Analysis of the Possibility of Implementing Meliponiculture in Achiote, Colon

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In collaboration with McGill University, the Smithsonian Tropical Research Institute, and CEASPA

http://meliponasdenicaragua.blogspot.com/p/especies.html

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Thank you and good wishes in your future endeavors.

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1. Introduction

1.1 Background

With nearly 20,000 species, found all over the globe besides Antarctica, bees are undoubtedly one of the world's most important pollinators. In Panama, native bees are of the tribe *Meliponini*, which when compared to African, Asian and European bees, are smaller, stingless and produce a honey of high quality. They are the largest group of eusocial bees and have a wide distribution spanning Indo-Australia, Africa-Madagascar and the Neotropics (Hrncir, Jarau & Barth, 2016; de Camargo, 2012). In the Neotropics, there are around 400 species of stingless bees, with most of them in Brazil and Colombia with 237 and 120 species respectively (Nates-Parra & Rosso-Londoño, 2013).

The raising and keeping of stingless bees is referred to as meliponiculture, a practice that has historical and cultural significance in the Neotropics. *Meliponini* have been used for their honey and wax production for centuries and have been important pollinators of native plants for longer. These stingless bees are important pollinators of 18 crop species and contribute to the pollination of around 60 other plant species in the tropics (Heard, 1999; Slaa, Chaves, Malagodi-Braga & Hofstede, 2006). Meliponiculture has been practiced for hundreds of years by indigenous people in Central and South America especially in Mexico and Brazil. The ancient Maya people used honey of *Meliponini* as sweetener as well as for medicinal uses. With a god of honey in the Mayan civilization, native bees have an important cultural significance as well (Cortopassi-Laurino, et al., 2006).

Nowadays, meliponiculture is practiced extensively in Colombia and Brazil, with 34 species used in Colombia and 32 species used in Brazil (Nates-Parra & Rosso-Londoño, 2013).

Meliponini are used for their honey (as a sweetener and for medicinal use), their wax and pollen, and as pollinators for native species, and at a smaller scale for commercial crops. A study showed that *Tetragonisca angustula* has antibacterial effects against several bacteria (Zamora, Arias, & Aguilar, 2012).

In recent years, bee populations have been declining globally including the stingless bees of the Neotropics. There are several reasons for the decline in wild stingless bees, namely deforestation and agricultural clearing, which cause the removal of native plants and destroys their habitat. Other reasons include agrochemicals used to control crop infestations and reckless looting of nests for honey collection which destroys hives, leaving them exposed (Kerr, Carvalho, & Nascimento, 1999). A study by Rodrigues et al. found that leaf fertilizers negatively affect stingless bee survival (2016). Several studies have shown that commonly used agricultural insecticides are toxic for several native bee species (Valdovinos-Núñez et al., 2009; Jacob et al., 2019). The alarming decline in insect pollinators has motivated urgent research and conservation efforts for bees worldwide (Zayed, 2009). With less attention focused on the decline of native stingless bees, their conservation is becoming increasingly important for the pollination of Neotropical plant species.

1.2 Project context

Despite Panama's neighboring and nearby countries having a history of meliponiculture, it is still a relatively new practice in Panama. Because of this there is little knowledge and research on the topic locally. With European honey bees (*Apis mellifera*) being the dominant species for the commercial use of bees, research is focused on them, with little research about native stingless

bees. This study will attempt to find out more about *Meliponini* populations in urban areas, specifically in the town of Achiote.

A study done by Jaffé et al. found that when keeping bees close to native vegetation, colonies are more likely to multiply (2015). This suggests that the available feeding resources has an influence on colony multiplication success. In cases where native vegetation is removed due to urban development, or deforestation for agriculture, *Meliponini* populations may be negatively affected. A community in Tabasco, Mexico places *Meliponini* hives in isolated places within the community because most of the food resources for the bees are in the mountains where vegetation is denser (Cano-Contreras, Martínez & Aguilar, 2013). This shows that stingless bees might have a greater chance of survival where food sources are dense. Because of the stingless bee's strong association with flowering plants, they may be able to be used as bioindicators for the quality and condition of an ecosystem; in other words, where *Meliponini* populations are high, the quality of the ecosystem may be greater and vice versa (Cano-Contreras, Martínez & Aguilar, 2013).

As explained by Quezada-Euán (2018), stingless bee colonies should be kept out of direct sunlight by providing shade to avoid overheating. Sun protection is important in meliponiculture and should be addressed in any set-up. Whether trees or houses a better environmental condition, in this case shade, is a question.

Through an archeological study review by Paris, Lope, Masson, Kú and Ojeda (2018) it was found that in Mayan civilizations, meliponiculture was practiced in households both in urban and rural areas. What was clear about the houses was that they had extensive and biodiverse gardens. There is evidence that bee hives were kept in houses, but little indication as to how or why it worked. The gardens which included a variety of native flowering plants may have allowed for

the keeping of bees in an urban setting. Similarly, a review by Cortopassi-Laurino et al. explains that in Costa Rica native beekeepers keep their colonies hanging under the roofs of their houses, but that when many colonies are raised, they keep them away from the house (2006). There is much evidence that shows that stingless bees are kept in and near people's houses, but there isn't research on whether colonies establish themselves better when close to or far from houses. This research aims to address this question.

The decline in native bees, which are important pollinators and high-quality honey producers, has prompted *Centro de Estudios y Acción Social Panameño* (CEASPA) to develop a native bee conservation project in the Costa Abajo region of Colón. This project is meant to actively contribute to the conservation of stingless bees by starting up *meliponarios* (breeding a keeping of bees) and generating knowledge on critical conservation issues while focusing on the sustainable development of the community of Achiote.

With the collaboration of CEASPA, we will be continuing the ongoing native bee conservation project by conducting an analysis of the possibility of implementing meliponiculture in the community of Achiote, which would improve the local flora and fauna and improve the wellbeing of the community members. This analysis will be done with the objective of creating awareness and evaluating the general interest of the community members in participating in meliponiculture in a sustainable manner; addressing both biological and socioeconomic dimensions. The possibility of implementing this activity in the region depends on many factors including social factors related to the community members, the perceived economic benefit for the community members, the maintenance and management of the colonies and the proper establishment of the stingless bee colonies. Most importantly, this analysis will address the willingness of the community to participate in this project.

The biological part of this analysis will investigate native bee abundance in different areas in the corregimiento of Achiote. The research question at hand is: Between yards, forested area and the border between pastures and forested areas, which has the greatest abundance of *Tetragonisca angustula*? This will help address the issue of finding the most appropriate location for establishing hives if meliponarios are set up in the community.

For this study, *Tetragonisca angustula* is the focus because they are one of the most common stingless bees in the Neotropics with a wide distribution (Brito et al., 2009; Velez-Ruiz, 2013; Francisco et al., 2017). Importantly for this study, they are successful in urban environments and build hives in a wide range of cavities including tree trunks or cement bricks (Brito et al., 2009; Francisco et al., 2017). Because one of the goals of CEASPA is to develop meliponiculture in Achiote, these bees will be tested because they are easily handled and are one of the most popular stingless bee species used for beekeeping in Latin America (Cortpassi et al., 2006; Brito et al., 2009; Francisco et al., 2017). A study conducted last year in Achiote showed that *Tetragonisca angustula* were present and were the fifth most abundant species found (Belz & Wang, 2018).

The social part of this analysis aims to have a better understanding of the current knowledge of people on the subject of native bees and to get an idea of the willingness of people to participate in CEASPA's conservation project.

With this information generated from this analysis we will know:

1) If people want to participate in CEASPA's project, which is the most important factor in the project's success.
2) Where to set up hive traps to attract the bees for establishing permanent bee colonies.

Tetragonisca angustula are generalists and it is expected that yards will have a greater diversity of flowering plants because of gardens. Therefore, with previous studies in mind that show *Tetragonisca angustula* are successful in urban environments and nest in households, it is predicted that the greatest abundance of these stingless bees will be in yards around houses.

2. Methods

2.1 Data collection

The study took place exclusively in the corregimiento of Achiote, an agricultural town in Chagres district in the province of Colón. Two full days in mid March were dedicated to data collection for the biological part of the analysis and two days in early April were dedicated to data collection for the social part.

The following methodology was developed after reviewing literature describing methods for attracting and counting bees, as well as consultation with entomologists Dr. Hector Barrios and Prof. Alfredo Lanuza-Garay.

2.1.1 Biological dimension

To compare the abundance of bees in different areas within Achiote, three types of sampling sites were looked at, each with 5 sites, for a total of 15 sampling sites. Sites were chosen semi-randomly, making sure they were separated by at least 250m as recommended by Mariló Castro. The maximum flight distance of *Tetragonisca angustula* is between 621 and 951 m, therefore, in order to be sampling in unique foraging areas separating the sites by at least 600 m would have

been better (Araújo, Costa, Chaud-Netto, & Fowler, 2004). The types of sampling locations were yards, forests and the borders between forests and pastures, and are described as follows:

Type of sampling location	Description of sampling location
Yard	Land surrounding houses, may or may not have cultivated gardens with flowering plants (though likely to have gardens)
Forest	At least 15 m in from cleared land (agricultural, residential or otherwise), non-cultivated forest growth
Border between forest and pasture	Pasture refers to currently or recently used pasture for cattle raising. The border between forests and pastures refers to where the pasture meets forested area.

At each sampling site, a plate containing a 50:50 sugar-water mixture and eucalyptus oil was used to attract *Tetragonisca angustula*. Sucrose is the main carbohydrate source for bees and in nature is the plant reward for foragers (Tsuruda & Page, 2009). The concentration of sugar water used was based on the average nectar loads of *Meliponini* which have 40 to 50% sugar content (Fidalgo & Kleinert, 2010). The eucalyptus oil was used based on a recommendation by Dr. Hector Barrios to attract the bees as well. The ratio of sugar-water to eucalyptus oil was 4:1.

The plate containing the attractants was placed on an upside-down bucket to prevent ants from crawling into the liquid (Figures 2.1, 2.2 and 2.3). It was important to ensure that buckets were level to make sure the liquid was level to prevent drowning bees in deeper parts.

Once the plates were set up, the *Tetragonisca angustula* were counted within a 1 m radius of the plates, every 10 minutes for 1 hour. Counting once every 10 minutes reduces the chance of recounting the same bee. Other *Meliponini* observed were counted, as well as other important meta-data.

In instances where there was light rain, the experiment was paused, and continued 10 minutes after rained stopped.

All sampling sites were done on private property, or in the case of the forested areas, required passing through private property. Permission was obtained from home and land owners 2 weeks before sampling. A permission form briefly explained the project and was signed by owners (Appendix III).

Figure 2.1. Experimental setup in yard.

Figure 2.2. Experimental setup at border of forest and pasture

Figure 2.3. Experimental setup in forested area.

2.1.2 Social dimension

For the social dimension of the analysis surveys were conducted with the people living in Achiote (Appendix I). The surveys consisted of 15 questions divided into four subtopics:

1) general information about the surveyee
    - This is to be able to do an analysis of the answers to the questions based on socio-economic factors and to have an understanding of the population being surveyed.
2) knowledge about stingless bees (Hymenoptera: Apidae: Meliponini)
    - This is to gather an understanding of the current knowledge of people and to see what kind of knowledge may be missing.
3) perception of the state of conservation of the ecosystem and *Meliponinis*
    - This is to see if people are aware of the surrounding ecosystems and their conditions, and if they are concerned about their environment.
4) knowledge about meliponiculture and socioeconomic valuation

    -This is to see if there is knowledge of meliponiculture in the region and to see if people are interested in learning more about it.

The main purposes for conducting the surveys, besides doing an analysis with the responses, are as follows: 1) to see what the level of interest is for participating in CEASPA's native bee conservation project, 2) to see to what extent people are willing to participate in CEASPA's native bee conservation project. This information will help CEASPA to determine what education if any is wanted by the community and how to develop appropriate workshops in the future, as well as if meliponiculture has a future in Achiote.

Surveyees were from a stratified random sample, with the two groups being female and males. They were split into two equal groups to make sure that any socioeconomic inequalities between males and females could be addressed. It was important to survey both young and old people, and rich and poor people (judging by the appearance of the house) to avoid bias.

In total, 80 surveys were filled out fully, representing just over 10% of the population, which was 771 according to the 2010 census (Instituto Nacional de Estadística y Censo).

Before surveys were conducted CEASPA's conservation project was explained, as well as the goals for this research. Surveyees were made aware that their answers were anonymous and that they could chose not to participate. The permission form is the same one used for the biological part of the data collection (Appendix III).

This research was conducted according to McGill University standards, abiding by the Code of Ethics. The Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2) Course on Research Ethics (CORE) certification was completed before the beginning of the project (Appendix II).

2.2 Data analysis

2.2.1 Biological dimension

Tetragonisca angustula were identified while flying around the attractant. They are easy to identify because of their small size, and a collection permit was not granted, therefore prohibiting trapping of any sort.

The number of *Tetragonisca angustula* found at each type of sampling site was tallied and then the frequency was compared between sites.

A multivariate analysis was run on the frequency of *Tetragonisca angustula* at each site (the types of sampling sites being the 3 interdependent variables) to see where the potential for finding most bees of this species is.

2.2.2 Social dimension

First general demographic information was analyzed, and means and modes were calculated for level of education and individuals per household. As well, occupations were analyzed separately for females and males.

First, the surveys were looked at all together. Then the surveys were divided into different groups in order to do the analysis. Female and male answered surveys were divided and analyzed separately to make comparisons in education level, occupation, knowledge of *Meliponini*, concern with the environment, knowledge of meliponiculture, and their interest to participate in CEASPA's conservation project. The same thing was done looking at different parameters such as occupation, level of education and age.

Each level of education was assigned a number on a scale for simplicity in analysis: *ninguna* (0), *primaria* (1), *premedia* (2), *media* (3), *universitaria* (4). To interpret the level of knowledge about *Meliponini*, a score was taken with each answer "yes" worth 1 point, and each answer "no" worth 0 points. Points were summed to determine the level of knowledge. A knowledge scale from 0-5 was created: 0 (not knowledgeable), 1 (slightly knowledgeable), 2 (moderately knowledgeable), 3 (very knowledgeable), 4 (extremely knowledgeable).

Surveyees were divided into 7 age groups: 18-24 (11 individuals), 25-34 (16 individuals), 35-44 (15 individuals), 45-54 (16 individuals), 55-64 (8 individuals), 65-74 (8 individuals), and 75+ (6 individuals). This was done to see any differences in responses depending on age.

To determine people's level of interest in participating in CEASPA's native bee conservation project, each answer "yes" to the questions about interest earn 1 point, and each answer "no" was worth 0 points.

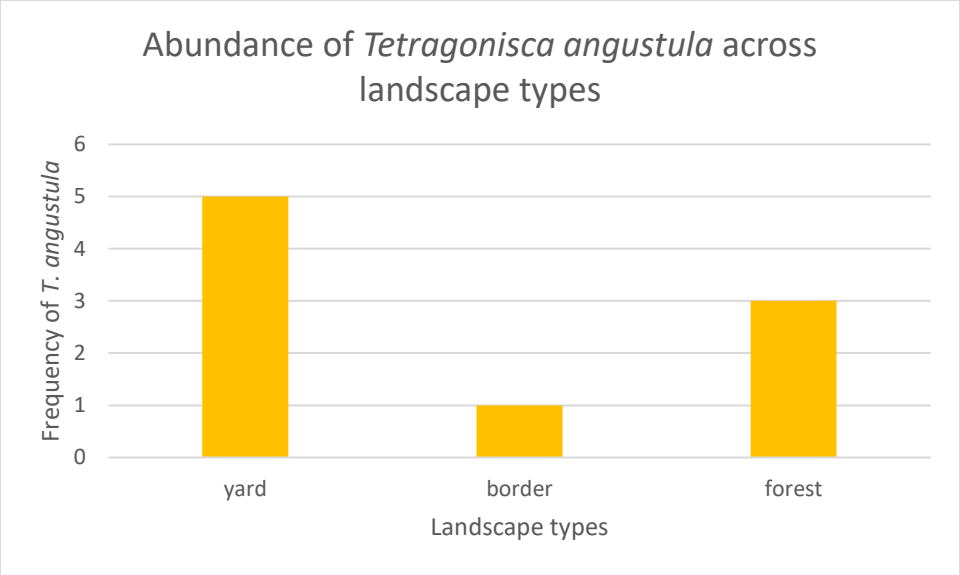
The most important things to look at were: 1) knowledge of people about *Meliponini*, and 2) people's interest in participating in CEASPA's native bee conservation project. The analysis for the first part compared sexes, age groups, and level of education. The analysis for the second part compared sexes, ages groups, and occupation.

3. Results

3.1 Biological dimension

Over the course of 15 hours of sampling, 8 *Tetragonisca angustula* were found on or near the attractants. As seen in figure 3.1, most of them were found in the yards (55.6%), the least were found in the borders between forests and pasture (11.1%), and the rest were found in the forested areas (33.3%).

Figure 3.1



The attractant used attracted many bees from the tribe *Euglossini*. From this tribe, 41 were found in the yards, 139 were found in the borders between forests and pastures, and 103 were found in the forested areas, for a total of 283. This does not relate to the research question but is important to mention in terms of the methodology.

The multivariate analysis shows that 53.1% of the variance is explained by axis 1, where the yard and the forested area have the greatest influence. Axis 2 explains 14.4% of the variance, in which the border between forests and pastures has the most influence.

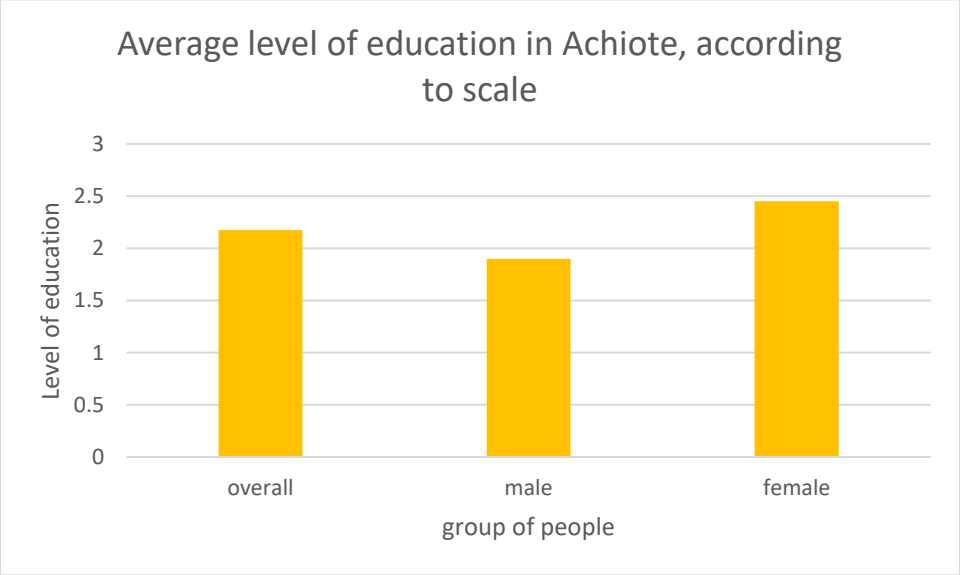
3.2 Social dimension

3.2.1 Demographic information

The overall average level of education of the sample 2.175 (standard deviation = 1.18), meaning a little higher than *premedia* and the mode is 1, meaning *primaria*. The average level of

education for males is 1.9 (standard deviation = 1.03) and for females is 2.45 (standard deviation = 1.28). The mode for each females and males is 1, *primaria*.

Figure 3.2



The average number of individuals per household is 4, while the mode is 3 with a close second place of 4.

For females, occupation was divided into 7 categories and for males, 9 categories. Most females (65%) are housewives (*ama de casa*), and 10% of them currently work, either in education or in commerce (Figure 3.3). Most males have no occupation (32.5%), 27.5% work in agriculture, and overall 60% currently work (Figure 3.4).

Figure 3.3

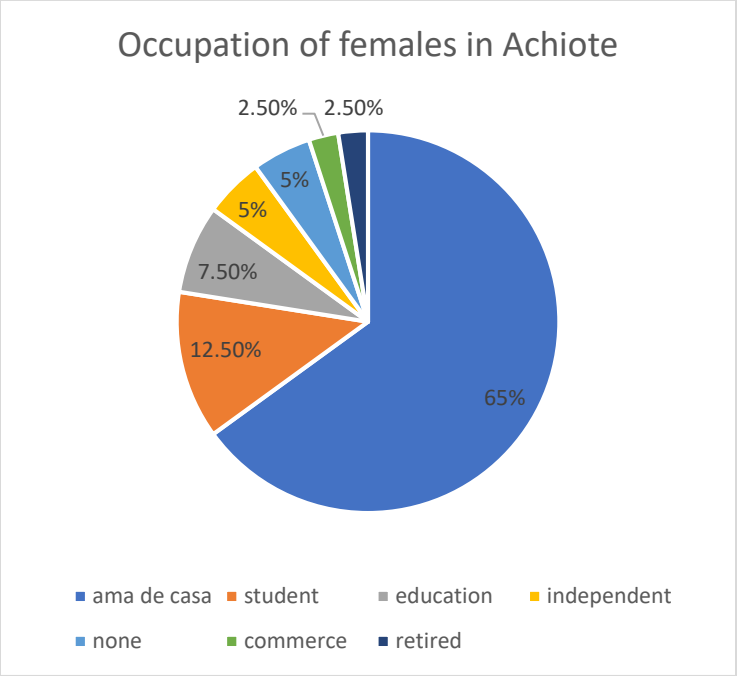
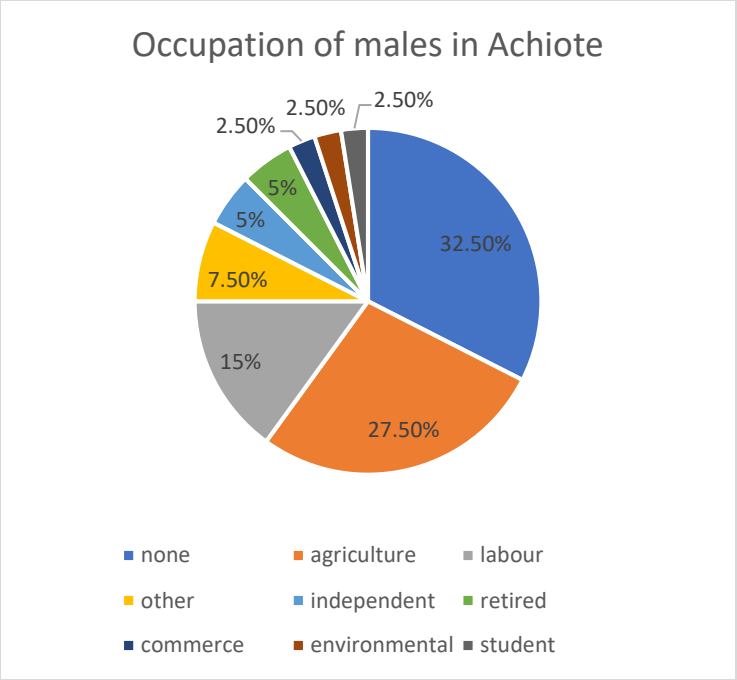
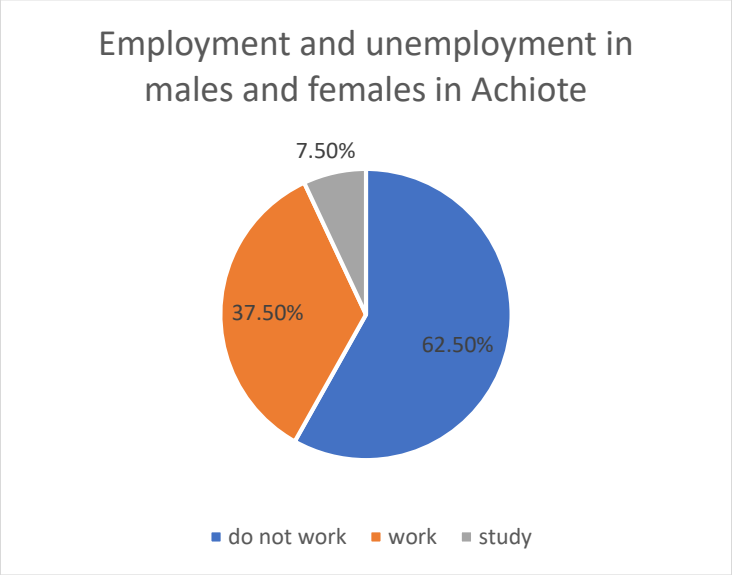


Figure 3.4



Overall, amongst females and males, 62.5% of people do not work, including students, and 37.5% do work. Not including students, 55% don't work, and 7.5% study (Figure 3.5).

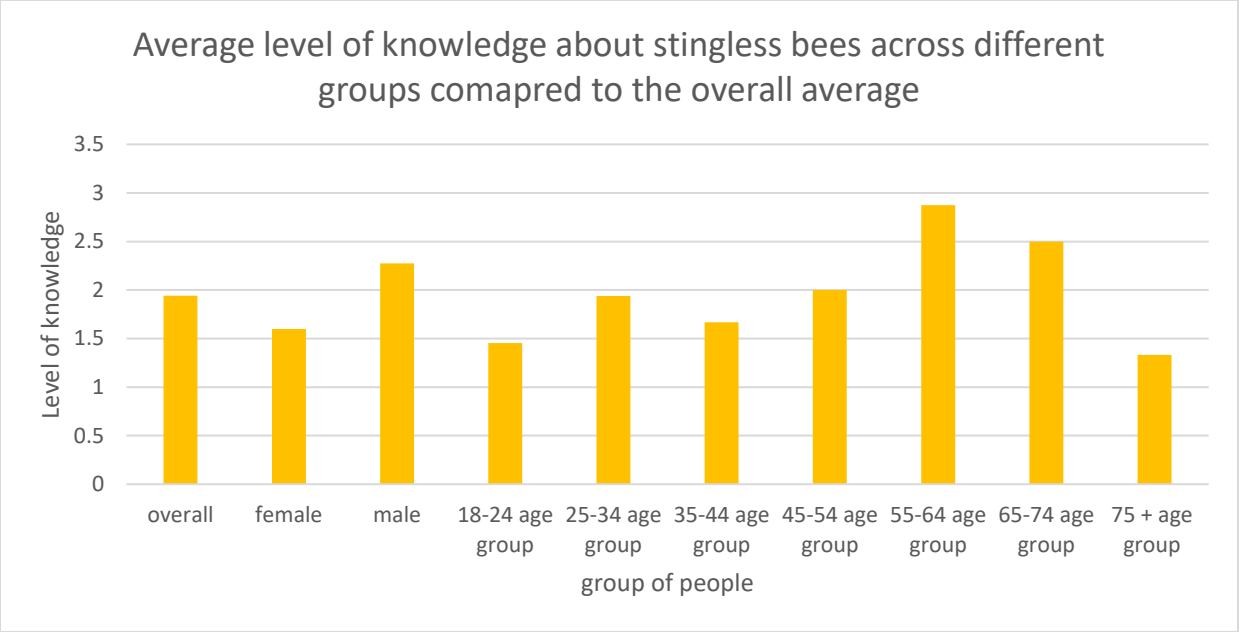
Figure 3.5



3.2.2 Knowledge of *Meliponini*

The overall average level of knowledge of stingless bees has a score of 1.94 (standard deviation = 1.50). The mode is 0, meaning most people are not knowledgeable about *Meliponini*. The average level of knowledge for men is 2.275 (standard deviation = 1.43), and for women is 1.6 (standard deviation = 1.50). The mode for men is 3 (very knowledgeable), while the mode for women is 0 (not knowledgeable). Figure 3.6 shows the level of knowledge about stingless bees across different categories of people compared to the overall sample knowledge (the first bar).

Figure 3.6



This graph shows that the average level of knowledge about *Meliponini* of males is greater than that of females in Achiote. This also shows that the age group with the lowest level of knowledge is the 75+ age group, then the 18-24 year age group. The most knowledgeable age group is the 55-64 year age group, followed by the 65-74 year age group.

Figure 3.7

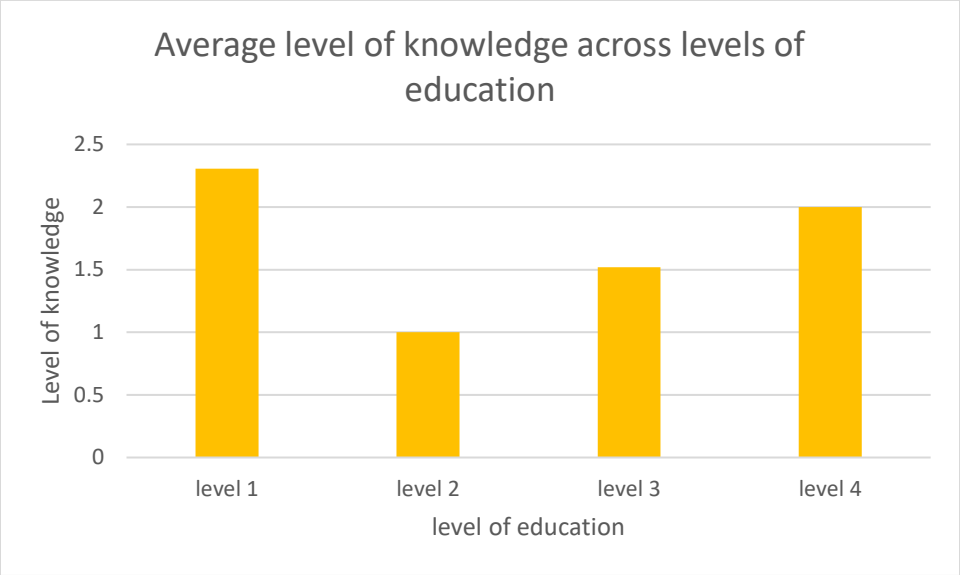


Figure 3.7 shows the average level of knowledge across levels of education. Those with primary and university education had higher level of knowledge of stingless bees. Of those with university education, 76.9% of them knew what *Meliponini* are.

3.2.3 Use of stingless bee products

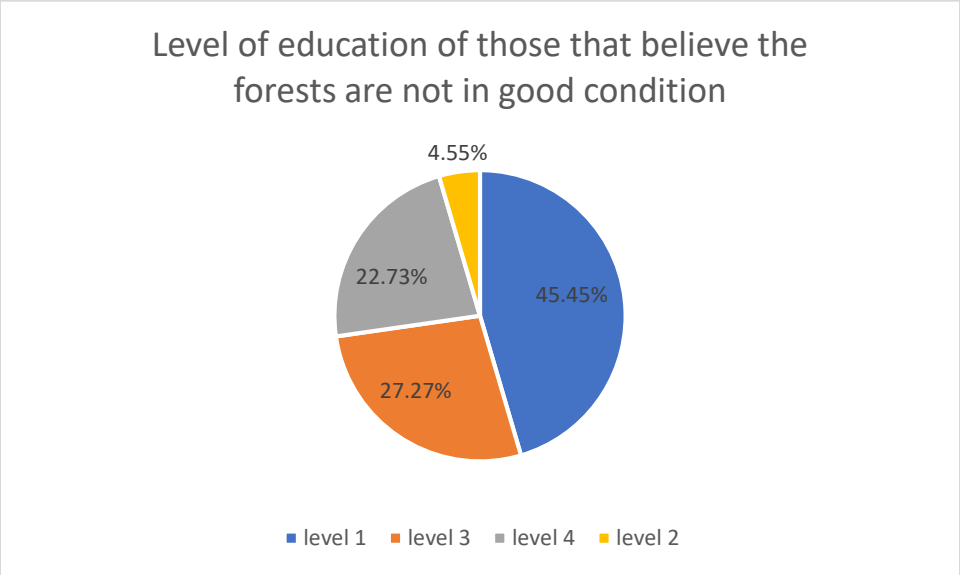
43.75% of people in Achiote claim to use products from *Meliponini* hives. Of this 43.75%, all of them said they use honey and no other products. Of those that consume honey, 60% use it exclusively for medicinal purposes, 25.7% use it exclusively as food, and 14.3% use it for both medicinal purposes and for food.

3.2.4 Perception of the environmental condition in Achiote

72.5% of the population believes that the forests around Achiote are in good condition, while 27.5% believe they are not in good condition. Of those that believe it is not in good condition, all say it is due to deforestation, some say it is also due to burning of forests on the side of the road, and garbage pollution.

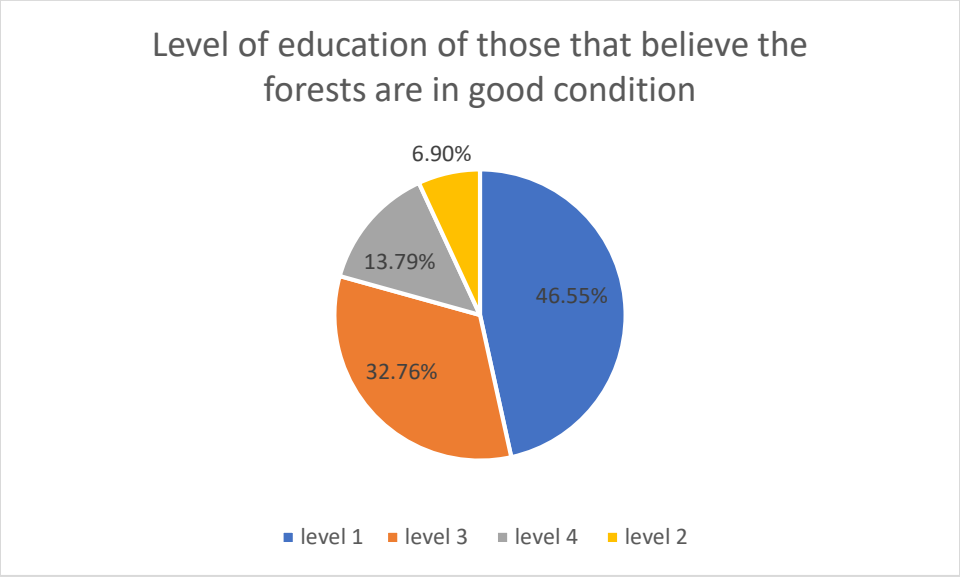
Of those that believe the forests are not in good condition, 45.5% of them have level 1 education, 4.5% have level 2 education, 27.3% have level 3 education, and 22.7% have level 4 education (Figure 3.8). Also, 40.9% of them are male and 59.1% are female.

Figure 3.8



Of those that believe forests are in good condition, 46.6% of them have level 1 education, 6.9% have level 2 education, 32.8% have level 3 education, and 13.8% have level 4 education (Figure 3.9). Also, 53.4% of them are male, and 46.6% are female.

Figure 3.9



Level of education does not seem to have an influence on people's perception of their environment.

3.2.5 Knowledge of meliponiculture

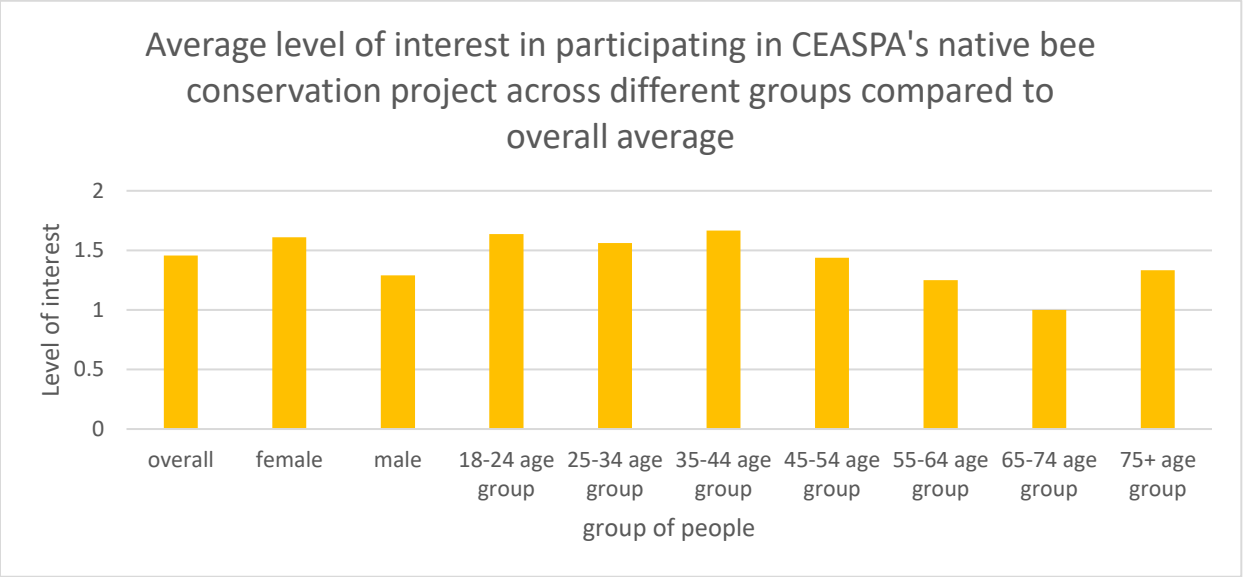
Of all the people surveyed, 10% of them knew what meliponiculture is. Half of them were female, and half were male, with most of them in the 45-54 year age group. Of those that knew what meliponiculture is, 62.5% had level 1 education (*primaria*) and 37.5% had level 4 education (university).

21.25% of the people surveyed knew about the potential social and economic benefits of meliponiculture for the community. Of those that knew, 41.2% were female and 58.8% were male.

3.2.6 Interest in participating in CEASPA's native bee conservation project

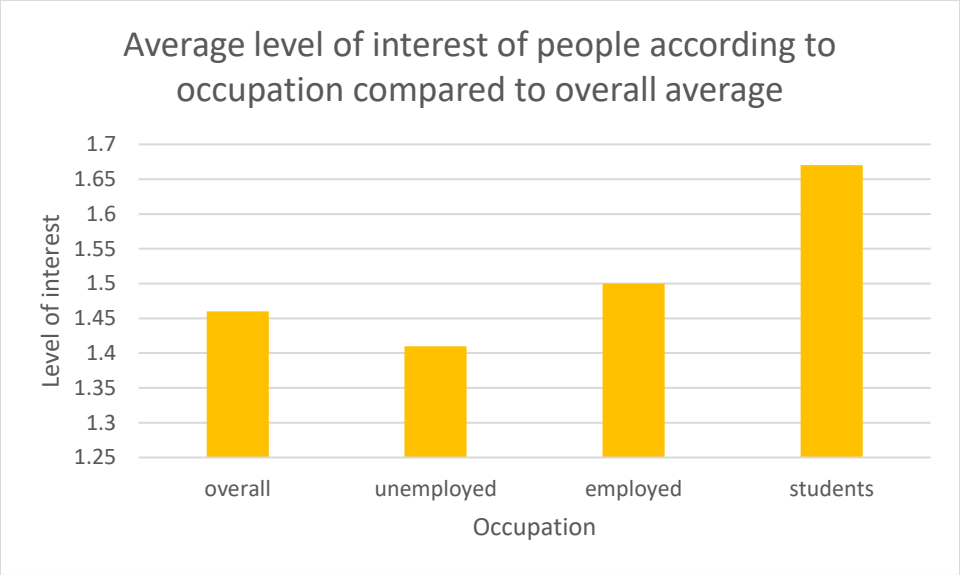
The overall level of interest according to a point system is 1.46 (Figure 3.10). The average level of interest for females is 1.61 and for males is 1.29. The age group with the greatest level of interest is the 35-44 year age group, followed by the 18-24 year age group. The age group that showed the least level of interest is the 65-74 year age group. 70% of people are interested in participating in the production of honey with stingless bee, and 76.25% of people are interested in participating in an education program involving workshops about stingless bees.

Figure 3.10



Unemployed people had an average level of interest of 1.41, while employed people had an average level of interest of 1.5 (Figure 3.11). Students had a level of interest of 1.67.

Figure 3.11



4. Discussion

4.1 *Tetragonisca angustula* abundance and recommendations for meliponiculture in Achiote

The multivariate analysis showed that the chance of finding *Tetragonsica angustula* is greater in yards and in forested areas, but not on the borders of forests and pastures. These findings contradict those of Slaa et al. (2006), who found 3 times the amount of *Tetragonisca angustula* colonies in transition areas between forests and pastures than in forested areas. It was found that they may not necessarily have preferences for the cavities found in buildings, but that they may have a tolerance for a wider variety of locations and cavity shapes and sizes than other species (Michener, 2013). The findings of this study agree with previous reports (Velez-Ruiz, Gonzalez, & Engel, 2013), and indicate that *Tetragonisca angustula* abundance does not scientifically differ between forested areas and urban environments (yards). Their study focused on foraging patterns, but abundance in a certain area can be a result of foraging patterns, therefore supporting

the findings of the current study. The success of *Tetragonisca angustula* in urban environments can be due to many things including: 1) its polylactic diet, 2) their tolerance of high temperatures, 3) their wide range of substrates for nests, and 4) their well-hidden nests (Velez-Ruiz, Gonzalez, & Engel, 2013).

It is likely that there was an increased abundance of *Tetragonisca angustula* in yards because of the presence of flowering plants in gardens. Also, many build nests in and around the houses in Achiote, and with their short foraging range, are more likely to be found near their nests.

Forests provide a large selection of cavities in dead trees for *Tetragonisca angustula* to make nests, explaining the greater abundance in these sampling sites.

It is possible that the low abundance of *Tetragonisca angustula* in the border areas is due to the low number of cavity substrates for creating hives. There were also no visible signs of flowering plants in those areas.

The abundance in each area was studied to determine where is the best place to set up *meliponarios* in the future. The goal for CEASPA's conservation project is to set up sustainable meliponiculture. For it to be sustainable, the artificial hives should be placed in the optimal location and should be easily accessible for harvesting honey. It is recommended that artificial hives are set up near houses because that is where abundance was greatest. This is true, as long as people maintain gardens with flowering plants to provide pollen and nectar for the bees. It is not recommended to set them up in forested areas because access to them in more limited, which is not favorable for having efficient *meliponarios*.

4.2 Attractant for establishing future *meliponarios*

It was clear when collecting data that *Tetragonisca angustula* were not attracted to the attractant used (4 parts 50:50 sugar-water and 1 part eucalyptus oil). Any sightings were within a 1 m radius of the plate, but none were hovering directly above. This may not have been an issue of there not being any bees of this species in the area, because several nests were seen. This was an issue of using the wrong attractant, as few approached the study sites. Without the use of specific pheromones, it is very difficult to attract a particular species of *Meliponini*.

Pheromones were not used for this study because of their high cost ($20 per L) and low availability. CEASPA at the Centro El Tucán gets the pheromones from Costa Rica, the closest place they are available. The pheromones are made with products from the nest, was and propolis mixed with alcohol. Even with access to the pheromones, preparing an artificial nest may or may not work, depending on many factors including season.

If redoing this experiment, if pheromones are not available, it may be better if using another concentration of sugar-water and eliminating the eucalyptus oil that attracted only *Euglossini* bees. *Meliponini* collect nectar with lowest concentrations around 20% sugar, so using a 1:5 sugar-water ratio may attract the *Tetragonisca angustula* better (Fidalgo & Kleinert, 2010).

CEASPA's bee conservation project aims to start meliponiculture in Achiote to have a socially, economically and environmentally sustainable development. For this project to be economically viable, there needs to be a way to attract the bees that is not too expensive and is readily available. At the moment the pheromones are expensive and are only available in Costa Rica. Perhaps a local production can reduce the cost and increase the accessibility of this essential

product. This would also help the local economy by selling a product that will be used to generate more income. This is especially important if this is meant to be a long-term project.

A way to avoid the high costs and low availability of the pheromones is to find out what are the active ingredients in the attractant. If these ingredients are available in more locally sourced plants, they may be able to be used as attractants instead of the *Tetragonisca angustula* pheromones. A study looking at *Teragonisca angustula* mating found that Isopropyl hexanoate is the most abundant compound in virgin queen volatiles and attracts drones (Fierro et al., 2011). This compound is found in several fruits including wine grapes, strawberry, and starfruit (*Averrhoa carambola*) (National Center for Biotechnology Information). Starfruit, which can grow in Neotropical environments may have potential for attracting *Tetragonisca angustula*.

4.3 People's knowledge of *Meliponini*

There is a noticeable knowledge gap between females and males on the subject of native stingless bees. Males on average know more than females in Achiote. It is unclear why this age gap exists, but it should be addressed if there is to be a successful native bee conservation project in Achiote. For sustainable development in the community, it is important that women are knowledgeable and equally involved in the learning and the benefit of the project.

The age group with the greatest level of knowledge is the 55-64 year age group. The lowest level of knowledge is the 75+ age group and the 18-24 year age group. It is unclear why there is such a lower level of knowledge in the youngest and oldest age groups. This can be addressed by CEASPA by making educational workshops focused on these two age groups, especially the younger ones which will carry the information and pass it to the next generation. Young people

make the changes for the future, and a successful conservation project can be lead by a generation of young people who have awareness about issues involving bee conservation.

Those with only primary education had the highest level of knowledge followed by those with university education. The high knowledge of stingless bees by those with only primary education may be because almost all of them are either housewives or work in agriculture. In the case of those working in agriculture they are outside for work and may come into contact with stingless bees while in the field. Housewives may also spend time outside and around the house, where many *Meliponini*, especially *Tetragonisca angustula* nest. The increased exposure to stingless bees of people with these occupations may contribute to their increased level of knowledge about them, and as a result, those with the lowest level of formal education have a greater knowledge of *Meliponini*.

Around 77% of people with university education knew what stingless bees are. This is the level of education with the most knowledge of the bees, suggesting that people with higher education may have access to more information about *Meliponini*.

While conducting the surveys, it was realized that people in Achiote know *Meliponinis* as *zagaños*. Therefore, it is possible that more people knew about the stingless bees than the results show because people were not familiar with the terminology used.

4.4 Use of *Meliponini* products

Over 43% of people surveyed in Achiote claimed to consume honey from stingless bees. This result may not be accurate because with over 43% of people not knowing what *Meliponini* are, it is hard to believe that that many use stingless bee honey. Honey from stingless bees is several

times more expensive than commercial honey and may not be affordable for many of the people living in Achiote (de Almeida-Muradian, 2012).

Producing stingless bee honey in Achiote would give access to the people to an important medicinal product that has shown to be of higher quality than commercial honey which is what many use at the moment.

4.5 Perception of the environmental condition in Achiote

Over 70% of the people surveyed believed that the forests in Achiote are in good condition. This is an issue when thinking about the destruction of the habitats of many stingless bees. It is apparent that there is deforestation happening in Achiote. This is done for agricultural purposes and for building infrastructure and houses.

When addressing the issue of worldwide and local decline in bee populations it is important to mention the clearing of forests and the issues it creates on a larger conservation perspective.

4.6 Knowledge of meliponiculture

There is very little knowledge about meliponiculture and its potential economic and social benefits for the community, in Achiote. This is something CEASPA will have to focus a lot of energy into in order to develop sustainable *meliponarios*. This will have to start with basics, such as explaining the goals of meliponiculture and then more details about what it is and how to successfully raise and keep native stingless bees.

4.7 Interest of people in participating in CEASPA's native bee conservation project

Overall, most people are interested in participating in CEASPA's bee conservation project. More people are interested in an education program to learn more about stingless bees through workshops and other activities. With 70% of people interested in participating in the production of honey with stingless bees, there is hope for CEASPA's future plans in Achiote.

Women had a greater level of interest than men. This originally was thought to be because more women are unemployed and therefore stay home, maybe leading to more time for participation. This may not be the case finally, because employed people had a greater average level of interest than unemployed people.

6. Conclusion

Both social and biological dimensions of this analysis are important to the success of CEASPA's native bee conservation project. If biological aspects are taken into account but people are not knowledgeable about the issues or interested in participating in the project, it will not work. On the other hand, if social aspects are taken into account but inappropriate attractants are used, or suboptimal locations are used for setting up artificial hives, the project will not be efficient.

Meliponiculture can provide the people of Achiote with an environmentally sustainable economic activity that can lead to improved community development. Stingless bee honey is a high value product that is part of a niche market (de Oliveira Alves, 2005). This is a sustainable practice because income is generated in poor communities and with low environmental impact. In fact, the keeping of these bees will help to increase the declining populations.

Properly educating the people of Achiote on efficient beekeeping is of utmost importance. It has been shown that even when beekeepers wish to use their honey to generate income, they lack the proper technical knowledge on breeding techniques and maintenance of colonies (Fuenmayor, 2012). Therefore, to avoid poor beekeeping practices and discouraging people with low performance, education is necessary.

Although meliponiculture is not deep-rooted in the culture of Panama like it is in Mexico or Brazil, introducing it is an opportunity for enhancing local knowledge in Achiote on bees that are native to their environment. The cultivation of stingless bees can provide a viable economic activity to the people of Achiote while conserving these insects. With the completion of the bridge on the Atlantic side of the canal, and the increasing tourism industry in Panama, Achiote may be able to use this honey as a tourism attraction, bringing in more income.

CEASPA will be able to use the results of this analysis to plan the future of the native bee conservation project. The biological part of the analysis will help to decide where to set up artificial hives for establishing *meliponarios* and to address the issue of having an appropriate attractant that is economically viable for the long term. The social part of the analysis will help to understand the complex ways that socio-economic background has on people's knowledge and interest levels. This will help to cater the conservation project to fit the needs and wants of the community.

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Appendix I. Copy of Survey

ENCUESTA

Esta encuesta tiene como fin determinar el grado de conocimiento sobre las propiedades de abejas sin aguijón, así como su valor socioeconómico y ecosistémico, como una herramienta para evaluar el potencial del establecimiento de proyectos de meliponicultura en la comunidad de Achiote, Colón, Panamá. Tiempo de duración: 20 minutos.

I- información general del encuestado

Sexo: M ☐ F ☐

Edad: _____

Ocupación: _____

Nivel de educación: primaria ☐ premedia ☐ media ☐ universitaria ☐ ninguna ☐

Número de individuos en el hogar: _____

2-Conocimiento sobre las abejas sin aguijón (Hymenoptera: Apidae: Meliponini)

- ¿Usted sabe lo que es una abeja sin aguijón?

SI ☐ NO ☐

- ¿Conoce usted la importancia de las abejas sin aguijón?

SI ☐ NO ☐

- ¿Ha consumido alguna vez productos de las colmenas de abejas sin aguijón?

SI ☐ NO ☐

- En el caso de contestar "Si", ¿Qué productos ha consumido?

Miel ☐
Polen ☐
Propóleo ☐

Cera ☐

Otros_____

- ¿Con que finalidad lo consume usted?

Fines medicinales ☐

Fines alimenticios ☐

Otros. Indique cuales_____

- ¿Ha visto abejas sin aguijón en su jardín y alrededores de su hogar?

SI ☐ NO ☐

- ¿Puede reconocer los nidos de abejas sin aguijón?

SI ☐ NO ☐

3. Percepción del estado de conservación del ecosistema y los meliponinos: Cómo considera usted se encuentra la salud de las zonas verdes de los alrededores de Achiote (bosque)

¿El bosque alrededor está en buen estado y sin problemas?

SI ☐ NO ☐

- Si la respuesta es "NO", indicar cuales serían los problemas que considera usted afectan al bosque y zonas verdes circundantes a la comunidad de Achiote

_____

_____

_____

4. Conocimientos sobre meliponicultura y valoración socioeconómica

- ¿Conoce usted qué es Meliponicultura?

SI ☐ NO ☐

- ¿Conoce usted los potenciales beneficios de la producción de miel de abejas sin aguijón, desde la perspectiva económica y social para su comunidad?

SI ☐ NO ☐

- Estaría usted interesado en participar de un proyecto de producción de miel utilizando abejas sin aguijón como fuente primaria (Meliponicultura)

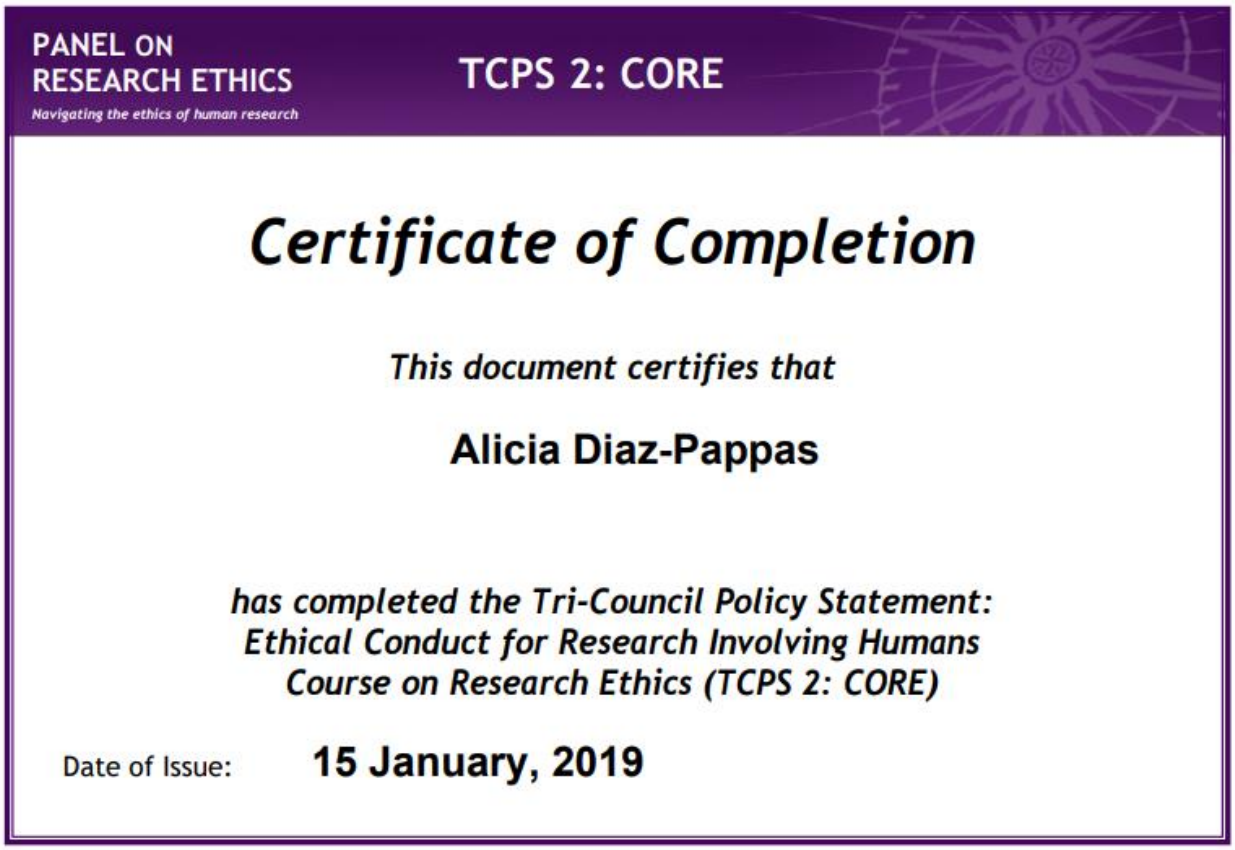
SI ☐ NO ☐

- ¿Estaría interesado en participar capacitaciones y talleres de formación abejas sin aguijón, su importancia y el aprovechamiento de productos derivados de ellas?

SI ☐ NO ☐

¡Muchas Gracias por su Cooperación!

Appendix II. CORE Ethical research certificate



PANEL ON RESEARCH ETHICS
Navigating the ethics of human research

TCPS 2: CORE

Certificate of Completion

This document certifies that

Alicia Diaz-Pappas

has completed the Tri-Council Policy Statement:
Ethical Conduct for Research Involving Humans
Course on Research Ethics (TCPS 2: CORE)

Date of Issue: **15 January, 2019**

Appendix III. Copy of permission form for sampling on private property and for participation in survey

Centro de Estudios y Acción Social Panameño

Vía Circunvalación, Casa N° 84 Coco del Mar,
San Francisco, Panamá
Tel. (507) 226-4529 / 6602 / 6783 • Fax: (507) 226-5320
Apartado 6-133, El Dorado, Panamá, Rep. de Panamá
Correo electrónico: ceaspa@sinfo.net

Achiote, 24 de febrero de 2019

Señor/Señora

Vecino de la comunidad de Achiote

Presente

El CEASPA, a través del Centro El Tucán, continuando con su labor de investigación y levantamiento de información relevante sobre la biodiversidad del área y en el marco de un proyecto de conservación de abejas nativas sin aguijón (Meliponinos) está realizando un estudio sobre la implementación de la Meliponicultura (cría de abejas sin aguijón) en la comunidad de Achiote

Para ello, dos estudiantes de la universidad de McGill, Canadá, van a estar en los próximos días visitando sus casas para conversar con ustedes y realizar algunas entrevistas.

Agradecemos cualquier apoyo que les puedan brindar a los muchachos, Alicia y Bret.