Hive feasibility report

CEPF project -100798

One of the goals of the project was to discuss with the community and possibly test the best model of the beehive for Príncipe's reality. In this document, we will present arguments about the tested or abandoned methodologies that we went through this initial project phase showing why, at this point and having honey production as a focus, we think that Langstroth beehives are the best option for the beekeepers on the Island.

Background on the four beehive models:

1. **Langstroth:**

The Langstroth hive was designed by Lorenzo Langstroth in the 1850's as an alternative to skeps hives. His design revolutionized the way people kept bees and allowed for both more manipulation and more humane practices. Skeps are woven baskets used to house bees when it was time to harvest honey, beekeepers often ended up destroying the hive in pursuit of honey and/or driving all the bees out of their home. Langstroth hives changed this because they allowed beekeepers to extract individual combs without any destruction for both health inspections and honey harvests.

Lansgstroth hives are the most common beehives in developed countries for many good reasons. The Langstroth hive is basically a box with 10 wooden frames in it. The frames can have a foundation already installed or they can be foundationless. The bees fill one box at a time and when the box is 70% full, the beekeeper adds another box on top. The biggest benefit of the Langstroth hives is that their size is only limited by how many boxes the beekeeper is willing to put onto the hive to grow it. That is a huge benefit for anyone who wants to sell honey.

The honey is easier to harvest; you just uncap the cells and spin the honey out in an extractor. Also, since the wax is attached to the frame on three or four sides the risk of it falling off is lower than when it's just hanging from the top.

With frames, you are able to give the bees their wax back. This means they don't have to spend any extra energy rebuilding their comb. They can just start filling it with honey. It saves time and results in higher production of honey.

One of the cons of the Langstroth beehive is the number of wood parts that need to be built or bought. Those parts need to have a precision size which demands a good carpenter and can increase its price.

It is important to note that in the tropics of Africa the Langstroth needs to have special sized wax foundations for the smaller tropical African bees - *Apis mellifera adansonii* compared to the European or Western honey bee, *Apis mellifera*. Therefore this can be solved by building "fake waxed foundation paper strips" or foundationless frames.

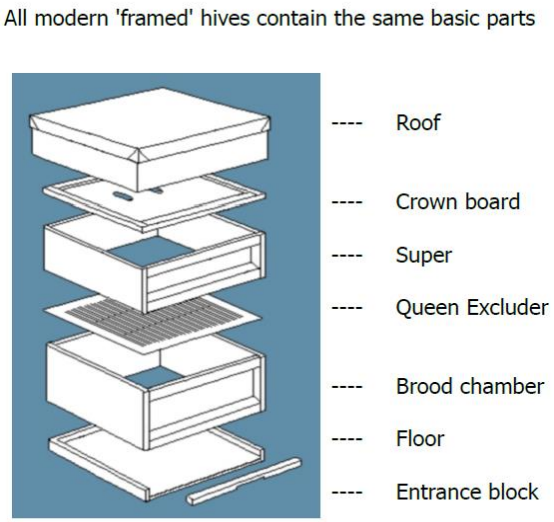

Figure 1. Langstroth hive used in Príncipe (left) and parts of modern framed hive example (right).

Figure 2. Beekeepers inspecting a frame with full comb and bees on Langstroth hive of Príncipe.

2. The Kenyan top-bar hive (K.T.B.)

Developed by Professor G.F. Townsend and his team of Kenyan bee students at Fuelph University, Canada, for use in East Africa. Instead of frames, there are only bars from which the bees hang their combs. Also unlike a Langstroth, this hive is formatted horizontally instead of vertically.

The hive is quite simple in concept. Combs are supported by bars of wood which lay across the narrow width of the trough-like hive-body. The width of each top-bar is equivalent to the natural width of a comb plus a bee-space (35 mm. or 1 3/8 inches). Thus, as in the Langstroth hive, the

combs are maintained at their natural spacing from one another. Unlike the Langstroth hive, however, the combs in a KTBH are supported only at the top and are not enclosed by a full frame. Comb from the KTBH is simply cut from the top-bars at the apiary and placed in buckets or other covered receptacles; later the honey is extracted by squeezing. The KTBH, on the other hand produces more wax since on every honey harvest the combs need to be destroyed and cannot be reutilized like on the Langstroth hive.

Since they have no frame holding the comb the management of this hive needs to be performed extremely carefully, which can be a challenge for new beekeepers. Also, a low experience beekeeper can lack the skill to position correctly the top and the bees can make crooked combs or glue them on the sides of the hive making the management even challenger.

Figure 3. Kenyan Top-bar hive used by some African beekeeper (not Príncipe) showing the comb attached only by top bar.

3. The Log Hive

The Food and Agricultural Organization (FAO) describes two main types of log hive. In some isolated areas of the West African coasts (e.g. Ghana and Guinea-Bissau), the ciba or palmyra palm (Borassus flabellifer) produces natural hollows for interested beekeepers to use as hives. When the plant dies, the beekeeper waits for termites to consume the soft inner pith. The tree is then felled and cut into pieces and the ends are sealed with woven grass, a few small holes being left at the ends to provide entry and exit for the bees.

For the second type, found in East Africa (e.g. Kenya and Tanzania), a tree is felled and cut into cylindrical logs which are carefully scooped out to form hollows. They are then sealed, leaving some small holes for exit and entry. In Tanzania, the hive is split into halves, which the beekeeper attaches together before baiting and installation. At harvest time, the hive is split open and the honeycombs

removed. The halves are then re-joined for the bees to start the next honey crop. The East African log hive, while simple in construction, is however expensive and inefficient.

Although log hives are the most widely used in Africa because it is inexpensive to make they are very difficult to work with. The combs are fixed to the top of the hive and is very difficult to perform inspections, to circulate smoke though and at the honey harvest, the combs are destroyed. In general, this is a very rudimentary way to do beekeeping.

Francis Waraga Kinuthia in his apiary of traditional log hives in Laikipia, Kenya

Figure 4. Hive inside of a log in Príncipe (left) and log apiary in Kenya (right).

4. Basket or skep Hives

Skeps, which are baskets placed open-end-down, have been used for about 2000 years initially made from wicker plastered with mud and dung but from the Middle Ages, they were made of straw. There is a single entrance at the bottom of the skep and there is no internal structure provided for the bees and the colony must produce its own honeycomb, which is attached to the inside of the skep.

Skeps have two disadvantages: beekeepers cannot inspect the comb for diseases and pests, and honey removal often results in the destruction of the entire colony. To get the honey beekeepers either drove the bees out of the skep or, by the use of a bottom extension called an eke or a top extension called a cap, sought to create comb with just honey in it. Quite often the bees were just

killed, sometimes using lighted sulfur, to allow the honeycomb to be removed. Skeps could also be squeezed in a vise to extract the honey. As of 1998, most US states prohibited the use of skeps.

Today the skeps are used by few beekeepers and as demonstrational beehives and a way to preserve this craftership art.

Figure 5. On the left a straw English skep and right straw and mud skeps in Viscri, Romenia.

Detailed experiments

Basket/Skep

From the beginning, this methodology was abandoned and not even tested. Since the goal of the project is honey and other bee products there is no point to introduce a technique that harms the bees and it is inefficient from the production point of view. Another factor to contribute to this decision was that although there are some artisans who produce baskets on Príncipe none of them proved capable or available to learn the necessary techniques for its construction. Another factor is the extremely rainy climate of the island that makes this material easily degradable when exposed to the environment, even under a cover. The use of skeps is currently linked to a historical rescue of tradition in Europe and not a viable practice of beekeeping and is even banned in some countries due to sanitary issues. Thus, the only possibility of using this type of beehive would be demonstrative and would not add value to the project objectives.

Log hives

Between October and December, 2017, Three Log-hives were tested using the method of cut logs with the wild beehives on it and transfer the logs to the apiary. This methodology demands a huge effort of the team in order to cut the tree without damage the hive, close all the entrances and holes on the wood and transport the log to the apiary. Even that the swarms were checked every 2 days all of them abandoned the hive in a week. When inspected the logs presented lots of parasites prevenient from the decomposition of wood as ants, termites and beetles. It was clear that in a tropical forest as humid as Príncipe's the decomposition of wood is a challenge and was the main responsible for the abandonment of bees. Even the local carpenters have problems to dry and prevent fungus on wood planks.

To test if the problem was the management, the transport or some mistake in the catch methodology we kept the logs in the apiary hoping that with the smell of wax and propolis we could attract a new swarm to the logs, which showed no results since today.

Figure 6. Beekeepers using a chainsaw to cut the logs with a swarm inside in November 2017.

Figure 7. The same trunk of figure 6 cut and sealed for transport to the apiary.

Figure 8. Inside of the same trunk of Figures 6 and 7 after being abandoned by the bees showing clear signs of decomposition of the wood inside.

Figure 9. Beekeepers preparing a new log hive from a rescue also in November 2017.

Figure 10. Detail of the interior of the hive shown in figure 9 showing the internal arrangement of the combs.

Langstroth

25 Langstroth brand new beehives of a top category (Thorne brand - https://www.thorne.co.uk/hives-and-bees/hives/langstroth-hives - costing 380 USD each) were donated by HBD to the project resulting in zero cost.

Figure 11. Langstroth hive by Thorne donated by HBD.

The other 25 beehives were built with materials and by local carpenters at a cost of 40 dollars each, which is relatively cheap. Local wood was used on the construction and surprisingly the local carpenters were able to deliver a great job with all the correct measures.

All the tests performed with both of those Langstroth beehives showed that there is no performance difference between them related to the success to maintain the swarms or honey production. The fact that Langstroth model can be built in Príncipe with low price solves one of the major criticisms of this model in relation to the KTB hives. Currently, we have 15 Langstroth beehives active on the apiaries.

As pointed by several researchers and beekeepers we also faced problems with the imported European wax foundation (also donated by HBD). The bees took a lot of time to accept or didn't accept at all this material, culminating in the abandonment of hives or very slow production of honeycombs. Once we realized this problem we solved it using foundationless frames or frames with just a small string of wax attached on the top of the frame, which the bees accepted very well.

One of the challenges of the project is to turn bee-burners into beekeepers. Due to their background, the majority of the members of the cooperative never had contact with any beehive. Despite that, some of them already worked with fix frame hives as Italian, Langstroth or German ones and many of them have contact with Youtube videos using Langstroth hives as a model. Although that doesn't mean that they fully understand the biology of the bees or the management of the hives it helped to initiate the training with Langstroth hives. With the second training event between June and July 2018 the beekeepers now have knowledge and experience to initiate the work with beehives. After that, we notice a huge improvement in the capture success and permanence of the bees inside the beehive, which we hope will be reflected in increased honey production.

One of the biggest advantages of the Langstroth hive on our case is the ease with which we can trap the combs of the natural swarms captured on the frames to perform the transference to the new beehive. Since our main font of bees still is the wild captures this is a huge benefit for the project.

Figure 13. Natural combs being attached to the frames with the aid of the fixing wires

The 15 Langstroth beehives are starting to produce honey but we still didn't reach the harvested season when it is safe to extract the honey without prejudice the bees.

Figure 14. Almost full honeycomb from a Langstroth hive.

The previous and incomplete beekeeping PAPAC project on Príncipe bought processing equipment for the honey house. Excepting the press, these equipments only can be used to process honey from Langstroth frames like the centrifugal and uncapping table. Several other materials like uncapping knife and fork and beehive tools are also available in abundance and waiting to be used.

Figure 15. Honey processing equipment from the COOPAPIP honey house. From left to the right: uncapping table, centrifugal and manual press.

Figure 16. Honey processing tools from COOPAPIP. From left to the right: beehive tool, uncapping fork, and uncapping knife.

In general, working with this model of beehive has obtained good results. The problem of cost, lack of skilled carpenters, beekeeping training and waxing were solved. According to Felipe Ramos, our consultant, we can expect that the production of each of these beehives is at least 15kg of honey per hive a year. With the 50 hives, the amount of honey produced by year would be of at least 750kg meaning more than 5000 USD to COOPAPIP.

K.T.B

Since all the equipments to work on Langstroth hives was already available we started to test this kind of hive first.

For several reasons the KTB beehives didn't show to be a good option for Príncipe:

- This model of hive is difficult to populate because of Its size, demanding big swarms. Since our font of bees is the capture of wild swarms the fixation of their combs only on the top bar is impractical resulting in crocked and broken combs. A newly-constructed comb and all combs filled with honey must be handled with the utmost care. It is not advisable to move a top-bar hive, occupied by bees and combs, on lorries along bad roads full of potholes, like the Príncipe ones.
- The beekeepers have no familiarity and show to have resistance to KTB also because of their shape, similar to a coffin according to them.
- Honey can only be extracted by destroying honeycombs, either by using the solar wax melter to dissolve the comb cells or by crushing them and squeezing out the honey. Bees have to build up new ones in their place, and this involves time, material and resources of the honeybees. If the focus of the beekeeper is the production of wax instead of honey this could be a good option but for honey, the Langstroth hive is still economically more profitable.
- Bees are often crushed between top-bars as the beekeeper rearranges the bars after removing them from the hive body. This problem is serious when colonies are manipulated at night, which is our case. When bees are crushed in this way, it is difficult to fix the last top-bar into place. Crushing bees is usually not a serious problem with frame hives as Langstroth.
- Teach at the same time two different methodologies of work and beehive models with two different goals (honey for Langstroth and wax for KTB) would confuse the beekeepers. Since the goal of the project is the production of honey that already has a huge internal market and external potential market that could improve the livelihoods in Príncipe the Langstroth hive is the best choice.

For those reasons, the top bar hive is not the ideal one for commercial beekeeping focus on honey like the expected on Príncipe. In the other hand, this could be a good option for pollination of crops, hobby and also wax production. Keeping this in mind, one of the intentions of the project is to distribute KTB hives to beekeeping enthusiasts and people interested in having them as a hobby through an agreement with COOPAPIP. Whenever the hive needs maintenance or be picked up, its tutor should contact the cooperative who will share the honey that may have been harvested and will have the remaining wax. This approach still needs to be tested and we already have a list of people interested in being hive tutors.

Conclusions

The basket beehive (actually the name is skep) and the Log (log gums) are fixed combs beehives used by early beekeepers. Because the combs are fixed the honey removal is difficult and often results in the destruction of the entire colony. Besides that, this kind of hive is difficult to be inspected for disease and parasites. After three months of the assessment of the local reality and the goals of the project, which is the conservation of bees with a strong component on the production of honey, we realized that these two options of beehives are not valid solutions. They are more indicated for single conservation initiatives and not for honey production. According to the reality of Principe Island, the log gums can be used for a rescue of wild swarms when a tree will be cut and move the hive to another area, with the proposal of conservation and maybe use the bees for pollination of crops. Tests with log gums were made with no success on Príncipe. Because of the level of craft ability necessary to make skeps and the amount of rain on the Island this model is not recommended to our reality, although are a very cheap model. The solutions found to solve the problems of the Langstroth hives make it viable and preferable for Príncipe. The KTB hives can and will be used to focus on pollination, awareness, hobby and potentially wax production but are not commercially sustainable for the production of honey.

In summary, we have concluded that the best hive type for Principe is the Langstroth hives. Despite initial reservations that these would not work well and the reliance on supplies from overseas would be restrictive, we now believe that these represent the best hive type to result in reliable, high quality honey production for the island.

Summary table

Hive type	Pros	Cons	Cons were mitigated by
Langstroth	• Used commercially worldwide • Can manage parasites • The beekeepers had some background with this model	• Equipment is a little more expensive • Reliant on supplies from overseas, especially processing equipment	• Close relationship with HBD and signed service agreement to support import logistics over the longer term • Identification of skilled carpenters to construct new hives from local materials
Basket/Skep	• Very cheap to produce	• Hive construction is complicated • Difficult to extract honey and bees can be harmed • Honey extracted is not pure • High humidity and rainfall on Principe can cause mold to form • No tradition on using those hives • High humidity and rainfall on Principe	

		can cause mold to form	
Log/Log gum	• A positive role in securing pollination services	• Difficult to extract honey and bees can be harmed • High humidity and rainfall on Principe can cause mold to form and other insects deteriorated the log making the bees left • Difficult operation and transport	
Kenyan Top Bar (KTB)	• Hive is simple to construct and can be made from local materials	• It takes longer for the bees to produce honey as this beehive is much wider than Langstroth • The management is complicated because the combs need to be operated very carefully or will break • The combs cannot be reutilized once the honey is extracted as in Langstroth making the time between harvests longer • It's very difficult to hold combs from wild swarms on the bars	