bee hunters and 4 (13.79%) were beekeepers (Table 2). The hunters usually gathered *A. cerana,* known as native honeybees (41.3%), *T. biroi* (stingless bees) (37.9%), and *A. dorsata, (*giant honeybees) (20.7%). The Bulusan hunters were more familiar with stingless bees that they hunted and sold to Balay Buhay sa Uma.

The hunters would detach the feral colonies from nest trees and bring them to the farm, where they were cultured. They were more adept in hunting giant honeybees for honey. They were influenced to engage in beekeeping mostly by friends who had taken up bee hunting (37.4%), family (25%), neighbors and others (9.38%), and parents/extensionists/academics (6.25%).

The oldest hunter was from Casiguran; he started hunting *A. cerana* and *A. dorsata* colonies in 1989 in Inlagadian, an area at the foot of Mt. Bulusan. His weekly hunt yielded at least four colonies. Another bee hunter sought *A. cerana, A. dorsata,* and *T. biroi* colonies at least twice a month starting in 1994. Each hunting run in Barangay San Juan in Casiguran usually yielded 10 colonies. From 1997 to 2000, four respondents hunted *A. dorsata* and *A. cerana* colonies on a bimonthly basis, collecting 2-3 colonies from Inlagadian during each hunting run. Only one hunter managed to collect four colonies each of the three bee species (*A. dorsata, A. cerana,* and *T. biroi*) in the higher elevations of Mt. Bulusan on a weekly basis in 2000. The Casiguran hunters were mostly from Barangays Inlagadian and San Juan.

Table 2. Apiculture involvement of bee hunters and beekeepers in Casiguran and Bulusan, Sorsogon (April, 2014)

Parameter	Casiguran		Bulusan		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Hunter	13	92.8	12	80	25	86.21
Beekeeper	1	7.2	3	20	4	13.79
Total	14	100	15	100	29	100
Bees gathered/ maintained						
A. cerana	6	42.86	6	40	12	41.38
T. biroi	4	28.57	7	46.67	11	37.93
A. dorsata	4	28.57	2	13.33	6	20.69
Total	14	100	15	100	29	100
Influencers						
Parents	1	9.09	1	4.76	2	6.25
Family	5	45.46	3	14.29	8	25
Neighbor	0	0	3	14.29	3	9.38
Friend	2	18.18	10	47.61	12	37.4
Extensionist	2	18.18	0	0	2	6.25
Academe	1	9.09	1	4.76	2	6.25
Others	0	0	3	14.29	3	9.38
Total	11	100	21	100	32	100
Harvesting frequency						
Monthly	1	7.14	1	6.67	2	6.89
Quarterly	1	7.14	4	26.66	5	17.24
Biannual	4	28.58	1	6.67	5	17.24
Yearly	7	50	6	40	13	44.84
Others	1	7.14	3	20	4	13.79
Total	14	100	15	100	29	100
Use of products						
Sold	10	52.63	17	56.68	27	55.10
Consumed	5	26.32	7	23.33	12	24.49
Social functions	0	0	1	3.33	1	2.04
Medicinal purposes	4	21.05	4	13.33	8	16.33
Others	0	0	1	3.33	1	2.04
Total	19	100	30	100	49	100
Knowledge of beekeeping						
With knowledge	6	42.86	7	46.67	13	44.83
None	8	57.14	8	53.33	16	55.17
Total	14	100	15	100	29	100
Source of knowledge						
Experience	4	28.58	7	46.67	11	37.93
Formal training	1	7.14	0	0	1	3.45
Media	0	0	0	0	0	0
Extensionist	1	7.14	0	0	1	3.45
None	8	57.14	8	53.33	16	55.17
Total	14		15	100	29	100
Receiving assistance						
Yes	0	0	3	20	3	10.34

Continued on next page

Table 2. Continued

Parameter	Casiguran		Bulusan		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
No	14	100	12	80	26	89.66
Total	14	100	15	100	29	100
Types of assistance needed						
Financial	8	40	7	31.82	15	35.71
Technical	8	40	11	50	19	45.24
Moral	4	20	4	18.18	8	19.05
Others	0	0	0	0	0	0
Total	20	100	22	100	42	100
Source of assistance						
Academe	3	13.04	5	14.71	8	14.04
Private Institutions	5	21.73	3	8.82	8	14.04
LGU	6	26.09	10	29.41	16	28.07
DA	5	21.74	8	23.53	13	22.81
Peer	1	4.35	3	8.83	4	7.02
Relatives	1	4.35	2	5.88	3	5.26
NGO/POS	2	8.7	2	5.88	4	7.02
Others	0	0	1	2.94	1	1.74
Total	23	100	34	100	57	100

The Bulusan hunters started bee hunting as early as 1976, specifically hunting *A. dorsata* and *A. cerana;* their yield was at least one colony weekly. Those who started hunting in 1980, 1983, 1984, 1989, 1990, 1996 and 2000 hunted only the two Apis species, while those who started hunting in 1989 and 2004 hunted all three bee species. One hunter who started in 2011 specialized in hunting *A. dorsata* only; his quarterly hunting runs yielded at least five colonies per month. It was noted that new hunters (those who started in 2013 and 2014) focused on stingless bees, collecting 5-10 colonies weekly. They supplied the colonies to existing bee farms in the municipality. Colonies hunted by local bee hunters were extracted from nests in the forests and agroforests surrounding Mt. Bulusan, particularly in Barangays San Roque and San Francisco.

The respondents' hunting frequency varied as follows: yearly (44.84%), quarterly and biannually (17.24%), monthly (6.89%), and no definite time or frequency (13.79%). The hunting frequency may be associated with the bees' honey production season or the honey flow season. During this season, there is an abundant supply of feral colonies in the forests of Bulusan and Casiguran. Some hunters would hunt twice a year when they needed additional income. Particularly, stingless bees were hunted based on the demand of colony buyers; thus, some hunters continuously hunted feral colonies on a monthly basis.

The introduction of stingless bees as a new source of livelihood has opened this endemic resource to a greater risk of depletion. Thus, there is a need to put in place measures to protect the bees' population such as regulating hunting frequency and the movement of feral colonies outside the region.

The hunters mostly sold directly (55.10%) the honey/bee products they collected at their homestead or in the market. Some consumed (24.49%) the bee products and/or used them for medicinal purposes (16.33%), social functions (2.04%), and others purposes (2.04%).

Most (55.17%) respondents did not have knowledge of beekeeping initially, but they persisted due to the influence of successful and productive hunters in the area. Almost half (44.83%) of them were trained by the owner of Grajo's farm in collaboration with beekeepers from Albay and Laguna. Some learned just from experience (37.93%) while a few (3.45%) underwent training conducted by an extensionist.

Assistance had been very limited, with respondents in Bulusan receiving more assistance than those in Casiguran. Among the 29 respondents, 26 (89.66%) received no assistance at all. Only three respondents benefited from an assistance provided by the LGU, particularly a training in stingless beekeeping. The respondents clamored for technical, financial, and even psychological assistance. Almost half of them indicated their need to learn the basic skills on beekeeping; half emphasized the need for financial support. Some of the hunter-respondents in Bulusan attended a training organized by the Balay Buhay sa Uma owner in 2013 but they had insufficient funds to start their own bee farms. Because of this, they remained as feral colony suppliers of the farm.

Various forms of assistance had been provided by different entities such as the LGU and the DA. The academe also provided technical assistance and private institutions offered financial assistance. A few respondents obtained assistance from peers and nongovernment organizations/people's organization (NGOs/POs) (4%) and from relatives (3%).

Regarding their knowledge of the usefulness of honey and other bee products, particularly on wellness, the Casiguran respondents indicated knowledge of their basic uses: honey and pollen as vitamins and food supplements, propolis as tincture for wounds, and wax as material for candle-making. They did not know about the chemical contents of honey and pollen that make these potent as vitamin and food supplements. Also, although they know that bees wax is used in candle-making, they themselves had not tried doing this.

The Bulusan respondents had more knowledge of the uses of bee products since some of them had attended training in beekeeping that discussed the uses and benefits of these products. They indicated that honey is a good source of vitamin C and that it increases stamina and body resistance against colds. They also knew that when mixed with lemon, honey can alleviate cold symptoms and that when added with garlic, it can alleviate cough symptoms, cure asthma, and be used as a cooking condiment. Bee pollen, on the other hand, can be used to condition fighting cocks, as energy source, and for various medicinal purposes. Bee propolis can be used to cure skin problems and as an additive to skin creams. Aside from candle-making, bees wax can be used as floor wax and processed as a beauty product.

Among the many uses of honey and other bee products, respondents indicated that the use of honey to cure asthma, colds, and cough is considered indigenous knowledge. The other uses of honey and other bee products were gleaned from training, seminars, the media, and through word of mouth.

Beekeeping practices of hunters

Table 3 presents the hunting practices of the respondents. Multiple responses were obtained from the bee hunters.

According to majority of hunter-respondents (62%), the best time for hunting is 6:00-9:00 a.m., particularly for *A. dorsata* (*pukyutan*), when the bees actively forage. Also, the early morning schedule considers the time it takes to trek up the mountains and search for wild bee colonies. On the other hand, more than a third (35%) of them hunted at 3:00-6:00 p.m. and a few (3%) at 9:00-11:00 a.m.

The hunter-respondents commonly hunted for honey and feral colonies during the honey flow season, or the months when many plants and trees are in bloom. In Sorsogon, this season usually occurs from December until May. The bee hunters were after the bee products—honey, pollen, propolis, and bees wax—of *A. dorsata* and *A. cerana* and feral colonies of *A. cerana* (*laywan*) and *T. biroi* (*lukot* or stingless bees).

Most hunters went to the mountains for the sole reason of collecting *pukyutan* honey during the honey flow season (70.59%). Others also collected pollen (12%), propolis (6%), and bees wax (12%). It was noted that hunters engaged in the bad practice of collecting the honeycombs and not tending to the bee brood. When hunters brought home the combs, they fed the bee brood to chickens, took out pollen from the cells, then melted the combs to extract bees wax.

Honey was extracted via the following methods: hand squeezing (54%), honey press (28%), using a mesh cloth (11%), and drip method (7%). The hunters preferred hand squeezing in the absence of a mechanical extractor because it is easier and faster. Some hunters preferred the drip method, specifically for stingless bees honey extraction, because it prevents the pollen from mixing with the honey.

The stingless bee honey normally has a tangy taste due to the pollen mixing with the honey during extraction. This can be minimized by using the drip method. For p*ukyutan* and *laywan* honey, the combs are pressed, squeezed, and filtered using a mesh cloth. Hunters usually mixed combs with ripe honey (cells sealed with wax) and unripe honey (open cells with high moisture levels). As a result, the honey harvested usually has a high moisture content level, which beekeepers do not consider as "pure" honey.

Table 3. Beekeeping practices of hunters in Casiguran and Bulusan (April 2014)

Parameter	Casiguran		Bulusan		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Best time to hunt bees						
6-9 a.m.	8	61.55	15	62.5	23	62.16
9-11 a.m.	1	7.69	0	0	1	2.70
11 a.m.-1 p.m.	0	0	0	0	0	0
1-3 p.m.	0	0	0	0	0	0
3-6 p.m.	4	30.769	9	37.5	13	35.14
Total	13	100	24	100	37	100
Bee products harvested						
Honey	11	64.71	13	76.47	24	70.59
Pollen	3	17.65	1	5.88	4	11.76
Propolis	2	11.76	0	0	2	5.89
Bees wax	1	5.88	3	17.65	4	11.76
Others	0	0	0	0	0	0
Total	17	100	17	100	34	100
Harvesting techniques						
Honey						
Honey press	6	50	2	12.5	8	28.57
Using mesh cloth	2	16.67	1	6.25	3	10.71
Hand squeezing	4	33.33	11	68.75	15	53.57
Crushing	0	0	0	0	0	0
Dripping	0	0	2	12.5	2	7.15
Total	12	100	16	100	28	100
Pollen						
Picking	3	100	1	100	4	100
Bees wax						
Solar melter	1	100	3	100	4	100
Propolis						
Scrapping	2	100	0	0	2	100

Pollen is never collected by the hunters from the honeycombs of *A. dorsata* and *A. cerana*. The combs filled with pollen are left in the field together with the brood combs. In the case of *T. biroi*, the colonies from the forest are detached from the nest trees and brought home. Pollen, bees wax, and propolis are harvested together with honey. Pollen or bee bread are individually removed from the pollen pots and air dried. Four of the 29 respondents extracted honey by hand press method. After the honey and pollen are extracted from the pots, the combs undergo solar melting to obtain the bees wax. Two hunters in Casiguran collected propolis employing the scraping method.

Marketing of the bee products

Table 4 indicates the respondents' selling scheme and mode of selling, as well as how they determine the products' prices and their sources of price information.

Most (57%) of the hunter-respondents bottled their extracted honey and sold these at the market directly or at their home (buyers picked up the products). On the other hand, 43 percent of the respondents delivered their bottled honey to buyers. More than half (55%) of the respondents engaged in direct selling, while the rest bought the other hunters' products and sold these to their pool of clients.

Pricing of bee products was based either on the approximation of the hunters (68%), and the quality of the product (27%). The remaining (5%) respondents set their products' prices on a case-to-case basis. Most (56%) respondents did not depend on traders or popular media as sources of information, while the remainder (44%) indicated that they gleaned information from the traders.

Table 4. Marketing of bee products by hunters in Casiguran and Bulusan, Sorsogon (April 2014).

Parameter	Casiguran		Bulusan		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Selling scheme						
Market	4	57.14	2	14.28	6	28.57
Delivered	3	42.86	6	42.86	9	42.86
Others	0	0	6	42.86	6	28.57
Total	7	100	14	100	21	100
Mode of selling						
Buyer	3	42.85	2	15.38	5	25
Seller	4	57.14	7	53.85	11	55
Other	0	0	4	30.77	4	20
Total	7	100	13	100	20	100
Pricing						
Prevailing price	6	100	9	56.25	15	68.18
Quality	0	0	6	37.5	6	27.27
Others	0	0	1	6.25	1	4.55
Total	6	100	16	100	22	100
Source of price information						
Trader	3	100	4	30.77	7	43.75
Beekeeper	0	0	9	69.23	9	56.25
Total	3	100	13	100	16	100

Problems encountered by bee hunters

Based on the FGD, the following were the common problems encountered by bee hunters:

1. risks of injury from bee and ant stings, wild pig and snake bites, and trees with spines and falling forest debris;
2. difficulty to hunt during the rainy season, when bees are more aggressive and honey harvest is reduced because of fewer flowering plants as nectar sources; and the trails are more slippery, especially in higher elevation;
3. time consuming and difficult; hunters lack proper paraphernalia in climbing tall trees heavily surrounded by parasitic plants/vines;
4. lack of skills in hunting and collecting honey, resulting in damaged colonies;
5. inappropriate transport method or facility of the acquired colonies; and
6. problematic peace and order situation in the hunting area.

Other problems were also encountered during marketing of the products, especially honey from *pukyutan* and *laywan*. The quality was often questionable due to the undetermined purity of the honey. Some hunters adulterated the honey with sugar solution or molasses to increase the product volume. The other hunters were not aware that mixing ripe and unripe honey can affect the product quality. Moreover, sellers in the market placed the honey in pails, prominently displaying combs and floating bees in order to convince buyers of the honey's purity. However, this is a very unhygienic practice that reduces the honey's quality. In other cases, honey was packed in unsterilized/non-food grade/recycled plastic bottles, which affected the quality of the product.

Extraction from honey pots was a major problem for stingless bee honey because of the unavailability of an efficient extractor. As such, squeezing and drip methods were employed, which exposed the honey to contaminants. Packing acidic stingless bee honey in plastic bottles causes an adverse reaction, which reduces honey quality. Long storage in plastic bottles, on the other hand, could lead to spillage, resulting in reduced honey quantity.

The hunters in Bulusan cited a problem regarding marketing of colonies. They sold hunted colonies to the bee farm in the barangay. After delivery of the colonies to the farm, the hunters had to wait for 15 days before being paid. This payment scheme was an insurance measure of the bee farm, in that it pays only for colonies that survived after the 15-day period. The hunters who delivered resilient colonies received their pay. The payment was determined by the buyer, and ranged from PHP 100 to PHP 150 per colony. The hunters did not get paid if the farm caretaker declared that their colonies died within the 15-day period, but they claimed that they were not shown proof of the dead colonies. They said they were forced to abide by the bee farm's terms since they did not have any other market. Some of them, however, had decided to culture the bee colonies that were not sold, even if they lacked know-how. Thus, they need to be trained in culturing stingless bee colonies.

Distribution and Abundance of Stingless Bees

The distribution and abundance of wild stingless bees at Casiguran and Bulusan were studied initially in May 2014. In Bulusan, this was done in Barangay San Roque because it had a farm that bought feral colonies. In Casiguran, the study was conducted in Barangay Inlagadian, which was reported by the hunters to be the major source of feral colonies that were supplied to the bee farm in the municipality. The number of colonies in each site was counted, the vegetation was identified, and the type of nesting was documented. Three colonies were obtained from each site and brought to Camarines Sur for morphological and colony characterization and identification. After three months and onwards, the same nesting sites were visited to recount the colonies.

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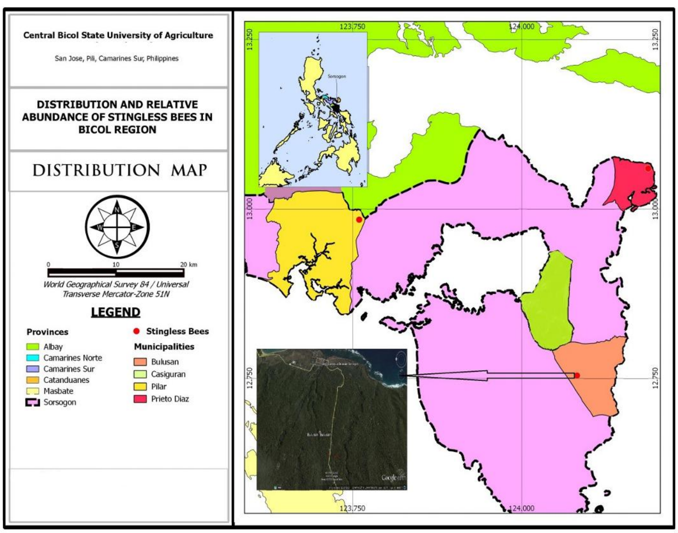
A transect line was laid down in three points to determine the distance of the colony nearest to the point. For Colony 1 (attached to coconut), the trees near the point were coconut *(Cocos nucifera)*, santol *(Sandoricum koetjape)*, mango *(Mangifera indica)*, and cacao *(Theobroma cacao)*, with a mean distance of 18 m. Colony 1 was attached 5 m from the base of a 20 m tall coconut. The second colony was found nesting 7 m from the base of another coconut tree 26 m away from the first colony. The height of this coconut was 18 m. The third colony was sighted on another coconut tree, which was 11 m from the first colony. This coconut tree was 7 m tall, and the colony nested 3 m from its base.

It was found that in that particular area bees used coconut trees as nesting sites. The hunters said the sampling time of this study was done a few months prior to the hunting season for feral colonies, which is why a very low population of colonies was observed in the area. During the honey flow season (December to May), more colonies of stingless bees could be extracted from coconuts.

The year-round blooming of coconut makes it a preferred nesting site of stingless bees, usually in *Drynaria,* a fern species. Mostoles et al. (2015) reported similar results in the other provinces of Catanduanes, Masbate, Albay, Camarines Sur, and Camarines Norte. Furthermore, Mostoles et al. (2015) observed that the land cover and floral resources influenced the adaptability of stingless bee to different ecosystems. The dominance of coconut in San Roque served as nectar and pollen sources of the stingless bees, contributing to their abundance. However, there were other factors, such as the uneven distribution of preferred floral resources within the forest strata and the fact that most of the other trees visited by stingless bees produced only small, inconspicuous, generalized flowers. Stingless bees are particularly abundant in drier areas and disturbed environments, including human settlements (Ramalho 2003).

Using available geospatial data, the study generated the natural occurrence map, which shows the distribution of stingless bees in San Roque (Figure 2) with a steep slope (Figure 3). All colonies were found attached to coconut trees, which were 18–20 m tall, geographically positioned 12°44'49.79" N, 124°07'12.08" E, elevation of 113.6904 masl, and 12°44'49.50" N, 124°07'10.02" E, elevation of 117.0432 masl. A vegetation and land-use map was also generated, showing Colony 1 and Colony 2 in shrubs/coconut (Figure 4) and Colony 3 in grassland/shrubs, coconut/grasses.

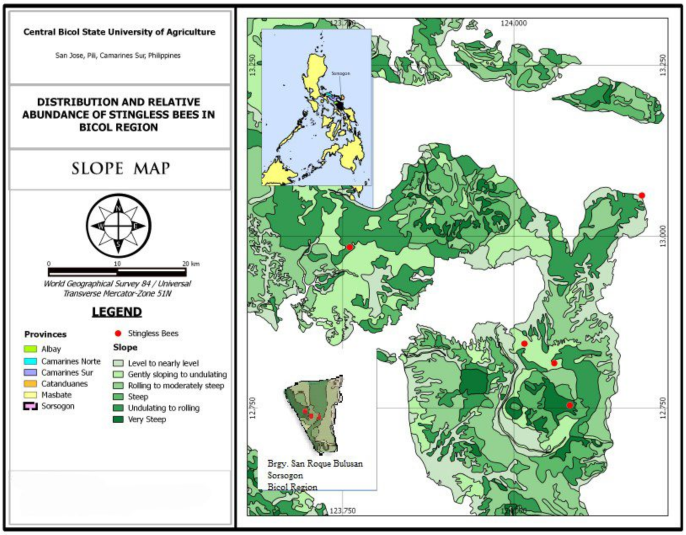
Figure 2. Stingless bees' geographical distribution map of Bulusan, Sorsogon



Reference: PhilGIS (2019)

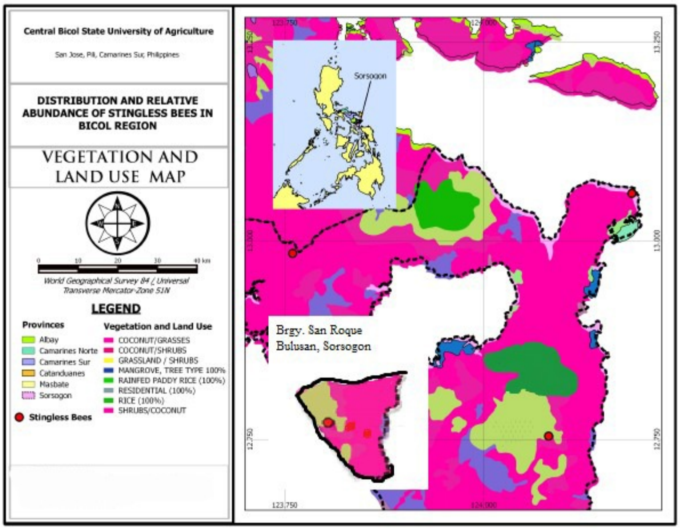
Using the World Geographical Survey 84/Universal Mercator-Zone 51N and the five-year isohyetal data of PAGASA, an annual mean precipitation map was generated. Annual precipitation ranges from 160 to 240 mm (Figure 5). A monthly average temperature graph was also generated. Average temperature was 26.7°C (Figure 6).

Figure 3. Slope class map of Bulusan, Sorsogon



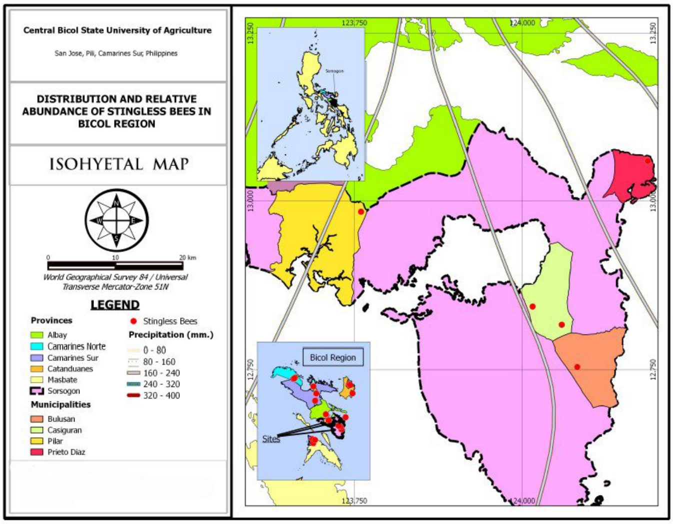
Reference: PhilGIS (2019)

Figure 4. Vegetation and land use map of Bulusan, Sorsogon



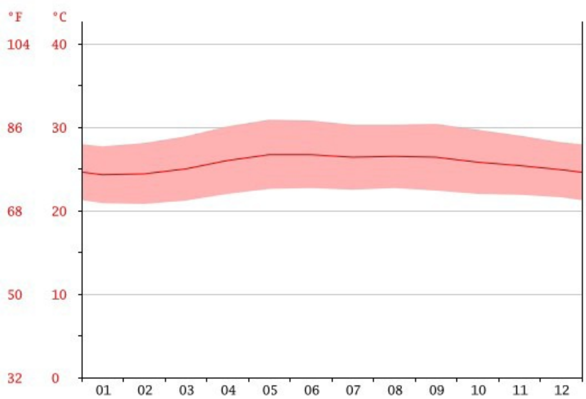
Reference: PhilGIS (2019)

Figure 5. Annual isohyetal range map of Bulusan, Sorsogon



Reference: PhilGIS (2019)

Figure 6. Monthly average temperature of Casiguran and Bulusan, Sorsogon



Abiotic factors may have affected the population dynamics, reproduction, and distribution of the stingless bees. Given the precipitation range, the stingless bees cannot gather food from floral sources because of the colony's vulnerability to water. Water can penetrate the interior part, resulting in high moisture that encourages the growth of fungi and other moisture-loving insects inside the colony, leading to absconding. Mostoles et al. (2015) noted the presence of powder beetles infesting the brood and compromising pollen and honey production due to water penetrating the colony.

The abovementioned maps are useful in understanding the occurrence of stingless bees in a particular area. They can also be used to measure the distance between a colony and the study sites, along with the exact coordinates and geographical position of stingless bees.

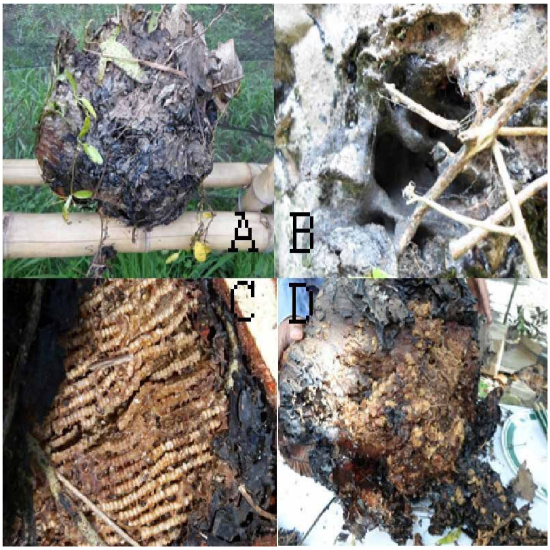
The architecture of the stingless bee nest maintains the nest temperature. Both architectural features and bee behavior decrease vulnerability, while large genera vary in nest habit, architecture, and defense against intruders (Roubik 2006).

It must be noted, however, that stingless bees construct a specific nest entrance. As mentioned earlier, stingless bee Colony 1 was found attached to a coconut tree (Figure 7A). The setup characterized an open nesting with the hive structure entirely occupied by nest elements. The hive's outside was almost completely covered by thick black batumen and associated with a fern species covering the cylindrical nest (Figure 8A). The shape of the nest entrance was irregular, and the dimension of the orifice varied with the size of the nest. The nest entrance was positioned at the third fraction of the nest; the single pillar connected to the entrance wall served as entrance to the hive (Figure 8B). The innermost part of the nest was composed of three layers—the first layer contained pollen pots and the second layer contained spherical brood cells, which were in a comb-like configuration and enclosed with yellow cerumen. The brood was horizontal in orientation and arranged in a spiral form. It was located at the lower middle part of the nest and surrounded by sheets of involucrum. The new brood layers were yellow, while the old ones were dark yellow (Figure 8C). The brood was connected by a tiny pillar that separated the combs from each other.

The third layer contained the storage pots whose shape ranged from spherical to oblong. The honey and pollen pots were very similar in size and shape, but differed in color. The honey pots were dark brown while the pollen pots were

Figure 7. Colony structures, semi-open nesting, and source

Figure 8. Nest architecture of stingless bee colony 1 nesting in coconut tree (San Roque, Bulusan, Sorsogon)



Note: (A) hive structure, (B) nest entrance, (C) Brood construction, and (D) pollen and honey pots

yellowish brown (Figure 8D). Both pots were enclosed in a sheath that protected the honey from contamination and prolonged its storage life. The stingless bee nest was observed to be associated with an ant colony. These findings corroborated a study by Roubik (2006) and confirmed that a stingless bee nest may be associated with termite, wasp, and ant colonies.

Colony 2 was located in a fern attached to the coconut tree (Figure 7B). This colony differed in size from Colony 1 (Figure 7A). The hive structure was entirely occupied by fern. This was the only colony located in an isolated area and covered by fern. The hive's exterior was populated by fern, which play an important function in the development, thermal regulation, and protection of the nest against enemies and intruders (Figure 9A). It was observed that the bees used some lateral fern branches as support through the nest cavity. The nest entrance was found in the middle part of the nest. The sole opening was the large hive entrance composed of hard, ear-shaped propolis and bee resin (Figure 9B). The inner part of the nest was composed of three layers. Similar to Colony 1, the first layer was composed of pollen pots and the second layer contained the brood cells and was located in the lower middle part of the nest. The brood was regularly arranged in a double-layered comb (two single combs melded together). The tiny pillar both connects and separates the brood layers.

Figure 9. Nest architecture of stingless bee colony 2, nesting in coconut tree (San Roque, Bulusan, Sorsogon)

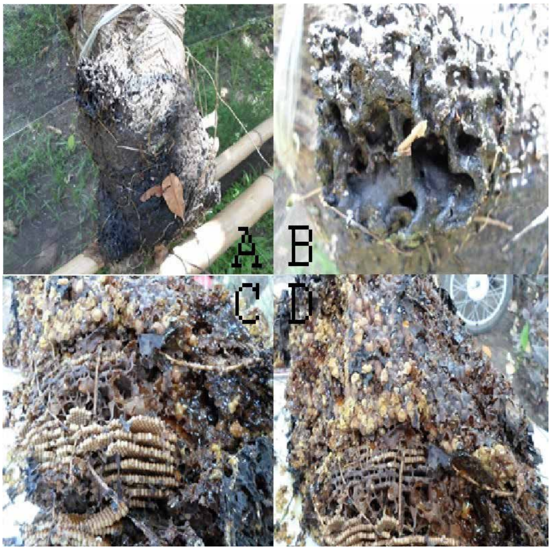
Note: (A) hive structure, (B) nest entrance, (C) brood construction, and (D) pollen and honey pots

Each spherical egg was enclosed in yellow cerumen, which protected it from harmful chemicals. The new brood cells were yellow, while the old ones were dark yellow and enclosed in cerumen (Figure 9C).

The third layer contained spherical to oblong-shaped honey pots and similarly-shaped but differently-colored pollen pots (Figure 9D). The pots were located in the upper portion directly above the brood area. A few pollen pots were also seen between the enormous batumen layers distributed unevenly throughout the brood area. The honey pots were dark brown, while the pollen pots were yellowish brown. Similar to Colony 1, the pots were protected by a sheath.

Colony 3 was likewise found on a fern species attached to a coconut tree, and was the largest among the colonies (Figure 7C). The hive's exterior was entirely covered by thick and waxy black batumen, and there was a pillar in the upper part of the nest (Figure 10A). The shape and structure of the nest entrance differed from the previous two colonies: it had a large orifice leading to other smaller tunnels. The radius of the orifice varied with the size of the nest. The nest entrance was found at the anterior part of the nest. A network of pillars supported the multi-entrance and exit areas. The pillars served as platforms that allowed more bees to be deployed simultaneously, as opposed to the previous

Figure 10. Nest architechture of stingless bee colony 3 nest in coconut tree (San Roque, Bulusan, Sorsogon)



(A) hive structure, (B) nest "flower or brain" entrance, (C) brood construction, and (D) pollen and honey pots

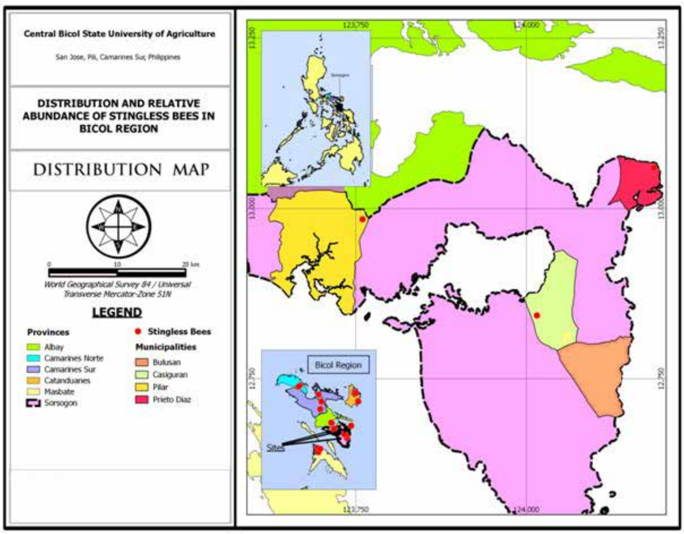
colonies' single, small openings that could accommodate only a few bees at a time. Figure 10B shows the unique shape of the colony's entrance. The upper part of the nest entrance was reinforced by resin, possibly as additional protection against external forces. The inner part of the nest was composed of two layers: the first layer contained honey and pollen and the second layer contained brood cells. The comb was horizontally arranged with single layers, and the brood area was divided into two portions separated by sheets of cerumen. The cerumen seemed to be part of the involucrum (Figure 10C). The features of the old and new brood cells, as well as the storage, honey, and pollen pots were similar to the previous colonies (Figure 10D).

Based on the nest architecture and hive entrances of the three colonies collected, the species of the stingless bees collected from San Roque was identified as *T. biroi.*

Inlagadian, Casiguran, Sorsogon

Based on sightings by the hunters, nest trees of stingless bees were located in Barangay Inlagadian in Casiguran, Sorsogon. Following the method used in Bulusan, nest trees were identified and measured using the point line. This method enabled the measurement of the distance of each colony in relation to the nesting area. Five colonies were sighted: three colonies in site 1, and one colony each in sites 2 and 3. All colonies were attached to a coconut *(C. nucifera)*. Aside from coconut, site 1 had other trees, namely: pili *(Canarium ovatum)*, guava *(Psidium guajava)*, mango *(M. indica)*, santol *(S. koetjapi)*, and narra *(Pterocapus indicus)*.

Figure 11. Stingless bees geographical distribution map of Casiguran, Sorsogon

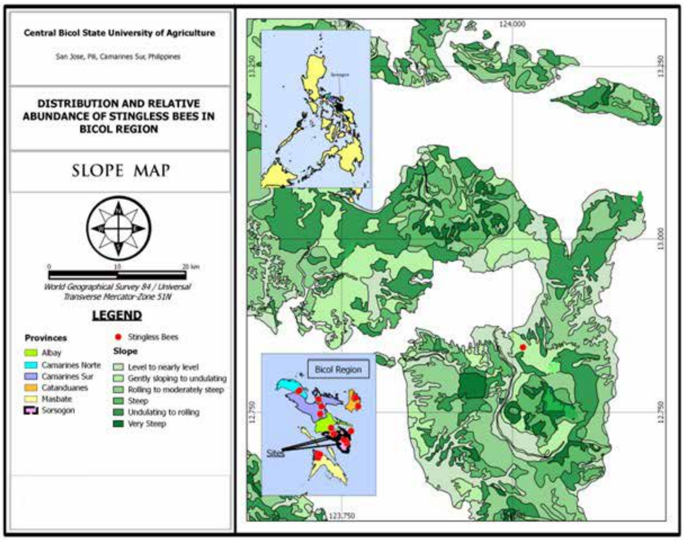


Reference: PhilGIS (2019)

Figure 11 indicates the distribution of the stingless bees in the area. Colonies were observed to be clumped in Barangay Inlagadian. This was supported by actual sightings of stingless bees by the hunters. They claimed that they never found colonies in the other barangays of Casiguran or areas that were heavily populated.

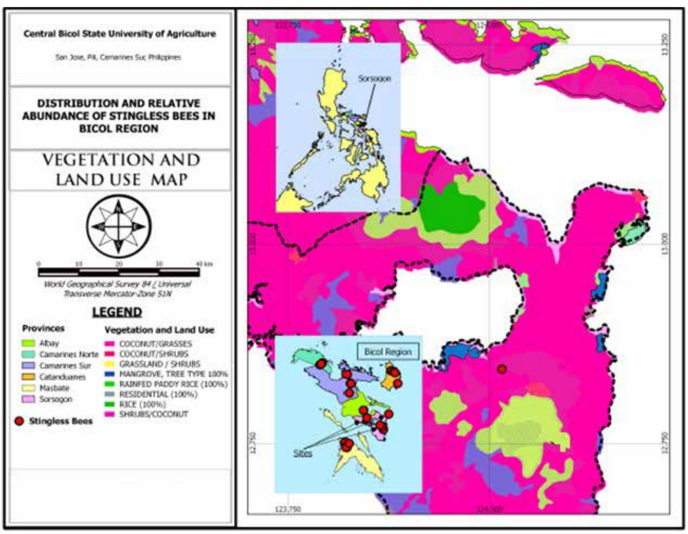
Based on the slope class map, Barangay Inlagadian is characterized as either level to nearly level, and gently sloping to undulating (Figure 12). Sites 1 and 2 were located in a gently sloping and undulating level, while site 3 was situated in a nearly level area. Other available geospatial data included a vegetation and land-use map, which indicated that the area was thickly covered with coconut, grasses, and shrubs (Figure 13). Site 1 was reached by passing through a natural spring and a few residential houses. As the elevation increased, forest trees were encountered, which could be the possible sources of stingless bee colonies. However, the identification of the sites was delimited to the previous sightings of the hunters.

Figure 12. Slope class map of Casiguran, Sorsogon



Reference: PhilGIS (2019)

Figure 13. Vegetation and land use map of Casiguran, Sorsogon



Reference: PhilGIS (2019)

In site 1, three colonies nested on coconut trees. These nests were inside ferns with nesting sites located at varying heights. Colony 1 was found 7 m aboveground. A closer examination of the colony revealed that it had only one hive entrance, with a barrier of fern at the center.

The second colony was 28 m away from the first colony. It was attached to the coconut trunk at a height of 14 m above ground, and enclosed by ferns and various plant roots. The hive entrance was a flat circle made of cerumen. Colony 3, meanwhile, was found 98 m away from the first colony, and was also attached to a coconut trunk at a height of 11 m aboveground. Figure 14A shows the nest architectures. The hive entrance was a large hole composed of soft black thick batumen (Figure 14B). Inside the hive, the brood construction was found at the center and horizontally arranged (Figure 14C). The honey pots were at the lower left side of the brood, containing only a small amount of honey (Figure 14D).

Figure 14. The hive structure of stingless bee from colony 3 (Casiguran, Sorsogon)

Note:
(A) hive entrance, (B) bee pollen, (C) brood construction, and
(D) honey pots

Colony 4 was attached also to a coconut at a height of 15 m aboveground and was composed of dry ferns (Figure 15). The hive had to be detached slowly from the coconut tree and placed inside a coconut husk to keep the colony intact and secure, since in its immature state, it was in danger of getting damaged if it fell to the ground. The lower part of the hive was composed of soft propolis that also

Figure 15. The hive entrance and nest architecture of stingless bee from colony 4 nesting on coconut tree (Casiguran, Sorsogon)

surrounded the entrance (Figures 16A, 16B). The oval-shaped and horizontal-layered brood construction was not fully developed yet (Figure 16C). There was only a small amount of bee pollen and honey (Figure 16D).

Colony 5 was found inside a hollow coconut tree trunk, occupying the upper part about 1.5 m aboveground. A hunter believed that the hive was still young and built on an old hive based on the presence of an old entrance hole (Figure 17). It was the only colony located in a hollow trunk. The propolis around the hive

Figure 16. The hive structure of stingless bee from colony 4 nesting on coconut tree (Casiguran, Sorsogon)

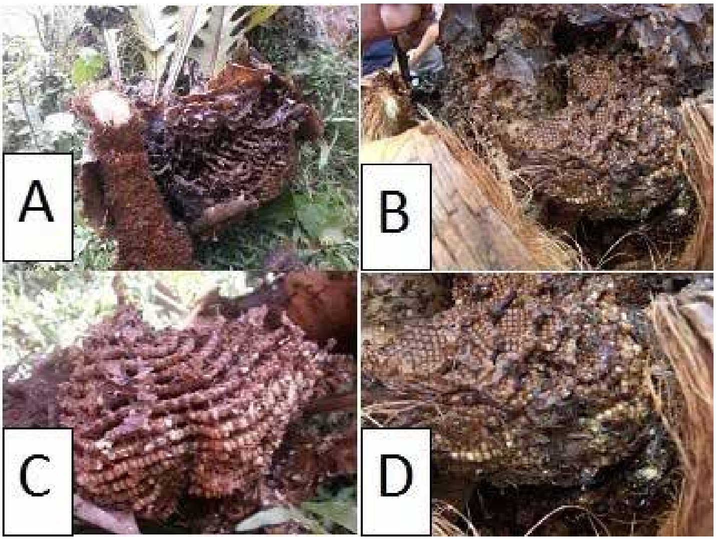
Note: (A) nest architecture, (B) hive entrance, (C) brood construction, and (D) bee pollen with honey was soft and the heart-shaped entrance was also soft (Figure 18). The young hive was not brought to the laboratory in accordance with conservation measures.

Based on the configuration of hive architecture and hive entrance, the bees in Casiguran were identified as *T. biroi* also.

Figure 17. The hive structure of stingless bees inside the coconut tree

Note: Left photo shows the hive entrance, while right photo shows the nest architecture, particularly the new hive and the old hive

Figure 18. The hive structure of stingless bee from colony 5 (Casiguran, Sorsogon)



Note: (A) break hive, (B) hive placed in coconut husk, (C) brood construction, and (D) honey pots

Capacity Enhancement

The farmers who attended the beekeeping training were from Casiguran and Bulusan. The Casiguran trainees were from Barangays San Juan, Mabini, Inlagadian, and Escuala. It was their first formal training in beekeeping, except for one participant from San Juan who had previously attended a similar training. The Bulusan participants were from the following barangays: Dancalan, San Rafael, San Roque, San Jose, San Francisco, and San Bernardo. Three participants were experienced hunters and had previously attended a similar training conducted by the bee farm owner in San Roque.

The training covered the following topics: value of stewardship, beekeeping benefits and potentials, biology and behavior of bees, and stingless bee culture. Beekeeping in Bicol has had ups and downs, and the values of the beekeeper have played a defining role. Success in beekeeping is greatly dependent on the understanding of human stewardship of organisms in an ecosystem. It has been observed that beekeepers tend to exploit bees by overharvesting the pollen and honey, which are also the food of the bees. As a result, the bees starve and colonies either abscond or die. Thus, colony collapse is due not only to pest occurrence but to beekeeper mismanagement as well. During the training, the trainees were made to understand that in order for beekeeping to be a productive livelihood, they should be good stewards of the bees. Techniques on proper handling must be followed.

The benefits of beekeeping include the following: (1) ideal as an alternative livelihood, (2) fast return on investment, (3) relatively simple in terms of technological requirements, (4) multiple products, (5) minimal processing, (6) can be marketed easily, and (7) can be integrated in rural livelihood programs.

Stingless beekeeping is considered as an ideal livelihood in Bicol due to the area's mild climate and lush vegetation. The predominance of coconut trees, which flower year-round, provides the bees with a continuous supply of pollen and nectar; thus, the bees do have have to be fed manually. The time needed to care for bees is minimal compared with livestock such as pigs and poultry.

Return on investment is achieved within seven months for honeybees and three months for stingless bees. Further, stingless beekeeping technology has an easy learning curve because only visual and tactile skills are required. As long as beekeepers know the floral bloom calendars and established beekeeping calendars, meliponaries can be expanded.

The most important benefit of beekeeping, which was emphasized to the trainees, is the wide assortment of products that can be derived from beehives. For example, the multiplication of nucleus (new colony) can be sold to budding beekeepers at a reasonable cost. There is a famous saying that goes, "a well-kept bee colony is a treasure-filled medicine cabinet, which can be kept in anyone's garden." Trainees were also informed of the benefits of honey, the most sought-after bee product. Honey, a natural product made from nectar, contains enzymes used by the human body to activate chemical processes like digestion. It stops bleeding from deep lacerations and promotes healing and minimizes scar tissue. It can be used as treatment for burns, ulcerated wounds, fatigue, arthritis, and insomnia. It also minimizes the occurrence of asthma attacks and alleviates stress. It even has dermatological uses—it can be used to cleanse the face and treat acne.

Aside from honey, other bee products are bees wax, pollen, propolis, royal jelly, and bee venom. Bees wax can be made into quality candles, which are dripless, smokeless, and fragrant. It is also an ingredient in other household and beauty products. Bee pollen, just like honey, has good medicinal value because it contains vitamins, minerals, enzymes, amino acids, and protein, contributing to the sustenance of a healthy body. Moreover, it is beneficial to children because its micronutrients promote high energy level, enabling children to benefit from heightened mental alertness. Royal jelly was discovered to alleviate the symptoms of internal ailments that affect cardiovascular, endocrine, gastrointestinal, respiratory, and immune systems. Propolis, also known as "bee glue," has antifungal, antibacterial, antiviral, and analgesic properties. The stingless bees produce enormous amounts of propolis that can be processed as tincture for wounds, mouthwash and toothache drops, creams for allergies, acne, eczema, and salve for other skin diseases. Meanwhile, bee venom is used to reverse the symptoms of rheumatoid arthritis and multiple sclerosis.

Managing stingless bees is easy because the bee products can be extracted using ordinary kitchen materials. Bee products are best consumed and sold fresh from the beehive. As such, they are ready for marketing right away. While bee products are highly priced, the demand is also high because they are organically produced. Establishing a meliponary in the backyard is most suitable since it does not require much land area, not gender or age-specific, entails minimal investment, promotes health, eco-friendly, balances the ecosystem, benefits from enhanced pollination, and fosters family enterprise—all of these make stingless beekeeping a suitable rural livelihood program.

The training also discussed the biology and behavior of stingless bees. To date, 13 species have been found in the Philippines. Among these species, *T. biroi* is endemic and abundant in the Bicol region and is considered as the most productive species. Cultural management practices were discussed, such as sources of feral colonies, hiving the colony, maintaining and developing a meliponary, pest and diseases affecting bees, and harvesting, processing, utilizing, and marketing bee products. Hands-on demonstrations of these practices were carried out, including hunting of feral colonies and dividing cultured colonies. Figures 19-20 present the documentation of the training conducted in Casiguran, and Figure 21 is Bulusan.

Figure 19. Actual hunting of the feral colonies at Inlagadian, Casiguran, Sorsogon

Figure 20. The Casiguran hunting team with some of the feral colonies sighted

Figure 21. The Bulusan hunters and actual hunting of colonies at San Roque

Establishment of Meliponaries

Casiguran meliponaries

Meliponaries were established in San Juan, Mabini, and Inlagadian, Casiguran by the hunters/beekeepers who attended the training. The meliponary in San Juan was owned by Manuel H. Grajo, a beekeeper who started in this trade 5 years ago. His son Leo started the beekeeping enterprise, but later on passed it on to his father when he left to work abroad. Initially, they maintained hunted colonies hived in coconut shells; later on, the colonies were placed in boxes. They have developed a four-layer box made of hardwood (particularly *kalantas*, *Toona calantas* of family Meliaceae), with a chamber that can accommodate a 15 cm brood size (Figure 22). At present, the farm has 170 colonies of stingless bees placed in a specially designed bee house. Initially, they sold honey, pollen, and propolis, but recently have started to sell starter colonies. Since Mr. Grajo had previous training in beekeeping, this project enhanced his knowledge of controlling pests and diseases, processing bee products and their use, as well as provided ideas in product marketing, and improving the bee farm. It was envisioned that Grajo's Bee Farm would someday be an agri-ecotourism site in Sorsogon.

The success of Grajo's Bee Farm had inspired the hunters in Casiguran who participated in the training. The project initially planned to establish a

Figure 22. Some of the stingless bee hives found at the Grajo's farm

meliponary at Barangays Mabini and Inlagadian, both in Casiguran. It provided 10 strong colonies of stingless bees to the beekeepers in each barangay to serve as seed or starter colonies for their meliponary. The beekeepers were expected to increase the number of colonies by dividing them at least once every six months. However, in the middle of the joint effort to put up the community meliponary, Typhoon Glenda occurred in 2015 and devastated the colonies. In the aftermath of the typhoon, the beekeepers failed to resuscitate their colonies, and some began to lose interest in developing the stingless bee farm, resulting in management problems. As of this writing, each barangay had only one surviving meliponary. Some trainees did not pursue the livelihood because they needed startup capital to venture into beekeeping. For them, the "seed" colonies provided by the project were not enough to sustain beekeeping and ensure success in their areas.

Jeron Come of San Juan, Casiguran was one of the project recipients and was recognized as a successful beekeeper. This was his first time to engage in meliponiculture. He had no experience in farming bees, but he worked as a part-time laborer at Grajo's Bee Farm. From the five colonies that were given to him, he was able to increase these to 10 colonies within four months. His colonies were also damaged by Typhoon Glenda's rampage. Prior to Typhoon Glenda, Mr. Come signified his willingness to put up his own apiary; however, after the typhoon, he did not have the capital for this venture, so he decided to practice his beekeeping skills as an able farm hand at Grajo's Farm.

Bulusan meliponaries

After the training, interest in stingless beekeeping was heightened among the hunters, to the extent that they formed an organization to establish a community meliponary. Their plan was to put up the meliponary in a farmstead of a group member, to be maintained by the whole group. Since the project will provide the "seed" colonies only, they planned to seek financial assistance from the local government and the DA. Their plans failed to materialize, however, since they did not gain the support of the said government agencies. Instead, only two meliponaries were set up in San Roque and one in San Francisco.

The two meliponaries in San Roque were established in the area of Raul Dangalan and Arnulfo Gabon. Mr. Dangalan, a beekeeper for three years, is a relative of Luz Gamba, owner of Balay Buhay sa Uma. His knowledge and interest in stingless bees originated from Mrs. Gamba. Mr. Gabon, on the other hand, was an experienced hunter of stingless bees. He sold the colonies he found to Balay Buhay. He decided to start his own colony after participating in the project's capacity enhancement activity.

Mr. Dangalan cultured stingless bees in coconut shell hives. He elevated the colonies by hanging them inside his house to protect them from the rain. Figure 23 shows stingless bee colonies enclosed in synthetic materials, such as umbrella and garbage bags. Prior to getting the project's support, Mr. Dangalan maintained 12 bee colonies in cocoshells. He harvested honey from the colonies

Figure 23. Stingless bee colonies of Mr. Raul Dangalan at San Rogue, Bulusan

once every six months, as well as from hunted colonies. He bought hunted colonies for PHP 150–200 apiece, and he would split a wild colony into two smaller colonies. He sold his cultured colony to interested visitors at PHP 700–800 per colony. The project enabled him to learn how to use boxes as hives for stingless bees. From April to July 2014, he successfully doubled the number of colonies through the division/splitting method, which he learned from the training. He obtained capital for the improvement of his bee shed from the sale of his colonies. He sold his honey harvest at PHP 200 per 150 ml bottle. However, Typhoon Glenda also caused damage to his property and colonies. After the typhoon, he started to expand his colonies from the initial 12 colonies that were spared from typhoon damage.

A monitoring visit conducted in December 2015 showed that Mr. Dangalan had successfully increased the colonies in his farmstead and had even extended his meliponary to several meters outside his house. Unfortunately the colonies were adversely affected again by a typhoon in January 2016 and the ash fall from Mt. Bulusan in February 2016. Once again, Mr. Dangalan started to collect feral colonies from the wild.

The meliponary of Arnulfo Gabon, a hunter-turned beekeeper, was initially composed of 10 starter colonies in box hives that were provided by the project. He increased the number of colonies by hunting from the wild and transferring the hunted colonies in boxes and cocoshells. He sold the additional colonies and harvested honey. Like Mr. Dangalan, he suffered colony losses from the onsalught of Typhoon Glenda. Nevertheless, he had managed to increase the stock of his meliponary to 15 colonies (Figure 24). However, as of the monitoring visits in December 2015,

Figure 24. Colonies of Mr. Gabon in his meliponary at San Roque, Bulusan

Mr. Gabon was down to only 10 colonies. Aside from the typhoon, he claimed that his colonies absconded due to the effect of the neighboring bee farms, which stole pollen, honey, and even propolis from his colonies. There are two established bee farms in the San Roque area, which stock no less than 2,000 colonies of stingless bees. Massive hunting of bee colonies had been undertaken to stock these farms. Since these farms had more capital to purchase feral colonies, the beekeepers' community had been adversely affected. It was observed that hunters trained through this project had no choice but to sell their hunted feral colonies to these farms instead of developing their own meliponary. Just like Mr. Dangalan, Mr. Gabon's remaining colonies absconded after the typhoon in January 2016 and ash fall in February 2016.

Likewise, two hunters, Jose Furague and Ruben Galicio from Barangay San Francisco, Bulusan decided to put up a joint meliponary in the homestead of Mr. Furague. Mr. Galicio was an experienced hunter of *pukyutan.* Together they showcased to the community the sustainability of their beekeeping activities through the establishment of a meliponary (Figure 25). Beginning with 20 starter colonies from the project, they applied the various techniques they learned in maintaining, propagating, and harvesting bee products. The income they gained from the sale of hived colonies encouraged them to increase their stocks using the splitting/dividing method. They had also begun to teach their neighbors in the community about stingless bee culture. They reported encountering some problems such as absconding of colonies due to the presence of brown beetle in moist/wet pollen and brood, lack of capital to buy materials for the fabrication of boxes, unavailability of cocoshells for use as alternative beehives, unfavorable weather conditions, and low buying price of the nucleus.

Figure 25. The meliponary at San Francisco, Bulusan

Meliponaries in Casiguran and Bulusan have a great potential as a source of livelihood for marginal communities. The environmental conditions in these areas are suitable for sustainable stingless beekeeping due to the abundant sources of pollen and nectar from coconut trees and a diverse population of forest trees. The stingless beekeeping technology was easily adopted by members of the community who previously established meliponaries in their backyard. However, several adverse factors such as competition from big bee farms, typhoons and ash falls, and the negative attitude of some hunters/beekeepers resulted in the failure of the community to continue their beekeeping operations.

Government support had been lacking also in terms of providing beekeepers additional capital to pursue other income-generating activities such as the utilization of different bee products. Assistance in product marketing and promotion was also needed. There is also a critical need to craft policies on the conservation of stingless bees in the Bicol region, particularly in terms of regulating the sale and movement of these bees' feral colonies.

Crafting Policies on the Conservation of Stingless Bees

The forest ecosystem has two types of resources: those that are non-destructively harvested for their reproductive propagules, and those harvested for their vegetative structures. Examples of the latter are non-reproductive vegetative structures such as gums, resins, latexes, barks, leaves, stems, apical buds, and even roots. Examples of the former include plants harvested for their flowers, fruits, and seeds; fungi like mushrooms; and a few animals such as bees, which are harvested for honey.

Harvesting a reproductive propagule using non-destructive means will not affect the individual plant/animal, though management is still essential. For example, wild bees like *pukyutan* are a resource from which honey is harvested and require intense management. Hunters destroy the wild bee colonies by burning the nest trees or smoking to drive away the workers. Combs with both ripe and unripe honey are detached from the nest and extracted. This practice results in increased scarcity of this reproductive propagule and lower quality of honey.

Improving the management of wild honeybees has been the prime concern of policymakers in India. They employed the participatory approach involving bee/honey gatherers in the analysis of the problem and formulation of initiatives toward conservation. Some of the initiatives were the following: (1) sketch mapping the hive location, monitoring the hives as well as the honey yield and quality at harvest, and keeping track of the environmental changes that could affect the resource; (2) creating a no-harvest refugium and reviving traditional zones among the hunters to prevent overharvesting; (3) setting a code of practice, such as the timing of harvest and optimal harvesting techniques to ensure that honey is harvested after the young bees have hatched, therefore improving the quality of honey; and (4) forming an association of honey gatherers, ensuring premium prices for honey and set standards for honey quality (Stockdale 2005).

Just like *A. dorsata,* the stingless bee is one resource that is being destructively harvested. It is not only honey that is harvested from the stingless bees, but the whole colony, which is detached from the nest trees and then brought to the meliponary for hiving. In the wild, feral species respond differently to human disturbance, and this has implications to conservation initiatives. In the case of stingless bees, Samejima et al. (2004) compared the responses to human disturbance of four abundant species: *Lisotrigona scintillans, Trigona collina, T. rufibasalis,* and *T. melanocephala.* The differences in their response were attributed to nest site preference. *L. scintillans* and *T. collina* prefer dipterocarps as nests due to the large size and amounts of resin produced, while *T. rufibasalis* and *T. melanocephala* prefer to nest in dead trees. However, in the dipterocarp forest, there is a limited number of standing dead trees with a large Diameter at Breast Height (DBH), thereby affecting the nests available for the latter two species. Furthermore, they found that colonies of *T. collina* prefer dipterocarps as nest sites, which was positively correlated with late successional trees and trees with more than 50 cm in DBH. Though it is not included in their study, they presented that *Tetragonula laeviceps* and *Trigona ventralis* were found to be likely correlated with flowering pioneer trees but not on the trees preferred by *T. collina.* As such, disturbance due to logging would affect only stingless bees nesting on live and standing trees. The existence of these bees in the forest is an addition to the available resources as pollinators.

Looking into the ecosystem of Sorsogon, evidence shows that the most abundant stingless bee species, *T. biroi,* prefers coconut and forest trees as nest sites. As such, disturbance by logging would definitely affect the population of feral colonies. The indiscriminate hunting of these feral colonies would be significantly contributory to the decimation of the species. Thus, a conservation policy must be crafted before the population of stingless bees in Sorsogon in particular, and in the Bicol region in general, decreases to a critical stage and the bees become in danger of extinction.

Culture of stingless bees has blossomed into a livelihood not only for marginal farmers but also for those with financial resources to operate large-scale meliponaries. The risk of overexploitation of these forest resources is great in the absence of policies for its protection. The general public must also be encouraged to participate in the conservation of this valuable species. Presented below are recommendations that policymakers may consider in crafting a policy for the conservation of stingless bees:

1. **Education of the general public on stingless bees through formal training, dissemination of information and educational communication (IEC) materials, and radio/TV lecture programs.**

   The Bulusan hunters have been trained twice, initially by the University of the Philippines Los Baños Bee Program in coordination with Balay Buhay sa Uma and a follow up training two years after through this project. The Casiguran hunters received training for the first time through this project. Interest in stingless bees must be sustained by making the hunters/beekeepers understand the enormous importance of stingless bees to humans and their environment. Emphasis should be given on correct hunting practices, cultural management practices in the meliponary, harvesting of bee products, and marketing of good quality honey. Value-adding activities may be done so that the hunter/beekeeper will not concentrate on marketing colonies but also on products developed from the bees. One significant input from the training is the topic on stewardship and value formation. Knowing that bees are a natural resource, keeping them would need a keen understanding that these products (honey, pollen, etc.) are produced by bees for them to survive. Thus, taking all of them for human consumption would result in either colony death or absconding.

2. **Keeping the environment suitable for the survival of the bees.**

   Some activities that could be initiated and sustained are planting of trees and other flowering plants to serve as nests and sources of pollen, nectar, and resins. There should be a massive campaign against logging and burning in the nesting sites of bees. A previous study citation showed that a mean colony population of 35 could be found in a tree in the agroforest ecosystem of Pilar, Sorsogon. Cutting them down would drastically reduce the said resource. Findings also showed that returning to a hunting site after obtaining the feral colonies must be done only after 18 months to allow the colonies to regrow. Regrowth starts only 9 months after extraction; thus, rehunting is recommended only after 18 months, on the condition that a portion of the nest was left to reproduce. Total removal of the nest will result in no regrowth.

Campaigns should likewise be done on the judicious use of pesticides in the agroecosystem landscape. In cases where application of pesticides is inevitable, cultured bees must be protected by restricting them from foraging during and a day after pesticide application.

There is a need to also conserve vegetation near riverbanks (riparian), which could serve as habitat or refuge of stingless bees. Promotion and establishment of forest reserves, parks, and gardens must be done to serve as sanctuaries for stingless bees.

Promotion and development of crop diversification schemes would encourage a pollinator-friendly environment. These schemes include research and development on the utilization of stingless bees and their products, enhancing the processing of stingless bee products, and encouraging the public to use hive products as food supplement and medicines for good health and primary health care. Consumer friendly prices and marketing schemes must be developed to promote healthy competition among producers.

3. **There is a need to establish a strong and operational beekeepers association in the Bicol region to protect not only the environment but also the technology that emanated from this region.**

   The association must work with policymakers in ensuring that conservation initiatives are properly implemented. Judicious control or regulation of the movement of stingless bee colonies outside the Bicol region must be a primary concern. Moreover, the association can propose resolutions particularly on the maintenance of good quality stingless bee products marketed within and outside the region. It can also provide valuable inputs in the development and implementation of the Bee Industry Roadmap in the Philippines.

   Due to time limitation and the environmental factors that affected the sustainability of the community-based beekeeping in Casiguran and Bulusan, the draft policies were not presented to the concerned authorities for their appropriate action. However, the output of this research can be put to good use by pursuing the initial plan to craft a policy, submit them for approval by the municipalities involved, and ensure their implementation by appropriate agencies in order to save the bees of the Bicol region.

SUMMARY AND CONCLUSIONS

Meliponiculture, a technology using stingless bees *(T. biroi),* has been introduced as an alternative rural livelihood that does not imperil biodiversity conservation. Community engagement was done to link the technology generators and bee hunters/beekeepers, instilling in the latter the value of stewardship of stingless bees, developing their management skills in handling meliponines, improving commercial production, introducing various means of producing and marketing quality bee products, and implementing conservation measures in meliponaries. The project was carried out to help communities in the province of Sorsogon, Philippines strengthen their beekeeping operations through sustainable utilization, management, and development approaches toward the conservation of the species. The objectives of the project were to (1) document ethnological/meliponicultural practices in Sorsogon; (2) determine the diversity and abundance of stingless bees' population in the municipalities of Casiguran and Bulusan, Sorsogon; (3) enhance the knowledge of community members of the stingless beekeeping technology; (4) facilitate meliponary establishment at the community level; and (5) develop a policy on conserving wild populations of stingless bees. The project was done in the municipalities of Casiguran and Bulusan in Sorsogon from February 2013 to January 2016.

Ethnomeliponicultural surveys were done through a focus group discussion (FGD), aided with a questionnaire for bee hunters, beekeepers, and other stakeholders. All activities were documented, and results were analyzed using means and percentages of responses. Stingless bee distribution and abundance studies were conducted in the wild using a participatory approach that involved hunters and students. One barangay per municipality was examined for possible nesting sites of stingless bees, wherein sampling points were identified. For each colony located, 20 stingless bee individuals were captured, placed in vials with 95 percent ethanol, properly labeled, and set aside for species identification. Two colonies were extracted from each site and brought to the laboratory for further examination. Each colony was characterized by noting the hive structure, hive entrance, brood construction, and honey and pollen storage pots. The exact location, which included the coordinates and elevation of the stingless bees, were encoded into a GIS software from digital data collection systems on survey instruments, GARMIN GPS 12 XL GADM-

BiogeMancer Project, WorldClim, and Philgis.com, to plot the data and further determine the distribution map of stingless bees in the two municipalities. The Quantum GIS Software (QGIS) version 1.8-0-Lisboa and DIVA-GIS software version 7.5 were also used to determine precipitation and temperature ranges. Nest trees were marked to determine possible regrowth of the reproductive propagules in the area. Findings served as input in crafting the conservation policy for stingless bees.

The beneficiaries underwent training, after which community meliponaries were established in the two municipalities. The bee farms and meliponaries were monitored. Biotic and abiotic factors greatly influenced the outcome of the project.

The ethnomeliponicultural survey had 29 respondents from Casiguran and Bulusan. Their sociodemographic profiles were obtained for possible influence on their beekeeping activities. The respondents were classified as beekeepers (13.79%) and hunters (86.21%). Bee species gathered were the native honeybees, stingless bees, and giant honeybees. The Bulusan hunters were more experienced than the Casiguran hunters. All of the hunters practiced detaching of feral colonies from the nest trees; the colonies were then transported to farms where they were cultured. The hunters were influenced by friends and family to engage in hunting of giant honeybees for honey. They began hunting as early as 1980, the frequency of which differed during the honey flow season. Honey collected from the wild was sold directly to consumers, consumed by hunters, and used for medicinal and other purposes. Most respondents had limited or no knowledge of beekeeping due to lack of access to training and lack of awareness regarding the benefits of bee products. Financial assistance to start up livelihood was also nonexistent.

Results showed that the hunter-respondents had different apicultural practices in terms of hunting time, species of bees hunted, and bee products collected. Honey, the main product obtained from bee colonies, was extracted in the field using honey press and drip methods. Pollen was not collected but was instead left in the field, except in the case of stingless bees, wherein the pollen was collected and fed to animals. Extracted honey was sold at the prevailing market price to local consumers by direct selling. Poor quality honey was evident in hunted honey, which was sold in the market. Hunters also faced many risks to life and limb.

Studies on the distribution and abundance of wild stingless bees in Casiguran (Barangay Inlagadian) and Sorsogon (Barangay San Roque) were conducted in May 2014. In each sampling site, the nest trees were identified as well as the distance from one nest to the other. Nest trees were coconut, santol, mango, cacao, pili, guava, and narra. Most of the colonies were found in ferns *(Drynaria* sp.*)* attached to coconut trees. The features of the nest entrance and architecture, as well as the morphological characteristics of the adult bees led to the species' identification as *Tetragonula biroi*.

The training of the 29 hunters/beekeepers covered topics such as (1) value of stewardship, (2) benefits and potentials of beekeeping, biology and behavior of bees, and (3) stingless bee culture.

In Casiguran, Barangays Mabini and Inlagadian were expected to establish community meliponaries and were provided with initial stocks of bee colonies. However, due to typhoons and the lack of interest and start-up capital among the beneficiaries, only one apiary was established and another one was monitored. In Bulusan, three meliponaries were established: two in Barangay San Roque, and one in Barangay San Francisco. Like in Casiguran, the community meliponaries in Bulusan were also provided with initial stocks of bee colonies. However, after a year of operation, the apiaries collapsed due to damages caused by a typhoon and ash fall from Mt. Bulusan, the lack of capital to sustain this livelihood, and the adverse effects brought about by the big meliponaries in the area.

In view of the need for measures to conserve stingless bees in Sorsogon, inputs to crafting conservation policies were provided, as follows: (1) education of the general public on stingless bees, (2) making the public interested in stingless bees, (3) keeping the environment suitable for the survival of the bees, and (4) creating a beekeepers' organization/societies, and implementation of similar or supporting conservation policies.

Meliponiculture in Casiguran and Bulusan has a great potential as a livelihood for bee hunters in these communities. The stingless beekeeping technology is simple and easily adapted. Sorsogon is ideal for meliponiculture due to its vast coconut and forest areas, which is suitable for sustainable beekeeping. The effects of big bee farms as competitors, climatic factors such as typhoons and volcanic ash falls, and the negative attitudes of some hunters/beekeepers are important factors to consider because they could deter the establishment of a sustainable beekeeping community. Moreover, financial support and further technical assistance are required.

POLICY IMPLICATIONS/ RECOMMENDATIONS

Beekeeping using native bees, specifically stingless bees in the province of Sorsogon, is a livelihood that has mushroomed due to the massive promotion of the technology. The abundance of feral colonies in the municipalities of Pilar, Castilla, Donsol, Prieto Diaz, Casiguran, Irosin, and Bulusan has led to the increase in the number of bee hunters and bee farms in these areas. The bee farms' demand for colonies has led to overhunting of wild bees, which poses the risk of depleting these valuable resources in the forest agroecosystem. Likewise, insufficient knowledge of correct hunting techniques can destroy bee colonies in the wild and hinder their regrowth. Moreover, unofficial reports indicate movement of feral colonies to the other regions by apiary owners and assemblers.

Conservation policies must be set in place to save this valuable resource of the Bicol region. The general public, particularly the Bicolanos, must be encouraged to take part in contributing toward the conservation of the "Black Gold of Bicolandia"—the stingless bee.

Understanding the role of bees, specifically the stingless bees, as an important resource in the forest agroecosystems and mangrove ecosystems is essential in biodiversity conservation. Bees are efficient pollinators of forest and mangrove trees as well as crops. Successful pollination increases tree/crop yield. There is a need to emphasize that bees are dependent on trees for nectar and pollen to discourage people from cutting trees in the said ecosystems. Trees are also the preferred nesting sites of feral colonies of stingless bees; thus, conserving these resources would also lead to a higher reproductive potential of the bee colonies as propagules. Proper hunting practices, cultural management practices in the meliponary, responsible harvesting of bee products, and marketing of good quality honey should be taught to hunters and future beekeepers. Value-adding activities could be done so that the hunter/beekeeper need not concentrate on marketing colonies alone, but also on products developed from the bees.

Policies on preservation of the wild or feral colonies and trees must be crafted initially at the barangay level up to the municipal level. Hunting of feral colonies must be regulated by imposing requirements such as hunting permits with due consideration on the regrowth of the hunting site. Implementation of good beekeeping practices must be encouraged to produce good quality of honey that can be sold to consumers. Quality standards for cultured honey and other bee products must be formulated and approved by the Bureau of Animal Industry.

Since the environment plays a big role in the survival of bees, there should also be a policy to regulate the use of pesticides in active beekeeping areas. Pesticides can affect not only the bees but also the quality of honey produced. As such, beekeeping is suitable in organic farms. If possible, a policy must be crafted on the certification of bee farms and bee products that are pesticide-free, or free from contaminants. Crop diversification schemes must be employed to encourage a pollinator-friendly environment.

Policies related to the conservation of vegetation near riverbanks (riparian), which could serve as habitat or refuge to stingless bees, as well as promotion and establishment of forest reserves, parks, and gardens must be encouraged to create more sanctuaries for stingless bees.

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