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Chapter 6

Beekeeping models

6.1 LOCAL-STYLE HIVES

6.1.1 History

A local-style hive, or native hive, is a hive that is simply and locally made, and in which the bees attach their combs to the ceiling. They are also often named "traditional" hives because they have been utilized for many years.

These hives can be highly profitable since the bees housed in them live naturally and are healthy, and they can form the basis for large, healthy and genetically strong bee populations. A beekeeper using this style of hive may own several hundred since they cost very little. These hives are highly sustainable, and ecologically and economically viable, making them an excellent choice for many situations, especially in rural areas.

Beekeeping is thought to have arisen in the first ancient civilizations living in areas where nectariferous plants, and therefore honeybees, were abundant. These places, rich in vegetation, sustained human populations, and so agriculture was born. One of these places was the so-called Fertile Crescent, often called the "cradle of civilization", a region in the Middle East that curves in a crescent shape from the Persian Gulf, through modern-day southern Iraq, Syria, Lebanon, Jordan, Israel and northern Egypt. The region has long been recognized for its vital contributions to world culture stemming from the civilizations of ancient Mesopotamia, Egypt, and the Levant, which included the Sumerians, Babylonians, Assyrians, Egyptians and Phoenicians. The Fertile Crescent is a significant part of human history, from the Neolithic Age through to the Bronze and Iron Age, and includes the fertile valleys of the four great rivers of the region (the Nile, the Jordan, the Tigris and the Euphrates) where the first agricultural civilizations developed.

When some human communities abandoned their nomadic hunter-gatherer lifestyles to settle permanently as farmers, the need arose to build containers to store food produced in certain seasons so that it could be consumed throughout the year. Beekeeping may have begun by chance due to social bees' habit of nesting in cavities. Since prehistoric times, humans have built various instruments, one of the most important being containers. However, when we led nomadic lives and had no pack animals and carriages, these containers had to be small, light and were probably temporary. Settling meant that containers could be made from more solid and longer-lasting materials and, most importantly, of greater capacity. Some of these containers were the perfect size for Western honeybees to build their nests in and start a new colony. Several scholars believe that bees entered some of these vessels voluntarily. Their decision to nest here could also be explained by the great impact that agriculture may have had on the environment.

The manufacture of containers with capacities of 30–50 litres, a volume similar to that preferred by bees, was certainly an important coincidence for the birth of beekeeping. Having observed bees choosing these containers as nests, humans could then make purpose-built containers for the swarms.

As beekeeping spread into different geographical areas, the hives used to host bees changed depending on location and availability of local materials (see Figure 2).

Beekeeping began using the technique of swarm collection, and swarm traps. Swarm trapping is done by setting out traps in strategic locations and attracting bees when they are in the reproduction phase at the colony level (swarming) and searching for a new nest site. Bees are captured before they find a nesting site because it can be difficult to remove them.

Numerous publications outline the history of beekeeping from its origins to modern times, but Eva Crane's *The world history of beekeeping and honey hunting* (1999) is especially worth reading.

FIGURE 2
Different kinds of local-style hives

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FIGURE 3
A local-style ferula hive

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FIGURE 4
A vertical local-style hive made of cork

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FIGURE 5
Vertical local-style hives made of wood

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FIGURE 6
Vertical local-style hives made of straw and earthenware roof tiles

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6.1.2 Definition

The term "traditional hives" is often used to refer to particular hives that are common in some regions, or in communities often associated with developing regions. This has wrongly created the impression that it is not fit for purpose in the modern environment. Thus, the term should be replaced with "local-style hives" to reflect hives made from locally available material.

It is possible to classify local-style hives into two main groups:

1. "Vertical hives" with fixed combs. Combs are freely built by the bees, which attach them to the ceiling of the hive. The bees are usually managed from underneath.
2. "Horizontal hives" arranged in overlapping rows with fixed combs. Combs are freely built by the bees, which attach them to the ceiling of the hive. The bees are usually managed from either side.

The use of horizontal hives has since spread from the Fertile Crescent throughout the Mediterranean basin. Today, horizontal hives of various shapes and built with various materials remain the most common type of hive used in traditional beekeeping throughout Africa, the Middle East and in some countries in southern Europe.

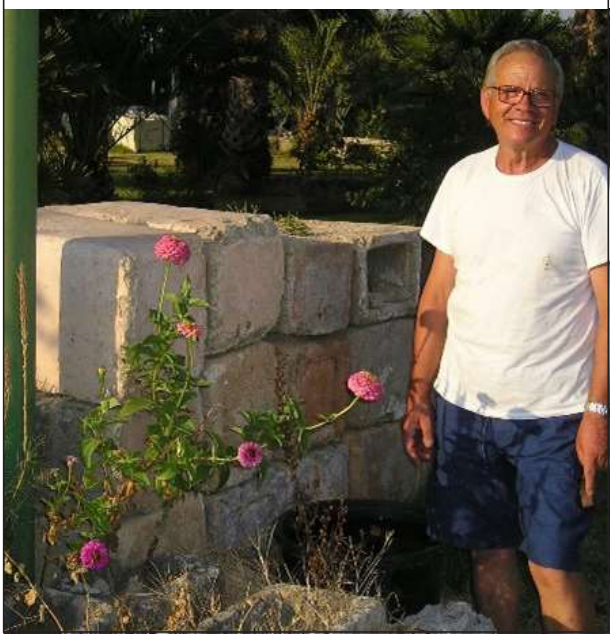
Obviously, these groupings are not entirely rigid. For example, Sicilian beekeepers (called "*fasciddari*") used and still use, albeit rarely, giant fennel hives ("*fascidde*") to build natural hives (ferula hives) (see Figure 3). They can dismantle a log hive comb by comb (they are very small combs), or divide the mother log hive into two (one with the original queen and one orphan colony).

Management of local-style hives diffes from that of hives with mobile frames. Some consider that they require greater knowledge of beekeeping techniques, but they are easy to use with some basic skills training. Construction requires only local natural resources (part of plants, minerals, stones, common/accessible/frequently used materials), which makes them cheaper and easily acquired in large numbers, compensating for their lower honey productivity (compared with movable-frame hives).

The next subsections provide a more detailed description and examples of different types of local-style hives in use in different parts of the world.

FIGURE 7
A vertical local-style hive made of woven canes

FIGURE 8
Horizontal local-style hives made of stone (called "*piluni*")



6.1.3 Local-style hives in Europe

Beekeeping spread from Asia Minor to the Aegean region and gradually throughout Greece, to the Magna Graecia, as well as throughout the Mediterranean, from Malta to Spain, probably helped by the Phoenicians.

Log hives made of terracotta, stone, wood, cork, straw and other materials, often finished with clay mud, lime or dung to weatherproof them and increase their thermal insulation, were used in different areas of Europe, depending on climate and availability of local materials (see Figures 4–8).

We owe much of our knowledge of beekeeping and honeybees to the culture of ancient Rome, which spread throughout the Mediterranean in the following centuries. Scientific and technical discoveries were mostly made from the seventeenth century onwards.

While images of the hives used by the Romans are very rare and there have been even fewer archaeological finds, we can deduct from descriptions that most were horizontal. Honey was taken from horizontal and vertical hives by removing only the combs with honey to ensure that bees had adequate supplies for survival. With the fall of the Roman Empire (476 CE), beekeeping witnessed a decline with the spread of apicide. This is when all bees are removed from their hives for the collection of honey and wax, and it is an aspect of ancient beekeeping that is often forgotten.

Across Europe, the various types of hives that became popular in the centuries following the fall of the Western Roman Empire did not change shape or materials, but were often used and named differently (e.g. "*fasceddi*" in Sicily and "*piluni*" in Apulia). Basket hives coated with mud or dung became common in lowland areas where it was difficult to find trunks of an adequate size. Here, horizontal wooden hives often became vertical hives for practical reasons. Only the Alps and southern Italy have a long tradition of horizontal hives.

Europe has since largely abandoned local-style hives in favour of movable-frame hives. These hives are easier to adapt to standardized, higher performances and industrialized processes.

6.1.4 Local-style hives in Africa

Africa has been home to bee species for thousands of years and several rock paintings prove that beekeeping has been practised for centuries in many countries. In the early years of civilization, many African groups ate honey, which they would gather through honey hunting. With the development of tools and instruments for an easier life, communities started making hives for the purpose of keeping bees.

Several types of hives have been used for generations based on materials at the disposal of the different communities, resulting in a wide range of local-style hives.

With demand for natural honey increasing on the global market, Africa has seen a marked increase in honey exports to the European market and other markets which recognize the uniqueness of African honey. More than 90 percent of the honey exported from Africa is harvested from local-style hives that have been used for generations. It is thanks to these hives that Africa also produces large volumes of beeswax, which is also exported to many countries across the globe.

FIGURE 9
A colonized log hive

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FIGURE 10
Bark Hive

©MUKOMANA D.

FIGURE 11
Round reed/grass/bamboo hive

©MUKOMANA D.

FIGURE 12
A grass-insulated local-style hive

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Local-style hives in many African communities do not follow specifications due to various factors, resulting in different sizes of hives. These factors include the type of tree trunk/bark or material available. For example, the length of a log hive ranges from 50 cm to 1.5 m. Their diameter can also vary, from as small as 25 cm, up to 50 cm.

Log hives

These hives are made from logs of different trees, depending on the forests in the respective communities or countries. Some are made from dead wood with a hollow in the middle due to the type of the tree, while some communities cut down trees and chisel the trunk to create the hollow.

Once a log has been prepared, both ends are sealed with curved pieces of carefully woven material, leaving a hole so that bees can come and go.

Log hives are usually placed high in the trees for security reasons, often at an average 3 m above the ground (see Figure 9).

Bark hive

This is a hive made from tree bark of a specific species. Bark is harvested such that it retains its original shape. The ends of the hive are sealed using pieces of curved wood,

or woven grass or thin tree twigs. The most popular tree for bark hives, especially in Southern and East Africa, is the Miombo. Like log hives, bark hives are usually placed in trees at an average height of 3 m above the ground (see Figure 10).

Reed/grass/bamboo hive

These hives are made with woven reeds/grass/bamboo/twigs, which are sometimes then plastered with cow-dung or clay soil for durability. They are the same shape as a log or bark hive, with both ends sealed with a curved piece of wood, or woven grass or twigs. Some look like baskets (see Figure 11).

Clay pot hives

Many communities in Africa were very good at pottery and made a number of utensils from clay. Pots that were broken or no longer usable for storing water were sometimes used as hives. Some clay hives would be purpose-made.

Gourd hives

Gourd is a popular fruit from the pumpkin family that is used for storing water and small grains. Some would be used by communities as beehives.

6.1.5 Local-style hives in Latin America

The breeding of *Apis mellifera* in Latin America began with the arrival of European settlers, who introduced honeybees with hives made in their countries of origin.

In some regions, as there was an abundance of other materials, hives were made from clay, ceramics or stranded reeds (see Figure 13), but they always followed the measurements and patterns of European countries, which is why Latin America has no hives for breeding *Apis mellifera* that we can call "local-style".

Latin America's native bees are stingless bees of the genera *Trigona* and *Melipona* (see section 8.2 on stingless bees), for which we can observe different types of hives, not only by region but by species of bee. They are different shapes, sizes and materials and store food in different ways.

6.1.6 Local-style hives in Asia

In the Middle East, the tubular hives managed in overlapping rows that were used in Ancient Egypt 4500 years ago are still used today (although in smaller numbers). *A. cerana* local-style hives differ greatly depending on locally available materials in the area, and like *A. mellifera*, *A. cerana* covers a large area ranging from tropic to temperate regions, with high environmental diversity. One of the most common types is the log hive. Hives are usually placed on top of supporting materials to keep them away from the ground. In some regions, they are mounted on the wall or placed on rooftops (see Figure 15).

FIGURE 13
Beehives made of mud

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FIGURE 14
Inside a beehive made of mud

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FIGURE 15
Local-style hives in Shaanxi Province, China

©DR WEI SHI

FIGURE 16
A local-style hive in Southeast Asia

©DR WEI SHI

Southeast Asian communities continue to practice wild harvesting from *A. cerana*. Beehives take many forms, from pots and simple mud-clad/grass and bamboo hives to hollowed logs, removable frames and top-bar hives (see Figure 16).

6.1.7 Local-style hives in Oceania

The arrival of European settlers significantly altered Oceania's social, environmental, political and agricultural landscape, including through the introduction of honeybees and beekeeping. While there are many native bee species across Oceania, there are no native honeybees (*Apis* spp.) east of the Wallace Line, which runs along the western edge of Sulawesi and Lombok in Indonesia. As a result, there is no historical social and cultural tradition of beekeeping with honeybees in this region.[2] This is an important consideration in the design and implementation of beekeeping for development projects in the region, since this influences prevailing indigenous technical knowledge, social perceptions, roles and acceptance of beekeeping, collection and management of bees, the creation of hives and the practices and uses surrounding the use of bee products as food and medicine.

Over the past two centuries, *Apis mellifera* colonies have been introduced into Oceania in skep hives at different points in time, and with varying levels of uptake and success. *A. mellifera* was first successfully introduced into Launceston, Tasmania in Australia in 1831, and then into Mangungu Mission Station at Hokianga in New Zealand in 1839. It took another 50 years or so before Langstroth hives were adopted.

Honeybees in Australia and New Zealand were originally obtained from England, which is home to European or British black bees (*Apis mellifera mellifera*). The Italian honeybee (*Apis mellifera ligustica*), also called the Ligurian Bee, was introduced to Australia in 1862. It is likely the most commonly kept subspecies throughout the world and has proved adaptable to most climates, from subtropical to cool temperatures. Other subspecies were subsequently introduced, including Carniolans (*Apis mellifera carnica*) and Caucasian honeybees (*Apis mellifera caucasia*). Many subspecies are hard to find in their pure form: since European honeybees were introduced into Australia, escaped (swarmed) colonies have often mated with feral bees, producing hybrids.

Apis mellifera was introduced into other Pacific Island Countries and Territories (PICTs) after 1840 and in many countries, only after 1950. (see Table 1). There is paucity of literature regarding what types of hive technologies were utilized in the introductions of *Apis mellifera* throughout Oceania, however, dates preceding 1880 are unlikely to have been in Langstroth hives. For most PICTs, *A. mellifera* was introduced from Australia and/or New Zealand through bilateral aid projects.

Hive technologies in developing nations in Oceania should focus on developing local industries, while sourcing local materials and skills in the design and manufacturing of beehives which suit the local environmental and social context.

6.1.8 Conclusion

The aim of this section was to provide a general overview of how local-style hives developed in the different regions of the world. Policymakers and project managers should always consider the use of local-style hives, depending on the natural/economical/social/cultural context. They can be highly profitable, are ecologically viable, and can form the basis for large, healthy and genetically strong bee populations.

The use of (quickly) renewable natural building materials for hives, locally adapted honeybee species and technologies with a low environmental impact should be favoured in all contexts.

Local-style hives and local bees are fundamental for beekeeping projects in rural development areas, and decision-making should always be driven by the context in which the project will develop. This includes awareness of indigenous technical knowledge, social perceptions, roles and acceptance of beekeeping, costs of hives and their potential productivity, and the use of bee products as food and medicine and/or their other potential markets.

[2] There are thousands of native bees in this area and significant indigenous technical knowledge, culture and traditional practices regarding bees and honey gathering, which is discussed further in chapter 10.3.

TABLE 4
Introduction of *Apis mellifera* into countries and territories of Oceania

Region	Country	Approximate year introduced
Melanesia	New Caledonia	1848
Melanesia	Fiji Islands	1872
Melanesia	Papua New Guinea	1948
Melanesia	Solomon Islands	1950s
Melanesia	Vanuatu	1910-1930
Micronesia	Guam	1907
Micronesia	Palau	1950s
Micronesia	Pitcairn	1963
Micronesia	Federated States of Micronesia	1976
Micronesia	Marshall Islands	1979
Micronesia	Northern Mariana Islands	1981
Micronesia	Kiribati	Absent
Micronesia	Nauru	Absent
Polynesia	Wallis and Futuna	Unknown
Polynesia	Hawaii	1857
Polynesia	Cook Islands	1990
Polynesia	French Polynesia	1902
Polynesia	Samoa	1951
Polynesia	Niue	1952
Polynesia	American Samoa	1976
Polynesia	Tuvalu	1983
Polynesia	Tonga	1986
Polynesia	Tokelau	Absent
Australasia	Australia	1822
Australasia	New Zealand	1839

6.2. MOVABLE-FRAME HIVES

6.2.1 Definition

Movable-frame hives are the result of chronological evolution of beekeeping from local-style hives. In short, movable-frame hives can be opened, allowing beekeepers to see what is happening inside. As such, there is no need for apicide and they can avoid destroying honeycombs, as well as apply treatments more easily. It also allows them to multiply colonies. This all results in increased honey production and honey quality. They can also enable the provision of pollination services and the adoption of several beekeeping techniques.

Movable-frame hives not only provide a suitable home for bee colonies, but also facilitate the production and harvesting of bee products. The beekeeper can fix a colony in place, protecting it from harmful weather conditions or predators, allowing for closer health monitoring, and enabling easy storage and harvesting of bee products (such as by directing production towards nutritious products rather than reproduction).

However, movable-frame beekeeping needs a starting amount of money and resources which are not always available in rural areas. Before opting for mobile-frame hives, you should first ensure that beekeepers can independently source the resources needed for more technically advanced beekeeping (specific training, beehives, frames, a smoker, queen excluders, levers, a beekeeping suit, centrifuges, solar wax, a honey extractor/honey house, scales, sieves, jars) and that rural populations are open to new beekeeping methods.

This section will cover the history of movable-frame hives and describe those currently in use in the different continents.

6.2.2 History

Having to suppress or chase away all the bees to harvest honey and wax is not a very productive form of beekeeping. Hives that relied on this technique were the most widespread in Europe during the Middle Ages, and so the honey and wax industry in this region was at a complete loss. Reading Latin texts on bees and beekeeping, many scholars of the fifteenth and sixteenth centuries realized that beekeeping was much more profitable in ancient times and that bees were never sacrificed to get their precious

FIGURE 17
Ancient and allegorical depiction of apicide labelled "Plans to avoid", from a seventeenth-century book

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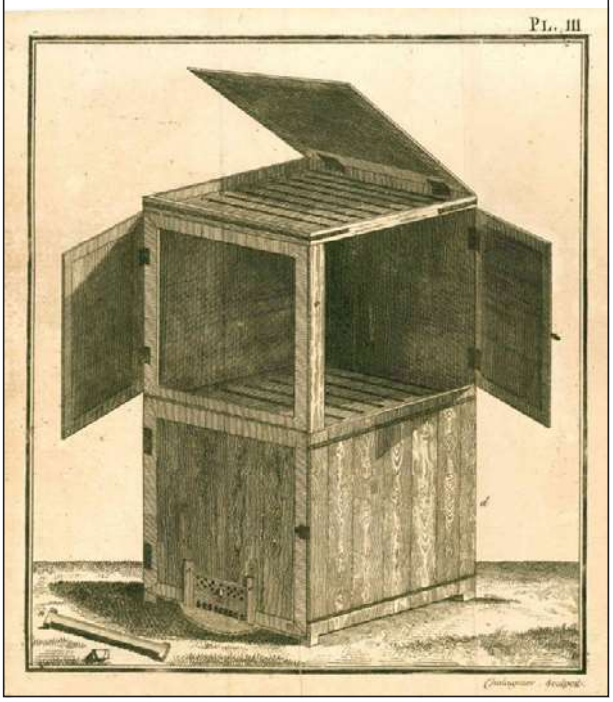
FIGURE 18
The hive described by Della Rocca



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products (see Figure 17). Even Leonardo Da Vinci (1452–1519), in some of his few notes on honeybees, condemns the practice of apicide, writing:

> *About the honeybee – And in many [beehives] their food supplies will be taken away and cruelly, by people without mind, they will be submerged and drowned. Oh justice of God, why don't you react to seeing your creatures abused.*

In the seventeenth century, George Wheler and Jacob Spon reported that Greek hives allowed for substantial honey collection and artificial division of colonies to prevent swarming. In 1790, the Abbot Della Rocca published a three-volume work that described a plan for "a hive that I have devised to multiply swarms, following the method… adopted today by the inhabitants of Crete" (see Figure 17). As such, from around the eighteenth century onwards, it was well known that hives with combs extractable from above, as observed by Wheler and Spon 130 years earlier, were also widespread in the Cyclades and in Crete.

Increasing awareness of the absurdity of apicide and knowledge of concrete alternatives therefore gave way, during the Enlightenment, to a sort of competition between scholars to define new forms of hives that would both allow the regrettable practice of apicide to be abolished and make beekeeping more profitable. It is sufficient to report only one of the many texts of the time that describe the qualities that such a hive must have:

1. As well as being made smaller can be expanded to take account of a population that is more or less numerous.
2. That it can itself be opened without disturbing the bees, either to clean it, or to form the artificial swarms, to make several swarms from one, or to place appropriate food during the winter.
3. That the product of the hive can be taken with the least possible damage to the bees.
4. That it can be internally clean, smooth, and without cracks.

In addition to studies for more productive beekeeping, the Enlightenment also significantly boosted real scientific research on honeybees. The use of observation hives and microscopes revealed a lot about the biology of *Apis mellifera.* The intercomb distance discovery – the way in which honeybees build their combs with just enough distance between them to allow a couple of bees to pass through back-to-back – further inspired the development of movable-frame hives. The Ukrainian Petro Prokopovych (1775–1850) invented his own movable-frame hive and is considered by many to be one of the founders of professional and commercial beekeeping, having raised as many as several thousand colonies in his apiaries.

Reverend Lorenzo Lorraine Langstroth (1810–1895) of Massachusetts (United States) was a Protestant pastor. He devoted his entire life to studying bees and devised a hive with removable combs, building on various other models. In 1851, he discovered "bee space", which is the precise gap

FIGURE 19
Dadant hives, each with a different number of supers according to the productivity of each colony

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FIGURE 20
Two Kenya top-bar hives

©PAOLO FONTANA

(9.5 mm) within a hive or nest that bees never fill with wax or propolis. When a gap of this size is left between frames, bees do not build honeycombs or bridges and the frame is mobile, obviating the need to destroy honeycombs to extract products. Langstroth is generally recognized as the inventor of the modern beehive. He perfected and standardized the measurements, assembling them into a hive model that forms the basis of today's most widely used hives.

However, the success of movable-frame hives cannot be explained without two other great inventions: the waxy sheet developed by Johannes Mehring (1816–1878) and the centrifugal honey extractor by František Hruschka (1819–1888).

6.2.3 Types of movable-frame hive

The term "movable-frame hive" refers to all hives in which the frames are not fixed and can be removed and put back again by the beekeeper, or even placed in another hive. As already mentioned, this allows the beekeeper to inspect the hive, diagnose and control bee diseases, and adopt countless beekeeping techniques. Moreover, some of these hives (the vertical ones) can be modular and adapted to the size of the colony throughout the year, giving the bees more or less room depending on their needs. The same modular technique can be used for the honey chamber of some vertical types of hives.

Hives are adapted to the productivity of the local bees in use. The dimensions of the frames (nest or super) and the number inside each module (generally 10 or 12), may vary according to the individual needs of the colony (see Figure 19).

Usually, movable-frame hives obtain higher high-quality honey yields than local-style hives, since there is no need to destroy combs.

Movable-frame hives can have one or two chambers:

1. Hives with one chamber only: horizontal hives

The top-bar hive. The bees are always managed from above. These hives are not equipped with frames, only top bars under which honeybees build their natural honeycombs. This means that the combs are not fixed to the inner walls of the hive as in natural hives, but are movable. They are also called "transitional hives" because they are between "local-style hives" (in which combs are attached to the inner walls) and other types of "movable frames hives" (which have complete frames and two chambers). Top-bar hives can be divided into two main groups: Kenya top-bar hives (see Figure 20) and Tanzania top-bar hives. They are easy to inspect unlike typical local-style hives. The Kenya model is characterized by inclined long walls while the Tanzania model has perpendicular long walls. Further developments of the top-bar hive include Corwin Bell's contemporary cathedral hive.

Since top-bar hives, in recent years, various horizontal hive frame models have been adopted by local beekeepers in many countries around the world.

The Layens hive. This is a horizontal hive conceived by Georges de Layens (1834–1897). It holds 20 large frames (13" long by 16" deep) on one level. The number of frames can be smaller or greater depending on the local honey flow. It is filled with frames in spring and then opened in the late summer/autumn for honey harvesting.

2. Hives with two chambers: vertical hives

Vertical modular hives are movable-frame hives that are divided into chambers, and are some of the most common hives in the world. On the bottom is the brood chamber, which is where the bee colony and its progeny (brood, pollen, queens and young workers) are concentrated. It can be made with one or more nest modules. The top chamber is named the "super", which is where the bees store the

FIGURE 21
Langstroth hive floor diagram

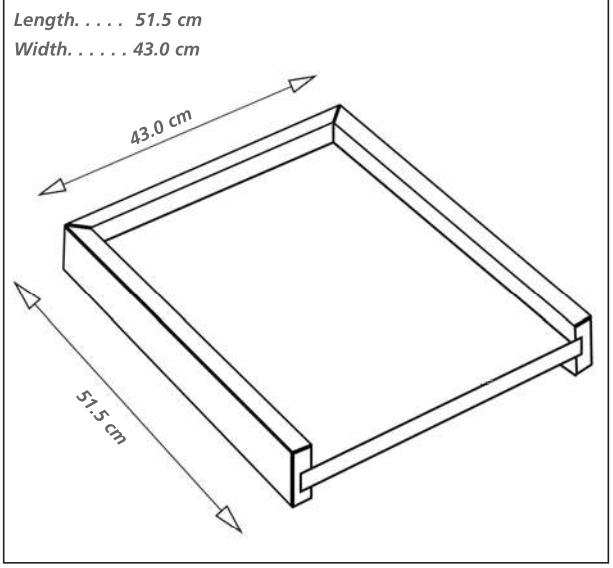

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FIGURE 22
Two Warré hives

©FONTANA P.

honey surplus and the beekeeper superimposes the modules intended for honey deposition and subsequent collection. These modules for collecting honey may be the same height as the nest modules, or smaller. A queen exclusion grid is usually placed between the brood chamber and the super to limit brood space to the brood chamber, since it stops the queen from laying in the super.

Above the chambers is a gap that functions as an air chamber so that the hive is not insulated and so that the bees can generate an air current between the roof and the top chamber.

The top of the hive is covered by a roof made of sheet metal, which is straight or gabled in areas where there is a lot of snow.

The hive has a base or floor which is generally made of hardwood or high-density fibreboard, since the lower part is prone to damp (see Figure 21). Small debris from the brood chamber are also found on the floor.

The most popular vertical modular hives in the world are the Warré hive, the Langstroth hive, the Zander hive, the standard hive and the Dadant hive.

The Warré hive (see Figure 22) is one of the most famous movable-frame modular hives. It derives from the hives of the eighteenth century. Its brood chamber is at the top, while the honey chamber is at the bottom. It allows the beekeeper to artificially divide colonies and collect honey without causing serious disturbance to the bees.

In the case of the **Langstroth hive** (see Figure 23), the chambers can be swapped around since they are the same size. In the case of a Dadant and Jumbo hive, the honey chamber is shorter than the brood chamber, making this more difficult unless extra modules are added to the honey chamber. The hive's dimensions change according to the colony's productivity and the space needed to store honey. Langstroth hives are the most popular modular vertical hives in the world. They are customizable, allowing the beekeeper to add more nest modules.

In the original Langstroth hive design, the brood chamber is 24 cm high, 51.5 cm long and 43 cm wide. It has ten 23 cm high frames that have four wires (some scholars write 22 cm and even 21 cm), a head or upper strip of 47.8 cm and a lower strip of 44.7 cm. This gives the hive a final volume of 44 litres for breeding.

In this type of hive, the nest tends to be ovoid (flattened at the top) and the three-dimensional relationship is not ideal when compared with a natural spherical swarm. In hives managed for productive purposes, beekeepers and technicians seek to have the largest population of bees during the period of greatest nectar flow. As such, the queen needs room to deposit as many eggs as possible one month before the greatest flow. However, many believe that the space and number of cells in Langstroth hives are insufficient for a queen of good posture, which is what causes her to go up to the second chamber. This leads to the use of a queen excluder grid, but this is risky because when the queen is confined to less space than she needs, she tends to swarm. To prevent this from happening, during the advanced spring season, beekeepers generally move some capped broodstocks into the (empty) honey chamber, which is blocked by the exclusion grid, and replace them with empty or waxed honeycombs, so that the queen will keep laying eggs. This practice is call"d "frame rotat"on". One of its drawbacks is that brood combs may have been in contact with pests such as wax moths, acaricides for Varroa treatment or sugar syrup that the bees did not consume. As these combs are built up, they have a greater chance

FIGURE 23
A Langstroth beehive with a half-rise

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FIGURE 24
Langstroth three-quarter-rises

©APICOLA DANANGIE

of containing some type of acaricide residue or traces of sugar syrup. For this reason, beekeepers should take care to adopt low-environmental-impact acaricides (organic acids, essential oils, etc.) for Varroa treatment.

During winter, with less space in the hive, bees keep fewer honey reserves, but in temperate and cold temperate climates, these reserves are insufficient to see them through to the next active season. As a result, beekeepers in these regions are forced to feed the hives or leave reserves in the honey chamber. This is also advisable to avoid nutritional stress which makes bees more susceptible to infectious diseases (American/European foulbrood or nosemosis).

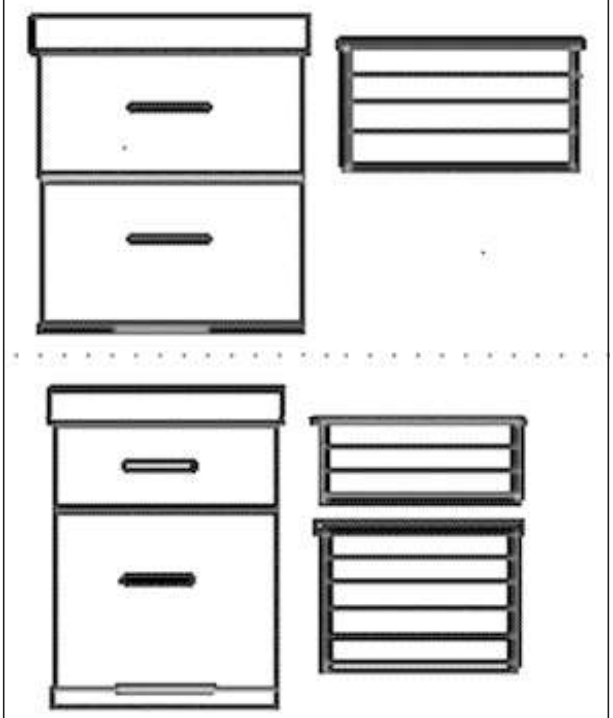
Although it has been mentioned that Langstroth hive chambers are the same size, a shorter honey chamber is used in Langstroth hives, called a half-rise or three-quarter-rise (see Figure 23), due to the hive's weight when full of honey (about 40 kg). Half-rises are the same length and width as the standard chamber but with a height of 14.5 cm, and a 13.5 cm box. Alternatively, it is possible to use a standard chamber for honey and a half-rise as the brood chamber, which requires a queen excluder grid. Different chambers or half-rises can be used and stacked as necessary.

One advantage of a standard-rise honey chamber is that bees find it much easier to fill; for this reason it is widely used to produce monofloral honeys.

Beekeepers also use honey chambers with the same dimensions as the brood chamber, but since there is no standardization among manufacturers, their height varies between 16 and 17 cm. These measurements are used exclusively for honey production, which favours wider frames.

There are also special measurements for a three-quarter-rise with a wider lower slat (which increases its resistance) and wider sides, resulting in only eight frames per rise (see Figure 24). The wires zigzag from top to bottom. This results in greater wax and honey production. Similar to Langstroth in concept and management are the Zander hive and the British National hive, which also allow for multiple brood chambers.

FIGURE 25
Design diagram of the Langstroth hive (top) and Dadant hive (bottom)



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The **Dadant** hive (see Figure 25) is also very widespread, with several variations. It is characterized by nest frames larger than those of the Langstroth hive, and by super frames half the height of the nest frames. In the original Dadant hive design, the brood chamber is 30.8 cm high, 51.5 cm long and 43 cm wide. The squares are 29.6 cm high, the head or top slat is 47.8 cm and the bottom slat is 44.7 cm. It has four separate wires 5.5 cm apart. Its volume is approximately 54 litres. In the original design, the Dadant hive had 12 frames, meaning that it varied in width.

The additional height gives it the ideal proportions to maintain a large enough brood nest in a natural spherical shape, and gives the queen enough room to lay eggs with no need to move chambers. That said, the super is only 16 cm, so the chambers cannot be swapped around as in the Langstroth hive The greater volume, meanwhile, means that more honey reserves can be saved for wintering and artificial feeding is generally not necessary.

The Dadant hive's one problem is its large size and weight, making this model highly impractical for migratory beekeeping, either for honey production or importantly for crop pollination.

The **pastoral Layens hive** has half-rise supers on top of the brood chamber. The **divisible Layes hive**, on the contrary, has modules and frames all half the height of the frames. Both versions of the Layens hive have a square section.

FIGURE 26
Jumbo hives

©MARTINEZ L.

FIGURE 27
Pictures of three-quarter-rise frames with honey

©APICOLA DANANGIE

Then there is the **Jumbo** or **Yumbo hive** (see Figure 26). Some beekeepers in the United States were unhappy with the Langstroth hive because the brood chamber is too small for good egg-laying queens: swarming is common when it reaches 60,000 bees – a great disservice. Therefore, A.N. Draper just changed the Langstroth brood chamber height from 24.0 cm to 29.5 cm, keeping the supers the same, and solved the problem. The hive is 51.5 cm long and 43 cm wide. It has ten frames that have four wires and a height of 27.7 cm. It has a head or upper slat of 48.1 cm, and a 45 cm lower slat. This size gives it the best proportions to house the brood nest and honey reserves for the winter. It is similar to the Dadant, but smaller and lighter, making it more portable.

FIGURE 28
Luigi Sartori's closet hive (left) and a bee house (right)

©FONTANA P.

Finally, there are **bee houses**, which are vertical hives with overlapping but not divisible sectors. They are effectively kind of pillars done by closed hives.

6.2.4 Contemporary hives

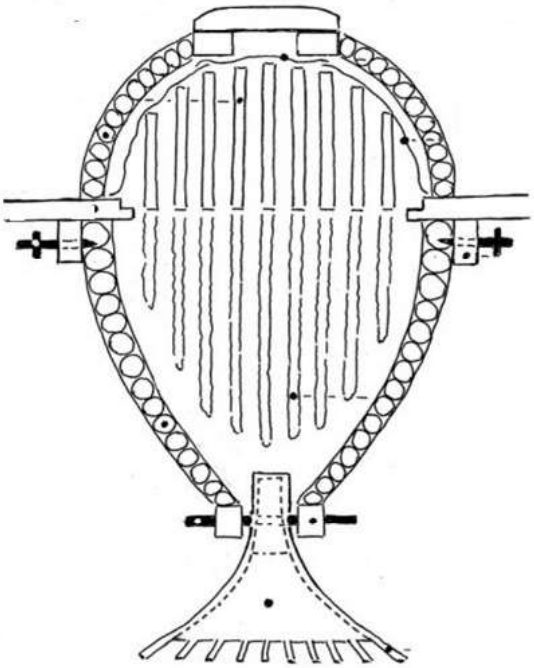
Several new hives have been designed in recent decades. Some of these hives are inspired by a desire for greater naturalness, such as the aforementioned cathedral hive which is derived from the top-bar hive, while others are based on innovative technologies. One example of a natural beehive is the complex **sun hive**, designed by the German sculptor Günther Mancke (see Figure 29). In this oval beehive, honeycombs are built by bees inside semi-elliptical frames. It has a funnel-shaped entrance at the bottom and is designed to be placed at a height of about 2.5 metres above the ground, which makes it very difficult to locate. It cannot be classed as a local-style hive due to the complexity of its design, nor as a movable-frame hive since it is not easy to inspect.

Technological hives include the **rotating hive** and the **flow hive**. The **rotating hive** has circular frames that rotate slowly and continuously thanks to an electric motor powered by electricity or a small solar panel. The rotating honeycombs serve a double purpose: avoiding swarming and reducing the effects of the parasitic mite **Varroa destructor**. However, there is no scientific evidence of their effectiveness and they are not based on honeybee biology, so this complex, expensive hive is largely dismissed as one of the many gimmicks that beekeepers love to invent and try.

Another type of technological hives have been developed with automated or facilitated honey extraction for family honeybee management, the best known being the **flow hive**. However, these self-harvesting hives are misleading, suggesting that all beekeeping requires is putting bees in a box and there will be enough honey for a whole family. In reality, beekeeping involves taking an active role in the care of the bees, especially today when Varroa is rife in most parts of the world.

Both these designs tend to be considered as novelty hive models rather than genuinely useful for productive purposes.

FIGURE 29
A vertical section of the sun hive



©MANCKE G.

TABLE 5
African standard specifications for the top-bar hive and Langstroth hive (brood and super)

Specification	Top-bar	Langstroth (brood)	Langstroth (super)
Length	80–100 cm	50 cm	50 cm
Width	44 cm – top / 19 cm – bottom	40 cm	40 cm
Depth	30.5 cm	28 cm	15 cm

6.2.5 Movable-frame hives in Europe

Bee houses or bee hotels are particularly widespread, with various local names, in Slovenia, Austria, Germany and Switzerland. They are no longer used in Italy.

The Langstroth and Dadant hive are popular in most European countries. That said, the Zander hive is common in Austria, as is the British National hive in the UK, both of which allow the brood chamber to be extended, and the Dadant hive is the standard hive in Italy. Both versions of the Layens hive (divisible and pastoral) are particularly widespread in the Iberian Peninsula, and Central and Northern Europe.

6.2.6 Movable-frame hives in Africa

What is now referred to as "modern" technology is gaining momentum in many African beekeeping communities with the help of development partners that are assisting them with beekeeping projects as a means of fighting extreme poverty and hunger. This has brought the establishment of commercial-level beekeeping initiatives, where proper "modern" beekeeping practices are followed to:

- multiply the colonies through queen-rearing and colony-splitting;
- increase honey output for commercial retailing;
- provide movable colony stocks for pollination services.

Two movable-frame hives are commonly used in Africa: the Langstroth hive (see Figure 30) and the top-bar hive (e.g. Kenyan top-bar hive; see Figure 31). The latter is the most commonly used because of the lower costs associated with construction and management of the hive and colonies (see Figure 32). Langstroth technology is considerably expensive, pushing many communal beekeepers to opt for local-style hives and top-bar hives.

Hive specifications

With the help of development partners and the acquisition of new beekeeping technologies, many beekeepers in Africa are choosing hives with specifications to optimize their bee colonies. Only new technological hives have specifications, namely the top-bar and Langstroth hive. Table 5 presents the specifications generally used, but some communities still make these hives with different specifications.

Communities that do respect the specifications use common beekeeping knowledge and available materials to make locally suitable hives. These include:

- the Tanzanian top-bar hive – this is a hybrid of the top-bar and Langstroth since it is a box hive with top bars;
- the Malawian top-bar hive – this is longer and wider than the standard Kenyan top-bar hive.

FIGURE 30
A Langstroth hive

©MUKOMANA D.

FIGURE 31
An apiary with Kenya top-bar hives

©KARIRAMOMBE N.

6.2.7 Movable frame hives in Oceania

The introduction of the Langstroth hive and movable hive technology in Australia and New Zealand from the mid-1880s, and subsequently throughout the Pacific region, enabled beekeepers to increase production, find queen bees more easily, harvest honey and inspect for pests and diseases. While Western honeybees have been in Australia and New Zealand for about 190 years, their distribution and abundance have increased dramatically over the last 80 years.

While Australia and New Zealand are the largest honey producers, some PICTs are also currently known to produce honey for market, including the Cook Islands (Raratonga, Mangaia and Atiu), the Fiji Islands, French Polynesia, Kiribati, Niue, Palau, Papua New Guinea, the Pitcairn Islands, Samoa, the Solomon Islands, Tonga, Tuvalu and Vanuatu (see Table 6).

FIGURE 32
A top-bar hive made of palm-tree trunk

©MUKOMANA D.

FIGURE 33
African apiary with top-bar hives

©MUTISI R.

TABLE 6
Beekeeping industry metrics for countries and territories in Oceania

Country or territory	Number of beekeepers	Number of bee colonies	Annual production (tonnes)
American Samoa	21	403	8
Australia	12 400	528 000	25 000
Cook Islands	U	U	U
Fiji Islands	1 200	12 000	215
French Polynesia	100	1 642	41*
Guam	20	265	7*
Hawaii	229	2 000	11
Kiribati	n/a	n/a	n/a
Mariana Islands	U	U	U
Marshall Islands	U	U	U
Nauru	n/a	n/a	n/a
New Caledonia	700	12 000	150–200
New Zealand	8 552	881 185	20 000
Niue	U	800	200*
Palau	U	U	U
Papua New Guinea	700	4 000	75
Pitcairn Islands	U	80	2*
Samoa	21	403	8
Solomon Islands	140	700	5
Tokelau	U	U	U
Tonga	3	30	600
Tuvalu	U	U	U
Vanuatu	30	400	5
Wallis and Futuna	U	551	U

**Symbols*: N/a = no honeybees present, U = unknown, * = estimated using per colony production average of 25 kg.

Both Australia and New Zealand have large-scale migratory commercial beekeeping operations centred on (8- or 10-frame) Langstroth hives. In the cooler southern states of Australia, commercial beekeepers tend to use 8-frame boxes (about 90 percent in Tasmania), and increasingly operations use 10-frame boxes in the northern states. Similarly, beekeepers in cooler areas tend to use ideal (shallow) depth frames and boxes (some standardize with ideal as brood boxes), while beekeepers mostly use full-depth frames and boxes in northern states. Approximately 70 percent of commercial beekeepers in Australia operate their hives on pallets, increasing slowly from around 40 percent three decades ago. Approximately 95 percent of the beekeeping industry now uses queen excluders, which have seen increases in uptake over the past 40 years.

Beekeepers in Australia and New Zealand mostly use wooden hives and frames with beeswax foundation, with plastic and polystyrene hive boxes increasingly being adopted. Historically, beekeepers in these countries were heavily involved in the production and maintenance of their own timber boxes. Commercial beekeepers are also increasingly using mechanized loaders and horizontal extractors, meaning fewer people are required to operate honey harvesting and extraction processing lines.

Over 70 percent of Australia's hives are operated by commercial beekeepers with more than 200 hives. Most commercial beekeepers operate between 400 and 800 hives, and some have more than 3000. In New Zealand, beekeepers owning 50 or fewer bee colonies are considered hobbyist beekeepers, and this accounts for 85 percent of all beekeepers. Meanwhile, in Australia, amateur or hobbyist beekeepers (considered 40 or fewer hives) account for 77 percent of registrations and generally own fewer than 11 hives. Pollination services, wax production, package bees and queen bee breeding industries also generate significant income for the commercial sectors of these two countries and Hawaii.

Beekeeping throughout Melanesia, Polynesia and Micronesia is typically characterized by smallholder producers with under 20 colonies. Essentially all beekeeping systems are based on Langstroth hive designs, but inputs are often expensive and difficult to source, and accessing honey extractors is a challenge for geographically isolated communities. While start-up costs are high, these beekeeping systems are typically low-input since many beekeepers do not actively manage hives to optimize production, keeping operating costs down.

While Langstroth hives have many benefits, unless there is significant competition among input suppliers, costs can be prohibitive for low-income farmers. Alternative industry models and hive designs may be suitable for some groups in remote and rural areas, however care should be taken when trying to adopt new approaches within existing knowledge, extension and management systems.

6.2.8 Movable-frame hives in the Americas

There are currently three movable-frame hive models used in the Americas. The Langstroth hive is undoubtedly the most widely used, followed by the Dadant hive which is still used in some regions of North America, and the **Jumbo or Yumbo** hive which is a mixture of both, used in Mexico, the United States and some Central American and Caribbean countries. In some countries of the region such as Colombia, other hives such as the Kenyan top-bar hive are used, since they have Africanized bees and have sought to introduce hives similar to those used in Africa, maintaining that they are better adapted

FIGURE 34
Palletized hives with modified ceilings

©ROJAS J.

©ROJAS J.

for that type. However, there are only a small number of these hives since they were introduced from extension projects.

Due to the increase in the number of transfers that beekeepers carry out, especially for pollination services, they have modified some materials, such as those of the floors or bases and ceilings or covers. The floors generally have two lower slats that directly support the pallet or platforms by which the hives are transported.

Another very common modification is the use of wooden ceilings or lids of a greater thickness but without sides, so that the hives are grouped on the pallet or platform without space between them. This way, they support can stay on the pallet or platform more homogeneously on the ceilings and are stackable more easily optimizing the available space (see Figure 34).

There are countless specific materials that beekeepers use in the Americas for different operations, such as feeders of different types (Alexander, Boarman, Doolitle, etc.), boxes or frames for queen breeding, smaller hives for reproduction such as core drawers, They can be one, two and up to five paintings, with their own floor and ceiling. A heading with a large number of variables are the fertilization hives or micro-hives, which are usually called baby hives, which are much smaller and there are countless models, with the most diverse materials such as wood, plastic, expanded polypropylene, etc.

6.2.9 Movable-frame hives in Asia

Movable-frame hives are used in Asia for both *Apis mellifera* and *A. cerana*. Different types of hives are used depending on which country *A. mellifera* was introduced from, but again, the most common type is the Langstroth. For *A. cerana*, hive sizes were modified to suit the biology of *A. cerana* and many different versions are used.

6.2.10 Conclusion

Before opting for movable-frame hives for your beekeeping project, you should always consider the geographical context, the traditions and the history of the people in your area of interest. As we have seen, this type of hive has both advantages and disadvantages.

The main advantage is that they are more productive than local-style hives. Moreover, working with movable frames makes many activities easier, such as colony inspection, location and inspection of the queen bee, health monitoring, monitoring of reserves and application of treatments to control bee diseases, as well as several other beekeeping techniques including artificial swarming and queen caging.

On the contrary, disadvantages include the need for standardized beekeeping equipment, training of operators, and materials (e.g. beehives, frames, a smoker) to ensure production. This kind of beekeeping works best in more industrialized countries, where beekeepers have the economic resources to buy the equipment, and apiaries and honey houses are easily accessible by car.

Sustainable beekeeping in Africa

Beekeeping has been practised for many centuries in Africa, mainly for food and medicinal purposes according to research and oral evidence from many African communities. In some communities in East and North Africa, honey was used for cultural purposes such as paying dowry and making traditional brew.

With the increase in demand for honey regionally and globally and access to information about the nutritional benefits of organic honey, there has been a surge in communities taking up beekeeping as an income-generating initiative from which to earn a living.

Many communities in Africa have been able to send their children to school using income earned from honey sales. As an 85-year-old beekeeper from Kitui, Kenya, puts it, "Since I took over beekeeping as a young man, I have never cultivated any crop in my farm. I have always fed my family by selling the honey I harvest to buy food, clothing and pay school fees for my children" (Nzengu, 2019).

Many communities have realized that beekeeping offers the chance to earn a living given the abundance of natural bee habitats surrounding them in the form of forests, rivers and mountains, and the strong wild bee colonies at their disposal. Many governments are beginning to invest in beekeeping as a strategy for:

- poverty eradication in rural communities
- job creation
- economic empowerment for women and young people
- pollination of food and horticultural crops
- environmental conservation.

Thus, resources are being channelled through relevant government departments and development partners to capacitate community beekeeping projects so that communal beekeeping initiatives can be upscaled from a hobby to commercial enterprises that are sustainable and protect the environment. This came after the realization that many natural forests were being destroyed across Africa for a number of reasons, but a major one being charcoal trade as communities were trying to earn a living. Many communities have also been cutting down trees to access wild bee nests for their honey (honey hunting), depleting the indigenous tree population. This is an unsustainable practice, exposing forests to wildfires which do serious damage to ecosystems, hence the efforts to educate, train and capacitate communities with modern beekeeping practices.

These efforts include the promotion of bee-friendly tree-planting initiatives, to reforest areas that have been cleared while also providing additional bee forage to support

community beekeeping initiatives. In this way, many communities in Africa are moving away from traditional beekeeping practices (honey hunting) to modern beekeeping practices with movable-frame hives, which are proving to be profitable and sustainable.

Strategies to support the development of Africa's beekeeping sector

Africa has huge potential as a honey producer given the abundant resources at its disposal. These include natural forests, water, healthy bee populations and good weather conditions year-round which are favourable for beekeeping. However, there are a number of areas requiring intervention before the continent can reach this potential and become one of the biggest producers of natural honey in the world. These areas are as follows:

Education and awareness campaigns

Many communities in Africa are struggling to meet the basic needs of their families, with many living below the poverty line. Yet these communities are surrounded by abundant natural resources that could provide them with income-generating projects such as beekeeping, and other related support services such as hive-making, equipment fabrication and protective clothing production.

There is a need for educational campaigns regarding two aspects of beekeeping:

- **The importance of bees to the environment,** including their pollination services for plants and food crops. This campaign should not not only target beekeepers but also policymakers so that all agricultural and environmental policies passed take into account the role of bees and the need to protect them. It could also include GBPs that not only protect bees and the environment but also increase honey production in a sustainable way.
- **The benefits of honey in diet and for medicinal purposes.** A society that appreciates the value of honey will see growing demand, triggering honey production at the community level.

Government support/political goodwill

There are very few governments in Africa with clear policies on beekeeping to the extent of having a dedicated budget to support the sector. As a result, the sector relies on development partners who often see beekeeping merely as a complementary initiative and provide little financial support. This has hindered the growth of the sector, with some policies adversely affecting the bees – especially excessive use of agrochemicals to boost food production.

Many programmes in Africa are sidelined in terms of funding and importance and depend on political goodwill to be sustained. Beekeeping is one such sector. Despite the important role bees play in pollination, efforts by Ministries of Agriculture to actively protect pollinators, including bees, are non-existent.

A number of countries are facing serious deforestation on account of charcoal trade and other human activities. Government intervention, namely enactment and enforcement of environmental protection laws and promotion of tree planting, is needed to conserve the environment and protect bee habitats. This will directly benefit beekeeping, since enough bee forage will be available to support extensive beekeeping activities.

Government and political support is also required in the form of incentives for beekeepers and other valuable supply-chain players to promote beekeeping in Africa. These include exemption of beekeeping equipment from tax so that beekeeping and honey-processing equipment are affordable. This would increase honey production and improve the quality of processed honey, which could be exported to international markets and earn foreign currency.

Capacitation of beekeepers

Many communities in Africa depend on food handouts from the government and NGOs, a situation that has created serious dependency syndrome. While handouts are necessary (especially food and medicines), if communities are capacitated in beekeeping, they can earn a living from the hives for years to come. Capacity-building should comprise:

- **Training of communities** on beekeeping so that they can benefit from their natural environment. This will have added benefits of communal policing of their local environmental conservation and protection. This approach has worked very well in Ethiopia where community members are permitted to mount hives in forests they contribute to protect.
- **Provision of basic beekeeping equipment** so that they can engage in beekeeping. Some community members do not have the means to acquire hives and start beekeeping after training. This is especially important since laws prohibit cutting down trees for purposes such as making log or bark hives, which was once a cheaper option.

Formation and strengthening of apiculture apex boards

A number of African countries do not have fully functional, sector-wide representative national associations, or apiculture apex boards, which can drive the growth of the sector and coordinate with government departments on policy development.

The growth of the sector requires the establishment of formal structures, starting with a strategy to encourage local clubs, groups and or societies to set up provincial/regional structures which will then constitute the national association.

In countries that already have national associations, there is a need to strengthen capacity so that they have the necessary skills and resources to grow the sector.

Strategic development of African beekeeping systems

Traditional African beekeeping systems need to be documented, particularly practices that have been passed from generation to generation, since this may increase the longevity of the African bee species.

Many parts of the world are using bee species with desirable characteristics that promote commercial beekeeping, while African bees have their own characteristics based on their natural habitat. Complete migration from traditional/African beekeeping systems to modern beekeeping systems without considering its possible effects on the behaviour of African bees may create unintended challenges. African beekeeping systems should therefore be developed by building on good traditional practices and merging them with modern practices, to support commercialization without negatively impacting on the physiological make-up of African bee species.

It is for this reason that the Apimondia Regional Commission for Africa has set up a Regional Working Group on African Beekeeping Systems, which will provide documentation and studies to inform the region of the various African beekeeping systems that are common throughout the continent. In this way, it aims to provide a scientific basis on which developments/improvements can be implemented to increase African honey production without adversely effecting the bees.

Funding models for processors

Support has been provided for beekeepers in a number of communities in Africa. However, the increase in honey has created a challenge in terms of marketing, with assistance only provided for training and hives for some beekeepers.

There is therefore a need to provide equal support for aggregators and processors so that they can take up the honey produced by beekeepers. In most cases, processors lack access to enough funding to buy all the honey available since honey is seasonal. This has resulted in a significant amount of honey not being collected for processing, leaving beekeepers with no choice but to process it the traditional way and sell it in their local communities.

Funding models need to be developed to enable processors and beekeeping manufacturing stakeholders to support beekeepers by bulking their produce at competitive prices. This will make beekeeping initiatives sustainable.

African honey

Africa is known for producing natural honey and beeswax with negligible traces of metals and antibiotics. This is mainly because more than 80 percent of African honey is produced in communal areas where farmers do not use agrochemicals and beekeepers do not artificially feed their bees or treat them with antibiotics.

Yet, despite its high quality, the price offered for African honey and beeswax is very low. Support is required to establish the medicinal and nutritional value of honey from different parts of the continent so that African beekeepers can be paid a price that is commensurate with the value of their honey.

Access to the European Union market

The European Union is the largest single market of honey and beeswax in the world. However, very few African countries are able to export to the European Union due to lack of support for the third-country listing process, which is expensive and requires coordination at the national level between government departments and beekeeping stakeholders. Most African countries do not have strong national associations with enough funds to support the process as it involves specialist activities and extensive engagements from all stakeholders.

Support for such an important process would see many countries increasing their honey production, since there would be a ready market for large quantities of honey and beeswax. Furthermore, a constant market with stable prices would build beekeeper confidence in the sustainability of the initiatives/projects, leading more to join the sector and resulting in improved environmental management.

Strategies to support Oceania's beekeeping industries

Further research and development of beekeeping industries in PICTs has significant potential to improve and diversify incomes for smallholder producers, strengthen food security and contribute to national and local economies. The outcomes of research in apiculture in the region also have significant global implications for developing the best honeybee biosecurity practice. It is critically important for industry sustainability that development projects focus on building capacity and skills rather than providing beekeeping inputs. The following strategic priorities may help to overcome challenges and improve outcomes for smallholder farmers:

- Beekeeping industries need capacity-building programmes to develop floral calendars and develop capacity for managing honeybee nutrition.
- Enhanced post-harvest handling and quality assurance systems are required to guarantee and improve marketing opportunities.
- Beekeeping industries need support to develop integrated pest management strategies for regional pest and disease pressures which are context-specific and consider the social and economic limitations of adoption.

- Regional biosecurity knowledge-sharing and capacity-building needs to be enhanced for effective protection of developing beekeeping industries and certification for market access.
- Introductions of new genetic stock may offer some solutions to current poor genetics, but any genetic introductions should undergo rigorous risk assessment and long-term monitoring and evaluation to ensure that pest and disease threats are mitigated.
- Beekeeping programmes should have significant social research capacity and skills in community development to ensure participation and engagement of industry stakeholders in all aspects of the project.
- Better approaches are needed for enhancing the agency of women and other marginalized groups, improving social relations and identifying key transforming structures to overcome barriers to inclusion in and benefit from beekeeping enterprises. Projects should also seek to improve capacity for beekeeping trainers and associations to give inclusive training and extension.