NON-WOOD FOREST PRODUCTS

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Bees and their role in forest livelihoods

A guide to the services provided by bees and the sustainable harvesting, processing and marketing of their products

by

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This paper discusses traditional and temporary beekeeping with some of the bee products proposed as medicines. This material is presented for information only and does not imply endorsement by the author or by FAO. Use of these products is not recommended unless taken under the care and guidance of a qualified physician. Transport of bee colonies and bee products (e.g. beeswax) across international boundaries can pose a risk of accidental introduction of insects, fungi or other potentially destructive agents. It is recommended that anyone planning to move bee colonies across international boundaries check with appropriate authorities in the country from where the products are to be exported and the countries into which the products are to be imported for import permit requirements, sanitary certificates or restrictions that might apply.

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The role of bees in sustaining forests and forest dependent livelihoods remains poorly known and appreciated. Bees are a fantastic world resource: they are essential for sustaining our environment because they pollinate flowering plants. Bees sustain our agriculture by pollinating crops and thereby increasing yields of seeds and fruits.

The product that most people first associate with bees is honey, although beekeeping generates much more than just honey: the maintenance of biodiversity and pollination of crops are perhaps the most valuable services provided by bees. Honey is just one of several different products that can be harvested: others are beeswax, pollen and propolis, royal jelly and venom, and the use of bees in apitherapy, which is medicine using bee products.

Bees and beekeeping contribute to peoples' livelihoods in almost every country on earth. Honey and the other products obtained from bees have long been known by every society. The diversity in bee species, their uses and in beekeeping practices varies greatly between regions. In many parts of the world, significant volumes of honey are today still obtained by plundering wild colonies of bees, while elsewhere beekeeping is practised by highly skilled people. Honey hunting of wild bee colonies still remains an important part of the livelihoods of forest dependent peoples in many developing countries.

Today, apiculture plays a valuable part in rural livelihoods worldwide, and this book aims to provide an insight into the many ways in which bees and beekeeping contribute to these livelihoods, and how to strengthen this contribution. While the rationale for the sustainable use of tree resources is widely appreciated, by contrast the sustainable use of bee resources is poorly promoted and appreciated. Rural people in every developing country are keeping bees or harvesting from them in one way or another. This book aims to help ensure that these people gain the most from these activities.

FAO wishes to thank Dr Nicola Bradbear, the author of this work, and is pleased to publish and disseminate this technical document to promote more sustainable beekeeping practices which will better sustain forest dependent livelihoods in the developing world. I hope that this publication will also contribute to many more small-scale efforts to encourage beekeeping interventions throughout the world, helping people to strengthen livelihoods and ensuring maintenance of forest habitats and biodiversity.

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1. INTRODUCTION

WHAT IS APICULTURE?

Apis is Latin for bee, and apiculture is the science and practice of bee keeping. The words ‘apiculture’ and ‘beekeeping’ tend to be applied loosely and used synonymously: in some parts of the world, significant volumes of honey are today still obtained by plundering wild colonies of bees – this ‘honey hunting’ cannot be properly described as ‘beekeeping’. Honey hunting still remains an important part of many rural livelihoods and falls within the remit of apiculture, and this book. In some parts of the world apiculture forms part of the work of hunter-gatherers, while elsewhere apiculture is practised by highly industrialised agriculturalists in the world’s richest nations.

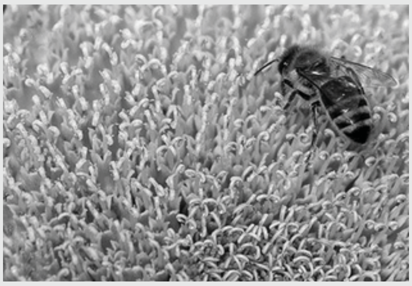
The product that most people first associate with bees is honey, although beekeeping generates much more than just honey. The maintenance of biodiversity and pollination of crops are the most valuable services provided by bees. Honey is just one of several different products that can be harvested: others are beeswax, pollen and propolis, royal jelly and venom, and the use of bees in apitherapy, which is medicine using bee products. It is still possible to harvest high quality, excellent products from bees using simple equipment and techniques, building on the traditions held in almost every society.

BOX 1
Services rendered by bees

The maintenance of biodiversity by the pollination of flowering plants
The pollination of crops
Apitherapy – medicine using bees’ products

Products harvested from bees

Honey
Beeswax
Pollen
Propolis
Royal jelly and venom



This book aims to provide the information that people working in rural areas of developing countries need to maximise the benefit they can gain from bees. There is no standard text on apicultural methods that is useful for every situation. This is because there is no standard, globally applicable apicultural method. Today, there is still great diversity of apicultural practices throughout the world, although most industrialised countries use standard styles of frame hives for keeping European races of honeybee. The resources available, and the reasons why people want apiculture, vary tremendously from place to place. Apiculture is diverse, varying greatly in the way it is practised from one region to another: in Africa, the Middle East and Asia, bees are often kept inside the walls of people’s homes (and are often not noticed by visitors); while in India, over 50 percent of honey is still harvested from wild-nesting bees. People practise apiculture not only in different ways, but also for different reasons: some farmers want to have bees to ensure that crops such as fruit, oil seeds and coffee are pollinated adequately; others keep bees to harvest honey and wax; some farmers keep stingless bees for their honey, which is especially valued for medicinal properties. Recently there was a report from Laikipia Plateau in Kenya of bees being used as a ‘living fence’ to keep elephants away from smallholdings (Vollrath and Douglas-Hamilton, 2002).

Honey hunting and beekeeping, i.e. keeping bees inside man-made hives and harvesting honey from them, has been practised by humans for at least 4500 years - so human societies have long been aware of the worthwhile benefits to be gained from bees. These benefits include the pollination of plants, harvests of honey and beeswax, as well as a number of other useful products.

Today, apiculture plays a valuable part in rural livelihoods worldwide, and this book aims to provide an insight into the many ways in which bees and beekeeping contribute to these livelihoods, and how to strengthen this contribution. While the rationale for the sustainable use of tree resources is widely appreciated, by contrast the sustainable use of bee resources is poorly promoted and appreciated. Rural people in every developing country are keeping bees or harvesting from them in one way or another. This book aims to help ensure that these people gain the most from these activities.

AREAS FOR APICULTURE

Bees and beekeeping contribute to peoples' livelihoods in almost every country on earth. Honey, and the other products obtained from bees have long been known by every society: perhaps it is only Inuit societies that have evolved without the possibility – in arctic conditions – to exploit bees for sweet honey and other products. The bees being exploited vary between regions, and beekeepers operate under varying conditions and with widely differing resources available to them. This great diversity in bees, and in beekeeping practices, explains why there is little beekeeping literature that is widely applicable. For example, the beekeeping practised in temperate climate Europe is very different from the beekeeping of tropical Africa – even though the honeybee is of the same species – *Apis mellifera* – and looks similar: in fact, their biology and behaviour differ significantly.

RESOURCES NEEDED

Some of the many variables that must be considered for apiculture are:

TABLE 1
Resources needed for apiculture

Natural resources	
Bees	The different species of bees exploited in apiculture are described in Chapter 2.
Plant resources	Types of forage good for apiculture are described in Chapter 7. The value of bees in pollination is described in Chapter 8.
Other natural resources	Chapters 3 and 7 discuss environmental reason for promoting apiculture.
Human resources	
Existing apicultural skills	Honey hunting and beekeeping methods are described in Chapter 5 and 6.
The value placed on different types of bee products	For example, some societies value honey from one type of bee more than honey from another: this is discussed in Chapter 9. Beeswax is described in Chapter 10, and other products in Chapter 11.
Apitherapy	Some societies place great importance on apitherapy: see Chapter 12.
Knowledge of the manufacture and use of secondary products	Different societies value different bee products and goods made from them: see Chapter 13.
Skills in packaging and marketing	Described in Chapters 9, 10, 11, 13 and 14.
Social resources	
Assistance available from families, friends, networks	This can determine the type of beekeeping feasible, see Chapter 4.
Membership of groups	Honey hunters and beekeepers benefit greatly by being organised into groups for marketing: this is described in Chapter 14.
Access to a wider society, market information, research findings	Global changes in the honeybee disease situation and changes in world trade can now affect beekeepers everywhere, who need access to up to date information. Chapters 9 and 15.
Physical resources	
Tools, equipment, buildings	Chapter 5 discuss the merits and relative costs of different equipment types, and the physical infrastructure need for beekeeping.
Transport, roads	These factors can determine market access: Chapter 14.
Financial resources	
Finance to purchase equipment, and access to credit to enable groups to buy honey from beekeepers	Chapter 5 describes equipment options and Chapter 14 discusses the need for credit for marketing purposes. Chapter 16 outlines potential sources of support.

BEEKEEPING AND FORESTRY

Forests provide excellent resources for bees and beekeeping, and bees are a vital part of forest ecosystems. Indigenous bee species are natural forest resources, and beekeeping enables their exploitation by humans for valuable products, without necessarily damaging the honeybee populations, or extracting anything except the products, honey and beeswax. This is also the case where exotic honeybee species have been introduced, for example in the tropical forests of South America, now home to large populations of African honeybees.

People living in or near tropical forests and woodlands are amongst the poorest in the world, often depending on shifting cultivation for their food, and local wood as their fuel source. These people will be the first to feel the consequences of deforestation: soil and water degradation, low agricultural productivity, wood fuel shortage and flooding. To conserve forests, local people must be assured of sources of food and income that are sustainable without being environmentally damaging. Beekeeping fits this category so perfectly: using locally available, renewable resources, forest beekeeping is an environmentally sound activity, yet one that enables forest – dwelling people to harvest products that can be of world quality.

In working to retain natural environments, it is widely understood that habitats cannot be protected without the interest and involvement of local people. Beekeeping offers a good way for people to create income from natural resources without damaging them. In fact, beekeeping contributes to the maintenance of biodiversity by pollination. When beekeepers are supported and have access to good markets for their products, they are motivated to support local conservation efforts.

Bees and trees are interdependent, and have been perfecting their relationship for over 50 million years. Bees are a fantastic world resource: they are essential for sustaining our environment because they pollinate flowering plants. Bees also sustain our agriculture by pollinating crops and thereby increasing yields of seeds and fruits, and they provide us with honey, beeswax and other products – valuable sources of food and income.

Trees do not just need bees for their own reproduction, but for the whole system within which the trees exist. The more species of fruit and seed generating within a system, the greater its biodiversity and the greater its life-carrying and life-enhancing capacity.

ASSETS CREATED BY APICULTURE

While products from bees such as honey and beeswax are well known, the main service provided by bees – pollination – remains poorly appreciated and underestimated in most countries. In the USA, scientists have attempted to measure the value of increased yield and quality of crops achieved by honeybee pollination: during the year 2000 in the USA, this was estimated at US$14.6 billion (Morse and Calderone, 2000). In June 2002, data was published about the beneficial effect of honeybees for coffee pollination: in Panama, coffee bean production is increased by 50 percent (Roubik, 2002). Yet we do not have data proving the benefit of honeybees for the pollination of many tropical crops, and it is impossible to put financial value on the effect of honeybee pollination of indigenous plants, and this important contribution to the maintenance of biodiversity. Other assets created by apiculture such as honey and beeswax are far more tangible, but their value must be far less than the wealth created as a result of optimal pollination of plants.

BOX 2

Ten excellent reasons for beekeeping

1 Pollination

Bees pollinate flowering plants and thereby maintain the ecosystem.

Bees pollinate cultivated crops.

2 Honey

People everywhere know and like honey, a valuable food and income source.

3 Beeswax and other products

Beeswax, propolis, pollen and royal jelly. These products have many uses, and can be used to create income.

4 Few resources are needed

Beekeeping is feasible even for people with minimal resources.

Bees are obtained from the wild.

Equipment can be made locally.

Bees do not need the beekeeper to feed them.

5 Land ownership not essential

Hives can be placed anywhere convenient, and so beekeeping does not use up valuable land.

Bees collect nectar and pollen wherever they can find it, so wild, cultivated and wasteland areas all have value for beekeeping.

6 Nectar and pollen are otherwise not harvested

Nectar and pollen are not used by other livestock: only bees harvest these resources, so there is no competition with other crops.

Without bees these valuable resources could not be harvested.

7 Different sectors and trades benefit from a strong beekeeping industry

Other local traders benefit by making hives and equipment, and from using and selling the products.

8 Beekeeping encourages ecological awareness

Beekeepers have a financial reason to conserve the environment: ensuring that flowers are available and bees are protected.

9 Everybody can be a beekeeper

Bees can be kept by people of all ages.

Bees do not need daily care and beekeeping can be done when other work allows.

10 Beekeeping is benign

Beekeeping generates income without destroying habitat.

Encouraging beekeeping encourages the maintenance of biodiversity.

2. BEE SPECIES DESCRIPTION

Bees kept by beekeepers are essentially wild animals and are not domesticated in the way of other livestock species. In some areas, for example, Europe and Africa, the bees used in beekeeping are indigenous species, and beekeepers are helping to maintain biodiversity by keeping healthy stocks of these bees. Until recently, it was true to say that any honeybees kept inside a hive by a beekeeper would be able to survive just as well living on their own in the wild. However, in recent years, man has spread honeybee pests and predators around the world, and this means that in some regions, the indigenous populations of honeybees have been killed and the only bees now surviving are those managed by beekeepers. For example, in Europe, honeybee colonies can only survive when beekeepers control levels of the (introduced from Asia) parasitic mite *Varroa destructor.*

Honey hunting, the plundering of wild nests of honeybees to obtain crops of honey and beeswax, is practised throughout the world, wherever wild nesting honeybee colonies are still abundant. However, for thousands of years it has been known that obtaining honey is made much easier and more convenient if bees are encouraged to nest inside a hive. Apiculture covers this whole, broad range of activities from the total plundering of wild bee nests for harvests of honey and beeswax, through to 'conventional' beekeeping, i.e. the keeping and management of a colony of bees inside a human-made beehive.

BEE SPECIES

In 1988, a bee preserved in amber from New Jersey was identified by US entomologists (Michener and Grimaldi, 1988). It was a worker, stingless bee of the species *Trigona prisca,* identical to bees of this species today. The amber dates from 80 million years ago, and we therefore know that bees of today were already evolved at that time. There are maybe around 30,000 bee species: about half have so far been recorded by entomologists. Most bees are solitary, which means that each female bee makes her own nest, lays a single egg and provides food for the single larva that develops. A few species show a high level of social development and live together in a permanent, large colony, headed by a single egg-laying queen. Although many species of bees collect nectar that they convert to honey and store as a food source, it is only these large colonies formed by social species that store appreciable quantities of honey. Only a very few species – maybe 30 or so – are exploited by humans for honey production.

These are the honeybees and stingless bees that have been, or are still, exploited by man to varying extents for their honey stores. Man has exploited them for thousands of years: until recent centuries, honey was the most common sweetening commodity. There are also a few, very rare instances of bumblebees being plundered for honey. Of course, the rest of the 30 000 bee species are also plant pollinators that are vital for the maintenance of biodiversity, and a few of these species are managed commercially for this purpose.

BEE TAXONOMY

The following is the current view of bee taxonomy according to Michener (2000): all bee species are classified within seven main families, and one of these is the family Apidae. Apidae has three subfamilies: Xylocopinae, Nomadinae and Apinae. The subfamily Apinae has nineteen tribes including Apini (honeybees), Meliponini (includes stingless bees), and Bombini (includes bumblebees). The tribe Meliponini are the stingless bees found in tropical and southern subtropical areas throughout the world (see Chapter 6).

The tribe Apini contains just one genus, *Apis* and these are the true honeybees. Like the Meliponini, they are social bees that establish permanent colonies. It is these bees' social behaviour, storing significant quantities of honey for the colony to survive dearth periods, which means they have been, and are still today exploited by human societies for their honey stores.

HONEYBEES

There are very few species of honeybees. Most beekeeping textbooks still declare that there are just four species: *Apis mellifera, Apis cerana, Apis florea and Apis dorsata* (Ruttner, 1988). The honeybee is one of the most studied of all animals, other than man, yet this research has been almost entirely on the European honeybee *Apis mellifera*. Amazingly however, only within the past 15 years or so a number of 'new' honeybee species have been recorded for science, and Michener names eleven species in the genus *Apis*. They are:

Apis andreniformis	*Apis koschevnikovi*
Apis binghami	*Apis laboriosa*
Apis breviligula	*Apis mellifera*
Apis cerana	*Apis nigrocincta*
Apis dorsata	*Apis nuluensis*
Apis florea	

These eleven species of honeybees nest in one of two different ways, and this nesting behaviour determines whether or not the bees will tolerate being kept inside a man-made hive. Some of the species make nests consisting of a series of parallel combs, other species nest on just one, single comb. The species that build a series of parallel combs usually nest inside cavities, and this behaviour enables them to nest inside man-made containers and therefore opens up possibilities for the keeping and management of these bees inside hives.

TABLE 2
Species of honeybees: type of nest

Honeybee species whose nests consist of multiple combs (cavity nesting honeybees)	**Honeybee species whose nests are single combs**
Apis cerana *Apis koschevnikovi* *Apis mellifera* *Apis nigrocincta* *Apis nuluensis*	*Apis andreniformis* *Apis binghami* *Apis breviligula* *Apis dorsata* *Apis florea* *Apis laboriosa*

The species that build single combs usually nest in the open. They cannot be kept in hives and the single comb behaviour does not lend itself to beekeeping management practices, although the honey and other products of these species are harvested by some societies.

Honeybee species whose nests consist of multiple combs

Apis mellifera

Other names for *Apis mellifera* are the hive bee, the European bee, the Western hive bee, and the occidental honeybee. Most standard beekeeping texts relate only to *Apis mellifera* (although this is not always stated).

Apis mellifera is indigenous to Africa, Europe and the Middle East. It has been introduced to the Americas, Australasia and much of the rest of the world. Today, Argentina, China and Mexico have the largest honey industries in the world, and all are based on the introduced *Apis mellifera* honeybee.

There are many different races of *Apis mellifera*, some tropical, others temperate. The Africanised honeybees in South and Central America are descended from tropical African *Apis mellifera.* Different races of *Apis mellifera* have different sizes of individual bees and colonies. Generally, *Apis mellifera* are regarded as the medium-sized honeybees, against which other species are judged as "large" or "small".

Apis mellifera usually builds its nest inside an enclosed space. The nest consists of a series of parallel combs, and there are typically 30 000-100 000 honeybees in one colony.

Apis cerana
Another name used for *Apis cerana* is the Asian hive bee, and it is sometimes incorrectly named *Apis indica*. *Apis cerana* is indigenous to Asia between Afghanistan and Japan, and occur from Russia and China in the north to southern Indonesia. *Apis cerana* has been introduced recently to Papua New Guinea. *Apis cerana* builds a nest consisting of a series of parallel combs, similar in style to *Apis mellifera*, and builds its nest within a cavity. As with *Apis mellifera*, *Apis cerana* occurs over a huge geographical area, and it varies in size throughout its range: tropical races are smaller, with smaller colonies. There are many different races of *Apis cerana*, as could be expected from the wide range of habitats it occupies from temperate mountain regions to tropical islands.

Apis koschevnikovi
This honeybee species has been identified only in Sabah, Malaysia in Northern Borneo. Locally known as the red bee, this species was named for a short period *Apis vechti*. The individual bees are slightly larger than *Apis cerana* found in the same locality, but otherwise the nests of these bees are similar in size and construction. They are known locally as red bees due to their reddish hue when clustering.

Apis nigrocincta* and *Apis nuluensis
Apis nigrocincta has been identified only in Sulawesi in Indonesia (Otis, 1996), and *Apis nuluensis* only in Borneo. Their nesting behaviour is similar to *Apis cerana* and *Apis koschevnikovi,* described above.

Honeybee species whose nests are single combs

Apis andreniformis* and *Apis florea
These are very small-sized species of bees, and their single comb nests are small too: often no larger than 150-200 cm wide. Other names include the little honeybee, and sometimes (wrongly) the dwarf honeybee. These bee species build a single-comb nest, usually fairly low down in bushes, or in the open, suspended from a branch or (for *Apis florea*) rock surface. *Apis andreniformis* has been identified in South East Asia, Borneo, the Philippines and the southern Chinese peninsula, while *Apis florea* is indigenous from Oman spreading southeast through Asia as far as some of the islands of Indonesia and the Philippines. In 1985, it was identified in Sudan and lately reported in Iraq. However, it is only recently that *Apis andreniformis* has been recognised, and some records for *Apis florea* may prove to be for *Apis andreniformis.*

Apis dorsata
Other names for *Apis dorsata* are the rock bee, the giant honeybee, or the cliff bee. On the western edge of its distribution, *Apis dorsata* is found only as far as Afghanistan but its southeast occurrence extends east of Bali. Its northern distribution is limited by the Himalayas. There is morphometric and genetic evidence for many different subspecies of *Apis dorsata* that may eventually be proved separate species. *Apis dorsata* bees are large, and their nests consist of single large combs suspended from a branch, cliff face or building.

Apis binghami* and *Apis breviligula
Apis binghami occurs in Sulawesi in Indonesia, and *Apis breviligula* occurs in the Philippines. Maa (1953) first recorded them as separate species, although subsequent authors ignored this and regarded them all as the same species, *Apis dorsata.* Recently, with genetic analysis allowing increasing understanding of the great diversity with the species *Apis dorsata,* these two are once again regarded as separate species.

Apis laboriosa
Apis laboriosa are the largest of the honeybees. They are found in the Himalayas (Nepal, Bhutan, and China) at higher altitudes than *Apis dorsata*. *Apis laboriosa* nests are similar to those of *Apis dorsata*, but *Apis laboriosa* colonies are usually found together in clusters, with sometimes up to 100 combs suspended from a cliff face very near to one another, although *Apis dorsata* may also be found nesting in this way.

BEE SPECIES USED FOR APICULTURE

The honeybees most widely used for beekeeping are European races of *Apis mellifera*, the species of honeybee also indigenous to Africa and the Middle East. No species of honeybee occurs naturally in the Americas, Australia, New Zealand or Pacific islands: European bees have been introduced to these regions during the last four centuries. Over the last 30 years, European bees have been also introduced to most countries of Asia. In industrialized countries, all beekeeping technology has been developed for use with European honeybees, and most beekeeping and research literature relate only to this bee.

Other honeybee species are also exploited by humans for their honey. Although the cavity nesting species can be kept in hives, and managed according to beekeeping practices, in some countries, wild nesting colonies of these bees are still sought by honey hunters.

The single-comb nesting species cannot be kept inside hives, so it is only wild-nesting colonies that are exploited by honey hunting. There are of course exceptions: *Apis florea* is managed by beekeepers in Oman (Dutton, 1982), and in several countries in Asia, *Apis dorsata* is managed to some extent, for example in India (Mahindre, 2004) and Vietnam (Mulder *et al*, 2001). There is more information on this in Chapter 5.

DIFFERENCES BETWEEN TROPICAL AND TEMPERATE ZONE RACES OF HONEYBEES

European races of *Apis mellifera* have evolved in temperate climates with long, cold winters when little or nothing is in flower. They store honey to serve as a food supply to survive these times of dearth when there is little or no food available. Apart from swarming (the colony's reproduction), they remain in their hive because they are unlikely to survive if they leave in search of a new nesting place. By comparison, all tropical races and species of honeybees are far more likely to abandon their nest or hive if disturbed, because in the tropics they have a reasonable chance of survival. In some areas, tropical honeybee colonies migrate seasonally. These are crucial factors making the management of tropical honeybees different from the management of temperate zone honeybees.

TABLE 3
Species of honeybees: indigenous distribution

Region	Indigenous honeybee species	Honeybee species introduced
AFRICA	*Apis mellifera*	*Apis florea* introduced to Sudan, 1985
ASIA*	*Apis andreniformis* *Apis binghami* *Apis breviligula* *Apis cerana* *Apis dorsata* *Apis florea* *Apis laboriosa* *Apis koschevnikovi* *Apis nigrocincta* *Apis nuluensis*	*Apis mellifera*
AUSTRALASIA	No indigenous honeybees	*Apis mellifera* *Apis cerana* has been introduced to Papua New Guinea
EUROPE	*Apis mellifera*	
MIDDLE EAST	*Apis mellifera* *Apis florea*	
THE AMERICAS	No indigenous honeybees	*Apis mellifera*

* Not all of these species are indigenous to every country of Asia.

AFRICA

Apis mellifera honeybees are indigenous to Africa. There are many different races of African bees; see Ruttner (1998) for more information. In South Africa bees are of the race *Apis mellifera capensis*, a race of bee with unique biology and behaviour (see below). Tropical races of *Apis mellifera* are slightly smaller than the European races of *Apis mellifera* and they have different biology and behaviour: they are readily alerted to fly off the comb and to defend themselves. In many African countries, local beekeeping methods are used, with log, bark, basket or clay hives placed in trees. Where the behaviour of bees is to swarm and migrate, it can be a good beekeeping strategy to use a large number of low cost hives. This means that the beekeeper can afford to have a large number of hives and accept that some of them will be unoccupied at some periods. Throughout Africa honey hunting from wild nests is carried out wherever sufficient natural resources remain. Stingless bees are also present throughout tropical and southern sub-tropical Africa.

BOX 3
Apis mellifera capensis

Apis mellifera capensis, known as the Cape honeybee, is a race of *Apis mellifera* whose natural distribution is confined to the southern tip of Africa, and which has a unique, highly complex biology that has only recently been understood. The unique feature of *Apis mellifera capensis* is that worker bees, without any mating taking place, are able to lay diploid, female eggs. This biology is not known in any other honeybee species or race, where the usual 'rule' is that worker bees lay only haploid, male eggs that develop into drones.

The recent (1990) movement by beekeepers of these bees from southern to northern South Africa caused the widespread death of African honeybee (*Apis mellifera scutellata*) colonies. The *Apis mellifera capensis* workers enter the *Apis mellifera scutellata* colonies, and this soon leads to colony break down and death. It seems that the eggs laid by the *Apis mellifera capensis* bees evade being killed by other worker bees, as would normally happen, and ultimately the colony breaks down. The spread of these *Apis mellifera capensis* bees in South Africa, together with the recent introduction of *Varroa* mites, has severely curtailed beekeeping in South Africa and these issues may eventually affect on bees and beekeeping throughout Africa.

ASIA

At least eight honeybee species, varying in biology and behaviour, occur naturally within Asia. Some of these bee species build nests consisting of single combs, in trees, bushes, or in cliffs, and a great variety of methods have been developed by human societies for their exploitation.

For example, the giant honeybee, *Apis dorsata*, suspends its large combs (often one metre in diameter) from tree branches and overhanging ledges on rocks and buildings. Man obtains honey crops from this species by plundering their colonies, and this activity is known as honey hunting. Throughout Asia, from Gurung tribesmen in the Himalayas, to mangrove-dwellers in the Sunderbans of Bangladesh, the rain-forest people in Malaysia, people living in the river deltas of southern Vietnam, and indeed, wherever the giant honeybee is present, honey hunters have their own customs for exploiting these bees (see Chapter 5).

Apis cerana is known as the Asian hive bee because like European *Apis mellifera*, it can be kept and managed inside a hive. Moveable frame hives and movable comb hives (top-bar hives) have therefore been developed for *Apis cerana* and the other cavity nesting hive bees.

Stingless bees are also present throughout tropical and southern sub-tropical Asia.

European *Apis mellifera* have been introduced to most of Asia as shown in Table 4, and this exotic species may now be the predominant honeybee species present in China, Japan and Thailand, and other countries of Asia.

TABLE 4
Numbers of *Apis mellifera* colonies in Asia

	1984	1994	2004		1984	1994	2004
Afghanistan	20 000	?		**Japan**	284 000	225 000	
Bangladesh	0	?		**Malaysia**	<500	present	
Bhutan	0	50		**Nepal**	2	1 000+	
Brunei	?	0		**Pakistan**	1 000	14 000	
Burma	2 000	2 000+	5 000	**Philippines**	2 000	6 000	
Cambodia	?	?		**Singapore**	?	present	
China	4 000 000	6 800 000		**South Korea**	280 000	300 000	790 000
Hong Kong	?	100+		**Sri Lanka**	4	not permitted	
India	3 000	80 000		**Thailand**	30 000	100 000	300 000
Indonesia	1 000	31 000		**Vietnam**	16 000	70 000	470 000
Laos	?	present					

AUSTRALASIA AND PACIFIC OCEAN ISLANDS
There are no honeybees indigenous to this region, although there are indigenous species of stingless bees that have been harvested traditionally. European races of *Apis mellifera* have been widely introduced and are used for beekeeping. Recently *Apis cerana* has been introduced to Papua New Guinea.

CARIBBEAN
Although indigenous stingless bees are present, no honeybees are naturally occurring in these islands. *Apis mellifera* of European origin have been introduced to most of them and beekeeping industries have developed using European-style beekeeping methods. With the rapid spread of honeybee diseases around the world, it is increasingly important that these islands endeavour to maintain stocks of disease-free bees. Caribbean beekeepers must watch for Africanised bees that have already arrived in Trinidad.

EUROPE
Apis mellifera is the honeybee indigenous to Europe, and there are many different races of the bees. See Ruttner (1988) for a detailed account. During the 20th century, bees were moved by beekeepers from one area to another and many hybrids were created. Today there is more interest to identify and preserve the original races of bees that are now appreciated to be the bees best suited for their own areas. For example, Slovenia is home to the indigenous Carniolan bee *Apis mellifera carnica*, known as "sivka" meaning "grizzly" because of the bright grey hair along the edges of its abdomen, and admired by beekeepers for its characteristic gentleness and diligence. Because of this behaviour, people started to keep it in hives close to home. News of the gentle character of this grey bee soon spread to other nations and by the end of the 19th century; there was the beginning of a lively trade in live bees and swarms, later to include Carniolan queens. Until the beginning of World War I, specialized Slovene merchants exported tens of thousands of bee colonies and, in many places; these completely replaced the indigenous dark bee. Today, honeybee queen breeders, who sell approximately 40 000 queens, mostly to the countries of Central and Western Europe, with exports increasing annually, are continuing their work. Slovenia joined the EU in May 2004, and the beekeeping sector was well prepared, with legislation for an "Authentic Carniolan Trademark" for the marketing of indigenous Carniolan genetic material and a well-organised reserve area for the indigenous bees.

Apis mellifera carnica is also kept fruitfully in neighbouring Austria and Croatia, as well as elsewhere in Central and Eastern Europe. This bee species is well adapted to the climate and foraging conditions of these countries. It tolerates local conditions: cold, snowy winters, frequent rainy and windy summers and makes good use of available forage. One of its beneficial characteristics is discovering and collecting honeydew from spruce and fir trees. Almost 60 percent of Slovenia retains its forest cover, with mixed coniferous and deciduous forests offering rich forage for bees. The most important honey-producing trees are fir and spruce, followed by sweet chestnut, lime, sycamore and wild cherry.

BOX 4
Save indigenous bees in Europe[1]

One of the last remaining populations of the European honeybee *Apis mellifera mellifera* is threatened. These are the Black Bees on the Danish Island of Læsø, an isolated island that lies west of Sweden in the Kettegat Sea. In 1992 Denmark signed the Rio Convention on Biological Diversity, and the law was passed for Læsø Island to become a protected area where only beekeeping with the Black Bees is allowed. After this, beekeepers who kept other bees claimed compensation, although this claim was later dropped. They also took their case to the European Court in Luxemburg, but were unsuccessful. The Court ruled that the Preservation Order on the Læsø Black Bee was a requirement of The Danish Government, and that no other race of bees should be allowed on to the Island. Today on Læsø there are about 30 beekeepers using the Black Bees, and just a few who continue to fight the ban and illegally use other bees, and even import bees. This has lead to the recent introduction of *Varroa* and *Acarapis* mites.

Ironically, it was only in September 2004 that SICCAM (The International Organization on the preservation of the Northern European Black Bee) held its biannual conference on Læsø, to focus attention on the need to protect this special bee population. SICCAM passed a resolution calling for this unique population of bees to receive the protection it needs.

Now, however, the Danish Minister of Agriculture and Food, Hans Christian Schmidt has decided that it is in the interests of human liberty for the few, vocal, beekeepers who request it, to be allowed to take in other races of bees to the Island, and that only a small part of the Island will be a protected area for the Black Bees. The island of Læsø is only 25 km long; therefore, as every beekeeper will understand, it is not possible to keep the populations of bees separate.

Meanwhile, the Danish Beekeepers Federation has fought hard to protect the black bees, even though its own government subsidy is at stake.

The majority of beekeepers in Denmark want the Black Bees on Læsø to be protected. This is a precious resource, not just for Denmark but also in world terms.

THE AMERICAS

There are no honeybees indigenous to the Americas. Instead, their ecological niche was filled by the many different species of stingless bees, which were, and still are in some areas, exploited for their honey that is especially valued for its medicinal properties. Knowing nothing of these indigenous bees, European settlers long ago took with them European bees, and an industry developed based on this bee. In 1956, some tropical, African *Apis mellifera* bees were introduced into Brazil. These bees survived far more successfully in tropical Brazil than their European *Apis mellifera* predecessors. These 'Africanised' bees (dubbed 'killer bees' by the media) have spread through tropical parts of South and Central America, and are now in southern USA. In Brazil and neighbouring countries, beekeepers developed new management methods and now make excellent livelihoods with these bees.

THE NEAR EAST

Apis mellifera is also the indigenous bee of the Near East, and as everywhere, there are indigenous races of *Apis mellifera* that have their own characteristics highly suited to local conditions. Middle Eastern races include *Apis mellifera syriaca* and *Apis mellifera yemenitica*, desert races that survive hot, arid conditions. *Apis florea* is also present in some countries of the Middle East, and its honey is highly prized, often changing hands at over US$100 per kilogram.

PROBLEMS WITH THE INTRODUCTION OF EXOTIC BEE SPECIES AND RACES

As far as beekeepers are concerned, throughout the 20thcentury the other man's grass was always greener – bees in other countries were viewed as more prolific, gentler, more disease resistant, less prone to swarming, more yellow, blacker. Indeed many beekeepers still think this way, and this has led

[1] Bradbear, 2005.

to the disasters of recent years, when races of bees, or diseases and parasites of honeybees have been spread around the world with serious consequences for the beekeeping industries, and indigenous populations of bees, in many countries. This has been caused entirely by the movement of honeybee colonies by man.

For example, the mite *Varroa destructor* is a 'natural' parasite of Asian honeybees that survive in the presence of the mite. However, when particular races of the mite are introduced to European *Apis mellifera* honeybees (the bee used for beekeeping in most industrialized countries), the whole colony will be killed unless action is taken by the beekeeper. These mites have now been introduced to many beekeeping countries and, for example, most populations of wild honeybees throughout Europe have been killed during the last 20 years or so. Mites become resistant to medicines developed for their treatment, and research is underway in many countries to find better, integrated control methods, or resistant strains of bees.

Recently another predator, the small hive beetle, *Aethina tumida*, has been spread from Africa (where it is a relatively harmless pest for bees) to honeybee colonies in the USA, where it leads to destruction of European honeybee colonies.

The introduction of African bees to south America was initially viewed as a disaster, as the introduced African bees survived very well in their new habitat, and their population quickly expanded through south and central America, replacing existing populations of European honeybees, there were less well suited to the tropical environment. However, today some view this amazing, dramatic event in a more sympathetic light – as beekeeping industries have learned to adapt to the African bees. The Brazilian scientist who introduced the African bees, Professor Warwick Kerr, has with hindsight, expressed the opinion that it would have been wiser to have focussed efforts on the Americas' indigenous, stingless bees (Bradbear, 1993).

Honeybees and used beekeeping equipment must never be moved from one area to another without expert consideration of the consequences. Just a very few regions remain without introduced honeybee diseases, and these are mainly in developing countries. It will be highly beneficial for these countries if they can retain their stocks of disease-free honeybees: they may in the future be able to market their disease free stocks, or export disease free queen bees, and it makes possibilities for organic honey and beeswax production cheaper and easier.

THE CONSERVATION OF INDIGENOUS HONEYBEE SPECIES AND RACES

Globalisation is taking place in beekeeping, as in every other sector. Beekeeping with European races of honeybees, plus all associated technology, is being spread around the world. The consequences of competition between introduced (exotic) honeybees and indigenous honeybee species and races are unknown.

3. THE IMPORTANCE OF BEES IN NATURE

BEES AS PART OF ECOSYSTEMS

Pollinators strongly influence ecological relationships, ecosystem conservation and stability, genetic variation in the plant community, floral diversity, specialization and evolution. Bees play an important, but little recognized role in most terrestrial ecosystems where there is green vegetation cover for at least 3 to 4 months each year. In tropical forests, savannah woodlands, mangrove, and in temperate deciduous forests, many species of plants and animals would not survive if bees were missing. This is because the production of seeds, nuts, berries and fruits are highly dependent on insect pollination, and among the pollinating insects, bees are the major pollinators. In rain forests, especially in high mountain forests where it is too cold for most bees, other pollinators like bats and birds play a greater role in plant pollination. In farmed areas, bees are needed for the pollination of many cultivated crops (see Chapter 7), and for maintaining biodiversity in 'islands' of non-cultivated areas. The main role of bees in the different ecosystems is their pollination work. Other animal species are connected with bees: either because they eat the brood or honey, pollen or wax, because they are parasitic to the bees, or simply because they live within the bees nest.

WHAT IS POLLINATION?

Pollination is transfer of pollen from the anther (the male part of the flower) to the stigma (the female part of the flower). Some plants can pollinate themselves: in this case, the pollen passes from the anther to the stigma inside the same flower, and this is called *self-pollination*. Other plants need pollen to be transferred between different flowers or different individuals of the plant. This is *cross-pollination*. Many plants can be pollinated both ways. Plants can be pollinated by wind or animals.

Some plants have only one method for pollination, others use a combination. The knowledge of pollination by animal pollination (*Zoophily*) in the tropics is still little known, and much work and research have to be done in this area. Some general rules can be used to detect whether a plant is pollinated by bees, flies, beetles, wasps, butterflies, moths, thrips, birds, bats, marsupials, slugs or rodents. Flowers pollinated by bees most often bloom in daytime, they can have different colours, but seldom red. The scent of daytime bee pollinated flowers tends to be less strong than that of night-pollinated flowers, often pollinated by bats or moths. Honeybee pollinated flowers have nectar tubes not more than 2 cm long. They have nectar guides (patterns to direct the bee towards the nectary) and often a landing place for bees. Bees are especially attracted to white, blue and yellow flowers. Plants pollinated by insects are called "entomophilous", and insects are generally the most important pollinators.

THE POLLINATION WORK OF BEES

If we look at the many colourful and different looking flowers, we should not forget that they have developed as an adaptation for the bees and other pollinators, and not to please humans! Bees and most flowering plants have developed a complex interdependence during millions of years. An estimated 80 percent of flowering plants are entomophilous i.e. depending more or less on insect pollination to be able to reproduce, and it is estimated that half of the pollinators of tropical plants are bees.

The efficiency of honeybees is due to their great numbers, their physique and their behaviour of foraging on only one plant species at one time. The bees have to find their food in flowers. The food can be nectar or pollen. Nectar is produced to attract the bees. Pollen is also attracting the bees, but it has another function too: it is produced to ensure the next generation of plants. Bee pollinated flowers have evolved in such a way that a visiting bee has to brush against the flower's anthers bearing pollen, or there may be a special mechanism to release the anthers to spring up or down to cover the bee with pollen. Compared with other insects, bees are extremely hairy. Each hair has a branched structure that makes it highly effective at catching pollen.

While flying to the next flower, the honeybee will brush herself and move many of the pollen grains, to arrange them in the pollen baskets made of stiff hairs on her hind legs. Some pollen grains are so dry that they cannot be formed into a clump. To prevent the pollen falling off during flight, the bee will regurgitate some nectar and mix it with the pollen. This gives the sweet taste when eating pollen balls collected by bees. It also makes the pollen a little darker so that it can be difficult to see from which plants it comes. Some bees do not have pollen baskets – they transport the pollen in the hair on their abdomen (e.g. *Osmia* bees and leaf cutter bees). When the honeybee with pollen is landing in the next flower, there will be pollen enough left on the bees' body hairs to pollinate the new flower, by delivering some grains to the flower's stigma. Now pollination has taken place. To create a seed, the pollen grain has to grow a small tube inside the stigma to the ovary of the flower. Then a male gamete can travel through the tube, fertilize the egg cell and start development of the fertile seed. Now the fertilization has taken place.

Some plants need several successful visits from bees to ensure that all the flower's eggs are fertilized. For example, some varieties of strawberry need about 20 pollen grains – requiring visits by several bees, an apple flower may need four or five bee visits to receive enough pollen grains for complete fertilisation. If the fertilization is inadequate because of lack of bees, not all seeds will develop, and the shape of the fruit will be poor and small. Fertilization is the beginning of a new seed, which perhaps will grow and develop into a new plant. The new plant will bloom, provide the bees with food, be pollinated, and be fertilized, and in this way, the story continues.

The forager bee returns to the honeybee colony with her pollen loads, which are placed in the nest in areas of comb close to the brood.

Bees have to learn where in a flower the nectar is to be found. To guide the bees, many plants have *bee-tracks,* which are lines of colour leading the bee towards the nectar. These can sometimes be seen by humans, but some are in the ultra-violet part of the spectrum and visible to bees, but not humans. In this way, the plant also guides the visiting bee to pass the anthers or stigma in the right way. Bees have no problems in finding the nectar in flat, open flowers, but in flowers that are more complex, they have to learn it by trial and error. After some visits in the same type of flower, the bee has learned where the nectar is, and learns this for the next visit. Pollen is the protein food for bees. Without pollen, the young nurse bees cannot produce bee milk or royal jelly to feed the queen and brood. If no pollen is available to the colony, egg laying by the queen will stop.

Usually a honeybee can visit between 50-1000 flowers in one trip, which takes between 30 minutes to four hours. In Europe, a bee can make between seven and 14 trips a day. A colony with 25,000 forager bees, each making 10 trips a day, is able to pollinate 250 million flowers.

The ability of the honeybee to communicate to other bees in the colony where to go for collecting more pollen and nectar is very important for their efficiency as pollinators. When a scout bee has found a good nectar or pollen source, she will return to the colony and communicate to other bees where they can find the same food. This is done with a special dance indicating the distance, quality, and direction from the nest. Flowers closer than around 200 metres are just announced with the waggle dance without indicating any direction. Chapter 6 describes how these stingless bees are guided to the flowers.

When bees begin foraging for pollen and/or nectar, they will visit the same species of flowers and work there as long as plenty of nectar or pollen can be found. For example, if a honeybee starts collecting in an *Acacia* tree, she will fly from *Acacia* flower to *Acacia* flower, and not behave as many other insects do, visiting different species of plants within the same trip without any great pollination effect. This behaviour of bees is called *foraging constancy*.

Some flowers are open and with nectar all day and night, but others are open only for a few hours in the morning, afternoon or night. The single worker bee learns and remembers what time the different flowers are worth visiting. One bee can remember the opening time for up to seven different types of flowers. The honeybees are pollinating a great number of different plant species, and they do it effectively. Some solitary bee species are much more specialized for pollinating specific plant species.

SPECIALIZED POLLINATION

Some species of plants and bees have developed a close interdependence in connection with pollination. Such a mutual adaptation and interdependence between a plant and pollinator is a result of a long and intimate co-evolutionary relationship. The pollinating bees of the Brazil nut tree *Bertholletia excelsa* is an illustrative example of such a relationship and its economic importance.

The Brazil nut tree grows wild in the Amazon Forest. Brazil nuts are one of the economically most important wild products growing trees in the area, with more than 50 000 tonnes of the nuts exported from Brazil every year. The Brazil nut trees cannot be grown in plantations, because they need to be pollinated by one special bee species, the small shining *Euglossa* bee. This bee is dependent on the presence of an orchid species that is found only in the rain forest. They are also the only pollinators for a number of orchids in the forest. In some species of *Euglossa,* the male bee collects some scented material from the flower, which they distribute to attract other males – who do the same and multiply the effect with a scented cloud, in the end so strong, that it attracts female bees so that mating can take place. During the collection of the scented material, male bees transfer pollen from orchid to orchid and pollination takes place. The female *Euglossa* bees live from nectar from the Brazil nut tree and pollinate it. This means that without the orchids, there would be no *Euglossa* bees and no Brazil nut trees, and none of the many other plants, insects and animals associated with that tree – including the people whose livelihoods include collection and sale of the Brazil nuts.

Studies in the Amazon forest have shown that many *Euglossa* bees do not cross open areas. That means that great parts of forest lose its pollinators when the forest is cut, and open parcels of land are created between remaining forest islands.

This example is only one of many important specialized interrelations between bees and trees. In spite of this, the bees perhaps play a minor role as pollinators in the rain forest compared to their role in temperate forests, monsoon forests and savannah woodland. In tropical rain forests, many trees are pollinated by birds, bats and insects other than bees. Animal pollination is of greatest importance, because there is no wind between the trees and because the distance between trees of the same species may often be great. In that way, it is most convenient for the trees to use animals as pollination vectors. In tropical forest, there may be rather few flowering plants on the ground because of the trees' shade.

In European deciduous forests, the forest floor can be totally covered by flowering plants in springtime, before the trees produce their leaves. These plants often need fast pollination from a great number of honeybees. Not many other insects are present in high numbers in early spring.

In Denmark, it is seen by forestry people that the presence of bees in forest areas helps to protect the newly planted trees from being eaten or spoiled from gnawing by roe deer, compared to other plantations with no bees. The reason is because bees secure a better pollination and seed production of so many other plants, which the roe dear can forage on instead of the tree seedlings. By pollinating trees, bushes and herbaceous plants, the bees are important for the food production of all the other animals and birds in the forest ecosystem dependent on it for food berries, seeds and fruits.

BEES ARE GOOD FOR TREES AND TREES ARE GOOD FOR BEES

Bees and trees belong together. The honeybees and stingless bees have originally developed in forest biotopes. Given the choice, wild honeybees chose nesting places in trees rather than in an open landscape. Most often the honeybees prefer to build their combs or nests high in trees instead of close to the ground, but bees nests can be found everywhere in a tree. In savannah areas with bushfires in the dry season, a high nesting place is an advantage. When beekeeping is present in a forest, the beekeepers will be interested in protection of the forests and especially the tall trees preferred by the bees. When enough bees are present in a forest, they provide a better pollination that leads to improved regeneration of trees and conservation of the forest's biodiversity.

BEES AND BIODIVERSITY

Without bees there would be no flowering plants, and without flowering plants there would be no bees. Without bees biodiversity would not be so great. Biodiversity is measured as the number of different plant and animal species found in a certain unit area. Biodiversity is highest in tropical forest areas and lowest in the Arctic. High biodiversity is related to the high age of the ecosystem, and a stable environment. A stable environment creates the possibility of development of specialization and use of narrow ecological niches. The explanation of the high biodiversity in tropical forests can be as the species' efforts to avoid attack by diseases and pests. Both can be much more serious in a tropical forest biome with a constant supply of water, and a hot and stable temperature. The high diversity with its high specialization in pollination relationships can also be a danger for the forest. The specialist pollinator must have access to food all year round. Many of the smaller trees flower all year round or nearly all year, but the larger trees have blooming seasons. Some flower every year, others every third or fifth year, where all trees from the same species bloom at the same period and maybe even at the same hours. If the specialized bees loose their stable resources by tree cutting, they will not be there when the bigger trees require their pollination service.

The reproduction of plants is simplest as vegetative reproduction – a new tree could just come from a root shoot. The new tree would then be genetically identical with the mother tree. Vegetative reproduction alone would be no problem if the environment were stable, but most environments are not stable over time, they change. It can be climatic changes, new diseases or pests. To be able to adapt to environmental changes there need to be genetically different plants. In that way there will always be some plants, which are better adapted than others because of special genetic constitutions. The only way to constantly mix the genes for the plants is by cross-pollination, where pollen from one plant is transported by bees to another so that the offspring become genetically different. In that way, there is a greater chance for at least some of the offspring to survive in the competition of life. In this we find the bees as one of the most important factors.

4. THE IMPORTANCE OF APICULTURE FOR RURAL LIVELIHOODS

Beekeeping tends to be perceived as ‘a hobby’, or as ‘a sideline activity’. These descriptions may often be true, but a resilient livelihood – one that keeps people out of poverty – is one that has access to range of options. In this case, apiculture and related trades can be sources of valuable strength to countless numbers of rural people's livelihoods. Rather than just a ‘hobby’, beekeeping may be seen as an important occupation and part of rural life worldwide. In rural communities where access to income is limited, small-scale beekeeping can contribute significantly to livelihood security. Apiculture and related trades tends to be underplayed in both policy and planning. One reason may be the focus of rural development, wherein crop production and livestock rearing are taken to be dominant activities in rural areas. This perspective can render invisible the part beekeeping occupies in social life, culture, and local economies.

Beekeeping does not fit easily into the sectoral divides of rural development: as an activity, it spans forestry, horticulture, agriculture, the natural environment, animal husbandry and entomology without fitting precisely into any one of these sectors. Likewise, pollination is an important part of horticulture, yet the management of bees is often considered part of animal production. Similar problems confront the classification of bee products because honey is a food, yet beeswax is listed amongst non-food waxes and oils. Beekeepers have been categorised in different times and places as farmers, hunters and gatherers, cattle-keepers, or rural dwellers – with beekeeping remaining hidden as an important skill and part of their lives. These ambiguities present complications for development policy-makers, practitioners and researchers, even though such complexity is in keeping with the way people themselves link different activities, resources and products together in their daily lives.

This very complexity explains the attraction of sustainable livelihoods approaches for securing a more visible position for beekeeping within rural development (Carney, 1998). Beekeeping fits well into the people-centred perspectives of sustainable livelihoods approaches. Such approaches have contributed towards moving rural development away from economic and resource-based interventions, towards people and their rights and obligations to the resources on which their livelihoods are based.

Beekeeping is a small-scale but very widespread activity. Unless you are aware of it, it is easy to visit villages and not see beekeeping. It does not attract much attention.

CREATING A LIVELIHOOD FROM BEEKEEPING

According to the accepted definition originally developed by Chambers and Conway (1992): “A livelihood comprises the capabilities, assets and activities required for a means of living. A livelihood is sustainable when it can cope with, and recover from, stresses and shocks and maintain or enhance its capabilities and assets, both now and in the future, while not undermining the natural resource base.

Everybody’s livelihood depends upon access to many different types of assets. In order to make it possible to think about people’s differing livelihoods, and to allow analysis, all assets may be allocated into one of five fundamental categories: human, physical, financial, social and natural. To understand this well, think about your own livelihood and all the diverse assets it depends upon: your skills; access to transport; equipment; telecommunications; the social networks you have been born into or have created yourself. No single category of capital asset – for example finance – is on its own a sufficient basis for creating a livelihood.

Beekeeping is a useful means for strengthening and creating people’s livelihoods because it both uses and creates a range of different capital assets. Successful beekeeping can be achieved by drawing upon all of the five categories of capital asset shown above, although financial capital need not be essential for productive beekeeping. (Although of course financial capital assets may be essential for family and household well being, without which beekeeping may not be possible.) The five types of capital assets are a fundamental part of the framework used to explain the Sustainable Livelihoods Approach (see Figure 1 on page 20).

BOX 5
The five types of capital assets

Natural capital
Needed for beekeeping: bees, a place to keep them, water, sunshine, biodiversity, environmental resources.

Social capital
Needed for beekeeping: help from families, friends, networks. Membership of groups, access to wider society, market information, research findings.

Human capital
Needed for beekeeping: skills, knowledge, personal attributes like good health and strength, marketing expertise.

Physical capital
Needed for beekeeping: tools, equipment, transport, roads, clean water, energy, buildings.

Financial capital
Needed for beekeeping: cash, savings, access to credit or grants.

Concerning natural capital for beekeeping

Livelihoods depend upon natural resource stocks: in the case of beekeeping, these are bees, flowering plants and water. Bees feed on the nectar and pollen from flowers: the nectar is eventually converted into honey. Bees also collect gums and resins from plants, and use plants and trees as habitat for nesting places.

Bees are a natural resource, freely available in the wild. Bees collect where they can, so wild, cultivated, wasteland and even land-mined areas all have value for beekeeping. Beekeeping is possible in arid areas and places where other crops have failed: the roots of nectar-bearing trees may still be able to reach the water table far below the surface. Beekeeping is therefore feasible in marginal conditions: just the sort of activity that is needed where people have to restore their livelihoods, or to create new ones.

Beekeeping provides an excellent bonus crop in addition to, but not instead of, other crops. Bees are the only livestock capable of harvesting nectar and pollen: there is no competition with other animals, and without bees, these valuable resources would not be harvested. The extra-remarkable aspect of beekeeping is that it ensures the continuation of natural assets: by the pollination of wild and cultivated plants, as explained in Chapter 3. As bees visit flowers, they are not only collecting food for today, but by their pollinatory activities are ensuring future generations of food plants, available for future generations of bees, and for us too; the perfect self-sustaining activity.

Beekeeping fits well alongside many other livelihood activities and the natural resources used by them (for example, forestry, agriculture, conservation activities). Although impossible to quantify, pollination is the most economically significant value of beekeeping. Flowering plants and their associated bees are interdependent: you cannot have one without the other. Referring to the definition of a livelihood, that it can enhance its capabilities '*while not undermining the natural resource base*', it is clear that beekeeping actually helps to sustain the natural resource base. How many other income-creating activities can be said to restore natural resources? Beekeeping has been in the past a regular part of village agriculture worldwide, and we need to ensure that it is retained as farming practices change.

Concerning human capital for beekeeping

Traditionally many societies have good skills relating to bees, honey and in making other products. Often the products of beekeeping are used by women in making secondary products: for example the important industry of *Tej* (honey wine) making in Ethiopia is run by women, and elsewhere in Africa it is often women who brew and sell honey beer. These are the types of human skills needed to create livelihoods within a society. Too many beekeeping projects have ignored existing skills, or worse, implied that they are wrong or out of date. The best projects recognise existing skills and build on them for greater income generation and ensured sustainability.

Concerning physical capital for beekeeping

These include the infrastructure (transport, water, energy, communications, buildings) and the production equipment that enable people to make their livelihoods from beekeeping. Frame hive beekeeping (see Chapter 5) is used in all industrialized countries and many beekeeping projects have tried to introduce this type of beekeeping. However, where a society does not have the physical, human or financial assets to support this type of beekeeping, the project is likely to fail. There continue to be projects introducing beekeeping technology that cannot be sustained. Yet, there are many ways of managing bees and obtaining a crop from them: a hive is just a container for bees to live inside and there are many types of such containers. To achieve sustainable beekeeping projects, all equipment must be made and mended locally, and in the process, equipment manufacture contributes to the livelihoods of other local people. Indeed, beekeeping can stimulate many different sectors within a society: village traders; carpenters (making hives and stands); tailors (making veils, clothing, gloves); container-makers and sellers. The equipment needed for beekeeping can be very simple: for example, the humble plastic bucket is one of the most useful items. For the beekeeping expert it may not bring great professional kudos, simply to recommend the provision of good quality, lidded, stackable plastic buckets. Yet these are essential items for beekeepers living in remote places that need to keep their honey clean until they are able to sell it. Excellent quality honey can be harvested as long as clean buckets are available, along with cotton or baskets for sieving honey, and containers for melting wax and for selling the honey and other products. Infrastructure such as transport and roads can be critical for beekeepers in remote places: access to transport brings access to marketing possibilities and better prices (see Chapter 13).

Concerning social capital for beekeeping

Social resources such as networks, producer and marketing associations, are of great significance for beekeeping development. Such associations provide the means for beekeepers to advance their craft, ensure protection of their bees, processing for honey and wax, access to markets, and marketing support. Access to a network at a wider level, as provided by Bees *for* Development, assists beekeepers to make contact with national and international networks, to find out about sources of training, markets, research findings, and raises their awareness of the industry and available opportunities.

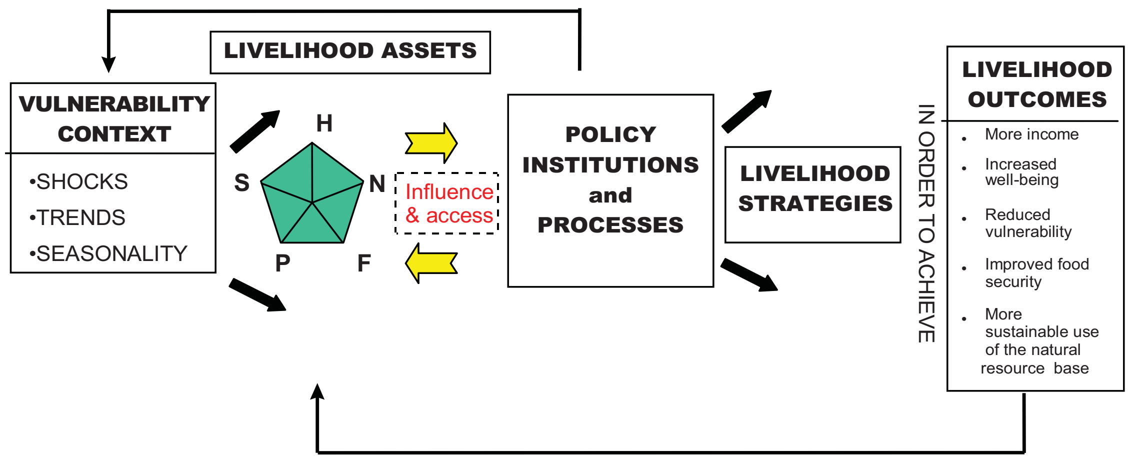
Concerning financial capital for beekeeping

Access to finance is essential for the further development of beekeeping enterprises: for example, successful marketing depends upon the purchase of containers for processing and packaging of products. Credit is necessary for beekeeping associations running collection centres, buying products from producers and selling on in bulk. However, significant financial assets are not essential for beekeeping at subsistence level (although having access to financial resources may be important for a family). A good beekeeping project will work to ensure that all available capital assets are taken into consideration, without dependence on any that are not. For example, too many projects have depended on the importation of the beeswax foundation used in frame hives: this is impossible for beekeepers without financial assets.

THE SUSTAINABLE LIVELIHOODS APPROACH

The Sustainable Livelihoods Approach allows appreciation of how these capital assets fit into the Sustainable Livelihoods Framework. The Framework assists with consideration of the various factors that constrain or enhance the livelihood of a beekeeper and his or her family. In the Framework shown below, the understanding of sustainable livelihoods is separated into five parts: the vulnerability context; people's livelihood assets; policies, institutions and processes; livelihood strategies, and livelihood outcomes.

FIGURE 1
DFID's Sustainable Livelihoods Framework (DFID, 2000 version)[2]



Where:

H	represents **human capital**: the skills, knowledge, ability to labour and good health important to the ability to pursue different livelihood strategies
N	represents **natural capital**: the natural resource stocks from which resource flows useful for livelihoods are derived (for example land, water, wildlife, biodiversity, environmental resources)
F	represents **financial capital**: the financial resources which are available to people (whether savings, supplies of credit or regular remittances or pensions) and which provide them with different livelihood options
P	represents **physical capital**: the basic infrastructure (transport, shelter, water, energy and communications) and the production equipment and means that enable people to pursue livelihoods
S	represents **social capital**: the social resources (networks, membership of groups, relationships of trust, access to wider institutions of society) upon which people draw in pursuit of livelihoods

Vulnerability

The Framework considers people living and working within a context of vulnerability. Analysis of vulnerability means we have to identify the risks beekeepers are under and the resilience they have to cope with negative change in their environment, both short and long-term. Vulnerability includes shocks, trends and seasonality. Shocks could be hurricanes damaging agriculture and destroying honey harvests, or the arrival of a new bee disease. Trends may be the gradual decline in the quantity of flowering plants due to habitat loss, or gradual increase in demand for honey. Vulnerability may be also seasonal: for example, a beekeeper's family may have less food at the beginning of the rainy season, making them more vulnerable to illness, and with less time for beekeeping. People's access to assets, and their capacity to utilise them, is shaped by their resilience to negative shocks, trends and seasonality.

According to the definition: *A livelihood is sustainable when it can cope with, and recover from, stresses and shocks*, we see situations worldwide where beekeeping can be especially valuable, as it remains an activity possible for people living in even the most difficult of circumstances, isolated by war or sanctions. This is because bees are nearly always available in the wild and equipment can be made from whatever is to hand.

For rural development projects, use of the Sustainable Livelihoods Framework can help to identify the ways in which people are most vulnerable, and how they are strongest. This may lead to suggestions of how to make them stronger, for example by helping them to diversify into beekeeping activities. It may also help a beekeeping project to identify ways for government and donors to reduce vulnerability, for instance, by providing training to cope with the effects of a disease of honeybees, or to prevent the use of insecticides.

[2] See www.livelihoods.org for updates.

Livelihood assets
Analysis of people's access to assets is based on the idea that they require a range of assets to achieve positive Livelihood Outcomes: this part of the Framework has been already discussed above, in relation to the assets needed for beekeeping.

Policy, institutions and processes
The Policy, Institutions and Processes part of the Framework includes organizations large and small, institutions, legislation and the processes which link organizations, institutions and policies to people's lives: these have a profound influence on people's access to assets. They shape people's livelihoods and effectively influence:

- Access to various types of capital assets, to livelihood activities (such as beekeeping), and to decision-making bodies and sources of influence.
- The terms of exchange between different types of assets (for example making it difficult to market honey because traders lack access to credit).
- The returns (economic or otherwise) achievable from any given livelihood strategy.

Policy, Institutions and Processes also have a direct impact upon whether people are able to achieve a feeling of inclusion and well-being. Looking at the Framework it can be seen that there is feedback from Policy, Institutions and Processes to the Vulnerability Context. This is because policies established and implemented by organizations affect trends directly and indirectly (for example by the protection of habitats). They can also help cushion the impact of external shocks, for example, a change in legislation affecting world trade in honey. Institutions influence people's choices of livelihood strategy, and policies and regulations often affect the attractiveness of particular livelihood choices (for example, legislation concerning honey marketing or making export difficult).

LIVELIHOOD STRATEGIES INVOLVING BEES
People's capacity to make a livelihood, and their resilience to negative change, is shaped by their *livelihood strategies*. These strategies are the combination of people's activities and the choices they make in order to achieve their livelihood goals. They depend on the opportunities and access individuals, households and communities have to exploit different levels and combinations of assets, and are probably the major influence on people's choice of Livelihood Strategy. For example, in a household that depends on farming for most of its food and income, one person may decide to take up beekeeping, and in time, this may provide the capital for another to start a small shop. The beekeeper's success will depend on the available opportunities: maybe there will be a friend who keeps bees. If the friend encourages the beekeeper to join an association, this may be a good opportunity (an example of how social capital works). The possibility to start depends also upon the beekeeper having access to suitable capital assets (human, social, natural and physical), such as tools and equipment, a safe place to keep the hives, and a means of learning (from the friend) how to keep bees.

APICULTURE'S ROLE IN POVERTY ALLEVIATION
When apiculture forms part of people's livelihood strategies there are various possible outcomes. Some of these outcomes will include income and material goods, but also non-material outcomes such as well-being and contentment. In terms of apiculture, the least visible livelihood outcome is the pollination of flowering plants, both wild and cultivated: this is an outcome impossible to quantify. Honey is a traditional medicine or food in nearly all societies and whether sold in a simple way at village level or packaged more sophisticatedly, honey generates income and can create livelihoods for several sectors within a society. Beeswax is also a valuable product from beekeeping, although in some places its value is not appreciated. Industrialized countries are net importers of beeswax, and the supply comes from developing countries. The beekeepers and other people in a community can create further assets by using honey and beeswax to make secondary products, such as candles, beauty creams or beer. Selling a secondary product brings a far better return for the producer than selling the raw commodity. Bees also generate other products (pollen, propolis and royal jelly) that can in some situations be harvested, marketed and made into secondary products: all of this work effectively strengthening people's livelihoods.

Another crucial livelihood outcome is where, through strengthening people's livelihoods, beekeeping has managed to help a family become less vulnerable, strengthening their ability to look into the future, and reducing the chance that they will slip into poverty if a member of the family becomes ill or if a season is bad for farming or other activities.

In addition to their financial value, honey and beeswax have many cultural values and form part of ceremonies for birth, marriages, funerals, Christmas and other religious celebrations in many societies. Beekeepers are generally respected for their craft. All of these aspects are Livelihood Outcomes from the activity of beekeeping. While some may be difficult or impossible to quantify, they are real outcomes that strengthen people’s livelihoods and therefore should be acknowledged by a beekeeping intervention.

BEEKEEPING PROJECTS

In financially poor societies, small-scale beekeeping interventions are valuable. However, development is business. Aid agencies and NGOs depend upon the margins they earn from projects: the larger the project, the higher the budget and the greater the overheads available to those involved. The work involved in starting and running a small project is much the same as for a larger project. For these reasons, small interventions like beekeeping projects have not always been popular with donors, nor with those charged with submitting proposals for donor support. Yet, in poor societies, large beekeeping projects with high capital input seem doomed to non-sustainability and failure. This has happened in far too many beekeeping projects where a well-meaning donor has allocated a significant budget to a project, much of which is inevitably spent on equipment. This leads to equipment being introduced that is not appropriate, and to the machinery (for hive making) that becomes obsolete as soon as a spare part is needed. Training is often provided that is irrelevant to people’s available resources. The many continuing examples of beekeeping project failure (see Svensson, 2002 and Lohr, 1998) raise the question of how to make beekeeping projects more successful.

CASE STUDY 1 - BEEKEEPING AND AIDS

M. Barany and C. Holding-Anyonge

The global HIV/AIDS pandemic continues to grow beyond levels previous thought possible in Africa, is expanding rapidly in Asia and Eastern Europe, and has a firm hold in Latin America (particularly among Caribbean countries). In sub-Saharan Africa, adult HIV prevalence exceeds 25 percent in several countries and is approaching nearly 40 percent in Botswana and Swaziland. With mortality rates not expected to peak in some countries for at least another five years, the worst still lies ahead (UNAIDS, 2003).

Development strategies to support rural livelihoods can no longer be designed, planned, or implemented outside the context of HIV/AIDS, nor can a response to the HIV/AIDS crisis afford to exclude synergistic inter-sectoral partnerships. Livelihoods and related development strategies now have to be viewed through the lens of HIV/AIDS. This means mainstreaming HIV/AIDS interventions in non-health related programming (e.g. AIDS awareness and education), but it also means synchronizing livelihood development programmes and activities with local and national HIV/AIDS programmes. The process of identifying such opportunities and transforming them into integrated interventions begins with an assessment of: 1) the impacts of HIV/AIDS; 2) interactions between the impacts HIV/AIDS, livelihoods, and social institutions/structures (e.g. markets); and 3) existing programmes to reduce HIV transmission and the impacts of HIV/AIDS. Following a review of the impacts of HIV/AIDS on rural livelihoods and markets, a summation of potential interactions between HIV/AIDS, beekeeping, and markets for bee products is provided with implications for the development of an expanded and comprehensive response to HIV/AIDS.

It is important to note that the understanding of HIV/AIDS, as it relates to rural non-agricultural livelihoods, is in its infant stages and continually evolving. This section is intended to canvas the complex nature of the epidemic; highlight relevant issues as they pertain to beekeeping; and facilitate awareness and dialogue in regards to the immense challenge of HIV/AIDS. There is still a lot to be learned from households, practitioners, and empirical analysis; nevertheless, the issue warrants immediate attention.

The impacts of HIV/AIDS

Household-level HIV/AIDS impacts and subsequent coping strategies are shaped by a complex dynamic of endogenous and exogenous factors including (but not limited to) the stage of the disease, household composition and socio-economic status, the capacity of community social safety nets, and agro-ecological variables. Though such factors may result in considerable inter- and intra-household variation, some generalizations can be made about the process through which HIV/AIDS impacts afflicted households. First, recurrent illness and eventual death of an infected household member result in a drastic reduction of household labour. At the same time that household production capacities are constrained, expenditures increase (e.g. travel to health centres, cost of the visits, medicines, and funerals). Household responses to these immediate impacts (e.g. the sale of land, livestock, and agricultural equipment) accompanied by disabling external responses (e.g. land grabbing) and socio-cultural structures (e.g. customary land inheritance laws), further erode the households productive assets, ultimately undermining the long-term sustainability of the household and making it more vulnerable to poverty and food insecurity.

Additionally, the widespread demographic and economic changes resulting from the epidemic, undoubtedly are having, and will continue to have, significant effects on society's broader institutions and structures. Markets, at local, regional and national levels, are one of the institutions affected. Though much less is understood regarding the effects of HIV/AIDS on markets in sub-Saharan Africa (Barnett and Whiteside, 2003) some assumptions can be made. An assumption of particular relevance here is that while HIV/AIDS slows, and in some cases, may reverse growth of national economies (Forsythe, 2002), certain markets – particularly those for inferior goods and those associated with healthcare – will likely be reinforced by the epidemic. This assumption is supported by two key trends. First, the rate of HIV infection continues to exceed the rate of mortality from HIV/AIDS[3] warranting that, in the short-term, the immense volume of people in need of medical care will continue to rise. Second, as the productivity and incomes of households afflicted by HIV/AIDS fall[4], purchasing power not only decreases within these households but also has a spillover effect into the broader economy dependent on consumer spending. Thus, informal markets for inferior products which are more affordable than their substitutes are likely to remain strong, if not grow in relation to the epidemic. How might these impacts interact with the livelihood strategies associated with beekeeping and the marketing of bee products?

Interactions between the impacts of HIV/AIDS and beekeeping as a livelihood/coping strategy

Potential interactions between the impacts of HIV/AIDS and the household livelihood strategies of beekeeping and honey hunting can be broadly represented in two hypothetical scenarios[5]. The first scenario represents the effect of HIV/AIDS on a household engaged in commercial beekeeping prior to the onset of AIDS while the second scenario represents the effect of HIV/AIDS on a household in which agriculture is the primary source of income and honey collection is occasionally engaged in for home consumption and sale. These two scenarios represent different aspects of the multiple livelihood continuum that is characteristic of rural households in sub-Saharan Africa.

Scenario 1: The household uses industrially manufactured hives to produce honey that is marketed through a cooperative. Income generated from honey production and marketing is the household's primary source of income after agriculture. The capital out-lays are relatively high. In addition to the hives, physical capital inputs include materials to maintain the health of the colonies and consumables

[3] An estimated 3.2 million newly infected in 2003, while 2.3 died (UNAIDS, 2003).
[4] In Botswana where the national adult HIV prevalence is approaching 40 percent, per capita household income for the poorest quarter is expected to fall by 13 percent between the years 2000 and 2015.
[5] These scenarios are drawn from discussions with technical specialists and extrapolated from literature.

required for frame hive beekeeping. Investments in human capital through technical training are necessary for harvesting honey of the quality demanded by the cooperative. A level of social capital is pre-requisite in garnering the trust of the cooperative to extend membership to the household.

The actual responsibilities of beekeeping and marketing are primarily the domain of the male household head, who has been unknowingly HIV-positive for several years. As the disease progresses into the symptomatic stage, income from the sale of honey provides an important source of cash for clinic visits and medicine. However, this leaves less money for inputs, and the inability to make payments on the start-up loan. Recurrent illnesses make it difficult for the young man to stick to maintenance and production schedules, and the quality and quantity of honey production decrease. After the young man dies, the hives are no longer productive. Without technical training in beekeeping and fearing that the hives will be stolen, the wife decides to sell the hives to help pay for a proper funeral. In addition to the traumatic emotional loss, the remaining household members are left without a main source of income and an unpaid loan. As a significant number of members of the marketing cooperative have also died in recent years, the cooperative is faced with difficulty in meeting the quotas.

Scenario 2: The household's only major livelihood activity is agriculture. During the dry season, honey is occasionally collected by the male household head for home consumption and sale. Both the male and female household heads are HIV-positive. The overall share of this activity to household subsistence and income increases in response to shortfalls in agricultural production resulting from labour constraints (e.g. sickness, care giving) during peak times (e.g. planting, weeding, etc.). However, as is normally the case, the young man is first to die from the disease, and because most wild honey collection and beekeeping duties (and associated woodland resources) are traditionally a male's domain, the household's access to consumption and supplemental income from honey is reduced. Several years pass and eventually the female household head also dies of AIDS-related illnesses.

Due to the process of capital erosion associated with the impacts of HIV/AIDS their adolescent children are left with very little in terms of productive assets. The orphans are unable to meet consumption needs through cultivation, and income is desperately needed to purchase food. Having learned the skills of traditional beekeeping and honey hunting from experience with his father, honey production and collection by the eldest son offers a supplemental seasonal source of food and income at minimal costs. The materials for constructing hives are obtained at little cost from nearby woodlands that also provide the habitat for wild bee colonies producing honey. Labour is the main input required for hive production, hive-siting, and collection of honey and is concentrated during the season when agricultural labour is not in high demand. (At this stage of HIV/AIDS in the household, labour is not constrained as before by illness or caring for ill household members.) The honey obtained from these activities is consumed, but more importantly, sold informally to provide much needed income.

These hypothetical scenarios reflect the potential effects of HIV/AIDS on beekeeping and honey collection livelihoods strategies. Despite the complexity involved in these interactions, the key points are:

- Commercial beekeeping, as a form of livelihood diversification, can provide an important source of income that can help buffer against the immediate costs of HIV/AIDS.
- The precise effect of HIV/AIDS on household livelihood strategies depends on household demographics; who and how many are chronically ill and die; the stage of the disease; and the resources available to household prior to the event(s) (FAO-ICRAF, 2004).
- HIV/AIDS erodes household capital, and thus capital-intensive beekeeping, as a mitigating strategy after the impact of HIV/AIDS may not be appropriate without support. Households afflicted by HIV/AIDS may be inclined to rely more heavily on rudimentary beekeeping and honey collection due to the low capital requirements of such activities.
- Gender of the deceased and remaining household members has a significant effect on how the impacts of HIV/AIDS affect livelihood strategies related to beekeeping.

Markets for bee products

Inferior goods are those goods that are consumed in place of higher quality goods because of their relative availability and/or affordability. Many non-wood forest products, such as low-grade honey, can be considered inferior goods. In households in sub-Saharan Africa, sugar is consumed directly, used as a sweetener, and as a fermentation agent for brewing alcoholic beverages. Sources of sugar include refined sugar processed from sugar cane or other sugar crops. Low-grade honey is considered an inferior substitute for refined sugar and in rural areas is often used in instead of refined sugar (EC-FAO, 1999). As incomes rise, inferior goods tend to be replaced with products of superior quality and the reverse occurs with a decrease in incomes. According to this economic principle, it can be expected that the negative effect of HIV/AIDS on wealth and purchasing power at the micro and macro levels may have a positive effect on markets for non-wood forest products (Barany *et al*, 2003), including low-grade honey[6].

In addition, the nutritional and medicinal benefits of honey and other bee products may also lead to an increase in their demand in association with the epidemic. Honey, as a source of energy, has been advocated in the diets of people living with HIV/AIDS (PLWHA) (FAO, 2002). Bee products are also widely used in Africa's traditional healthcare system. Roughly 80 percent of Africans rely on traditional medicine to some extent. Though traditional medicines definitely cannot replace the antiretrovirals that are urgently needed in the region[7]; traditional medicines do however, effectively treat opportunistic infections (e.g. *candidiasis*; *herpes simplex*, and *zoster*) and symptoms (i.e. appetite loss, nausea, fever, diarrhoea and coughing) associated with HIV/AIDS. These medicines are affordable and easily accessible; thus, it has been extensively observed that, to varying degrees, many, if not the majority of people living with HIV/AIDS on the sub-continent rely on traditional medicine for quality-of-life improvements and for treatment of HIV/AIDS-related illnesses.

Honey, royal jelly, beeswax and bee venom are used in both modern and traditional health clinics. Honey has antiseptic properties and is used as a medium for the topical and internal delivery of herbal remedies used in treating illnesses such as those described above. Where HIV is increasing demand for healthcare and reducing household incomes, markets for bee products used medicinally and for subsistence can be expected to remain strong, if not grow in relation to the epidemic. What implications do these interactions between HIV/AIDS, livelihood strategies and markets have for the expanded and comprehensive response to HIV/AIDS?

Implications for integrated interventions of the expanded and comprehensive response to HIV/AIDS

Strategies to reduce the transmission of HIV and the impacts of HIV/AIDS can be grouped into the three main components: prevention, treatment and care, and mitigation.

Prevention

HIV/AIDS prevention interventions target factors directly related to HIV transmission (i.e. risk-taking behaviour), but also social factors associated with HIV transmission such as poverty and mobility. Because poverty increases vulnerability to HIV, rural development through support for livelihoods can be seen as part of the comprehensive approach to HIV/AIDS prevention. At the same time, activities such as commercial beekeeping and marketing may also bring increased mobility and cash to spend on leisure. Thus, such programmes have the responsibility to include preventative interventions such as behaviour change communication and condom promotion. Forgoing such interventions misses the opportunity to reduce transmission, but also fails to prevent the potential impacts of HIV/AIDS on programmes as demonstrated in Scenario 1.

[6] A decline in demand for luxury items has been observed in South Africa (Forsythe, 2002). Growth in the informal sector is expected to result in an HIV/AIDS, structurally changed economy (Waal, 2003).
[7] Only 2 percent of those in need are receiving anti-retroviral medicine.

Treatment and care

In sub-Saharan Africa, where nutrient deficiencies are common and access to healthcare is limited, early and adequate nutrition interventions (e.g. education, counselling, etc.) are considered one of the most important interventions for PLWHA. Given the adverse impacts of HIV/AIDS on household food security, effective nutrition interventions need to account for the adaptation of household food strategies. Where households afflicted by HIV/AIDS have access to, and/or consume honey either because it is available locally or it is more affordable than other forms of dietary sugar, nutrition interventions need to include information regarding the benefits and disadvantages of honey consumption for PLWHA. For example, elevated intakes of carbohydrates, including honey, are recommended for PLWHA because HIV/AIDS increases energy requirements (FAO, 2002). However, excessive sugar intake may be detrimental under certain circumstances. For example, the sugar in honey can aggravate opportunistic infections such as *candidiasis* (i.e. sores in the mouth or throat).

Mitigation

There is a need for mitigation, or, the creation of policies and strategies that build on the capacities of afflicted households to facilitate a rehabilitation process. Key components of such efforts include support for the improvement and diversification of livelihoods including income-generating activities (IGAs) (FAO, 2003). Due to the low-capital requirements, and ease at which households can enter and exit natural resource-based activities, these activities have long served as safety-nets during periods of food insecurity and tend to form a more consistent component of livelihood strategies for the rural poor. As described in scenario two, traditional beekeeping and honey collection offer low-input supplemental IGAs potentially suitable to the capacities of HIV/AIDS-afflicted households at the same time that markets for bee products may be reinforced by the epidemic.

Current apiculture programmes should be considered in efforts to mitigate the impacts of HIV/AIDS on afflicted households, particularly in those regions heavily affected by the epidemic, which are part of ecological zones conducive to honey production (e.g. miombo woodlands of southern Africa). Commercial beekeeping using modern hives located near dwellings can be a low-labour intensive remunerative IGA. However, the capital erosion associated with the impact of HIV/AIDS and the potential for indebtedness, would require that equipment is granted, which calls into question the sustainability of such an approach. Programmes oriented towards supplying high-end honey markets and requiring substantial inputs may not be suitable for such households. Instead, low-input technology transfers necessary for low to middle grade honey may be more appropriate. These may include transferring production skills (i.e. hive designs from local materials, sustainable harvesting of wild honey, knowledge of forage resources and qualities, hive siting, collection and related temporal factors), knowledge of processing and storage, and marketing skills (i.e. market information – prices, diversification, products for medicines, quality preferences, seasonal price fluctuations). Market development in general can improve the profitability of such activities, while ensuring that goods flow to where they are needed when they are needed.

Targeting and prioritizing interventions

A multisectoral response to reduce the transmission of HIV and the impacts of HIV/AIDS is imperative. Designing integrated interventions requires an understanding of the impacts of HIV/AIDS; the interactions between these impacts, livelihood strategies and related structures (markets); and existing HIV/AIDS programme priorities. Specific interventions and combinations of interventions are many, while resources necessary for their implementation are severely inadequate. Prioritizing is necessary to determine which interventions are optimal, when, where and for whom. As illustrated in the scenarios presented above, the types of interventions that are needed (and likely to have the greatest impact) depend on a complex dynamic of factors. In short, certain interventions are relevant to certain target populations at certain times.

The phase of the epidemic in a given region or community is useful in deciding which interventions are appropriate. The progression of HIV/AIDS in a given community or region can be separated into four phases (Villarreal, 2003). In areas that can be classified in phase I (i.e. prevalence rates are low – 1 percent, but where HIV is a threat) and phase II (i.e. prevalence is around five percent – the turning point for a rapid and exponential increase in prevalence) priority should be given to the mainstreaming of HIV/AIDS *prevention* interventions. Opportunities to invest in interventions that may buffer the impact of HIV/AIDS (e.g. income diversification) also exist in these early phases. Mitigation interventions become an important component in areas where the epidemic has progressed beyond phase II to phases III and IV in which morbidity, mortality, and the socio-economic impacts of HIV/AIDS manifest.

Targeting specific households afflicted by HIV/AIDS is not necessarily feasible, or wise (can aggravate stigma, etc.), but initiatives should make a conscious effort to include these households (they may have prohibitive time constraints or be alienated so that they are not part of meetings, etc.). As households within communities experience HIV/AIDS differently and at different times: consideration should be given to how these households are impacted, how they cope, and their needs and capacities. For example, traditional collection and beekeeping practices are often the domain of men, and women may perceive working alone in woodlands potentially dangerous. Thus, support for traditional honey production may not be an appropriate mitigation strategy for female widowed household heads.

Understanding of the impacts of HIV/AIDS and the interactions with livelihoods and markets continues to evolve. This section demonstrates the relevance and potential of integrated interventions that involve apiculture in multi-sectoral, livelihoods-based, comprehensive responses to HIV/AIDS.

5. HONEY HUNTING AND BEEKEEPING

Humans have devised many different ways to exploit bees for their honey and other products. Considering the wide range of bee practices still existing world wide and which can be categorized into three working definitions: honey hunting, beekeeping and a third category, named here as 'bee maintaining' which falls somewhere between honey hunting and beekeeping – where the beekeeper provides a nest site, or protects a colony of wild bees for subsequent plundering. Table 5 below shows these three types of apicultural activity and the types of bees that are being exploited by them.

TABLE 5
Types of apicultural activity and the bees that are exploited

Activity	Genus	Species
Honey hunting	Honeybees	All honeybee species: *Apis andreniformis* *Apis cerana* *Apis dorsata* *Apis florea* *Apis koschevnikovii* *Apis laboriosa* *Apis mellifera* *Apis nigrocincta* *Apis nuluensis*
	Stingless bees	Many species
'Bee maintaining' (guarding a wild nesting colony)	Honeybees	*Apis florea* (in Oman) *Apis dorsata* (rafter beekeeping in South East Asia, 'bee trees' in Malaysia, and many other examples) *Apis laboriosa* (cliffs in Bhutan) *Apis mellifera* (Africa) And many other examples….
	Stingless bees	Many species
Beekeeping (keeping bees inside a hive)	Honeybees	Cavity nesting species: *Apis cerana* *Apis koschevnikovii* *Apis nigrocincta* *Apis nuluensis* *Apis mellifera*
	Stingless bees	Many species

This Chapter will discuss the various ways of exploiting honeybees. Chapter 6 will look at ways of exploiting stingless bees (Part 2).

HONEY HUNTING OF HONEYBEES

Honey hunting – plundering wild nests of honeybees to obtain crops of honey and beeswax – is still widely practised where people are poor and living at subsistence level and wild honeybee colonies are still abundant. Honey hunting may be seen as part of the lives of the world's remaining hunter-gatherers, often at the margin of the farming world. The colonies of honeybees are nesting in the wild and, depending on species, may be nesting in tree cavities, in trees, or rocks, termite mounds or underground. Where bees are plentiful, honey hunting may be practised widely. Sometimes wild honeybee colonies are regarded like the 'hole in the wall' automated cash machines of industrialized countries. When a family or individual needs some cash – a quick way to obtain it can be by honey hunting – plundering a known colony for some honey and quickly gaining some cash or 'barter value' in this way. The products from honey hunting may be indistinguishable from the products from beekeeping in hives.

Positive aspect

- For hunter-gatherers, honey hunting is a way of quickly obtaining high carbohydrate (honey) and high protein (pollen and bee larvae) foods with no financial cost. When a buyer is available, honey hunting is often seen by very poor people as a quick way to raise cash.

Negative aspects

- Honey hunting kills bees.
- It may now for some bee species and in some areas represent a non-sustainable depletion of honeybee colonies and habitat.
- Honey hunters may cause forest fires.

Honey hunting in Asia

In Asia, large volumes of honey are still obtained by plundering wild colonies of honeybees. This is because some of the Asian honeybee species exist only in the wild, and cannot be kept inside man-made hives. Honey hunting of *Apis laboriosa*, a honeybee species that nests at high altitudes, is practised in the Hindu Kush Himalaya region. Honey hunting of *Apis dorsata* is practised throughout its distribution range: from Pakistan in the West to the Philippines in the East. Honey hunting of cavity nesting *Apis cerana*, *Apis koschevnikovii*, *Apis nuluensis* and *Apis nigrocincta,* and the 'little' honeybee species *Apis florea* and *Apis andreniformis* is practised wherever they occur.

The large Asian honeybee species, *Apis laboriosa* and *Apis dorsata* often nest high on cliffs or in high trees. However, the combs are very large and yields of honey are worthwhile. Honey hunting is therefore a dangerous, although worthwhile activity in many regions of Asia. Local customs and traditions have become associated with honey hunting, and have been studied by anthropologists and social scientists: this means that traditional honey hunting and cultural associations have been well documented in some areas. Indeed, in Nepal and Malaysia tourism based on viewing traditional honey hunting spectacles has taken off. Details of publications, videos and CD's detailing honey-hunting traditions are shown in Further Reading in Chapter 15.

Honey hunting outside Asia

Honey hunting of indigenous *Apis mellifera* colonies is commonly practised in Africa, and of feral *Apis mellifera* colonies in Central and South America, wherever colonies are abundant – most often in forested areas.

BOX 6
The African honey guide

Honey guides are African, woodland birds belonging to the genus *Indicator*. They are remarkable for having evolved the behaviour of apparently leading honey hunters (as well as honey badgers and other bee predators) towards bee nests. There are several different species of honey guide, the most common being the greater honey guide *Indicator indicator*, and the lesser honey guide *Indicator minor*.

Honey hunters whistle to locate the honey guides. The birds then chatter continuously and flutter conspicuously, gradually leading the honey hunters towards the vicinity of a bees' nest, when they become quiet. When the honey hunters plunder the nest, the honey guides are rewarded with feeding from the bees' nest: brood, pollen and honey. Another unusual feature of these birds is their apparent ability to digest beeswax.

SHOULD HONEY HUNTING BE ENCOURAGED?

Witnessing honey hunting is to see large numbers of bees killed with burning brands and colonies destroyed. There is no data available on the population sizes of Asian honeybee species: indeed beekeeping texts written before 1990 list only three Asian species – *Apis* cerana, Apis *dorsata* and *Apis florea*; five additional species have been described since then! We do not know the impact of honey hunting upon these populations: supporting, for example, the hunting of the Himalayan honeybee (*Apis laboriosa*) may indeed be the bee equivalent of hunting tigers.

Efforts have been made to encourage honey hunters to harvest without destroying the whole colony: i.e. to harvest only comb containing honey and leave comb-containing brood intact. However, this is easier to discuss in the classroom than it is to achieve in practice. Certainly traditional honey hunting practises in some areas have involved rules to ensure that bee populations were sustained. We do not know the effect of decreasing tree habitat and increasing human population pressure on honeybee populations. In many areas, honey hunting has increased with increasing human population, and this combined with a loss of large trees for nesting of bees. The loss of large trees makes it more difficult for bees to find secure nesting places: when they nest in smaller trees, they are easier to locate and to plunder. Certainly, in the Gambia and Senegal, honey hunting has lead to a lack of bees, and with possible bad effect upon pollination and biodiversity maintenance, just as the need for these increases.

THE PRODUCTS OF HONEY HUNTING

Because honey hunting usually takes place under difficult circumstances (swinging from a rope on a cliff face, high in trees at night time), the product from honey hunting is usually a mixture of ripe and unripe (i.e. high water content) honey, beeswax, dead bees and other debris. However, this is not to say the product is of low value: often it will ferment quickly but has high local value as a cultural food, tonic, aphrodisiac or medicine. In Africa, honey from honey hunting is most often made into honey beer. In this case, the various impurities help it to ferment all the faster. However, not all honey ends up this way, certainly for example in India, large volumes of honey are harvested from *Apis dorsata* colonies, and this honey reaches the domestic honey market. There are no statistics available on the volumes of honey harvested from wild bees.

PROVIDING SUPPORT TO HONEY HUNTERS

People from honey hunting regions who receive formal training in beekeeping tend sometimes to become quickly indoctrinated into the belief that honey hunters are not beekeepers and somehow outside the beekeeping community. This has meant that extension services in many developing countries often assist only beekeepers and completely ignore honey hunters. This can also be because beekeepers are more accessible than honey hunters who may be found among the poorest and most remote rural people. People who practise honey hunting, as mentioned above, may be seen as hunter-gatherers and tend to be poor, self-effacing and invisible to mainstream extension efforts. Many textbooks completely fail to mention the existence of honey hunters, although in many Asian countries the majority of honey on the local market may be obtained from honey hunting.

If it is decided that honey hunting is sustainable and if honey hunters want support, they can be assisted to harvest honey that is of better quality, by reducing contamination during and after harvest and especially by providing clean, lidded containers in which to store the products. Assistance with marketing is often the best assistance that can be provided. Honey hunters usually discard beeswax, but they can gain from training in how to harvest, render and market beeswax.

BEE–MAINTAINING

Harvesting of a bee colony nesting in a tree would be described as honey hunting. The piece of tree cut and, containing the bees, and placed conveniently near the human's home, would be described as beekeeping (the tree has become a log hive). However, there is an intermediary stage where the beekeeper may have ownership of the bees and/or the tree and protects them in some way – from other honey hunters, or other predators. This intermediary stage occurs in many situations. For example, for *Apis mellifera* colonies in Sudan and other African countries, beekeepers can have ownership over colonies in specific trees or rocks. The same is true in Asia, of individuals or communities having ownership over bee trees or bee cliffs. In the past, this type of 'bee tending' was widespread. Traditions from Africa, the Mediterranean region, Persia, Europe and Asia have been documented by Crane (1999).

Honey from the little honeybee *Apis florea* is particularly highly prized in Oman, being sold for over $US100 per kilogram. *Apis florea* builds a single comb and cannot be kept inside a hive, but in Pakistan and Oman, beekeepers 'manage' *Apis florea* colonies by maintaining them in small shelters (Dutton, 1982).

In the *Melaleuca* forests of Vietnam, beekeepers provide artificial nesting places for *Apis dorsata*: this makes harvesting of the combs convenient and easy: see Case Study 3 (at the end of this chapter) on rafter beekeeping.

These are all examples where the beekeeper provides some care for the colony, but the colony is still living life entirely as it would in the wild. Other examples of keeping *Apis dorsata* on rafters have been described from Cambodia (Jump and Waring, 2004), Indonesia (see Case Study 2 on *Traditional honey and wax collection from Apis dorsata in West Kalimantan*), Malaysia, and the Andaman Islands, India.

BEEKEEPING

For thousands of years it has been known that obtaining a honey crop is made much easier and more convenient than honey hunting if bees are encouraged to nest inside a man-made hive. The hive makes ownership of the colony very clear, it can be kept near to home, and harvesting the honey is easier. Depending on the type of hive, and the species and race of bees, it is also possible to manage the colony to some extent. This is beekeeping – although the term beekeeping tends to be used colloquially to describe all activities involving bees, including the subsequent harvesting, and processing of their products.

There are many different routes to successful beekeeping that suit different situations. At one extreme is the placement of an empty hive and at some future point if it has been colonised by bees, cropping of honey – with no other interference by the beekeeper. At the other end of the scale is beekeeping involving expensive hives, the provision of selectively bred or instrumentally inseminated queens, sophisticated monitoring and control of honeybee diseases (now essential in many regions), the movement by the beekeeper of the bees to different crops as they come into flower, mechanical harvesting and processing of honey, and much else.

THE SELECTION OF EQUIPMENT

In selecting equipment, the following factors should be considered:

- If beekeeping is being promoted as a sideline activity then it must be wholly sustainable, using equipment, which is available locally. Although equipment can be imported to serve as a prototype, small-scale beekeeping can only be economical in the long-term with equipment, which can be serviced and manufactured locally. The equipment needed for honey hunting, traditional and low technology beekeeping can usually be made at village level.
- Honeybee species and races vary in size. A honeybee nest (of those species that can be kept inside hives) consists of a series of parallel beeswax combs. Each comb contains rows of wax: hexagonal compartments containing honey stores, pollen or developing bee larvae (brood). The combs are evenly spaced and are attached to the ceiling of the nest. This spacing, known as the 'bee-space', is critical in maintaining optimal conditions within the nest with just enough space for the bees to walk and work on the surface of the combs, while maintaining the optimum nest temperature. Bee-space, dimensions of combs and nest volume all vary with race and species of honeybee. The bee-space is a critical factor in the use of bee equipment and honeybees cannot be managed efficiently using equipment of inappropriate size. When buying equipment it is important to have an understanding of the honeybees to be housed and the specification of the equipment offered. Most equipment is manufactured to the specification for bees of European origin.
- Honeybee species and races vary in biology and behaviour. Strategies for the management of honeybees have been developed mainly for temperate-zone races of honeybees and most movable-frame equipment is intended for this type of management.
- Colonies of tropical honeybees show a tendency to abandon their hive – this may be due to either seasonal migration or absconding because of disturbance by predators, and no reliable management techniques have yet been developed to prevent these – apart from feeding bees to ensure they do not abscond for lack of food, and to prevent disturbance by predators as far as possible.

- During the last three decades, there has been a tremendous increase in the spread of bee diseases and predators around the world. This has been brought about by man's movement of honeybee stocks. There are still a few remaining regions without introduced honeybee diseases and parasites, and most of these are in developing countries. It will be in the future benefit of these countries if they can retain their stocks of disease-free honeybees. It is therefore essential to ensure that used beekeeping equipment is not imported. Honeybee colonies or even single queen bees must never be moved from one area to another without expert consideration of the consequences.
- It can be helpful to import basic equipment (protective clothing, smokers, hive tools, etc.) to serve as prototypes for local manufacture.
- For beekeepers practising on a larger scale, for example where a co-operative has established a honey packing unit there are often items which necessitate importation, for example honey gates (effective honey 'taps' for use on honey containers), specialized gauzes for the filtration of honey, or the equipment for determining honey quality.

CHOICE OF HIVE TYPE

A hive is just a container to keep bees inside, and good, serviceable hives can be made from many different materials. The purpose of a hive is to encourage the bees to build their nests in such a way that it is easy for the beekeeper to manage and maintain them. Different styles of hive may be of greater or lesser convenience for the beekeeper, but the honeybee is only concerned to have a safe place, large enough for the whole colony (the bees' family) and its stores, and protected from unfavourable weather and predators.

The best method for any situation will be determined by the available human skills, physical and financial resources, and the species and race of bee being utilised.

Hive type need not determine honey quality

The type of hive a honeybee lives in has no effect upon the quality of honey that she makes. Honeybees always store clean and perfect honey regardless of where they are living: it is subsequent handling by humans that leads to reduction in quality.

The volume of honey harvested from a colony is decided by the forage for bees that is available in the area, and the strength and needs of the colony. As long as the hive is of large enough volume, bees will store as much honey as they can. (The more honey they can store, the greater the chance of the colony surviving through hard times ahead.) Movable frame hives influence honey production because they save bees' effort in creating beeswax comb: therefore, movable frame hives enable harvests of honey rather than beeswax. This is explained further below in the section of movable frame hives.

BOX 7
The three main types of hive

Fixed comb hives: clay hives, wall hives, log hives, bark hives and many others
Movable comb hives: top-bar hives, of which there are many styles
Movable frame hives: Langstroth, Dadant, Adz, National, Smith, WBC, etc.

Fixed comb hives

These are containers made from whatever materials are locally available: typically, hollowed-out logs, bark formed into a cylinder, clay pots, woven grass or cane. It is common in some countries of Africa, Asia and the Middle East to keep bees inside cavities built into house walls. This keeps bees safe from predators and protected from extremes of heat or cold.

BOX 8
Use of the name 'traditional' for hives

Fixed comb hives are sometimes named 'traditional hives'. However not all fixed comb hives are of traditional style. Further, there are traditional hives which are not fixed comb hives, but are **movable comb hives**, and the WBC **movable frame hive** (invented over 150 years ago) is by now regarded in some countries as a traditional style hive.

The sole purpose of a hive is to encourage bees to nest in a site that is accessible to the beekeeper. In a fixed comb hive, the bees build their nest inside the container, just as they would build it in a naturally occurring cavity. The bees attach their combs to the inside upper surface of the hive. This means that combs cannot be removed without being broken when the beekeeper harvests the nest to obtain crops of honey and beeswax. Bees may or may not be killed during this process, depending on the care of the beekeeper. If the colony is destroyed, the hive will remain empty for a while. If there are plenty of honeybee colonies in the area then eventually a migrating colony or swarm may settle in the empty hive and start building a new nest.

Beekeepers using local-style hives often own many hives, and expect only a proportion of these to be occupied by bees at any time. In many ways, this style of beekeeping works well for tropical races of honeybees. As described in Chapter 2, the biology of tropical races means that they abscond and migrate. In a tropical country it can be a better strategy for a beekeeper to have a large number of low cost hives, only some of which will be occupied at any time, than to have a small number of high cost hives, some of which may be empty.

The main region of the world where traditional beekeeping practises are still the most widely used – tropical, sub-Saharan Africa – is also the region with least honeybee disease problems. Frequent natural movement of the colony to new nesting sites means that diseases do not have the chance to remain within the colony as they do when colonies are static.

Positive aspects of fixed comb hives:

- May be highly appropriate for the race and species of bees (see above).
- Local people may have knowledge and skills for this type of beekeeping.
- Low financial input costs (usually zero).
- These methods do not spread honeybee diseases, and they maintain healthy honeybee populations.
- Local beekeeping methods provide a source of financial income with no financial input. As one farmer in Uganda put it: "It is the cheapest way to do farming".
- It is possible to harvest first grade, export-quality honey and beeswax from local hives.
- This activity can be entirely sustainable and need not harm bees. Beekeeping does not compete for resources used by any other form of agriculture: unless harvested by bees, the nectar and pollen inside flowers will not be utilised.
- Only a little training, and a few inputs, are needed to upgrade farmers' skills.

Negative aspects of fixed comb hives:

- As with honey hunters, beekeepers are blamed for starting forest fires.
- Less-skilled beekeepers kill the honeybee colony when they harvest from it, making this non-sustainable when combined with habitat loss, and loss of bees by pesticides.
- The great disturbance of the bees' nest may cause the colony to abscond.
- In fixed comb hives, combs may not be built in a way (orientation within the hive) convenient for harvesting by the beekeeper.

- It can be difficult to see when the honey is ready for harvesting – although local beekeepers often are highly skilled in knowing the best time for harvest.
- When harvesting honey, combs near the end of the hive must be removed, and if these happen to contain empty comb, brood, pollen and unripe honey, all of these will be wasted.
- Honey produced by such methods is often (but not necessarily) of poor quality, being contaminated with unripe honey, pollen, brood, wax and dead bees.
- Fixed-comb hives cannot be inspected for disease. On the other hand, beekeepers still using traditional methods often still have disease-free bees! It is the possibility to move frames of bees, and move colonies of bees, which has allowed humans to spread bee honeybee diseases and predators worldwide!

Assistance for fixed comb hive beekeepers

All requirements for this type of beekeeping will be locally available, but beekeepers using fixed comb hives can be assisted by the provision of effective protective clothing, smokers, and most importantly, good containers for harvesting and storing the honey, and also the beeswax. In particular, beekeepers with few resources may benefit from assistance to:

- maintain the quality of the harvested products;
- present products for marketing; and
- access markets.

It is certainly possible to produce top-class honey and beeswax from fixed comb hives. For example, beekeepers in North West Province of Zambia are harvesting high quality honey and beeswax from fixed comb hives made from bark. This honey is organic certified and, because it meets EU market requirements, is exported to the EU (Wainwright, 2002) (see Case Study 10 in Chapter 13).

Movable comb hives

Low-technology hives have been developed as a way of obtaining the advantages of movable frame hives (no need to break combs, standardisation, manageability, efficient honey harvest) without the disadvantage of high cost manufacture. Bees are encouraged to construct their combs from the undersides of a series of top-bars – instead of attaching comb to the ceiling of the hive (as in a fixed-comb hive) or building comb inside a rectangular, wooden frame (as in a frame hive). These top-bars then allow individual combs to be lifted from the hive by the beekeeper. The combs can then be replaced back in the hive, removed for harvest, or maybe moved to another hive or colony.

The container for the hive may, like traditional hives, be constructed from whatever materials are locally available.

Another advantage of this type of equipment is that it opens up beekeeping to new sectors of society: forest beekeeping has traditionally tended to be a male-only activity. Low-technology hives can be kept near home, and can, if constructed and transported with care, be moved between crops as they flower successively (Mangum, 2001).

All equipment for low technology beekeeping needs to be made locally. The only items that need construction with precision are the top-bars. These must provide the same spacing for combs within the hive, as the bees would use in the natural nest. This spacing will depend upon the species and race of honeybees that are being used. As a very general guide, *Apis mellifera* of European origin need top-bars 35 mm wide, and *Apis mellifera* in Africa usually need 32 millimetres. *Apis cerana* in Asia need 30 millimetres. The best way to determine the correct width is to measure the spacing between combs in a wild nest of the same bees. The volume of the brood box should equate roughly with the volume of the cavity occupied by wild-nesting honeybees. Other necessary materials are hive tools, smokers, protective clothing and containers for harvesting, storing, processing and marketing honey.

Main advantages of movable comb hives over fixed comb hives

- The combs can be lifted from the hive and then replaced and this allows the beekeeper to examine the condition of the colony without harming it.
- Honeycombs can be removed from the hive for harvesting without disturbing combs containing brood. The colony is therefore not harmed and the bees can continue gathering honey to replace that which has been harvested.
- Good quality honey can be harvested, free of contaminating pollen or brood.

Main advantages of movable comb hives over movable frame hives

- The top-bar hive is relatively easy to construct, and simpler and cheaper to build than a hive with frames.
- Harvests of both honey and wax are obtained in this type of beekeeping, because the empty comb is not returned to the hive.

Main disadvantages of movable comb hives

- Movable comb hives with top-bars can be more expensive than hives made from hollowed-out logs, etc.
- Combs attached to top-bars must be handled much more carefully than combs built in frames.
- Wax combs cannot be returned to the hive after harvesting.

Some people have experimented with creating extractors for top-bar combs, such that the empty comb can be returned to the hive after harvesting. However, this loses the point of top-bar hives being a simple, low technology and cheap beekeeping option.

Principles for construction of a movable comb top-bar hive

Top-bar hives can be made from whatever cheap or scrap containers are available locally. These could be cardboard boxes, barrels cut in two lengthways, tea chests, or hives made from scrap timber. If timber is being used, it must be properly seasoned, otherwise shrinkage and warping of the hive will occur. The wood must be durable and able to last for several years without replacement, and be suitable for carpentry. The hive must be of a suitable volume: large enough for colonies of bees to build their brood combs and have plenty of room left for building extra combs for storage of honey (it is of course the *inside* measurements of a hive that are important). The hive must be clean and free from any contaminating odours, free of cracks and gaps, and may need some insulation depending upon the climate. Straw or cow-dung is often used as insulation for low-cost hives.

If the hive's top-bars are to be placed next to one another to form a bee-tight top, then each top-bar must be of the correct bee space for the bees to build one comb from each bar (see above). Placing bars next to one another cuts down the number of bees leaving through the top of the hive to disturb the operator, and this can be beneficial when working with highly defensive bees. However, other people recommend using narrower top-bars (that can be cut with less precision) with a plastic sheet placed over the top (Romet, 2004).

Whatever width is used, it must be constant for each top-bar hive in the hive. If top-bars are too narrow, then combs will be too close to one another with no "corridor" for bees to work in – in this case, the bees will fill the gap with comb or propolis. If top-bars are too wide, resulting in too much space between combs, bees will build extra "brace comb" to fill the gap.

It is a skilled job to make top-bars of exactly the correct dimensions using hand tools, and if power equipment is available it is valuable for this operation. The width of the top-bars is the only measurement that must be exact in this type of hive.

After the top-bars have been cut to size, fix a vertical strip of beeswax along the centre of the underside of each bar to guide the bees in building their comb.

In the wild, honeybees build combs that have curved edges and are rounded at the bottom. If the side walls of the hive are rounded or slope at approximately the same angle as natural comb then the bees will not attach their comb to the walls and this allows easy removal of comb. The sides of the hive can therefore be curved or slope inwards towards the bottom to form an angle of 5° with the bottom base. However, this is not essential, and hives with sloping sides are more difficult to construct. In straight-sided hives, bees will sometimes slightly attach the comb to the sidewall of the hive. In this case, it is necessary to gently cut these attachments before the top-bar and its comb may be lifted from the hive.

Movable-frame hives

These are the hives used in industrialized counties and developing countries where beekeeping is an important part of mainstream agriculture and the infrastructure exists to provide specialized expertise and equipment. The objective of movable-frame hive beekeeping is to obtain a maximum honey crop. The possibility of recycling beeswax combs means that the colony can quickly build up honey stores during the flowering season, and may also be managed specifically for the pollination of particular crops.

Rectangular wood or plastic frames are used to support the bees' combs. These frames have two major advantages:

- They allow the beekeeper to inspect and manipulate the colonies (for example moving frames from a strong colony to strengthen a weaker one).
- They allow efficient honey harvesting because the honeycombs within their frames can be emptied of honey and then returned to the hive. This allows increased honey production as the bees' resources are saved from having to build fresh beeswax comb.

Frame hives must be constructed with precision. The spacing between frames must achieve the same spacing as in a natural nest. Frames are contained within boxes and each hive consists of a number of boxes placed on top of one another. Usually the bottom-most box is used as the brood chamber. This means that brood is present only in this box: this is achieved by placing a queen excluder between this box and one above it. The queen excluder is a metal grid with holes of a particular size such that worker bees can pass through but the queen is unable to do so because of her larger size. This ensures that honey alone is stored in boxes above the queen excluder and allows for efficient honey harvest.

In addition to the boxes and frames, a floor and roof are required, along with various other specialized items of equipment.

Frame hive equipment should not be used unless the infrastructure exists for manufacturing it locally. Frame hives require well-seasoned timber, planed and accurately cut, as well as other material like wire, nails and beeswax foundation. They are therefore relatively expensive to make. Frames and boxes must fit together precisely and need accurate carpentry. There must be access to supplies of the parts, which need frequent renewals, particularly foundation and frames. Centrifugal extractors are needed to achieve full potential in harvesting the honey from frame hives.

Main advantages of movable frame hives over movable comb hives

- Standardization of equipment.
- Efficient honey harvest with the possibility to recycle combs.
- The use of separate boxes enables the queen to be confined to particular areas of the hive.
- This type of beekeeping is practised worldwide and most beekeeping techniques and literature relate to this style.

Main disadvantages of movable frame hives

- Frame hives and frames are expensive and intricate and must be built with precision requiring a large amount of timber and nails of different sizes.

- The dimensions of the hive, the frames and their spacing are critical.
- If honey is to be extracted so that combs can be returned empty to the frame hive, expensive equipment is required to extract the honey.
- The continuous re-use of combs can lead to disease build up.
- The continuous re-use of combs can lead to build up of residues used to control bee diseases and predators.
- Beeswax yield is low compared with top-bar hive, and fixed comb hive beekeeping.
- Frame hives placed on the ground are susceptible to tropical pests and predators. Frame hives are not suitable for suspending by wires or hanging in trees (as are fixed comb hives, and to some extent, top-bar hives).

OTHER EQUIPMENT

Smoker

A beekeeper needs a source of cool smoke to calm the bees, and this is achieved by use of a smoker. The smoker consists of a fuel box containing smouldering fuel (dried cow dung, hessian or cardboard) with bellows attached. The beekeeper puffs a little smoke near the entrance of the hive before it is opened, and gently smokes the bees to move them from one part of the hive to another. Imported smokers are useful as prototypes, but smokers can be manufactured by village blacksmiths.

Protective clothing

A broad-brimmed hat with some veiling will serve to protect the head and neck from stings. Adequate protective clothing gives beginner beekeepers confidence, but more experienced beekeepers find that too much protective clothing makes it difficult to work sufficiently gently with the bees, and it is very hot. Some people find that a good way to protect their hands is to put a plastic bag over each hand, secured at the wrist with a rubber band, although this can quickly become very sweaty! Rubber bands prevent bees from crawling up trouser legs or shirtsleeves. Always wear white or light-coloured clothing when working with bees – bees are much more likely to sting dark-coloured clothing. Imported clothing can provide useful prototypes, but modified overalls can be made locally and provides a useful stimulus for local industry.

Hive tools

Apis mellifera honeybees tend to close up every gap and seal every joint in the hive with a sticky substance known as propolis (see Chapter 10). The hive tool is a handy piece of metal which is used to prise boxes apart, scrape off odd bits of beeswax, separate frame-ends from the supports, and so on. It is possible to use an old knife for this job, but knife blades tend to be too flexible and give insufficient leverage. Village blacksmiths should be able to produce a suitable implement and once again, an imported hive tool could serve as a prototype.

BEEKEEPING: MAKING A START

Choosing a place

When choosing a site for keeping bees you must make sure that:

- There are plenty of flowering plants and trees in the area.
- There are no serious environmental problems nearby, such as crops being sprayed with pesticide, etc.
- There is a source of water nearby.
- Hives are sheltered from wind.
- Hives are shaded from strong sunlight.
- Hives are placed out of sight and not near places where humans are likely to be: this is to avoid possibilities of people being stung if the bees are defensive, and to avoid theft.
- Hives are not going to suffer from water dripping from overhead branches.

If you plan to create an apiary, do not site it too near other large apiaries. Start with a maximum of 10 colonies in an area and then gradually find out how many colonies that area can support.

Shade for bees

Honeybee colonies must not get too hot. If the colony temperature becomes too high then foragers will be busy collecting water, to reduce the nest temperature, rather than nectar or pollen. In very sunny conditions, colonies protected by solid shade can produce 50 percent more honey than colonies exposed to the sun. Beekeepers obtain greater honey harvests by providing nearby water sources and protecting colonies from too much heat.

In hot climates, wild-nesting colonies always choose a shady spot for their nest, near to a water supply. The easiest way to protect colonies from the sun is to place them under shade trees in a green grassy area. If no shade trees are available then artificial shades must be constructed. The roof of the shade should be high enough to allow the beekeeper to work amongst the hives. If a large number of hives are to be shaded and a long shade is to be constructed, then it should run east-west to give maximum benefit. In very sunny situations, colonies receive heat radiating from the ground. Reduce this effect by placing the hives on vegetation, or placing mats under the hives. Hives can also be painted white or a light colour to reflect rather than absorb heat.

Hive stands

Hives are best raised off the ground to protect them from various predators. Often old tyres are used as ‘hive stands’. However, the higher a hive is raised, the easier it is for the beekeeper to work with. ‘Living hive stands’ can be very good: this is where the supporting timber takes root and eventually provides a non-rotting stand, providing shade and a good environment for the bees. If wooden stands are used, then in many countries it is essential for the base to stand in a container of oil or water, to prevent ants from entering the hive.

In east Africa, honey badgers are a serious predator of bee colonies, and they can be deterred by hanging fixed comb hives, or top-bar hives from wires:

Hanging a fixed comb or movable comb hive

1. Use strong posts of at least 13 centimetre diameter to hang the hive. Posts that have been treated with wood preservative last longer.
2. The hive should be hung at approximately waist level to the beekeeper for ease of working.
3. Hives should ideally be placed at least two metres away from one another so that one hive can be inspected without disturbing its neighbours.

Obtaining bees

The best way of getting started in beekeeping is with the assistance of a practising, local beekeeper, who will have advice and experience of local bees and conditions that no textbook can provide.

A good way to obtain bees is by transferring a colony from the wild into a hive. The wild colony will already have a number of combs and these can be carefully tied on to the top-bars of a hive. Another way to get started is to set up a hive, perhaps rubbed inside with some beeswax to give it an attractive scent, and wait for a passing swarm of bees to occupy it: this will only be successful in areas where there are still plenty of honeybee colonies.

MANAGEMENT OF HONEYBEE COLONIES

There are many basic texts giving advice on the management of bees, but most of these relate to frame hive beekeeping using honeybees of European origin. Publications on tropical beekeeping are not widely available, but a few are obtainable from specialist suppliers like ***Bees for Development.***

Basic tips for working with bees

- Never stand in front of the hive entrance, or in the bees' flight path.
- Chose the right time of day to work with bees to cause least distress to bees (local beekeepers can advise you best).
- Work quietly and calmly. Do not knock the hive, and always try to disturb the bees as little as possible.
- Wear a bee veil to protect your face from stings.
- Avoid using strong smelling perfume, soap or shampoo. Bees in India do not like the scent of 'Head 'n' shoulders' shampoo!
- Avoid crushing and killing bees (squashing them with equipment, standing on them, burning them with the smoker). Apart from reducing the colony strength, each dead bee emits an odour (pheromone) that encourages the other bees to defend the colony, and squashed bees increase the chances of spreading diseases such as *Nosema*.
- Use cool smoke to calm the bees (see below).
- Always remove the lid slowly and carefully. Puff smoke gently at the entrance and anywhere else where bees are leaving the hive. Do not apply the smoker too near to the bees or you may burn them and this will cause them to become aggressive.
- Always leave enough resources (honey and pollen stores) for the bees.
- Do not inspect the bees too often: every time you open the colony, it creates work for the bees and stress, and reduces the amount of honey stored.

Working with top-bar hives

- Remove a few empty top-bars from one end of the hive – this will provide space for working in. Bees at the other end of the hive should not be disturbed by this and will stay calm.
- If a top-bar has been stuck down by the bees with propolis (only with *Apis mellifera* honeybees), gently loosen the top-bar free using your hive tool or knife.
- Continuing from the gap at one end, inspect one comb at a time, lifting it very slowly and deliberately, and then moving it along into the gap.
- Always hold a top-bar so that the comb is hanging vertically. This takes a bit of practice. The comb may break if you tilt it sideways, especially if is heavy with honey and the weather is warm.
- During inspection of the hive, always keep top-bars in the same order.
- After a period of honey flow, inspect the hive for honey. Only top-bars holding combs with fully capped honey and no brood or pollen should be removed for honey extraction. Brush the bees gently from the comb with a brush made of grasses or a feather. Cut the honeycomb from the top-bar but leave about a finger's width of comb attached along the top of the bar to guide the bees in rebuilding straight comb. Only the extra honey in outside combs should be removed, as the bees require a certain amount of honey for their own survival.
- When the harvest or inspection is complete and all the top-bars are replaced, push the bars together to ensure that there are no open spaces between them.
- Replace the lid gently; making sure that the hive is firmly closed on all sides.

Basic tips for inspecting a colony

- Check the overall size of the colony: number of combs covered with bees.
- Check that the bees and brood are not suffering from any disease or predators.
- Check for the presence, and the amount of, brood (eggs and developing larvae and pupae).
- Check the amount of stores (honey and pollen).
- Look for any signs of swarming.
- Observe the numbers of drones present.
- Check if the hive is clean inside, and predators are being kept away.
- Be sensitive to the behaviour of the bees and the sounds they are making (these skills develop with time – old beekeepers will tell you that they never stop learning about bees!).

Dealing with bee stings

Inevitably, every beekeeper will experience bee stings. The best way to avoid being stung is to behave in a calm and gentle way with bees. People who are not used to bees, on hearing a bee near to them, tend to waive their arms about, and this is a good way to encourage a bee to sting. Beekeepers are most often stung when a bee becomes trapped in clothing or caught in hair (bees' bodies are hairy, and they easily become 'stuck' in human hair), or when the bees initiate defence behaviour when their nest is disturbed. The bee will die after stinging: it is not in the interest of the colony to lose too many bees this way. However, different colonies differ in their propensity to sting. Some colonies are so defensive that they begin to attack as soon as the hive is approached, and others will follow you out of the apiary! It is important to wash beekeeping clothing to remove the odours of stings, and clean any equipment that may have been stung and has dried venom (smokers, hive tools, etc.). As mentioned above, strong perfumes, deodorants or detergents can also encourage bees to sting. Bees may also be highly defensive when there is a dearth of nectar, when they have large honey stores to defend, or when they are preparing to swarm or supersede.

On being stung, the sting and venom sac are visible, and the venom sac goes on pumping venom for a few minutes. The best action therefore is to remove the sting as quickly as possible – the sting has a barb like a fish hook – a fingernail or the tip of a hive tool or knife blade is the most effective way to get the sting out.

The amount of swelling depends on the thickness of the skin. For example, a sting into the thick skin on the sole of the foot will be painful but may not cause much swelling, whereas a sting in the soft tissues of the face usually causes much swelling. A sting inside the mouth or in the eyeball can be very dangerous. For these reasons, beekeepers should always wear a veil to cover their head when working with bees.

After people have been beekeeping for some time they tend not to take much notice of stings. However, bee stings can be painful, and may be a shock for the beginner. It can be normal to experience considerable swelling: this does not necessary mean the person is allergic to bee stings. If some treatment is desired, a cold compress or application of cooling skin lotion can be used. Proprietary sting remedies that contain antihistamines can, if used several times, begin to cause a sensitivity reaction in the skin. Aspirin is useful if the area of the sting is hot, swollen, and causing more than usual discomfort.

Bee sting allergy or hypersensitivity to bee venom is a very large subject beyond the scope of this text. For more information, see references at the end of this document.

BOX 9
Bee stings - Medical aspects of beekeeping (Riches, 2001)

When a bee stings and venom enters the body, antibodies, known as immunoglobulins are formed. Immunoglobulin G (IgG) is formed in response to bacterial and other foreign substance invasions: it circulates in the blood and is of great benefit in the development of immunity. Beekeepers with immunity to stings usually have high levels of specific IgG in their blood. Immunoglobulin E (IgE) is quite different. After formation it attaches itself to mast cells and very little circulates in the blood. Mast cells are special cells scattered throughout the tissues of the body and are reservoirs of histamine and other active substances. If a person forms excess IgE after exposure to a sting, when stung again after an interval, the IgE that is then adherent to mast cells combines with the venom. This reaction at the cell surface causes a change in the cell wall that allows the liberation of histamine and other substances involved in the inflammatory process. These cause all the symptoms and signs of an allergic reaction. Bee venom hypersensitivity presents in three main ways: (a) large local reactions; (b) systemic reactions; and (c) anaphylaxis.

Large local reactions simply mean excessive swelling after a sting; an example would be gross swelling of the whole leg after a sting on the ankle. This may take 24 hours to develop fully. Systemic reactions usually occur within a few minutes of a sting. The mildest symptoms are flushing of the skin, followed by an itchy nettle rash. Symptoms that are more serious may include chest wheeze, nausea, vomiting, palpitations, etc. Anaphylaxis is the most serious and must be considered a medical emergency. Its main features are faintness followed by confusion and unconsciousness. Death can occur.

The essential treatment of systemic reactions and anaphylaxis is adrenaline. A collapsed person should be put in the recovery position, with the airway cleared, and then kept warm with coats or blankets. Medical help should be called. Those with a history of serious allergy often carry adrenaline for self-administration in the form of an Epi-Pen. These should be used as quickly as possible at the first sign of a reaction. If there is no benefit within five minutes, the dose should be repeated.

Taking an antihistamine tablet BEFORE being stung can often prevent mild symptoms of hypersensitivity. Hyposensitizing treatment is effective but time consuming and not easily available everywhere.

HARVESTING HONEY AND BEESWAX FROM FIXED COMB AND MOVABLE COMB HIVES

Honey is harvested at the end of a flowering season. The beekeeper selects the combs that contain ripe honey, covered with a fine layer of white beeswax. These combs are usually outer-most ones. As far as possible, combs containing any pollen or developing bees are left undisturbed.

The honeycomb can be simply cut into pieces and sold as fresh, cut comb honey. Alternatively, the honeycomb can be broken up and strained through muslin or another form of filter to separate the honey from the beeswax. After honey is separated from the beeswax combs, the beeswax can be melted gently (over water) into a block. Beeswax does not deteriorate with age and so beekeepers often save their scraps of beeswax until they have a sufficiently large amount to sell.

Equipment appropriate for the harvesting and processing of honey and beeswax

Choice of equipment depends upon the quantities to be processed, and the type of product required. In some areas, traditional beekeeping is practised on a large-scale and may well justify the provision of relatively expensive, large-scale honey processing equipment capable of dealing effectively with honey in bulk for export. Small-scale processing of honeycombs from fixed comb hives, movable comb hives, and frame hives is discussed further in Chapter 9 and 10.

CASE STUDY 2 - TRADITIONAL HONEY AND WAX COLLECTION FROM *APIS DORSATA* IN WEST KALIMANTAN, INDONESIA[8]

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The Danau Sentarum National Park (DSNP) in Kalimantan, Indonesia includes around 132 000 hectares of lakes, seasonally submerged forests and rainforest. The Park has 6,500 inhabitants living in 39 permanent or seasonal villages. The majority of the population are Melayu, whose main activity is fishing. They live in floating houses in villages built on stilts. Besides Melayu, around 10 percent of the population consists of Dayak groups, mainly Iban, who live at somewhat higher sites, mostly with several families living together in longhouses. Their activities, besides fishing, include collecting and selling forest products, hunting and agriculture.

With 3,600 millimetres rainfall per year the lakes are almost continuously filled with fresh water flowing into the Kapuas River. The water retreats only during a short period from July to September, causing some lakes to completely dry out. This seasonality has great consequences for the vegetation. As a result most of the forests in the area are low stunted forests, flooded for most of the year. In the dry season there is a great danger of forest fires, as relatively dense canopies dry out, and dried fallen leaves and wood act as a fuel layer on the soil.

The end of the dry season is followed by a rise in water level, which leads to bud induction and a massive blooming from December to February. This period of flower abundance is vital to the honeybee colonies. Due to the absence of a dry season in 1995 there was almost no honey harvest in early 1996 with the same phenomenon happening in 1969 and 1970.

Nests of *Apis dorsata* the giant honeybee have traditionally been exploited to produce large volumes of honey and wax for trade. Usually when *Apis dorsata* nests are hunted, the bees are chased away with smoke, and the comb is completely cut away for collection. Traditional honey hunters are well known in many areas of Asia where they climb steep cliffs, or ascend tall bee trees using hand-made ladders and local tools (Crane, 1999).

In 1989, the existence of managed honey and wax collection from this bee was confirmed to be still a common practice among beekeepers in U Minh, Southern Vietnam (Crane *et al*, 1992). References and

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[8] Mulder, V. *et al*, 2001.

early notes confirmed that a special system, referred to as rafter beekeeping, had existed for more than a hundred years.

An old Dutch reference from 1851 on an expedition to Kalimantan reported the existence of a similar management system for honeybees, locally called *tikung* beekeeping, which was later described in more detail (Wickham, 1997; De Mol, 1933). As in U Minh, the bee management system described for Kalimantan occurred in an area of submerged forest, with a lack of tall trees (or rock faces) on which bees could build their nests.

This report is the result of a study visit to the upper Kapuas Lake Region, which surprisingly revealed the *tikung* system to be still popularly practised by a relatively large group of the local population. Much use was made of recent studies by project staff of the DFID Danau Sentarum Conservation Project active since 1992 (Giesen and Aglionby, 2000). This Park was gazetted as a wildlife reserve in 1982, and subsequently as a National Park in 1999, with a total area of 132 000 ha. Several studies have described the local honey and wax business on which a Community Based Income Generating Programme was designed (Colfer *et al,* 1993; Rouquette, 1995; Wickham, 1995).

The Danau Sentarum flooded forest contains a variety of tree species. According to the honey collectors, around 20 species are important for honey production. Tembesu (*Fagrea fragrans*) is most important as it is used for making the *tikung* or honey planks. At present beekeepers recognise the following important nectar source trees: masung (*Syzygium claviflora*), tahun (*Carallia bracteata*), tengelam (*Syzygium* sp.), putat (*Barringtonia acutangula*), kawi (*Shorea balangeran*), pecaras or bakras (*Homalium caryophyllaceum*), samak (*Syzygium* sp.) ubah (*Syzygium ducifolium*) and lebang (*Vitex pinnata*). The most popular are honeys from *masung* and *tahun*.

Superior honey is said to be produced from nectar of the ransa palm (*Eugeissona ambigua*) but this plant is very rare nowadays. The palm was heavily exploited in times of famine for its starch content. Honeys from putat, kawi and timba tawang (*Crudia teysmannia*) are known for their bitter taste and are therefore less favoured.

Tembesu wood and rattan (for example, *Calamus schizoacanthus*) are among the most exploited products in the Park. However, timber and rattan exploitation account for only seven percent of the total overall income of the population. By far the largest portion of income for the Melayu (89 percent) is generated from fish resources. Honey production, though variable from year to year, contributes roughly one percent.

HONEY HUNTING PRACTICE

In this article we deal only with *Apis dorsata* (mwonji) that produces almost all of the honey in the area. However *Apis florea/andreniformis* (mwonji lalat) is present in the area and is occasionally hunted. *Apis cerana* (nyerungan) is rare for the lake region, but is found in tree cavities in the higher rainforest surrounding the Park. Also stingless bees (*engke lulut*) are known to produce small amounts of honey.

Although the *tikung* system is the most typical honey production method practised in the Park, honey hunting from tall bee trees is also popular in this region. This technique is locally called *lalau* in Melayu language, or *tapang*, which is Iban language for *bee tree*. Tree species that bees occupy in this area are predominantly: rengas *Gluta renghas*; tempurau *Dipterocarpus gracilis*; ran *Dipterocarpus tempehes*; menungau *Vatica* cf *umbronata*. In a narrower sense, *tapang* refers to *Koompassia* species, of which *Koompassia malaccensis* occurs in the lowland forests around the Park. On elevated land and riverbanks adjacent to the lake area, these tall trees often stand alone, due to clearing for agriculture on the levees. This marks the fact that these *lalau* or *tapang* are respected trees due to ownership, religious beliefs or simply economic value. Between 10-50 and often up to 200 *Apis dorsata* nests can be seen hanging from the thicker branches at 15-30 metres high, forming a wide canopy. Although the bee colonies seasonally migrate to settle on the *lalau* tree, some trees have nests all year round. Others show only abandoned combs during part of the year. Swarms settle from December to February and are said to come from the hills or rocky mountains that can be seen at a distance surrounding the lakes. A second arrival of bees is said to occur each year from July until October. Honey is harvested on moonless nights in February. Starting in January some colonies from these *lalau* trees are said to move to the *tikung* area – the dwarf or stunted forests in the lakes.

Although local customary laws protect *lalau* trees their number is decreasing. In Meliau six people own 22 *lalau* trees. Ten years ago there were 30 trees: eight have been felled by storms or lightning.

Incidental cutting of bee trees is reported in 1960, 183 *lalau* trees were cut by their Iban owners near Semalah village because of shifting cultivation. At present only six trees remain.

Due to clearance of the forest on the riverbanks no trees are available to the bees, as no new *lalau* have been planted. In primary forest sites young *lalau* trees are recognised by the people and protected as such.

Ownership of a *lalau* tree is maintained for a lifetime and can be inherited. Customary laws define ownership of *lalau* trees, which has to be recognised by the local leadership. If accepted, the whole community is informed and no ownership marks are made on the trees. Determining the right time for harvest is important, and once it is decided, the village head communicates this to all *lalau* owners and families that have the right to share part of the harvest. In the past, in the Kapuas River Delta this communication sometimes required several nights travel for the messenger who would carry a piece of knotted rattan, indicating the number of days remaining until the night of harvest (Dunselman, 1959).

Harvest is carried out at or around the new moon. In most cases, a group of local shamans – specialized bee hunters – gather for this activity. A few days before the harvest, they start making a ladder along the trunk of the bee tree up to the branches. Wooden pegs 30 centimetres long made of bamboo are hammered into the tree trunk at a distance of 1.5-2 metres. A long pole is attached to the end of each peg by rattan. When the ladder is finished, the harvest can commence. Usually around 7.00pm one or two honey hunters ascend the ladder, with a smouldering torch made of dried roots of jabai (*Ficus microcarpa*), a wooden knife and a basket attached to the hunter's waist by a long piece of rope.

The hunters sing songs at various stages of the harvest. There appears to be a basic text formula, which is sung in five stages: (1) finishing the ladder; (2) clearing the bees from the nest; (3) cutting the comb; (4) hoisting the basket; and (5) descending the ladder. The songs are passed from fathers to sons, and are sung to the spirits of the trees to make them friendly. We recorded one such song by a Melayu honey hunter from Semalah, Mr Abdullah Sani.

The songs are humorous, and tease the crowd below, who respond with a whooping yell. Often honey is mentioned in reference to a woman or young girl's beauty and their sexual attractiveness. Local and regional politics can also receive mention in the spontaneous lyrics of the creative singers/honey hunters.

TUNTUNG JANTAK
Tempukung sekuta bangan
Oh nemiak belahar nyumpit
Pakau ku tuntung Tapang dan
Udah ku anjak enda begerak
Udah ku init enda beretit
Paya lucak ulu Tempunak
Ningkam di dalam ulu Sekayam
O...o...o...

NEPAS
Bukan emas sembarang emas
Emas pelinggang se dari Jawa
Bukan tepas sembareng tepas
Serdap di diam si jaga Rengas
O...o...o...

MINTA MADU
Tetak kayu si tetak kayu
Tetak kayu secapit Ubah
Anang nuan seisi' madu
Pecit susu dara di rumah
O...o...o...

NGULUR
Ngiang-ngiang akar genali
Unjung di rumpu' setabah tabah
Jaga nuan ini' Sengiang Tali
Kami ngulur lingang bunga lingang Kebaca
O...o...o...

PULANG
Perang alu, perang kelelap
Perang di lengkong si kayu Ara
Pulang ayu, pulang semengat
Pulang semua kita berdua
O...o...o...

THE LADDER IS READY
There are nests of ants in the jungle.
Children learn to shoot the *Sumpit* (blow darts).
I have already made the *Pakau* (ladder steps) on the *Tapang* tree.
I climbed, but the ladder didn't move.
Mud in the upper Tempunak river.
And in the upper Sekayam river.
O...o...o... (*yelling by the crowd*)

CLEARING AWAY THE BEES
Not just any gold.
This gold pan is from Java.
Not just to clear away the bees.
But to make the spirits of the *Rengas* tree friendly.
O...o...o...

TAKING THE HONEY
Cut the log, cut the log.
The logs are cut from the *Ubah* tree.
Don't have no honey.
Else I'll squeeze the girl's breast in the house.
O...o...o...

BRINGING DOWN THE HONEY
Hanging around the roots of the *Genali* tree.
Don't be afraid to bring it to the grass.
Ask Grandmother Sengiang Tali to protect you.
We are bringing down some honey from the *Kebaca* tree's flower.
O...o...o...

GOING HOME
We've fought against the bees.
We've fought against the *Ara* tree's twisted bumps.
Go home spirits.
Let's go home all of us.
O...o...o...

Once the honey hunter reaches the branch above a comb, a wooden knife is used to cut the comb. With a smouldering torch the bees are brushed away from the comb, after which they disappear as falling sparks down below. It is believed that an iron knife should not be used to avoid damaging the tree bark, after which the bees would not return. In some cases the brood comb is cut separately and thrown down. The honeycomb is then cut and put into the basket and lowered to the ground. Traditionally these pieces are provided to please any bad spirits.

Honey collected from a single *lalau* tree may be hundreds of kilograms, depending on the number of nests. A study describes a crop of 140 kilograms from more than 20 nests on one *lalau* tree. In this case 16 people, owners and hunters shared the honey. Division of harvest seems to vary with every situation: agreements are probably made *ad hoc* prior to harvest.

Bee nests in *lalau* trees are said to contain more honey compared with *tikung* nests. However, losses due to spillage are higher with *lalau*. The actual average honey crop from a nest of a *lalau* tree is said to be much less than 10 kilograms because of the difficulty in harvesting the entire combs. As mentioned above, in the lake region honey harvest from *lalau* trees is of lesser importance than from *tikung*. In recent years the proportion of *lalau* honey has declined due to the decreasing number of *lalau* trees. Furthermore, *tikung* is more popular as it is an easier and safer way to crop honey.

Beeswax is also collected from the honeycombs. The combs are boiled after which the liquid is filtered. A nest with six kilograms of honey gives about 0.5 kilograms of wax. The prices are about the equivalent of US$1.2 for one kilogram of honey and US$1.4 for one kilogram of wax. The villagers immediately consume bee brood from a harvested comb.

TIKUNG

Among the honey hunters that collect honey through the *lalau* and *repak* systems, many also collect honey using the *tikung* technique. *Tikung* is the name of a carved hardwood plank (approximately 0.8-2.5 metres long by 25-40 centimetres wide); one side has a convex and the other side a concave shape. It is made of tembesu (*Fagraea fragrans*) or sometimes medang (*Litsea* sp.). Carving and shaping a *tikung* with simple tools is a time-consuming process – often taking a full day to complete just one board.

Such planks are attached to tree branches in the stunted swamp forests. The ends of the *tikung* planks are carved with notches (mainly rectangular, but sometimes V-shaped) to which a wooden peg is inserted, thus attaching it to a branch.

Tikung planks are positioned with a slope of about 30° with the upper part oriented towards the open sky. The concave side faces downward, so the upper convex side can facilitate rainwater runoff. Sometimes a pole is horizontally attached about two metres below the *tikung* for the *tikung* owners to stand on while attaching or harvesting the *tikung*.

Tikung planks made of durable *tembesu* wood can last over two generations (40 years), and can still be used after enduring a forest fire.

Ownership of a *tikung* is indicated by an individual owner mark – usually a series of indentations at the side of the plank, recognised as the family mark. Each new generation (son) adds a new indent. This mark system is complicated, but well understood by all *tikung* holders in the same area.

In one day, 5-6 *tikung* planks can be positioned in the submerged forest, which is usually two metres above the highest water level during rainy season. The trees preferred for hanging *tikung* planks are kamsia (*Mesua hexapetala*), masung (*Syzygium claviflora)* and empai/timba tawang (*Crudia teysmannia*).

The *tikung* harvest is always done after *lalau* harvest. Prior to the arrival of the swarms, some minor clearance of the *tikung* undergrowth and a small boat channel to the *tikung* may be made. The last blossom from the tahun (*Carallia bracteata*) gives the signal that honey is ready for harvest.

Honey collection from *tikung* resembles that of *lalau*. However, no songs are sung, as no spirits are believed to live in *tikung* trees. It is a collective practice. Harvest is done on moonless nights, usually from 7.00pm until 4.00 to 5.00am during which more than 20 *tikung* can be harvested. In discussions beekeepers said that harvesting in daylight would be very dangerous as bees sting fiercely. (However, in the village of Belibis we were told that in recent years a small group of *tikung* holders had started daytime collecting, using large quantities of smoke. They now seemed to favour daytime harvest as it is quicker due to better visibility. After harvest, the bees returned to the *tikung* for some days, after which they would leave.)

Tools for harvest from *tikung* are similar to that for *lalau*. At present, a plastic or tin container is used instead of the traditional bark/rattan basket. A wooden knife is used to cut the comb. *Tikung* honey collectors believe that if the comb is cut with iron the bees will not return to the site next season. In addition, there is a fear of wounding each other in the dark when harvesting with a sharp iron knife. No protective clothing is used.

The nests are approached in small boats. A man reaches up close to the *tikung* to smoke away the curtain of bees. All bees either fall into the water and drown or crawl up branches and leaves, as it is too dark to navigate and fly. In order to ensure floating bees do not crawl into the boat, other men in the boat use paddles (or their hands) to move the water away from the boat. Usually the brood comb (*sarang anak*) is cut first and temporarily put on top of the *tikung* plank. This enables the honey collector to focus all his attention on the honeycomb, at the head of the *tikung*, which he then cuts and puts into the basket first.

Bees are not likely to return to the *tikung* the following day, and are believed to return to the mountain area. All *tikung* nests in the same vicinity must be harvested the same night to avoid some remaining nests being robbed by other bees.

Tikung owners are mainly Melayu men, however, at harvest night, women and children may join the activity as well. Traditionally the *tikung* owners within the same area formed groups, who abide by their own rules and regulations. These groups also put their *tikung* in the same area. Both that area and the groups are called *priyau*. In the past, each *priyau* belonged to headmen, who gave his subordinates rights to place *tikung*. The *priyau* area was hereditary and sometimes subdivided to each one of the inheritants. The owner marks on the *tikung* reflect these interdependencies of *tikung* holders in the same *priyau* caused by inheritance.

At present rules applying to *tikung* owners in the same *priyau* include: a minimum number of *tikung* to be put up (for example 25 in Leboyan); obligation to put all *tikung* in one *priyau* only; a minimum distance between two *tikung* positions (for example, 15 metres in Leboyan); and to report the number and positions of *tikung* to the head of the *priyau*.

The 1994 study gives data on the number of families, *tikung* holders and number of *tikung* per family for selected villages in five main *tikung* areas: 30 percent of the families owned *tikung*, one family having from 10-500 (in Leboyan the average was 81 per family). The number of *tikung* occupied by bee nests in that season was around 23 percent. Average honey yield per collected nest was around six kilograms. This gives a total production figure for all of the Danau Sentarum Lake area for that year to be between 20 and 25 tonnes (an average year).

CASE STUDY 3 - RAFTER BEEKEEPING IN *MELALEUCA* FORESTS IN VIETNAM[9]

Phung Huu Chinh, Nguyen Hung Minh, Pham Hong Thai and Nguyen Quang Tan

The honeybee *Apis dorsata* is indigenous to tropical and subtropical Asia. The bees build their nests from the branches of big trees and tall, projecting cliffs. Occasionally colonies build nests on high water towers or the roofs of buildings. The nest comprises a single comb in the open air. *Apis dorsata* are defensive and migratory, and the domestication of this bee was thought impossible.

In some *Melaleuca* forests of southern Vietnam, people use a traditional method of collecting honey and wax from *Apis dorsata* colonies. This method of "rafter beekeeping" was first reported in 1902 by Fougères (Fougères, 1902).

According to Vietnamese sociologists, in the early 19th century honey hunting or raftering was the most important occupation of the people who lived in the *Melaleuca* forest swamp. At that time people paid taxes to the government in exchange for living in the forest. Beeswax was used to pay tax and for making candles and was sold to visiting ships from Hainan, China (Dau, 1992; Son Nam, 1993).

Between 1945 and 1975 the forests were devastated first by wars, and then by forest clearing for wood and agricultural purposes. As a consequence rafter beekeeping dramatically decreased in the area.

The technique is still used today at the state farm of Song Trem in Uminh forest, South Vietnam. According to our survey, there are about 96 beekeepers in the area. In 1991, they harvested 16,608 litres of honey and 747 kilograms of wax.

What is a rafter?
Simply, a rafter is the trunk of a tree, two metres in length and 15 centimetres in diameter supported by two vertical poles. One vertical pole is about 2 m high and the second 1.2 metres high. The rafter therefore slopes at an angle of about 15-35° to the horizontal. It appears like the branch of a tree and *Apis dorsata* can build its nest beneath it. It is named rafter because it looks like the rafter of a house.

How to make a rafter
A tree trunk 1.8-2.2 metres long and 10-20 centimetres in diameter is split lengthways into two parts to make two rafters. A rectangular or triangular hole is made at one end of the rafter (when the rafter is erected, the hole is slotted over the top of the higher vertical pole). A channel is often made along the flat side of the rafter to drain off rainwater so that it does not seep into the comb. The bark is removed and some beekeepers cover the curved side with a thin layer of beeswax.

How to erect a rafter
The beekeeper chooses a quiet, open space in the *Melaleuca* forest, or makes one by cutting down some tall trees. The direction of the rafter is decided before the vertical poles are positioned. The rafter is supported by the higher pole with the hole in the rafter slotting over the end of the pole. The lower pole supports the rafter with its V-shaped top. The curved side of the rafter must face downwards.

Grasses and small trees beneath the rafter are cleared. Finally the rafter is shaded using small branches and leaves. The rafter is now an ideal place for an *Apis dorsata* colony to build its nest.

How to harvest honey and wax
A good beekeeper knows when the honey is ripe for harvest by observing *Melaleuca* in flower, or the water collecting activity of the worker bees. On average the first harvest can take place 20-30 days after the rafter is occupied. The second harvest can be carried out about 30 days later. It is possible to harvest a third time from these colonies.

The bees are chased away using a torch of dry leaves and *Melaleuca* leaves. This used to be the main cause of forest fires in the area and therefore since 1993 smokers have been used.

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[9] First published in *Bees for Development Journal 36* (1995) pp. 8-9.

Honey is stored in the highest part of the comb and it is cut off without destroying the brood. Beekeepers usually cut a part of the brood from a big colony because they believe that if they do not the next harvest will be smaller. This does not seem logical – the more bees, the more honey produced for harvesting. It is possible however, that when the brood is cut, queen cells are removed which prevents swarming.

Honey is squeezed, filtered and then sold in the local markets. Beeswax is harvested from the honeycombs. Very little wax is taken from old brood combs.

Flower supply and honey harvest seasons

The *Melaleuca* forest in Vietnam is located in Asia's tropical monsoon area. The weather is generally hot and humid. There are two season in the year: the dry season from December to April and rainy season from May to November.

Melaleuca is the main forage plant in the forest, with other flowers in small quantities. *Melaleuca* blooms mostly from January to April and June to August. The bees come to the area in December and stay until May. The first honey harvest is between February and April. In May the colonies fly away and return in June. The second honey harvest season is in July and August after which the bees depart. At other times of the year, some *Apis dorsata* colonies can be found in the *Melaleuca* forests, but honey is stored only in small amounts.

A video of this rafter beekeeping was awarded 'The Gold Medal' at the Apimondia Congress in Lausanne in August 1995.

6. MELIPONICULTURE OF STINGLESS BEES

MELIPONINAE

Stingless bees are closely related to the honeybees, bumblebees and orchid bees. Work with stingless bees is called meliponiculture. Stingless bees are amongst the longest evolved bees, and have been found preserved inside pieces of amber 80 million years old. Stingless bees developed before the continents drifted apart from each other. Therefore, they are present in all tropical parts of the world. It is estimated that 400 to 500 different species of stingless bees are known, but new species are identified every year.

Approximate numbers of species so far identified are 50 in Africa, 300 species in the Americas, 60 in Asia, 10 in Australia. Four species occur in Madagascar.

The different species are diverse: their size ranges from two millimetres (e.g. the tiny sweet bees) to stingless bees slightly bigger than the European honeybee. The number of bees a colony can contain ranges from some few hundred to more than a hundred thousand bees. This differs from species to species.

The stingless bees have evolved a wide range of nesting and feeding behaviours that allow them to share habitats and to occur in high densities. Some species of stingless bees are nest parasites. This means that their queens are laying eggs in other bee's nests. All stingless bees build their nest in a closed structure. The *Melipona* species of stingless bees and most of the species *Trigona* usually build their nests in hollow tree trunks or branches, and some in cavities in the ground or empty mice or parrot nests. Other species live in ants or termites' nests. Nests can sometimes be found in cavities in buildings. The various species prefer different cavity dimensions and most species have characteristic nesting sites. For example, the nests of *Trigona fulviventris* most often are found at the foot of a tree. In other species, the selection of nest sites is more variable. The entrance of the nest is most often very small, so that it can be protected against other bees, phorid flies and ants. The entrance can be a tubular structure, extending into the open air. Some have the opening pointing up – other openings are pointing downwards.

In *Tetragonisca,* the entrance can be closed at night by a network of fine threads. The entrance tube can be so small, that only one bee can guard it, or it can be so wide that a whole group of soldier bees are necessary for its protection. Outside the entrance of *Tetragonisca angustula* there will even be a group of guard bees hovering around and able to catch intruders in flight.

The shapes of the nests of stingless bees are quite different from the nests of honeybees. Honeybees always build vertical hanging wax combs. The typical stingless bee nest is made with horizontal brood combs, often consisting of one type of cell with the openings upward, from which workers, queens and drones emerge. The queen cells being a little larger and situated on the end of the brood nest. Some few species build brood cells in piles in a special brood chamber, and one African stingless bee, *Dactylurina staudingeri*, builds vertical double-sided combs. The brood chamber is surrounded by a protective wall made with wax and propolis - the involucrum. Outside the involucrum, the bees build soft wax pots for pollen and honey. These pots can be from five to 40 millimetres high. In some species the honey pots and pollen pots are segregated, in others they are intermixed. In a few species, the honey pots are oval and the pollen pots appear like stalactites hanging over the brood cells. The whole nest, or the ends (if placed in a hollow trunk) is enclosed in the batumen, a special material made by a mixture of resin, wax and various amounts of other materials like mud, oil, paint, and sometimes, animal faeces. It is like dark, hard propolis. The batumen can be very strong and thick and protects the colony against water and enemies. Stingless bees are often seen visiting trees that are secreting resin from recent wounds, because they need a lot of resin for building. The bees transport it home in their pollen baskets for construction work in the nest. Some species keeps stores of wax and propolis, ready for use.

The life cycle of the stingless bees is different from that of the honeybees. In stingless bees, there can be two or more queens laying eggs in the same nest. New queens are produced regularly, but most of them are killed and never allowed to produce eggs. Some queens may remain imprisoned in special cells as reserves. Replacement of the egg-laying queen does not happen every year, and some queens may live for 3-7 years.

The queen lays eggs in a special way. First, a completed cell is half filled with honey and pollen by the workers. Then one or more workers lays an egg in the cell and the queen is encouraged to come near. Then the queen eats the worker egg from the cell and lays her own egg instead, and then proceeds to another cell. One or more workers closes the cell by bending the upper collar of the cell against the centre. The cell is closed until the adult bee emerges. This is called the mass provisioning system and differs from the situation in honeybees where the honeybee larvae are fed continuously as they develop. Stingless bee queens can provide 10-100 cells with eggs a day, depending on the species. When the fully developed bee leaves the brood cell, the cell is torn down, and the material is reused for building new cells. Fertile eggs from the queens develop into worker bees and queens. Drones come from unfertilised eggs from the queen, or from egg laying workers. It sometimes happens that an egg laying worker bee lays an egg into a cell already containing a queen's egg. The male egg develops into a larva more rapidly than the female egg. The male larva then punctures the queen's egg before it hatches, and is able to eat all the food in the cell. After 10 to 15 days, the drones leave their parent colony forever. Where they go is not known.

Stingless bees multiply themselves by swarming. When a colony has reached a certain size and a usable new nest place is found, some worker bees will start transporting building materials to the new place. More and more bees will fly to the new nest over the next few days, and in the end, a queen from the old nest will transfer to the new nest and begin producing eggs there. Now a new colony has been established, and little by little, the flying between the two colonies will stop. In most species, mating between a new queen and drones takes place outside the nest.

Stingless bees are connected with tropical and subtropical forest areas. Here navigation by means of the sun, as used by honeybees, is not as easy as in open habitats. Stingless bees use different ways of communicating to each other the way to food sources. There are three main methods, depending on the different species. One method is that the scout bee returns and makes a special sound in the nest that gets other bees to fly out and search for the flowers at random. Another method is that the scout bee lays out an odour trail by marking stones and plants on the route with a special scent. Inside the colony, she makes a sound and a zigzag dance. When leaving the nest again, she leads a group of recruits to the source by following the trail. The third method is like the second, but instead of the odour trail, the scout bee guides a group of recruits by means of a pheromone emitted during her flight back to the flowers.

The communication systems of the stingless bees are three dimensional, and indicate how high in the forest the nectar and pollen sources are. In this way, stingless bees are well adapted for tropical forests.

KEEPING STINGLESS BEES

Meliponiculture developed in Central and South America long before the European settlers arrived. During this period, the Indians obtained honey and wax from stingless bees. Subsequently honeybees were brought from Europe and, during the 20th century, from Africa. Elsewhere in the tropics, where stingless bees and honeybees are present, people have not developed management of stingless bees in hives, but simply harvested from wild colonies. The amount of honey from the stingless bees could not compete with the amount of honey from the honeybee, but honey from stingless bees is usually valued more highly.

Today meliponiculture is mainly found Central and South American countries, especially in Mexico as a heritage of the Mayas, and in NE Brazil. The most commonly used species are *Melipona beecheii*, *M. scutellaris*, *M. compressipes* and the tiny bee *Tetragonisca angustula*. This last named bee produces very little honey, but is kept because its honey is used as a medicine against eye cataracts.

Among the food resources used are pollen, nectar and fruits. The necrophagous species of *Trigona* also live from fluids from dead animals. There is a great diversity in preferred flowering plants and different niches are used by different species. This results in a great variation in the type of honey produced.

The yearly honey harvest from a stingless bee colony is most often between 200 grams to five kilograms. It depends on the species of bees, vegetation and handling. Today, there are farmers in Tanzania keeping stingless bees in log hives as they keep honeybees, and it is impossible to tell how long back this tradition goes. In Australia honeybees were not present before colonisation by Europeans, and as in the Americas, stingless bees were harvested for their honey.

Meliponiculture has developed from bringing log hives with bees' nests inside to the home, or to special shelters. This practise is still most widely used in Central America. Eventually a nest is placed in a simple box of wood. Many local beekeepers do not know how to divide a colony even though it is quite simple. New methods have developed in Brazil, and this is named the *Rational Hive.* It is a hive made of wood, in a way so that it easily can be divided in two parts, each with half the brood and honey and pollen cups. The one hive part with bees inside is equipped with a new top, the other with a new bottom. If the two boxes are not equally strong, the weakest, or that without a queen is left in the old site and the other box is placed in a new place. Nest boxes can also be equipped with inspection "doors" so that it is possible to watch for new queen cells, if the colony is of the type that places the queen cells at the edge of the brood area. From a wooden box hive the honey pots can easily be inspected, and if ripe, placed on a strainer upside down or they can be harvested by a small vacuum pump or syringe. It is very important when using log hives or box hives, that every crack or opening except for the main entrance is carefully closed after opening of the hive. This can be done with clay or a mixture of clay and cow dung. If not, the bees can be attacked by other bees or enemies.

The ripe honey from stingless bees has higher water content than honeybee honey. Therefore, it may also have a higher antibiotic activity to prevent fermentation. In laboratory tests, *Melipona* honey had a higher bacteria inhibiting effect than honey from honeybees.

7. THE IMPACT OF BEEKEEPING ON MANAGEMENT AND CONSERVATION OF FORESTS

THE IMPACT OF HONEY HUNTERS AND BEEKEEPERS ON FORESTS

All forest ecosystems contain indigenous species and races of bees, and some now contain introduced honeybee species. Not all indigenous bee species can be exploited by people for honey and wax, but in every forest ecosystem, there is usually one or more indigenous honeybee or stingless bee species that may be useful to man for honey production. In the past, honey hunting (described in Chapter 5) seems to have been practised in forests everywhere, and the value of forests for humans has almost always included their contribution to honey production. Case Study 4 gives an example from Europe.

CASE STUDY 4 - HONEY FROM EUROPE'S CHESTNUT *CASTANEA SATIVA* FORESTS

In past centuries, for people living in Europe's forested areas, which then included much of the Mediterranean's shoreline, forests of chestnut *Castanea sativa* were very important. These sweet chestnut forests extended from the mountainous uplands of Portugal and Spain, through France and into northern Germany, the west coast of Italy, and throughout central Europe as far as Turkey, and provided an important source of livelihood. In previous times, chestnuts were harvested and dried, milled into flour, or used whole with other foods, providing an excellent source of protein and carbohydrate-rich nutrition. When chestnut trees flowered between June and July, they provided abundant nectar and pollen forage for bees, from which is harvested valuable chestnut honey with a dark colour, a fruity scent like over-ripe apples, and a strong, slightly tannic flavour.

The chestnut forests provided a labour-intensive, slow-maturing harvest – the trees take 20 years to bear chestnuts, but then remain productive for a hundred years or more. The New World's quick-growing staples such as potatoes, maize and beans eventually replaced the chestnut crop. This left the forests, where chestnuts remained untended and vulnerable, no longer valued as providers of food and income. Equally at risk were the additional crops the forest supported, including the honey produced by the forest's indigenous *Apis mellifera* honeybees, as well as valuable fungi such as chanterelles and truffles.

In recent years, new harvesters have arrived in some of these forests, often escapees from urban life, who are commercially educated and aware of the need for the forests to create a livelihood. New industries have developed, using local labour and expertise to harvest the chestnuts and market them using modern methods of processing and packaging. Invisible earnings include a sustainable industry to assist the survival of smallholding communities in danger of losing their livelihoods, in addition to fine harvests of forest fungi, and the top value chestnut honey.

Forest trees and other flowering plants provide food and habitat for bees, and by pollination, bees enable them to reproduce. In addition to pollen and nectar, bees also collect propolis, honeydew and water, and trees provide nesting places for the bees.

Today's overexploitation of tree resources has many consequences that are documented elsewhere, but has also lead to decreased populations of honeybees. Loss of honeybee colonies not only deprives local people of sources of food and income, (see Case Study 6 from Benin below) but there will be consequences from lack of pollination leading to reduced biodiversity. It is impossible to value the role of bees as pollinators of trees in natural ecosystems, and understanding of the pollination of economically important crops is only partially understood. Yet, as explained in Chapter 3, most plants need an animal to visit their flowers in order for them to produce fertilised seeds, fruit, and future generations of the plant. Around half of the animal pollinators of plants are bees.

CASE STUDY 5 - HOPE IN THE CONGO

Paul Latham

The Salvation Army[10] runs a fascinating project in the lower Congo and it has been my privilege, from time to time, to have seen it in operation. It is helping rural people support themselves. As it has been in operation now for over 20 years it has achieved some impressive results.

Tata Buansa farms near Kavwaya. In the past, he farmed like his neighbours, cutting down the forest to plant his crops, until the forest had largely disappeared. Useless coarse grass still covers much of his land, taking out the goodness, which should have gone into his crops. This catches fire in the dry season killing any young tree seedlings that might germinate. However, for several years now Tata Buansa has been planting fast growing local trees in selected areas of his farm. The trees make the soil fertile, protect it from rain and encourage wild life. When they are cut down, the crops he plants afterwards grow on the stored fertility. Rather than wait for nature to replace gradually the tree cover he plants collected tree seed along with his crop so that they are protected by it and take over the land after harvest. He now runs his farm on a rotation, cropping the land every 10 years. Crop yields are up, he has plenty of firewood and building poles but he also is able to collect wild mushrooms, edible caterpillars and keep some beehives in his woodland. He finds the woodland is actually more productive than his crops!

Mama Christine is a beekeeper, also near Kavwaya. Beekeeping is a new activity in the lower Congo. In the past people simply raided wild colonies of bees living in trees or holes in the ground but now over a thousand people have taken up beekeeping and earn cash for paying school fees or medical expenses from it. From five hives, she harvested 75 litres of honey recently. That is worth more than most people earn in a year in the Congo. Beehives are usually made from wood but that is too expensive for most people. Instead, they use whatever is available and I have seen hives made out of old oil drums, plastic basins, bricks and raffia palm. African bees tend to be rather aggressive so, to protect themselves, Mama Christine and her friends use old cotton flour bags made up into bee-suits.

CASE STUDY 6 - SITUATION IN BENIN

Currently I am training beekeepers and their communities against deforestation and starting tree nurseries of specifically melliferous species at each individual site. Apparently, there has been a significant drop in honey production since the installation of the hives around year 2000 – drastic deforestation of the region has been a major contribution.

Jenny Hislop, PCV - Environmental Action, Athieme, reported in Bees for Development Journal *2005, 75, 11.*

An example where lack of pollinators has come to light is in the Amazon, where the destruction by fires of the habitat of the bee pollinators of brazil nuts (*Bertholletia excelsa*) is cited as one possible reason for the decline in Brazil nut production (Mori and Prance, 1990b). The detrimental consequence of habitat destruction, lack of pollinators, and subsequent loss of plant reproduction and habitat regeneration has been well described (Roubik, 1995). The Tanzania National Beekeeping Programme

[10] The War Cry 7 June 2003, 4-5 Reproduced with kind permission from The War Cry, The Salvation Army UK.

2001-2010 reports that bees are disappearing from many areas in the country due to the decreasing of availability of bee fodder, caused by an increase in deforestation[11.]

In Africa, Asia, Central and South America it is often the most poor and most remote people, with few other livelihood options, who practise beekeeping. Many of these poorest people are living in areas that are rich in natural resources, such as tropical forests and woodlands, and beekeeping is a feasible way for them to create food and income using the natural resources around them.

Beekeepers and honey hunters are sometimes perceived to cause damage to forests, through the careless use of fire during harvesting and because they kill trees to make beehives. Beekeepers in some parts of Africa make bark hives by peeling cylindrical sections of bark from mature trees, which then die. The Forest Department/IRDP Beekeeping Survey explored this issue in the Zambia's North West Province from 1987-1992 (Claus, 1992). Here the researchers reported that the three species most used for making bark hives, *Cryptosepalum exfoliatum pseudotaxus, Brachystegia spiciformis* and *Julbernardia paniculata* were also excellent nectar species. The researchers also estimated that 3.1 trees/km^2 were destroyed by beekeepers in the whole province but this figure was later challenged by the honey trading company NWBP who believed the Beekeeping Survey had overestimated the number of beekeepers and therefore the number of trees harvested (Muzama, 1996). Despite this discrepancy researchers argued that even if the higher figure was accurate this was still well within the forests capacity to regenerate sustainably.

Serious late season fires can cause considerable damage to forests and where these are caused by honey hunters or beekeepers, it is due to carelessness in the use of fire to create smoke during honey harvest, or from campfires, as honey hunters and beekeepers always camp in the forest while they are collecting honey. However the survey undertaken in Zambia's North West Province also showed that beekeepers were strong advocates for forest conservation, as they value dense woodland and are keen to avoid damaging late fires. Clauss (1992) noted, "Beekeepers are generally worried about late fires between August and October which widely scorch the flush and above all the flower of the most important nectar species like *Cryptosepalum exfoliatum pseudotaxus, Brachystegia* spp. and *Copaifera"*. Early burning is a conventional forestry management practice that is employed to prevent late season wild fires, and it is reported that beekeepers understand and are supportive of this practice.

The beekeepers of Zambia's North West Province have managed to achieve good market access for their bee products through the company NWBP, and the prices they receive for their honey are enhanced because they have achieved organic certification. This adds further credence to the environmentally sound techniques of these beekeepers because Soil Association Organic certification inspectors deny organic certification to activities that cause forest destruction (Oxfam, 1995).

Evidence suggests that the beekeepers that have a clear financial gain from protecting the habitat of the bees are interested in forest conservation. What is not documented is the extent to which other beekeepers throughout the world are interested in and invest in forest conservation.

Forest Departments in some countries have banned people from making local-style log or bark beehives, as they perceive this to be a cause of tree destruction. This is a short sighted move as with no alternatives, this can seriously reduce the level of beekeeping which affects people's livelihoods, may reduce the potential bee population and yet local-style beehives can remain in use and productive for many years. There is often little interaction between the forestry and beekeeping sectors.

Beekeepers rarely own the land and forests where their bees forage. This is typical because in some societies, ownership of land is only secured through clearing forest and using the land to cultivate crops. Beekeeping, whilst important for income generation, does not create sufficient wealth to buy land. Rather, beekeepers recognise the value of communally owned forests or open access

[11] Ministry of Natural Resources and Tourism, Government of Tanzania (2001). National Beekeeping Programme 2001-2010.

woodland for beekeeping and take advantage of these resources. They have a stake in the maintenance of these areas of forest. Honey hunters and beekeepers are often knowledgeable about which trees are valuable for bees. Sometimes they tell that the special taste of a honey is because it comes from the nectar of a particular tree species. In many countries of Africa and Asia, trees holding wild nests of bees are regarded as valuable, and beekeeper families often have traditional ownership of such trees, even though they have no ownership of surrounding land. There are examples of beekeepers planting trees for bee forage, claiming usufruct ownership to individual trees that hold wild bee nests. Anecdotal evidence suggests that people who clear trees if they are being used to support beehives leave small clusters or strips of natural vegetation alone, and firewood and charcoal cutters may avoid areas where beehives have been sited because they are afraid of being stung. There are also examples of local-style hives acting as deterrents to elephants: on the Laikipia Plateau in Kenya, log hives were used to 'mine' a favourite elephant foraging area of fever tree *Acacia xanthophloea* regrowth (Vollrath, 2002).

CASE STUDY 7 - BEE TREES IN MALAYSIA

In the tropical forests of Malaysia, the so-called 'giant honeybees' *Apis dorsata* build their single comb nests high in tall trees such as *Koompassia excelsa* which have few horizontal branches. The lowest branches are at least 30 metres above the ground, and the trunk is smooth and without climbing plants and epiphytes. The main predators of these bees are bears and man. One such 'bee tree' may contain up to 200 colonies. In Sarawak, people from the Iban and the Kelabit tribes mention special trees as host trees for wild bees: *Alstonia scholaris*, *Hopea pentanervia*, *Shorea plantyclados* and other *Shorea* species, and *Ficus* sp. In many places in South East Asia, spirits were believed to live in the bee trees that protected the trees against being felled (Christensen, 2002).

Loss of trees has only negative implications for beekeepers: loss of food for bees, loss of nesting sites for bees, loss of materials for building hives, loss of places to keep hives. However, there has been little research to investigate how beekeepers make deliberate and conscious efforts to protect and conserve forests in which their bees forage, despite their dependency on these resources. This is an area of investigation that has been neglected and yet holds significant potential for future sustainable forest management initiatives.

BEES ADD TO THE VALUE OF TREES AND FORESTS

The multipurpose value of trees and forests is increasingly well appreciated, and beekeeping provides one of the most benign ways of obtaining a harvest from natural forests. Apiculture's unique feature as an activity is the fact that its continuation, through pollination, fosters the maintenance of an entire ecosystem, and not just a single crop or species. Beekeeping is practised by a variety of different techniques that can be selected and adapted depending upon the situation of resource-poor farmers. Honey and beeswax are products that people can harvest which can be of world quality, and for which there are significant local and international markets. A significant proportion of honey produced in Africa is used to make beer and is valued for its medicinal and cultural properties. Beekeeping should always be taken into account when the economic importance of trees and forests are being calculated.

The financial outcome of forest beekeeping will, however, depend upon many variables including the skills of the practitioners, the markets available to them, as well as the botanical resources available, climate and other variables. The difficulty of making this calculation, the multiplicity of beekeeping practises and the widespread and small-scale nature of the activity means that there is little research data that can be quoted here. Furthermore, in many communities, the honey that is produced is consumed by family and neighbours, bartered for food and other goods or used to make beer for home use or sale. This makes it difficult to assign a market value to the honey. In some communities honey is used for medicinal purposes in which case the economic value could only be calculated if there were available equivalent medicines for sale. However, these medicines often have social and cultural values that are impossible to quantify.

The only route towards valuing forest beekeeping is to measure the income earned from the sales of bee products. The Tanzanian National Beekeeping Programme[11] describes beekeeping in Tanzania as a dynamic forest-based industry that is currently threatened by forest resource depletion but has the potential to earn foreign exchange. Table 6 shows the income earned over a 12-year period.

The Tanzania National Beekeeping Programme explains that at prevailing costs and profit margins, an ordinary beekeeper keeping an average of 150 local-style beehives can earn more than US$200 a year. This figure is comparable with income earned from beekeepers in Zambia (IFAD, 1997). Other site-specific figures of income are available but these rarely incorporate the costs of production.

TABLE 6
Beeswax and honey exports from Tanzania

Year	Beeswax		Honey	
	Metric Tons	Value US$	Metric Tons	Value US$
1988/89	326	324 070	20	14 727
1989/90	203	328 353	33	20 487
1990/91	234	378 495	38	23 591
1991/92	696	2 088 000	123	221 400
1992/93	569.5	1 522 739	32	31 216
1993/94	124	237 883	78	71 540
1994/95	120	371 625	19	25 837
1995/96	226	7 82 662	56	74 459
1996/97	326	1 359 843	310	370 094
1997/98	449	1 523 544	190	237 175
1998/99	403	1 440 678	39	35 533
1999/2000*	462	1 863 387	135	148 808

* Up to March 31, 2000.

The pollination services of bees are widely understood to be of immense value to natural and agricultural systems but putting a figure on this value is difficult. Some recent studies have however broken new ground by showing the gains in coffee yields and profit margins caused by the proximity of coffee bushes to natural forests that provide a habitat for bees. A study exploring the economic benefits of native ecosystems in Costa Rica found that forest-based pollinators increased coffee yields by 20 percent within approximately one kilometre of forest (Ricketts, 2004). The quality of the coffee near to the forest also improved as the frequency of "pea berries" (i.e. small misshapen seeds) was reduced by 27 percent. The economic value of the pollination services of the bees in two natural forest fragments (46 and 111 hectares) during 2000-2003, translated into US$60 000 per year for one Costa Rican farm. This works out to be $389 per hectare per year although this figure would rise if the benefits to other farms was also included, or it was found that a smaller area provided the same level of services. This value exceeds conservation incentive payments, where landowners are paid in the region of US$42 to conserve forest, as well as some non-forest land uses such as pasture for beef cattle that yield on average US$151 per hectare per year. These findings show that investment in maintaining the habitat of wild bees with an agricultural landscape yield significant economic benefits for coffee production. This study also supports the earlier findings of Roubik (2002) who also demonstrated that bees could augment pollination and boost coffee crop yields by over 50 percent. He concluded that coffee plants would benefit from being grown in habitats that are suitable for sustaining valuable pollinators.

The paucity of robust quantitative data about the value of forests for beekeeping and their contribution to livelihoods in financial terms, is one reason why beekeeping remains in the margins of development planning.

CASE STUDY 8 - BEE RESERVES IN TANZANIA
Yves Hausser, President of ADAP and Jean-Félix Savary, Head of Inyonga Project 2002[12]

The forests of Inyonga area are some of the least disturbed, wild ecosystems in Africa. They are located between the protected areas of Katavi National Park, Rukwa-Lukwati Game Reserve and Ugalla Game Reserve. Beekeeping is traditionally practiced in the area. However, immigration and environmentally destructive activities are posing a threat to these valuable ecosystems. Those responsible for protecting the area were attempting to disallow beekeepers access to the protected area, which in the meantime was being expanded. The Association for the Development of Protected Areas (ADAP) stepped in to assist the Government of Tanzania to tackle the problem and a multi-stakeholder workshop was held to explore some opportunities for improvement.

A major outcome of the workshop was a much clearer appreciation that beekeeping is environmentally friendly and contributes directly to the effective protection of the whole ecosystem by ensuring the long-term protection of the forests, whilst generating income for local communities and it relies on local knowledge and skills. Given the existing links between the beekeepers and 'Goldapis', a Tanzanian company that is marketing bee products, beekeeping also offers a highly viable income stream to local people.

This consequently led to the creation of Bee Reserves within the forests that would be protected and managed by beekeepers for their purposes. This provides them with a strong incentive to maintain and manage these forests.

BIODIVERSITY AND WILDLIFE

Efforts to encourage beekeeping inside wildlife parks and reserve areas are beneficial for the livelihoods of nearby communities. For example, in Nyika National Park, Malawi the Department of National Parks and Wildlife encouraged local people to place beehives in suitable foraging locations within the park. This allows local people to gain benefits from the park and therefore have a vested interest in its protection. It also has the added advantage that the beekeepers will engage in controlled early burning near their hives to protect them from later destructive wildfires. This activity also benefits naturally regenerating trees from the damaging effect of fires. Furthermore during the honey harvest periods, the beekeepers spend time in the park and can act as additional eyes and ears for the Departmental staff, and help to see and report poachers.

The National Beekeeping Policy of Tanzania includes the creation of bee reserves: this is a main component of the strategy to continue to promote beekeeping within the country. This development is taken in recognition of the positive relationship between beekeeping and forest protection, and that without adequate forest protection the bee industry could collapse.

[12] Hausser, 2002.

FLORAL CALENDARS

For any forest supporting populations of bees, it is possible to compile a flowering calendar which shows the times of year when important bee forage species flower. Typically, it is possible to compile lists of the most important bee trees as well as complementary or supplementary species. Complementary plants are those which “fill the gaps” in the flowering calendar of the important species, and supplementary species are those which can help to compensate fluctuations in main nectar flows. Complementary and supplementary species are therefore extremely important for bee habitats.

It is difficult to identify the causes of periodic fluctuations of flowering of important bees trees. Beekeepers interviewed in the NW province of Zambia during the Beekeeping Survey stated that good flowering of trees and shrubs is dependant on good rainy seasons and that fluctuations are normal. Studies on selected tree species undertaken by the Beekeeping Survey suggested additional factors that have effect upon flowering intensity such as hydrological conditions, heat waves, frost, fires and pests. In trees, the effect of these influences can persist for one year or longer masking cause and effect. Constantly interacting factors like soil conditions, genetic dispositions of single specimens as well as whole populations and biological characteristics also add to flowering fluctuations.

MELLIFEROUS TREE SPECIES

Beekeepers are always interested to observe the herbaceous plants, shrubs and trees that are especially important for bees, and will often know whether the bees are collecting nectar and/or pollen. Often beekeepers will recognise, from the colour of pollen being carried by workers arriving at the hive, which plant species the bee has been visiting. The following tables give details of nectar-producing tree species that may have other uses too, and are reproduced with kind permission from Bees and Trees (Svensson, 1991). As Svensson points out, these lists are not complete, but provide a stating point for further studies.

Other good nectar producers in lowland rainforest: *Acacia farmesiana*, *Alstonia bovrei*, *Combretum smeathmanii*, *Dalbergia kisantuensis*, *Erythrophleum guineense*, *Gaertnera paniculata*, *Gilbertiondendron dewevreii*, *Harungana madagascariensis*, *Mimosa pudica*, *Pentaclathra eetveldeana*, *Phyllanthus nivosus*, *Prosopis chilensis* and *Virectaria multiflora*.

TABLE 7
Nectar-producing tree species

Terms used	Abbrev.	Explanation
Vegetation zone		Divisions between vegetation zones have been made as simple as possible. Some tree species are represented in many different zones (e.g. *Citrus* spp., *Coffea* spp., *Cordia* spp., *Eucalyptus* spp.).
Pollen	P	The tree is reported by at least one author as a major pollen source for bees.
	(P)	The tree is reported to give pollen of value to bees.
	-	No information.
Food	Fo	Food for humans can be prepared from flowers, fruit, seeds, leaves, bark, etc.
Fodder	Fd	The tree provides fodder for at least one kind of animal.
Fuel	Fu	The tree has value for firewood production.
Timber	Ti	The tree has value as timber.
Land	La	The tree has a value for land use, land conservation or land development such as windbreaks, shade, forestation, land reclamation, living fences, fire belts, soil conservation, nitrogen fixation, organic mulch, weed control, erosion control, or sand stabilization.
Ornamental	Or	The tree has a value for amenities.
Others	+1	Other uses such as medicinal, insecticidal, oil, wax, gas, fibres, tannin, or dyes. The number given indicates number of other uses.

TABLE 8
Nectar-producing species in lowland rainforest

Tree name	Pollen	Food	Fodder	Fuel	Timber	Land	Ornamental	Others
Anacardium occidentale	(P)	Fo		Fu	Ti			+4
Brachystegia laurentii	-							
Coffea spp.	(P)	Fo	Fd			La		
Cordia alliodora	(P)							
Cynometra alexandrii								
Eugenia spp.								
Gymnopodium antigonoides	-			Fu				
Haematoxylum campechianum	P				Ti		Or	+1
Hevea brasiliensis	-							+2
Ilex spp.	-							
Inga spp.	(P)					La		
Litsea glabberima	P							
Lonchocarpus spp.	-							
Musa spp.	P	Fo						+1
Nephelium lappaceum	(P)	Fo						+1
Pithecellobium spp.	P	Fo	Fd	Fu	Ti	La	Or	+3
Syzygium spp.	(P)	Fo	Fd	Fu	Ti	La	Or	+4
Terminalia spp.	(P)			Fu	Ti	La	Or	+3

TABLE 9
Nectar-producing species in highland forests

Tree name	Pollen	Food	Fodder	Fuel	Timber	Land	Ornamental	Others
Acacia polyphylla	-							
Aesculus spp.	P		Fd	Fu	Ti	La	Or	+1
Calcophyllum Candidissimum	-				Ti	La		
Castanea sativa	P	Fo			Ti		Or	
Citrus spp.	P	Fo					Or	+3
Correa spp.	(P)	Fo	Fd			La		
Cordia spp.	(P)	Fo			Ti	La		
Croton spp.	(P)							
Dombeya rotundifolia	P				Ti		Or	+1
Erica arborea	P				Ti		Or	+1
Eriobotrya japonica	P	Fo					Or	
Eucalyptus spp.	P		Fd	Fu	Ti	La	Or	+6
Gleditsia triacanthos	(P)	Fo	Fd	Fu	Ti	La	Or	
Gliricidia sepium	-	Fo	Fd	Fu	Ti	La	Or	+3
Grevillea robusta	(P)			Fu	Ti	La	Or	
Inga spp.	(P)					La		
Musa spp.	P	Fo						+1
Olea africana	(P)	Fo	Fd	Fu	Ti			+1
Robinia pseudoacacia	P	Fo	Fd	Fu	Ti	La	Or	
Tilia spp.	(P)				Ti	La	Or	+2
Tipuana tipu	-				Ti			
Trichilia glabra	-				Ti			
Vernonia polyanthus	(P)							
Vitex spp.	-	Fo						+3
Ziziphus jujube	(P)	Fo					Or	

Other good nectar producers in highland forest: *Albizia* spp., *Cupania* spp., *Matayba apetala*, *Ricinus communis*, *Rosa abyssinica* and *Triumfetta rhomboidoea*.

TABLE 10
Nectar-producing species in wooded grassland (savannah)

Tree name	Pollen	Food	Fodder	Fuel	Timber	Land	Ornamental	Others
Acacia spp.	(P)	Fo	Fd	Fu	Ti	La	Or	+5
Azadirachta indica	(P)	Fo	Fd	Fu	Ti	La	Or	+4
Brachystegia spp.	(P)	Fo		Fu	Ti	La	Or	+4
Calycophyllum candidissimum	-				Ti	La		
Ceiba pentandra	P	Fo	Fd		Ti	La	Or	+1
Cochlospermum spp.	(P)					La		
Combretum spp.	-			Fu	Ti			+5
Cordia spp.	(P)	Fo			Ti	La	Or	
Cryptosepalum pseudotaxus	-							+1
Dialium engleranum	-	Fo						+1
Dombeya rotundifolia	P				Ti		Or	+1
Eucalyptus spp.	P		Fd	Fu	Ti	La	Or	+6
Faurea saligna	(P)				Ti			+2
Gilibertia spp.	-							
Isoberlina spp.	-				Ti			+2
Julbernardia spp.	-				Ti			+5
Leucas aspera	(P)							
Lonchocarpus spp.	-							
Madhuca longifolia	(P)	Fo						+2
Marquesia macroura	-				Ti			+1
Parkia biglobosa	-	Fo	Fd		Ti	La		+2
Prosopis spp.	P	Fo	Fd	Fu	Ti	La	Or	+2
Pterocarpus spp.	(P)				Ti			
Sclerocarya caffra	(P)	Fo	Fd					+2
Syzygium spp.	(P)	Fo	Fd	Fu	Ti	La	Or	+4
Terminalia spp.	(P)			Fu	Ti	La	Or	+3

Other good nectar producers in wooded grassland: *Adansonia digitata, Albizia* spp., *Bauhinia* spp., *Burkea* spp., *Commiphora* spp., *Copaifera guineense, Erythrina* spp., *Erythrophleum*, spp., *Euphorbia* spp., *Ficus sycamorus, Grewia* spp., *Hymenocardia* spp., *Jacaranda mimosifolia, Lannea* spp., *Parianari* spp., *Protea* spp., *Pseudolachnos tylois, Schinus molle, Schwartzia madagascariensis* and *Vernonina* spp.

TABLE 11
Nectar-producing species in arid and semi-arid land

Tree name	Pollen	Food	Fodder	Fuel	Timber	Land	Ornamental	Others
Acacia spp.	(P)	Fo	Fd	Fu	Ti	La	Or	+5
Adansonia digitata	-	Fo	Fd		Ti	La		+4
Balanites aegyptiaca	-	Fo	Fd	Fu	Ti			+3
Combretum spp.	-			Fu	Ti			+5
Commiphora spp.	-		Fd	Fu	Ti			+2
Cordia spp.	(P)	Fo			Ti	La	Or	
Dombeya rotundifolia	P				Ti		Or	+1
Eucalyptus spp.	P		Fd	Fu	Ti	La	Or	+6
Euphorbia spp.	P	Fo				La		+1
Guaiacum officinale		-			Ti		Or	+2
Gymnopodium antigonoides		-		Fu				
Khaya senegalensis			Fd		Ti			
Leptospermum spp.	(P)				Ti	La		
Parkinsonia aculeate	(P)	Fo	Fd	Fu		La	Or	
Prosopis spp.	P	Fo	Fd	Fu	Ti	La	Or	+2
Terminalia spp.	(P)	Fu			Ti	La	Or	+3
Ziziphus spp.	(P)	Fo	Fd	Fu	Ti	La		+3

TABLE 12
Nectar-producing species in coastal plains

Tree name	Pollen	Food	Fodder	Fuel	Timber	Land	Ornamental	Others
Acacia spp.	(P)	Fo		Fu	Ti	La	Or	+5
Anacardium occidentale	(P)	Fo		Fu	Ti			+4
Antigonon leptopus	P	Fo					Or	
Bombax ceiba	P	Fo	Fd		Ti	La		+2
Bucida buceras	(P)				It		Or	
Ceiba pentandra	P	Fo	Fd		Ti	La	Or	+1
Citrus spp.	P	Fo					Or	+3
Coccoloba uvifera	-	Fo						
Cocus nucifera	P	Fo	Fd		Ti		Or	+3
Cordia spp.	(P)	Fo			Ti	La		
Durio zibethinus	(P)	Fo						
Ehretia acuminata	(P)		Fd		Ti		Or	
Eucalyptus spp.	P		Fd	Fu	Ti	La	Or	+6
Haematoxylon campechianum	(P)				Ti		Or	+1
Litchi chinensis	(P)	Fo						
Mangifera indica	P	Fo				La	Or	
Melicoccus bijuga	-	Fo				La		
Musa spp.	P	Fo						+1
Nephelium lappaceum	(P)	Fo						+1
Parkinsonia aculeata	(P)	Fo	Fd	Fu		La	Or	
Persea americana	(P)	Fo						
Pithecellobium arboreum	(P)				Ti			
Psidium guajava	P	Fo			Ti			+3
Roystonea regia	P		Fd			La	Or	
Schinus terebinthifolius	-	Fo	Fd		Ti	La	Or	+3
Syzygium spp.	(P)	Fo	Fd	Fu	Ti	La	Or	+4
Triplaris surinamensis	-				Ti		Or	

TABLE 13
Nectar-producing species in mangrove

Tree name	Pollen	Food	Fodder	Fuel	Timber	Land	Ornamental	Others
Avicennia spp.	(P)	Fo	Fd	Fu	Ti			
Nyssa spp.	-	Fo			Ti		Or	
Rhizophora mangle	-			Fu	Ti	La		+4
Serenoa repens	(P)							

Other good nectar producers: *Actinidia chinensis*, *Agave sisalana*, *Albizia* spp., *Aleurites* spp., *Annona* spp., *Averrhoa carambola*, *Bauhinia purpurea*, *Cola* spp., *Cydonia oblonga*, *Eugenia* spp., *Feijoa sellowiana*, *Ficus* spp., *Jacaranda mimosifolia*, *Macadamia integrifolia*, *Malpighia* spp., *Phoenix dactylifera*, *Pistacia vera*, *Pyrus* spp. and *Ricinus communis*.

TABLE 14
Nectar-producing species for agricultural land, roadside plantings and urban areas

Tree name	Pollen	Food	Fodder	Fuel	Timber	Land	Ornamental	Others
Anacardium occidentale	(P)	Fo		Fu	Ti			+4
Antigonon leptopus	P	Fo					Or	
Azadirachta indica	(P)	Fo	Fd	Fu	Ti	La	Or	+4
Carica papaya	(P)	Fo						+3
Cassia siamea	(P)		Fd	Fu	Ti	La	Or	+1
Castanea spp.	P	Fo			Ti		Or	
Ceiba pentandra	P	Fo	Fd		Ti	La	Or	+1
Citrus spp.	P	Fo					Or	+3
Cocos nucifera	P	Fo	Fd		Ti		Or	+3
Correa spp.	(P)	Fo	Fd			La		
Diospyros spp.	-	Fo			Ti			+3
Durio zibethinus	(P)	Fo						
Elaeis guineensis	P	Fo	Fd	Fu				+2
Eucalyptus spp.	P		Fd	Fu	Ti	La	Or	+6
Euphoria longana	-	Fo						
Gliricidia sepium	-	Fo	Fd	Fu	Ti	La	Or	+3
Grevillea spp.	(P)			Fu	Ti	La	Or	
Litchi chinensis	(P)	Fo						
Malus spp.	P	Fo						
Mangifera indica	P	Fo				La	Or	
Melicoccus bijuga	-	Fa				La		
Moringa oleifera	P	Fo				La	Or	+3
Musa spp.	P	Fa						+1
Nephelium lappaceum	(P)	Fo						+1
Persea americana	(P)	Fa						
Prosopis spp.	P	Fo	Fd	Fu	Ti	La	Or	+2
Prunus spp.	(P)	Fo					Or	
Psidium guajava	P	Fo			Ti			+3
Roystonea regia	P		Fd			La	Or	
Sapindus detergens	(P)					La	Or	+3
Schinus terebinthifolius	-	Fo	Fd		Ti	La	Or	+3
Syzygium spp.	(P)	Fo	Fd	Fu	Ti	La	Or	+4
Tamarindus indica	P	Fo	Fd	Fu	Ti	La	Or	+3
Terminalia arjuna	(P)			Fu	Ti	La	Or	+3
Tilia spp.	(P)				Ti	La	Or	+2
Toona ciliata	(P)		Fd		Ti		Or	+2
Ziziphus spp.	(P)	Fo	Fd	Fu	Ti	La		+3

TABLE 15
Nectar-producing species for commercial plantation

Tree name	Pollen	Food Fodder		Fuel	Timber	Land	Ornamental-	Others
Anacardium occidentale	(P)	Fo		Fu	Ti			+4
Ceiba pentandra	P	Fo	Fd		Ti	La	Or	+1
Citrus spp.	P	Fo					Or	+3
Cocos nucifera	P	Fo	Fd		Ti		Or	+3
Coffea spp.	(P)	Fo	Fd			La		
Dalbergia sissoo	-		Fd	Fu	Ti	La	Or	
Elaeis guineensis	P	Fo	Fd	Fu				+2
Eucalyptus spp.	P		Fd	Fu	Ti	La	Or	+6
Gmelina arborea	P			Fu	Ti			+1
Hevea brasiliensis	-							+2
Manihot glaziovii	(P)					La	Or	+1
Musa spp.	P	Fo						+1

Other good nectar producers for possible plantation use: *Albizia falcataria*, *Balanites aegyptiaca*, *Cordia* spp., *Leucaena leucocephala*, *Melia azadirachta*, *Sclerocarya caffra*, *Shorea robusta*, *Tamarindus indica*, and *Ziziphus abyssinica*.

BEEKEEPING IN MANGROVES

Mangrove is highly specialized coastal forest growing only in brackish or salt water in tropical and subtropical regions, and covering more than 70 percent of the tropical and subtropical coastlines. Different mangrove species form zones in the inter-tidal region or even beyond, they protect and stabilize low-lying coastal land and provide protection and food sources for estuarine and coastal fishery food chains. Mangroves serve as feeding, breeding, and nursery grounds for a variety of fish, shellfish, birds and other wildlife. In America and West Africa, the red mangrove (*Rhizophora mangle*) forms the outermost zone. These red mangrove trees have prop roots that provide attachment surfaces for oysters and other organisms, and protection for crabs and fish. Other mangrove species are the white mangrove (*Laguncularia racemosa*), black mangrove (*Avicennia germinans*), and buttonwood (*Conocarpus erectus*). These species are distantly related and are only grouped based on their similar ecological functions within mangroves. In Asia, the red mangrove is formed by *Rhizophora mucronata* and *Rhizophora conjugate*. The black mangrove (*Avicennia nitida*) forms a zone nearer the shore, with its roots sticking up vertically above the mud. Here the soils are exposed to the air at low tide, but covered at high tide. The highest trees in the mangrove can be over 40 metres tall, but usually mangrove trees rarely exceed 10 metres.

The ecological importance of the mangrove is huge. It prevents coastal erosion, and mangroves produce significant leaf litter that benefits estuarine food chains: many depend upon the continuously dropped evergreen leaves from the mangrove vegetation. Mangrove creates an important protection, foraging and breeding area for birds, fish, mussels, crabs, manatees and dugongs. Mangrove vegetation is threatened by man. Every year the world area of mangrove is diminished because the vegetation is cut for termite resistant timber and firewood and to give room for rice fields, shrimp farms, tourism and other human activities. Destruction of mangrove has been one of the factors, along with removal of coral reefs and coastal dunes, which lead to the massive coastal destruction and loss of life in South India, Sri Lanka, Thailand and Indonesia following the December 2004 Tsunami.

The black mangrove *Avicennia germinans* is also known as the honey mangrove. It has small white flowers that produce abundant nectar. There is little research on the relationship between bees and mangrove, however from observation of the type of pollen, nectar and scent, it appears that mangrove species are dependent upon bee pollination, and mangrove provides excellent forage for bees and significant honey crops (Hogarth, 1999; Lacerda, 2002). In Florida the main species for pollen and nectar production are the black mangrove *Avicennia germinans*, buttonbush (*Conocarpus erectus*), and white mangrove (*Laguncularia racemosa*) (Stanford, 1983). Local beekeepers also regard the red mangrove (*Rhizophora mangle*) as contributing to the nectar producing species of importance for beekeeping. Many beekeepers in Florida migrate their hives between the citrus growing areas in central Florida and the mangrove areas, with the mangrove honey season extending from mid May to early August. Average honey production from the mangrove is 35-40 kilogram per colony (Hamilton and Snedaker, 1984). In Cuba, there is a tradition of moving thousands of bee colonies to mangrove during its long blooming season. Mangrove areas have high potential for honey production: this can be seen also from the high numbers of honey hunters visiting mangrove in some countries, unfortunately often using destructive methods of harvesting, for example as seen in the Sundarbans of Bangladesh (Burgett, 2000).

When mangrove occurs near dry areas, for example such as in West Africa where the Rivers of Gambia and Senegal are lined with mangrove vegetation and extend inland for 150 kilometres, the mangrove provides some of the best flowering forage available to bees. In this area, mangrove is considered by local beekeepers to be one of the best types of vegetation for beekeeping.

Termites and specially adapted ants existing on and in mangrove trees are not a great problem compared to termite and ant problems in the savannah. Hives placed in mangrove are well protected against seasonal bushfires, although they can be difficult to protect from thieves. Between the mangrove trees is black, sticky mud, and it can be a problem to transport and place hives in the area. The hives must be situated above the highest spring tide level, and above the highest level of the river following heavy rain.

CASE STUDY 9 - BEEKEEPING IN THE MANGROVE OF BIJAGOS ISLANDS, GUINEA BISSAU

Ole Hertz

The easiest way to achieve sustainable beekeeping in mangrove is just to harvest the biggest honeycombs from a wild and free-building colony. The necessary equipment is protective clothing, a smoker, a knife, a bucket and some type of bee brush. This type of beekeeping developed as a result of the Danish supported beekeeping project in Bijagos Islands west of Guinea Bissau. The beekeepers look for wild bee colonies in the mangrove and when a new one is found, it is marked as a sign that it belongs to a beekeeper. Because of the protective clothing, the beekeeper (or honey hunter) does not have to kill the bee colony as happened previously. The smoker can be used to move most of the bees away from the honeycombs, which are then carefully cut off, brushed free from the last bees, and transported home to be pressed. One beekeeper can in this way, without any high investment, become the owner of 30 or more bee colonies.

Beekeeping provides one of the few sustainable ways to use mangrove. If the beekeeping is done without harming the bees, it has no negative impact. On the contrary, because of pollination of the trees by foraging bees, beekeeping may exert a positive influence on the forest, and beekeeping extension can be used as a way to protect the mangrove vegetation against being cut. By making the local people aware of the economical potential in mangrove beekeeping, it is easier to protect the vegetation against total destruction from cutting and burning.

8. THE VALUE OF BEES FOR CROP POLLINATION

It is estimated that about one third of all plants or plant products eaten by humans are directly or indirectly dependent on bee pollination. More than half of the world's diet of fat and oil comes from oilseeds such as cotton, rape, sunflower, coconut, groundnut and oil palm. Even though some of these have special pollinators belonging to other types of insects, these plants all depend on, or benefit from bee pollination to some extent. In addition, many food crops and forage for cattle are grown from seeds of insect-pollinated plants. The great value of bees as pollinators has been known for many years, but unfortunately, this knowledge is not widely appreciated and understood.

The value of bee pollination in Western Europe is estimated to be 30-50 times the value of honey and wax harvests in this region. In Africa, bee pollination is sometimes estimated to be 100 times the value of the honey harvest, depending on the type of crop.

In a country like Denmark, about 3,000 tonnes of honey is harvested every year. It has a value of 60 million DKK or about €7.6 million. However, the value of oilseeds, fruits and berries created by the pollination work of bees is estimated to be between 1,600 and 3,000 million DKK, equivalent to €200 and €400 million.

Some types of crops have flowers that may only be pollinated during a short period. If such a crop is not pollinated during that time, the flowers will fall and no seeds, berries or fruit will develop. There have to be sufficient numbers of bees in the pollinated crop. This is especially important in crops where the single flower may only be pollinated in a restricted time or in crops where the nectar production, or bee visits only take place during days where the temperature is at a certain level. In such a crop, the pollination in some years has to take place within three or four days. This can be the case in growing white clover seed. The flowers only produce some special smelling products attracting the bees to the flowers when the ground temperature is above 15° C. When the temperature is lower, only a few bees are interested in visiting the clover flowers. It means that the whole pollination work in some years has to be done in a very few days, where thousands of worker bees are needed to do the job. If the farmer does not provide fields with honeybees or other bees for pollination, the whole harvest can fail. In years with plenty of hot days during the blooming season, bumblebees, solitary bees and the few honeybees will have time to do the pollination and the farmer can get a good harvest, even without bringing in pollinating bees. The risk for the farmer is the unpredictability of the weather in temperate areas where white clover is grown for seed production. The white clover flower has evolved so that the bees can reach and collect the nectar. A honeybee can therefore visit 18-20 flowers in one minute.

To measure the need for honeybee pollination, crop areas in Russia with white clover were covered during blooming, so that no bees could enter. In the covered square only one gram of seed was harvested, but in the uncovered area of the same size 331 grams of seeds could be harvested.

Lack of bees for pollination can mean a loss for the farmer of maybe 75 percent of the crop. It is recommended to white clover growers that they provide their fields with two to three colonies per hectare to secure the best pollination. A single coffee flower is only open for three to four days when blooming. If a bee or another insect does not pollinate the flower during these days, it will wither, and no coffee bean will be produced. Clever coffee farmers take care that there are plenty of honeybees or stingless bees for pollination in the farm.

Insect pollination and pollinator protection are not included in most of the training books for agronomists, extension officers and farmers. Many farmers all over the world do not recognize the need for bee pollination and consequently many bees are killed by careless use of pesticides. Even many beekeepers and honey hunters do not know about pollination and cannot inform the farmers about the need for protection of bees.

In Europe, Australia, New Zealand and North America, fruit and berry growers, and white clover growers pay beekeepers to bring bees for pollination in the blooming season. They know this will give a far better chance for a good harvest. Some farmers believe that the beekeeper will get a big honey harvest when moving bees to fields for pollination, and therefore they do not want to pay for the work. However, this is not necessarily the case. The beekeepers often lose many bees when moving hives for pollination purposes, and they often do not get a worthwhile honey harvest from pollination work. It is therefore necessary for beekeepers to be paid for the service. In Denmark, there are rules for payment for pollination concerning the size of the bee colony being rented. It is recommended that there should be at least four combs with unsealed brood, to ensure that bees have to collect a lot of pollen for feeding the brood.

It is sometimes found that the farmer or owner of a plantation wants the beekeeper to pay to place the beekeepers' hives in the farm. If neither beekeepers nor farmers are aware of the pollination value of the bees, this situation will never change. The farmer receives a smaller harvest and the beekeeper does not gain access to a good site for the bees. The pollinatory value of bees, even in the same crop, can vary from one place to another. This is because there are many variables: the temperature, the water table, the other pollinator insects in the environment, and other available forge for bees, etc. For example, opinions differ on the value of bees in coconut pollination: one example from India mentions a double harvest of coconut because of bee pollination.

The best arrangement can be a permanent apiary inside a fenced area of a plantation, to ensure adequate pollination. It can be an agreement between the farmer and the beekeeper, so that the farmer provides the beekeeper with a protected site, and the beekeeper provides the farmer with permanent pollination. The space needed for ten hives would only need to be between 10 and 60 m^2, and this can be any scrap of otherwise unusable land. See Chapter 5 for details of choosing a place for bees. A good place for an apiary is where there is forage for the bees outside the blooming of the crop: if this is the case, the bee colonies will be strong for the crop pollination period.

BEE POLLINATION GIVES BETTER QUALITY AND QUANTITY OF HARVEST

Bee pollination not only results in a higher number of fruits, berries or seeds, it may also give a better quality of produce, and the efficient pollination of flowers may also serve to protect the crops against pests. The better weight due to sufficient pollination arises from the development of all seeds in a fruit. An apple, for example, will only develop all the seeds inside if it has been pollinated by several bees and fully fertilized. It is possible for an apple flower to develop about ten seeds. If all the seeds do not develop, the fruit itself does not develop where the seeds are not developing. This results in poorly shaped apple of low weight. The same can be the case with strawberries, where a fully developed strawberry needs about 21 visits of bees: at least this is the case for the old varieties of strawberries; some new ones are not so dependent on bees. A single strawberry can have 400-500 seeds (or actually small nuts) sitting on the surface of one berry. The higher number of seeds developing fully – the bigger and more even shaped the berry will be.

Research with bilberries showed the following interesting result: in bilberries grown close to an apiary, fertilization and berry production occurred in 89.1 percent of the flowers. In an area without bees, fertilization and berry production was only 47.5 percent. The average weight of a berry was 0.578 grams for the bilberries close to bees, and 0.348 grams without bees. Harvest of berries from 100 flowers was 51.1 grams with bees in the neighbourhood, and only 16.8 grams where the bees were not present.

The bee pollination in *Brassica* oilseed production creates a higher content of oil in the seed. Sufficient bees will also take care that all the plants in the field are pollinated in the same period, so the seeds ripen at the same time. This allows harvest of a uniform crop, with less green and unripe seeds among the ripe ones. That will give the farmer a higher price.

A sufficient number of bees for pollination can also protect the crop against serious pest attacks. A single *Brassica* flower is waiting for pollination and fertilization before it closes and falls off. If bee pollination is needed, yet there are not enough bees present, pollination can take many days. In that time the flower is attacked by different pests eating the pollen, sucking the sap, laying eggs in the flower, or spoiling it in other ways. If there are sufficient bees in the field, the flowers will only have to be open for a short time, and the different pests will not have so much time for their destruction. In that way, adequate numbers of bees ensure rapid and efficient pollination and protect crops against pests.

WHERE TO PLACE HIVES FOR POLLINATION

It is important that colonies of honeybees can be moved quickly to a crop that is ready for pollination. It is not possible to have readily available, high populations of transportable colonies of other pollinating insects, except the small bumblebee colonies used in greenhouse pollination. If honeybees are placed in a crop for pollination, they will be working in the field, even in relatively bad weather, because of the short flying distance. The hives of honeybees have to be moved at night-time or at least when all the bees have returned from foraging. The hive entrance must be closed, and some ventilation provided with a net screen at the top or bottom. When the hive is transported, the bees inside start moving around and produce much heat. If they are moved in the tropics in day-time, they must be kept cool with wet sacks placed over the hives. They always have to be moved with soft and slow movements. It is also recommended to feed the bees with water. If a hive with bees is not handled carefully, or it is too hot during the transport, the temperature inside can become so high that the combs start melting and the whole colony can collapse. The melted wax mixed with honey is extremely attractive for stingless bees, other honeybees and ants and they will start robbing the melted colony as soon as the entrance is opened. The result can be the death or absconding of a good honeybee colony.

When moving bees some forager bees are always lost. Maybe they do not orientate when they fly out in the morning in the new place. If a hive is only moved a few metres the forager bees will return to the place where the hive entrance used to be. When they do not find their hive there any more, they try to enter into other colonies, with the risk of being killed. Therefore colonies should never be moved a distance of less than two kilometres. It is better to have greater distances and longer moving times: then the bees will be more aware that something has happened, and they will orientate when the hive is opened in the new place. If it is necessary to move a colony a shorter distance, it should only be moved one metre a day. It is also possible to tranquilise bees with a special smoke with “laughing gas”. After receiving such a treatment the bees seem to lose their memory and start over with orientation flights after the hive is moved and opened again.

The beekeeper can guide the bees to special crops for pollination. By feeding the colony inside the hive with sugar syrup mixed with flowers from the crop. To a certain degree, this will make the bees search for that scent and find the crop concerned. The feeding has to take place inside the hive to prevent fighting between bees from different colonies. It is important not to spill any sugar water on the ground because it will attract ants to the area.

It is important to place colonies for pollination inside or as near as possible to the crop requiring pollination. If there is another crop also attracting the bees, the hives must be placed so that they have to cross the field the farmer wants pollinated, before they can reach the other attracting crop. If possible, the hives should be spread out within the crop.

If we consider that maximum harvest of seeds or fruits require maximum pollination, it is clear that there is a potential lack of bee colonies in many areas of the world. This lack is much bigger than the number of existing bee colonies, and even if all hives were easy to transport and could be placed in the fields for the most effective use, still there would be a lack of many millions of bee colonies.

WHY HONEYBEES OFTEN ARE THE MOST IMPORTANT CROP POLLINATORS

The effectiveness of honeybees is due to their great number, their social life and their ability to pollinate a broad variety of different flowers. A colony can consist of 20-80 000 bees, and they will normally be visiting flowers over a distance of two kilometres when they are collecting pollen and nectar. If nothing is to find in the neighbourhood, they can fly even seven kilometres. A normal *Apis mellifera* honeybee colony will make up to four million flights a year, where about 100 flowers are visited in each flight. The honeybee's pollination effectiveness also arises from the special constancy to flowers of one species. Scout bees communicate to other bees in the colony which species to visit, and even give small tastes of nectar and scent from that flower.

When the pollen loads of honeybees are investigated, pollen mixed from different species of flowers will only be found in three percent of loads. The rest will be with pollen from just one species. If pollen loads from bumblebees are investigated, about 40 percent of the loads are of mixed pollen. This clearly indicates the flower faithfulness of honeybees.

Honeybees do not waste their time visiting flowers not yet ready for pollination. Some flowers can only be pollinated during a certain time of the day; they guide the bees to come at that time by restricting their nectar production to that time. Individual bees learn when the different flowers produce most nectar and apparently 'remember' it from day to day. As mentioned before, a worker bee remembers "opening hours" for 7-10 different types of flowers.

In Northern Europe, it is estimated that 75 percent of all wild blooming plants depend upon insect pollination, and most of the flowers are pollinated by honeybees and bumblebees. All the crops, fruit trees and wild flowers blooming before midsummer are dependent from visits of bees to be able to develop their seeds, berries and fruits. The economic value of bee pollination in nature and the great ecological importance of that cannot be counted, but for sure, it must be much greater than the economic value of crop pollination.

HOW TO SEE IF A CROP IS ADEQUATELY POLLINATED

It is difficult to give exact numbers for how many colonies a particular crop requires for the best pollination, but at the time of harvest, it can be judged if there have been sufficient bees, and that experience must be used for the next season. At harvest time, a well-pollinated crop has:

- well-shaped fruits;
- well-filled seed pods;
- a uniform seed set; and
- tight clusters of fruits or seeds.

From research and experience, it is possible to recommend a certain number of bee colonies per hectare when growing a crop, but many other factors can influence if it is right. It should be known how many wild colonies or apiaries there are nearby and if there are other fields in the neighbourhood with attractive crops competing for the bees. This estimate is partly a matter of experience.

It is possible to measure the need for bees directly in some crops. In cotton, for example, at the flowering time there should be one honeybee to every ten open cotton flowers to provide adequate pollination. Every time it is possible to count ten flowers when walking in the field, there should be at least one honeybee observed among them. If it is possible to count 20 flowers before one bee is seen, the number of hives for pollination should be doubled.

It is recommended to use between five and 12 colonies of bees for pollination of one hectare with cotton. The case with cotton also illustrates a great problem. Cotton needs many bees for pollination, yet at the same time, cotton is one of tropical crops on which most pesticide is used. Cooperation between farmer and beekeeper is essential if both are to benefit from each other.

TABLE 16
Examples of cultivated plants that need honeybee pollination

Crop	Bee colonies* to 1 ha
Alfalfa (Lucerne) seed	8 colonies or 70 000 leafcutter bees
Apple	4
Apricot	2
Asparagus seed	4
Avocado	5
Bean (Lima)	3
Blackberry	7
Blueberry	8
Cabbage	5
Brassica (canola, oilseed rape)	5
Carrot seed	8
Clover seed (White)	4
Citrus	2
Cotton	8
Cucumber	7
Eggplant	3
Gourds	4
Kiwifruit	8
Mandarin	4
Mango	15
Melon	7
Onion seed	17
Peach and nectarine	2
Pear	4
Pepper (Green, Sweet)	?
Pumpkin, squash, gourd	4
Strawberry	8
Watermelon	5
Safflower	2
Sunflower	2
Onion seeds	36

* Number of colonies refers to colonies of *Apis mellifera.*

USE OF OTHER BEES FOR POLLINATION

Solitary bees play a great role in the pollination of wild plants. They also pollinate many cultivated plants. The sizes of natural populations of solitary bees fluctuate greatly from year to year and from place to place, and this makes them difficult to rely on for the pollination of crops. A few species are utilised by farmers for the pollination of special crops. The availability of suitable nesting places seems to be a regulating factor for many solitary bees and a simple way to increase the bee population is by creating artificial and better nest places. In many countries where industrial farming is dominant, the natural population of solitary bees has declined as their natural habitat was destroyed. Nevertheless, some farmers and beekeepers try to use these bees for agriculture.

The most commonly used solitary bees are Alfalfa leaf cutter bees *Megachile rotundata*, *Osmia* species of bees including *Osmia cornifrons* and others, and Alkali bees *Nomia melanderi*. The bees are solitary, which means that the female bee alone takes care of the next generation. However, these species are all gregarious, meaning that they like to nest close to each other, and that seems to stimulate their activities. Bumblebees *Bombus* spp. are social bees like the honeybees, and are used for specialized pollination work.

The use of all these bees is for pollination only: no honey can be harvested from them. The use and study of solitary bees first started and became an industry in Japan after the Second World War. The problem was that many farmers were lacking bees for pollination because the honeybees had been killed from heavy use of pesticides. Some solitary bees are especially well adapted for pollinating fruit trees. The *Osmia* bees for example, develop so that they emerge just at the blooming time of the trees, and they live as flying adults for just a few weeks. The possibility to spray trees just before and after blooming was one of the ideas behind the great interest in using these bees.

The use of solitary bees for pollination is not a new invention. Farmers in Egypt have long used bundles of dry straw, or rolled straw mats as artificial nests for leaf cutter bees. 'Bringing the "mat-bees" to the fields' was when bundles with larvae and pupae inside were taken from old cultivations where bees are present, to new irrigated areas in the desert to ensure sufficient pollination of new crops of tomatoes, alfalfa and others.

Leafcutter bees *Megachile rotundata* are only half the size of a European *Apis mellifera* honeybee. They are black with white stripes. The males have green eyes when they are young. They occur naturally in the countries around the Mediterranean Sea, and have now been spread to other continents. Leafcutter bees nest in straw or other organic horizontal tunnels with a diameter of about six millimetres and about 10-12 centimetres long. When the bees come out of the straw cell after about 21 days of development (dependent on the temperature), they mate and the females start building new leaf cells inside the straw. The cells are like small hollow cigars made of pieces leaf, and two thirds filled with pollen and honey. When an egg is placed in the cell, it is sealed with other leaf pieces and a new one is built outside the first. There can be 10-13 cells in a row before a new straw is used. When a tunnel is finished and filled with cells, the bee closes the entrance hole with up to 100 round pieces of leaf. This protects against parasitizing wasp and other insects that want to attack the larvae. The eggs in the first two to three cells develop to females, the rest into males. The males develop some days faster than the females, and in that way the tunnel is clear when the female bees are ready to emerge. They prefer to nest in tunnels where the entrance is a little lower than the other end. The females can fly around for about nine weeks, and then they die. The male bees are only flying for about two weeks. Nests can be made artificially from poles with drilled holes six millimetres in diameter, but when working with bigger populations it is necessary to use a nest type where the tunnels can be opened to remove the cells for storing and artificial hatching next year. The farmer can arrange the hatching time, and most of the small parasite wasps can be removed before they are spread to the new breeding place in the field. Leafcutter bees do not need any water throughout their life and they are therefore excellent pollinators in arid areas. The cells with larvae inside can be kept in cool rooms with a temperature of 3-5°C until they are needed for pollination. Then they are placed in a hot room at 30°C with high air moisture, and they will hatch in 17-26 days. These bees are used extensively in Russia, Canada, USA and New Zealand – especially for pollination of alfalfa (lucerne). Canada exports US$1 million worth of leaf cutter bees every year.

Mason or osmia bees are indigenous bees of Europe: the most commonly seen in spring is *Osmia rufa*. The female is reddish brown and at 10-13 millimetres long is a little smaller than the European honeybee. The widespread *Osmia lignaria* is indigenous to North America and has the same size but is darker in colour. The males are more slender than the females in both species. Like leafcutter bees, the females collect pollen in the hairs underneath their bodies.

The life cycles are similar to that of the leafcutter bees, but mason bees make their cells from mud, resin, dung, leaves and petals. They can be attracted to nest in bundles of tubes like bamboo sticks. The preferred diameter of the tunnels is 7-8 millimetres. *Osmia rufa* works at lower temperatures than

Megachile spp. and can be used for very early pollination in greenhouses. The *Osmia* cells are kept in refrigerators at the same temperature as the leafcutter bees. They overwinter in their last pupae stage and can be taken directly from the refrigerator to the greenhouse where they will start to emerge the next day. The *Osmia* bees are highly effective pollinators of fruit trees, and are used for almond tree pollination in California. Much development work still needs to be done with these bees.

Alkali bees are black with yellow bands on the abdomen and a light yellow layer of hair over the whole body. They are of same size as the European Apis *mellifera* honeybee, although more slender. Alkali bees are present in many of the north western states of the USA. Their importance as pollinators of alfalfa was first detected around 1940, and from the 1950s, many seed growers started to build nest places for alkali bees. They are used together with leafcutter bees for pollination of lucerne. The alkali bee has been introduced to France and New Zealand where they are used for pollination. The alkali bee makes nests in the ground: they can make their tunnels very close-up to 540 nests in one square meter. The males emerge from the end of June up to the middle of July, with the females emerging one week later. The females and males mate, and the same day the females start digging a nest tunnel. During the night, the tunnel is finished and the next day the first cell is made and supplied with pollen. The following day the first egg is laid and a new cell constructed. The bee will continue building up to 15-20 cells before she dies. The bees overwinter as prepupae and the development continues when the earth becomes warm again the following spring. The alkali bees require a special soil type for nesting: fine salty sand and clay with a moisture content of 25 percent. Artificial nesting areas can be made by digging a one-metre deep hole – one to 20 acres in size. The bottom is covered with a layer of plastic and on top of that is placed a 15 centimetre layer of fine gravel or sand. On top of that is another layer of about 85 cm with a mixture of fine sand and clay. The top layer is mixed with 2-5 kilograms of salt per square meter, to draw the moisture from the bottom layer. The bottom layer is supplied with water to a certain height. A simpler system has been developed with plastic drain tubes supplying the nesting ground with water. Salt is just sprayed on the surface of the ground. Bees can be transferred from one nest place to a new one by transplanting blocks with over wintering pupae. One acre with one million alkali bee nests can pollinate 200 acres of alfalfa.

Small bumblebee colonies are most often used in greenhouses. As with the solitary bees there are no problems with stinging, and people working in the greenhouses prefer bumblebees to fly around instead of honeybees. Cardboard nest boxes with bumblebees can be bought every spring for greenhouse pollination. A box with a colony consists of one queen and about 20 workers in the beginning. The price for the farmer is about €130 (2003), bought from the Netherlands. It has been a significant business in Southern Europe to catch bumble queens during spring for export to the Netherlands or other European countries, but this activity has damaged local populations of wild bumblebees in many places.

PESTICIDES

Bees are living hazardous lives, as farmers all over the world use more synthetic pesticides. Environmental pollution by pesticides continues as an increasing problem, especially in the tropics and subtropics. It arises from the development of large-scale cultivation of single crops or monocultures. The increased use of exotic cultivars of crops is often accompanied by increased use of pesticides. When these plants are growing under new environmental conditions they are often attacked by pests to which they are not adapted, and that problem is often approached by using more pesticides. When bees are in agricultural areas, they often collect their nectar and pollen from cultivated plants – from fields with oil seeds, orchards or vegetable gardens. Farmers are treating these same areas with pesticides and herbicides. Most of these chemicals are poisonous for bees and some are extremely dangerous both for bees and for people. If they are spread even in very small amounts over a blooming field, they can result in serious destruction of many bee colonies.

Some types of pesticides only show their negative effects after a long time or with great doses, but synthetic pesticides can never be used without any risk. Even if they do not kill the bees, they can disturb the normal function of the colony, for example by causing bees to lose their ability to orientate correctly, or to communicate.

We often find heavy use of pesticides in small vegetable gardens, producing food for the family and the local market. The use of pesticides should be banned in these places, because it poisons people eating the sprayed products, and because the local drinking water and other food were contaminated.

Herbicides (used against fungus and weeds) are often thought to be of no danger for bees, but that is not true. If the bees have no fresh water close to the hive or nest, they will collect dew in the morning on the leaves of grasses or other crops, independent of any flowers around. If such a crop has been sprayed, the bees can be poisoned as they are collecting their water.

To prevent this from happening the beekeeper should always provide the apiary with fresh water. It can be given in a tin can with sticks or grass inside where the bees can sit and drink without drowning. If monkeys are a problem because they want the water, the tin can should be secured to a tree or pole and covered with a metal net. The water source must never become dry, as then the bees will immediately start looking for water in another place. Ensuring an apiary always has water has other good functions. The bees do not need to use so much energy for fetching water and can make more honey instead, and if they always have water nearby, they do not disturb people at the wells, who may step on the bees with bare feet.

In Denmark, there was a case where a farmer poisoning the bees around his fields was forced to pay compensation to other oilseed and white clover farmers, because they also suffered because of the lack of pollinating bees. In Denmark, it is forbidden to use dangerous pesticides in blooming crops, and there are laws in many countries against the use of insecticides in flowering fields. If bees are killed by a farmer using pesticides illegally, the farmer must pay compensation to the beekeeper. If the beekeeper has not supplied the apiary with water, it can be a problem to receive the compensation. In one case a farmer who killed many bees by spraying carelessly, had to pay compensation to several beekeepers, but also to the neighbouring seed growers – because their harvests were diminished due to the lack of bees in the area.

Many pesticides forbidden in the industrialized countries are dumped in developing countries: i.e. companies selling their stocks of pesticides to developing countries after the product has been forbidden in Europe or in North America. An estimated one third of all pesticides used in the developing countries do not fulfil international standards for security. FAO has declared that this is a serious danger for the health of people and the environment.

Instead of paying for safe destruction of the pesticides these companies can receive support for exporting them. Even when selling the products at a very low price this is better business for the company than safe storing or destruction. Some of these products have a bad quality and contain chemicals leading to fatal accidents if not used very carefully.

A great problem in developing countries is bad labelling of products. Often the farmer receives a pesticide in old bottles or plastic bags without any hazard warning sign. There are also cases where pesticides containing DDT have been sold as a harmless natural product. When pesticides are delivered in second hand food containers like cola bottles or sugar bags, this results in people accidentally drinking or eating the poison. Often pesticide containers are subsequently used for rainwater containers, and people are poisoned in that way.

Some pesticide producers are more interested in selling their products, than in giving information concerning the dangers of using them. In developing countries, it is often easy to get hold of cheap pesticides, but often impossible to get sufficient protective equipment for use of the person spraying. Some tropical honey hunters have the idea that insecticides made for killing flies and mosquitoes can be used in honey hunting. Instead of using fire and burning the bees, they now use the spray. The honey gets a nice smell of perfume and does not smell from smoke, and they do not know that people eating this honey can be very ill – and even die. The poisoned honey is sold in second hand bottles in the market and the costumers cannot see if the honey is from a beekeeper or a honey hunter. It should be the responsibility of the producer to take care that the product is used in a way as safe as possible for the farmer. Many farmers in the developing countries cannot read a label, but it is possible by using drawings to inform about their use and danger. There are groups of tropical farmers acting against the import of dangerous and (in industrialized countries) forbidden pesticides, but the lobby of the producers has until now succeeded in preventing such a ban.

HOW TO SEE IF BEES ARE POISONED BY PESTICIDES

The skilled beekeeper will soon know that something is wrong if he or she visits the apiary after bees have been poisoned by pesticides. Among the symptoms are:

- Dead worker bees accumulating at the hive entrance. They will usually represent 10-20 percent of the total number of bees being killed, but ants will often remove them very quickly. The rest of the poisoned foraging bees die in the field.
- The bees are becoming agitated and aggressive – caused by many types of poisons, but especially evident with Lindane and organophosphorus compounds.
- The bee colonies are producing loud and angry sounds, and the bees are showing stressed and nervous behaviour, frantically running around on the surface of the hive.
- If the hive is opened, it is possible to see hive bees performing the special “alarm dance”. The returning bees and some of the hive bees run around on the combs in spirals or irregular zigzags. This can stop proper flight activities completely for some time. On the landing board or around the entrance, bees will perform abnormal communication dances.
- Bees will be crawling around on the ground in front of the hive, unable to fly, sometimes for three days before they die, if they are not eaten by ants. Some bees will lay spinning on their back.
- Many of the bees killed by poison will have their tongue extended.
- Especially associated with exposure to organophosphorus insecticides, there will be a regurgitating of the stomach contents.
- Dead and dying light coloured young and newly emerged bees will be seen. That is a sure sign of pollen contamination.
- Some time after the poisoning, the queen will produce only drone eggs. There may be other reasons for that as well, but it will lead to the death of the colony.

Sometimes all bees in a colony die immediately, but often the bees will survive for some time before they die. A poisoned bee colony will lose its forager bees, and most of the young bees will die after some time, because they eat the contaminated pollen in order to produce the “bee milk”. This means that no bees are cleaning the empty cells for egg lying, and there are no bees to feed the larvae. After the storage in the comb, the pollen can remain toxic to bees for the next eight months or even a year. Usually the queen will be superseded within the first 30 days after the poisoning, or the colony becomes queenless. When there is a lack of pollen, the hive bees will start feeding on the eggs, but when there are no eggs or young larvae present, the workers can no longer rear a new queen.

HOW TO PROTECT YOUR BEES AGAINST PESTICIDES

The beekeeper can help reduce bee poisoning in different ways:

Bees can be kept at a distance safe from areas where pesticides are being applied. This must be at least seven kilometres to be quite sure. In that case, the farmer gets no pollination from the bees. The beekeeper and farmer can co-operate. If the beekeepers learn about different pesticides and their use, they can discuss with farmers, warn them against the most dangerous pesticides and develop beneficial agreements concerning pollination services and the prudent use of pesticides. It will often be an advance if the beekeepers have an organization, which can help in negotiating with farmers or authorities.

Bees can be moved away before the spraying takes place, and be kept away as long as the poison is still active in the flowers. If pesticides are used on flowering plants, near the hives, and it is too difficult to move the hives away, the bees can be confined inside the hives. That can be done by closing the entrance with a net and cover the hive by large burlap sacks. In hot areas or hot days, it is necessary to put water on the sacks to cool the bees. The bees should also be provided with water inside the hive, so that they are able to cool the brood.

It may be necessary to apply water to the sackings every one to three hours to keep the colony sufficiently cool during the day in the tropics. If the hives are placed in shade, and the sacking is kept wet, the bees can be covered for up to two days in the tropics. Overheating of a colony of bees may lead to rapid death, as described in connecting with movement of bees. Larger colonies are more sensitive to overheating than small, and it is important that there is plenty of space and good ventilation in the hive.

If the bees are near a water pipe, it can be possible to keep them inside the hive by constantly sprinkling them. Make an agreement with the farmer, so that he or she does not spray in flowering crops or at least that does not spray in daytime when the bees are working in the field. The spraying should only take place during late evening or night. Tell the farmer, that there are some repellent insecticides with a smell that makes bees abandon the flower instantly.

ALTERNATIVES TO PESTICIDES

In discussions with farmers, it can be useful to know that there are alternatives to pesticides – at least in small-scale farming. When using pesticides, a detailed knowledge of the life cycle of the pest is necessary. A pesticide used at the wrong time, in the wrong place and in a wrong manner, can be more harmful than not using it. Wrong use of an insecticide can kill the pest for a while, but it also kills many enemies of the pest. After some time, the pest population will recover, but then there will only be a few natural predators left to eat the pest, because they normally do not recover as fast as the pest. Now the pest population can grow even larger. Then even more insecticides are needed and after some time it often happens that the pest develops resistance to the chemicals, and new, stronger and more expensive pesticides must be bought. It can continue in this way until so much poison has been used, that the environment is spoiled or the farmer ruined. That is what happened in Central America in the cotton growing areas, where the crop had to be sprayed 44 times during the growth. The cotton growing had to stop, and the areas was used for cattle, but the environment was so polluted that the export of the cattle meat to the United States was stopped.

If pesticides have to be used, it must be done in combination with other ways of fighting pests. Often the local farmers have traditional knowledge of how to live with or fight pests, and many of these methods seem to work. In reality, most pesticides used in the tropics are for export crops, and in that way some of the poison returns to the industrialized countries, where they were produced.

There are many ways of controlling crop pests without using imported pesticides. Local conditions are of importance but some few activities useful in gardening and small-scale farming can be mentioned here.

- Make sure that the cultivated plants are properly nourished. Too much or too little fertilizer, water or sun can cause aphid attack.
- Plants can be grown as mixed crops, so that the pest or disease cannot spread so easily as in a monocrop, e.g. maize intercropped with cassava reduces the spread of cassava bacteria wilt.
- Planting with the right density can prevent some pests. For example, groundnut should be sown close to prevent aphid attack to the lower part of the plants.
- All infested fruits or tubers have to be removed from the field, so that pests from them cannot develop a new generation.
- Do not let leaves or fruits touch the ground.
- Prevent flow, splash or runoff of water from infected plants to healthy ones.
- Rotate the cultivation of different plants. Crop rotation is very unfavourable to nematodes.
- Always use healthy seeds, plants or potatoes when starting a new plant generation.
- If possible use resistant plant varieties, e.g. some of the old types of millet in West Africa are better protected against birds and beetles because of their sticky hair.

- Self-made natural products can be used to fight pests without them developing a resistance, e.g. fine ashes to prevent leaf chewing insects. The juice of tobacco stems is poisonous to aphids; vegetable oil or fatty soaps mixed with water combats aphids; earth mixed with salt prevents termites to spoil poles (for a time).
- Do proper weeding and destruction of infested plants. If possible, use the weeds in compost making, so that the high temperature will destroy germs of diseases and pests eggs before the material is returned to the fields.
- Try to organize fields in an environment providing a habitat for a great variety of the farmer's natural allies, such as insect eating birds, spiders, wasps, etc. When clearing new land some areas of trees and bushes should be left between fields.
- Make some biological control. This means to import or cultivate the natural enemies of a pest. It could be parasitic wasps, or by using harmless bacteria which only attack worms and do not poison other creatures.

COOPERATION BETWEEN FARMERS AND BEEKEEPERS

In the recent years, there has been an increasing amount of data concerning the harvest of seeds in bee-pollinated crops. Some crop failures may be incorrectly blamed on poor soil, pests or drought, when in fact the real cause is lack of bees in sufficient numbers to pollinate the crop. Data shows that it is necessary to do something more to protect the pollinating insects, and to continue the study of how they are used in the best way. Use of bees for pollinating crops is to a certain degree developed in Europe, North America, Australia, Japan and New Zealand, but in many countries (also in Europe) the bees are not used effectively, partly because of lack of knowledge and partly because the hives are so big and heavy that they are difficult to transfer to a field.

Knowledge of bee pollination can be so small that farmers try to get rid of the useful bees by using smoke among their orange trees and coffee bushes. They wrongly think the bees are spoiling the flowers, while they actually are helping the farmer.

To help farmers obtain better harvests and to protect the beekeepers' bees, it is necessary to have much more information about the need for bees for pollination of special crops. If the beekeeper is informed, he or she must inform the farmers so that they also take care when using pesticides. If farmers and beekeepers cooperate, it is possible to a certain degree to protect the bees against the chemicals.

MAIN TYPES OF PESTICIDES

Pesticides kill by direct contact, stomach poisoning or fumigation. There are eight main types of pesticides. The most dangerous pesticides for bees are among the insecticides, but some of the other pesticides harm them too. Most insecticides are dangerous for people as well as bees.

TABLE 17
Main types of pesticides

Main types of pesticides	Kill
Rodenticides	Rats and mice
Fungicides	Fungi
Miticides/acaricides	Mites
Herbicides	Plants
Insecticides There are four major groups of insecticides: Chlorinated hydrocarbons (organochlorines) Organophosphates (organophosphorus) Carbamates Pyrethroides	Insects
Nematicides	Nematodes
Molluscicides	Molluscs, slugs, snails
Bactericides	Bacteria in humans and other animals

9. DEFINITION AND USES OF HONEY

WHAT HONEY IS

Bees make honey from the nectar that they collect from flowers, other plant saps and honeydew are used to a minor extent. The colour, aroma and consistency of honey all depend upon which flowers the bees have been foraging. Forager honeybees are always female worker bees. The queen bee and drone bees never forage for food.

After visiting a flower, the foraging honeybee flies back to her nest that may be in a hollow tree or other natural cavity, or inside a man-made hive. The nectar that she collected from the flower is carried in her honey sac, a modified part of the gut. Once inside the nest, she regurgitates the fluid and passes it through her mouth to one or more 'house' bees, which in turn swallow it and regurgitate it. As each bee sucks the liquid up through her proboscis and into her honey sac, a small amount of protein becomes added and water is evaporated. The proteins added by the bees are enzymes, which convert sugars in the nectar into different types of sugars. The liquid travels through a chain of bees in this way before it is placed in a cell of honeycomb. After the liquid has been placed in the cell, bees continue to process it, and further water evaporates as they do so. The temperature of the nest near the honey storage area is usually around 35 °C. This temperature, and the ventilation produced by fanning bees, causes further evaporation of water from the honey. When the water content is less than 20 percent, the bees seal the cell with a wax capping: the honey is now considered 'ripe' and will not ferment. The bees have prepared for themselves a concentrated food store, packed in minimal space that can be stored until they need it during any future period with no flowers, or winter period ahead. The honey has been produced and stored in such a way that it will not significantly deteriorate in quality – it will not go mouldy, and there will be no problem of fermentation during storage.

BOX 10
Definitions of honey according to the Codex Alimentarius and the EU[13]

Definition of honey according to Codex Alimentarius
Honey is the natural sweet substance, produced by honeybees from the nectar of plants or from secretions of living parts of plants, or excretions of plant-sucking insects on the living parts of plants, which the bees collect, transform by combining with specific substances of their own, deposit, dehydrate, store and leave in honeycombs to ripen and mature.

Definition of honey according to the EU
Honey is the natural sweet substance, produced by *Apis mellifera* bees from the nectar of plants or from secretions of living parts of plants, or excretions of plant-sucking insects on the living parts of plants, which the bees collect, transform by combining with specific substances of their own, deposit, dehydrate, store and leave in honeycombs to ripen and mature.

The EU definition states that honey is only honey according to the definition when it is produced by *Apis mellifera* honeybees.

FORAGING BY BEES

Bees commonly forage on flowers within two kilometres of their nest, although they can travel much further – bees have been recorded foraging 14.4 kilometres from their home, and foraging distances of five kilometres are common (Ratnieks, 2002). Assuming a foraging range of just two kilometres, the honey produced in one hive may have therefore come from flowers in an area of 12.6 square kilometres. How bees detect flowering plants and make decisions about which plants the colony should use is very complex and interesting – but beyond the scope of this book. Foraging strategy involves honeybees communicating foraging information to one another, recruiting other bees to join in, changing from nectar-gathering to pollen – or water-gathering, making decisions to change to new foraging sources, and taking many other decisions about how to most efficiently exploit available forage resources so as to meet the colony's constantly changing requirements.

[13] Codex Alimentarius (2001) Draft revised standard for honey. Alinorm 01/25 19-26. and EU Council (2002) Council Directive 2001/11 O/EC of 20 December 2001 relating to honey. Official Journal of the European Communities L10, 47-52.

To produce one kilogram of surplus honey requires bees to visit several million flowers and to fly a total flight path equal in distance to six orbits around the earth!

THE USES OF HONEY

For bees

Bees produce honey to act as a food store for the colony for periods when there are no flowers, or the climate is adverse. For example, during the winters of northern, temperate countries, few plants are flowering between October and March, and bee colonies need honey stores to survive throughout this flowering dearth period, and when it may be too cold to leave the nest. In tropical countries, bees need to survive through seasons when there are no flowers, periods of drought, or when bees are not able to forage because of rain or other adverse weather.

As food for humans

Honey is a useful source of high-carbohydrate food, and usually contains a rich diversity of minor constituents (minerals, proteins, vitamins and others), adding nutritional variety to human diets.

TABLE 18
Energy value of honey

Energy value	3,040 kcal/kg
Sweetness	High
Sugar content	80%
Minerals, protein, enzymes	Very little, but valuable

As a medicine or tonic

In many countries, honey is regarded more as a medicine or special tonic, rather than as an every-day food. Honey does have medicinal properties that are acknowledged increasingly by modern medicine. Read more about this in Chapter 12.

Other uses

Honey is widely used as a source of sugars for making honey wines and beers, and in the manufacture of many secondary products: breakfast cereals, bakery goods, and a multitude of other value-added products. Read more in Chapter 13.

CHARACTERISTICS OF HONEY

Granulated honey

Glucose is one of the major constituents of honey and when this crystallises the honey becomes solid, known as granulated honey. Granulation is a natural process and there is no difference in nutritional value between solid and liquid honey. This process may be likened to ice and water – liquid honey and granulated honey is the same substance but in a different form.

Some honeys are much more prone to granulation than others are, and almost all honey will granulate if its temperature is reduced. As with the colour of honey, different people favour different qualities: some prefer granulated honey while others choose liquid honey. If honey is required in the granulated form, but it is slow to granulate, it is possible to start the granulation process by ‘seeding’ it by adding some finely granulated honey and stirring this in until it is evenly distributed. The honey will now granulate if kept at a low temperature.

If a jar of granulated honey is required in the liquid form, stand it up to its neck in a container of warm water (60 °C) – it should soon liquefy. However, heating honey always reduces its quality by destroying its enzymes, evaporating volatile compounds and therefore reducing the flavour.

The following factors are important for rapid granulation:

- temperature below 15 °C;
- high concentration of glucose; and
- availability of nuclei to act as seeds to start the process of crystallisation (e.g. pollen or existing crystals).

Honey quality

It does not matter where they are living – in their own nest built in the wild or in any type of hive – bees always store clean and perfect honey. The place where they live has no effect upon the quality of honey that bees make. It is only subsequent handling by humans that leads to reduction in quality; if the honey is harvested when the water content is still too high (honey is still 'unripe'), if it is contaminated, over-heated, over-filtered or spoiled in any other way.

Quality – according to the consumer

For the consumer of honey, the important features of honey are its aroma, flavour, colour and consistency, all of which depend upon the species of plants being visited by the bees. For example, bees foraging on sunflower will produce a golden honey that granulates (crystallises) quite quickly, while bees foraging on avocado produce a dark honey that remains liquid over a long period. The factors of aroma and flavour of honey are subjective, and honey is often judged according to its colour. Usually dark-coloured honeys have a strong flavour while pale honeys have a more delicate flavour. A great number of different substances (alcohols, aldehydes, organic acids, and esters) contribute to the flavour of honey. These are volatile compounds and evaporate easily at temperatures above 35 °C: this is one of the reasons why honey quality is reduced by heat.

It is impossible to give a comparable value to the subjective values of flavour and aroma: the relative popularity of dark and light coloured honey varies from country to country. Colour can sometimes be a useful indicator of quality because honey becomes darker during storage, and heating will darken honey. However, many perfectly fresh, unheated and uncontaminated honeys can be very dark.

Quality – according to trade criteria

Honey is not a simple commodity with a single, standard composition. It is a product that is harvested and marketed in nearly every country, and marketed globally, yet there is no single, international standard for honey quality. Nations and market regions set their own criteria for honey, defining what honey is, and what its composition should be (see Definitions of honey above, and Honey legislation below). This can make honey marketing very difficult for exporters. Honey is a natural product, produced by different bees in widely differing vegetation zones and climates worldwide. Honey content can vary greatly even within one nation, let alone between regions and continents. Inevitably, attempts to define honey have proved imperfect to characterise all honeys.

Currently a major issue of concern for the world honey market is contamination of honeys with the residues of medicines used to control bee diseases (see below). The best way forward for the honey trade may be, rather than to attempt to define exactly what honey should be, to focus on defining only the non-permitted constituents of honey. The EU has the most stringent honey quality requirements: honey is not permitted to contain any trace of antibiotic. In the US, some trace levels of antibiotics are permitted.

Colour

Colour of honey is measured using a "Pfund grader" (named after the inventor Dr Pfund). In this instrument, a sample of the honey is placed in a wedge-shaped glass container. (Only liquid honey can be graded for colour; granulated honey must first be liquefied). The sample is viewed through a narrow slit and the "wedge" of honey moved until the density of colour visible through the slit matches with a piece of standard amber-coloured glass. A scale on the instrument gives a numerical value for the colour of the honey, and using this, the colour category of the honey can be determined. Colour descriptions range from "water white" through shades of amber to dark.

Honey categories

Honey may be categorised according to its origin, the way it has been harvested and processed, and its intended use.

HONEY CATEGORIES CONCERNING ORIGIN

Blossom honey is obtained predominantly from the nectar of flowers (as opposed to honeydew honey).

Honeydew honey is produced by bees after they collect 'honeydew' – secretions of insects belonging to the genus *Rhynchota*, which pierce plant cells, ingest plant sap and then secrete it again. Honeydew honey colour varies from very light brown or greenish to almost black, and is an important type of honey for producers in coniferous forest areas of Central and Eastern Europe. Honeydew honey is very highly valued in these countries, and for example in Slovenia, beekeepers transport their bees to forests to forage for honeydew. Fir and spruce trees produce honeydew regularly each year, yet in each place differently. A well-organised, computer-based service for predicting the appearance of honeydew on forest trees provides migratory beekeepers with accurate information on the locations and intensities of the flow. Each year, several observation hives located in Slovene forests provide information on the quantities of honey collected by bees in certain periods. Based on such data, beekeepers decide where and when they will take their bees to forage. They use lorries, trailers and containers into which their hives are stacked like dominoes.

Monofloral honey is where the bees have been foraging predominantly on one type of plant, and is named according to that plant. Common monofloral honey types are clover, *Acacia*, lime (linden) and sunflower honey. Monofloral honey is priced more highly than polyfloral honey. Light, monofloral honeys like orange blossom or *Acacia* – because they look so attractive – always obtain higher prices then blends of honeys.

Multifloral honey (also known as polyfloral) has several botanical sources, none of which is predominant, for example, meadow blossom honey and forest honey.

HONEY CATEGORIES CONCERNING PROCESSING

Comb honey is pieces of honeycomb, as produced by the bees, where the beekeeper has done no processing to separate the honey from the beeswax. The beeswax comb, as well as the honey, is edible. Comb honey always fetches a very good price, as the consumer can be sure that the honey has not been contaminated in any way. Ironically, this can be one of the easiest forms of honey to harvest and prepare for sale (see below).

Strained honey is honey obtained by straining honeycombs, to separate the honey from the beeswax.

Chunk honey is a jar of liquid honey inside which is placed a piece of comb honey. This can look very attractive. It is important that the liquid honey is a type that is very light and clear, and will not granulate over a long period. Honeys from *Acacia* and *Robinia pseudoacacia* are often used for this. This type of product depends on the right type of honeys and excellent packaging, and can achieve a very good price.

Extracted honey is honey obtained by centrifuging honeycombs.

Pressed honey is extracted by pressing honeycombs with or without the application of moderate heat.

Crystallised or granulated honey is strained honey that has crystallised (see below).

Creamed honey is strained honey that has been seeded to start crystallisation and then stirred to produce a honey of uniform, soft consistency. On an industrial scale, honey is creamed by the 'Dyce method' (Dyce, 1975). About 20 percent of fine crystallised honey is mixed with liquid honey and the crystals are allowed to grow at 14 °C. This procedure stabilises the honey consistency, and does not affect the honey's authenticity, as no foreign matter has been added or removed.

HONEY CATEGORIES CONCERNING INTENDED USE (TRADE CATEGORIES)

Table honey means honey intended for consumers, to be eaten directly or as a natural sweetener for drinks or in cooking.

Industrial or bakers' honey is honey that does not meet fully all the criteria for table honey, for example, the hydroxymethylfurfural (HMF) content may be higher than 40 mg/kg, although the regulations allow some exceptions. This may be because it has been heated too much, or it naturally has a high HMF, and is therefore regarded, according to the EU criteria, to be of lower quality than table honey. In this case, it still qualifies for use in the food industry, for the manufacture of bakery goods, confectionery, breakfast cereals, sauces, tobacco, and products such as honey-roasted nuts and pharmaceutical products. About 20 percent of honey on the world market is classified as bakers' honey. Major substitutes for industrial honey are sugar, invert sugar, and corn syrup, but honey is valued because it conveys a message of 'natural value' to manufactured products.

CONSTITUENTS OF HONEY

Honey consists of a mixture of sugars, mostly glucose and fructose (White, 1975). In addition to water (usually 17-20 percent), honey also contains very small amounts of other substances, including minerals, vitamins, proteins and amino acids. A minor, but important component of most honey is pollen. Pollen is carried to the bees' nest (hive) and stored inside it quite separately from nectar, but a few pollen grains find their way into nectar, and eventually into honey. The pollen in honey can be identified using a microscope, and gives a guide to the plants from which bees have been collecting nectar and pollen.

Experts are able to determine the geographical origin of honey by the pollen it contains. This science of melissopalynology requires only an optical microscope for seeing the pollens in honey, and knowledge of the characteristic shapes of pollens that should be present in particular honeys. In many countries, pollen analysis of the locally produced honeys is regularly carried out and the pollen specialists have a precise knowledge of the pollen spectrum of the honeys of their region.

TABLE 19
Major constituents of honey

Major constituents (99%)		
	%	**Mean (%)**
Water	13.4-26.6	17.0
Fructose	21.7-53.9	39.3
Glucose	20.4-44.4	32.9
Sucrose	0.0-7.6	2.3
Other sugars	0.1-16.0	8.5
Minor constituents (1%)		
	% of 1%	
Acids (gluconic)	0.17-1.17	
Minerals		0.02-1.03
Nitrogen (protein)		0.00-0.13
Enzymes		>0.1%
Aroma		>0.1%
Others (HMF, etc.)		>0.1%

The 'ash' content of honey is mainly mineral trace elements. Minerals present are calcium, copper, iron, magnesium, manganese, potassium, sodium, and chlorides, phosphates, silicates and sulphates. Dark honeys are often very rich in minerals, but variation in the mineral content of different honeys is great. These trace amounts of minerals may be important for human nutrition.

Other constituents
Some honeys have a very high pollen content that makes them appear cloudy: for example, honey extracted from combs by squeezing often contains a relatively high level of pollen. In some countries this 'unfiltered' honey containing plenty of pollen is sold at a premium price, elsewhere such honey is sometimes thought (wrongly) to be of low quality. The presence of any other contaminants in honey (for example particles of wax, parts of dead bees, and splinters of wood or dust) make the honey of low quality and low value.

HMF
HMF is hydroxymethylfufural, a breakdown product of fructose (one of the main sugars in honey) that is formed slowly and naturally during the storage of honey, and much more quickly when honey is heated. The amount of HMF present in honey is the reference used as a guide to the amount of heating that has taken place: the higher the HMF value, the lower the quality of the honey is considered to be. Some countries set an HMF limit for imported honey (sometimes 40 miligrams per kilogram), and honey with an HMF value higher than this limit will not be accepted. However, some honeys have a naturally high HMF level. HMF is measured by laboratory tests.

Enzymes
The levels of enzymes present in honey are sometimes assayed and used as a guide to honey quality. The enzymes in honey (invertase, glucose oxidase, amylase, etc.) come from the bees, or from the plant where the bee foraged. They are present in very small quantities, but may still have a nutritional importance in the human diet. The enzymes are very sensitive to overheating (above 35 °C) or storage at too high a temperature. Because they are destroyed by heating, a low enzyme level may mean that honey has been heated, but many honeys of good quality are naturally low in enzyme content.

Water
The water content of honey can naturally be as low as 13 percent or as high as 23 percent depending on the source of the honey, climatic conditions and other factors. If the water content of honey is greater than 20 percent then the honey is likely to ferment. Low water content is therefore most important. Water content is measured using a honey refractometer, a small instrument that measures the refraction of light as it passes through a glass prism on which a few drops of honey have been smeared. In areas of high humidity, it can be difficult to produce honey of sufficiently low water content.

Different countries set different values for acceptable water content of honey. The Codex Alimentarius and EU regulations set a level of 20 percent, with exceptions for bakers' honey and heather honey. US regulations state 18.6 percent. International honey buyers often insist on lower water levels, typically 17 percent, in order to buy a reduced volume of water. The above information relates to honey from honeybees. Honey from stingless bees (see Chapter 5) usually has relatively high water content (23-24 percent), yet does not ferment.

OTHER FACTORS CONCERNING HONEY
Acidity
Honey is acidic, usually with a pH within the range 3.7-4.5.

Fermentation
Fermentation of honey is sometimes a problem. The main factors causing fermentation are:

- high moisture content (above 20 percent);
- high temperature; and
- a high yeast count (>10/gram).

Uneven granulation of honey within a container can lead to small pockets with high levels of water, and this may result on fermentation. Honey that has begun to ferment can be used for making into fermented products like beer, wine or vinegar.

Sweetness
Honey sweetness depends on high fructose content and acidity. A few plants give bitter honey: *Agave* sp. (sisal), *Datura* sp., *Euphorbia* sp., *Senecio* sp. – in some societies (for example, in East Africa), these honeys are very popular.

Hygroscopicity
Honey, especially when rich in fructose, is very hygroscopic i.e. it absorbs moisture from the air when the container is not closed. This may lead to an increase in water content and possible fermentation. For this reason is it important that honey is always stored in containers with tight fitting lids.

POST-HARVEST HANDLING
Once harvested, honey need not necessarily require further processing. On a small scale, simple equipment as used in other forms of food preparation is adequate: plastic buckets, bowls, sieves, straining cloths and containers. Honey is a stable commodity with a long shelf life: if harvested carefully and stored in containers with tight-fitting lids, it will remain wholesome for several years.

Honey is a food and it must therefore be handled hygienically, and all equipment must be perfectly clean and without any odour of cleaning materials. Honey processing is inevitably a sticky operation, however, because honey is hygroscopic and will absorb moisture; all honey processing equipment and containers must be completely dry. Any water being added to honey increases the chances of fermentation.

PROCESSING HONEYCOMBS FROM FIXED COMB HIVES OR MOVABLE COMB (TOP-BAR) HIVES
Cut-comb honey
Because the whole comb is harvested from these hives, it is possible to harvest pieces of cut-comb honey for sale this way. Select pieces of comb consisting only of sealed and undamaged honeycomb, cut them into neat portions and package them carefully for sale. Since the honey in the comb is untouched and is readily seen to be pure, honey presented in this way always fetches a good price, and honey that has not been open to the air has a finer flavour than honey that has been subjected to processing in any way. Beekeeping equipment suppliers sell cutters to cut uniform sizes of comb, and plastic boxes with transparent lids for selling cut comb honey. The sharp edge of a tin can can make a useful comb cutter.

Strained honey
Because combs from fixed comb hives or movable comb (top-bar) hives do not have the support of a wooden frame or wired foundation, they would break up in the type of extractor used for frame hives (see below), and the product would be a mixture of honey and fragments of wax.

The simplest way to prepare strained honey is to remove the wax cappings of the honeycomb with a knife, break the combs into pieces, and strain the honey from the wax. Make sure that you do not use unsealed combs containing unripe honey or pollen. Strained honey must not contain any trace of beeswax or other debris. It is best to first use a coarse strainer to remove large particles, and then to use successively finer strainers. Use a cotton cloth, basket, or sieve to strain the honey from the pieces of honeycomb. Collect the honey that strains through in a clean and dry container. Finally squeeze the combs inside a bag made from the cloth to remove as much honey as possible. Do not discard the empty wax comb – it is valuable! Form the wax into a block by melting it gently in a water bath or solar wax extractor (see Chapter 9).

With larger volumes of comb, it may be worthwhile to make or buy a press. This has a container for the pieces of comb and a mechanical device to squeeze them. Some equipment suppliers sell extractors for honeycombs. In these especially modified extractors, the combs are placed in wire mesh baskets that support them securely as they are spun.

PROCESSING HONEYCOMBS FROM FRAME HIVES

Cut-comb honey

To produce cut-comb honey from frame hives it is necessary to use beeswax foundation that does not contain strengthening wires. The wax foundation should also be thinner than that normally used in wired frames. Portions of cut-comb can then be prepared for sale as described for top-bar hives. After the combs are cut, the frames must be refilled with fresh foundation sheets before returning to the hive.

Strained honey

Remove the wax capping from the frames of honeycombs with a long, sharp knife. If the room is cold, then the knife may be one that is heated electrically (obtainable from equipment suppliers), or which has been standing in warm water. In the latter case, it is important to dry the knife before you use it. Hold one end of the top-bar of the frame and rest the other end of the top-bar on a piece of wood placed across a collecting tray, the frame is therefore held at right angles to the tray. Start cutting downwards across the frame, and with a zigzag movement of the knife, cut off the thin layer of wax capping and allow it to fall into the dish below the frame. Turn the frame around and cut off the capping from the other side, and then place the frame in the extractor. Practice makes perfect with this task – the trick is to cut all the wax cappings, but with as little of the honey as possible. Some honey will stick to the wax cappings; do not waste this, but strain it out of the collecting tray. Honey drains slowly from cappings and this process may take over 24 hours.

Honey extracting

A honey extractor is a machine to remove honey from combs in frames by rotating them at high speed so that honey is thrown out of the comb on to the wall of the extractor, and then runs down to the bottom of the drum. Honeycomb built inside a wooden frame is not damaged by this process and when empty, can be returned to the hive. The extractor consists of a metal drum containing holders in which the frames are placed. There is a tap at the base of the container so that the honey can be run out. There are two types of extractor: tangential and radial. The tangential extractor is the most common type, being relatively easily available and appropriate for small-scale beekeeping. The tangential extractor holds two, three or four combs in cages, held at right angles to the radius of the container, and is usually hand operated. Although it sounds complicated, a village blacksmith can make a radial extractor. Plastic bins can be modified to serve as the drum, and parts from bicycles can be used to provide the means for spinning. Radial extractors are larger than tangential ones and often hold up to 20 frames arranged radially inside the cylinder. Radial extractors are usually operated with electric motors.

Honey should always be strained as it runs out of the extractor so that any pieces of wax capping, dead bees or splinters of wood (from frames) are removed.

Storage

Honey is best stored in clean, dry buckets with tight fitting lids. As long as it is kept away from heat, it can be stored this way until it is packaged for consumption or sale. Chapter 14 gives information on the marketing of honey.

PLATES[1]

[1] Copyright of the photos Nicola Bradbear (© NB) and Ole Hertz (© OH)
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1.1 Beekeeping is great for maintaining biodiversity. Here a beekeeper works in the central forest of Tobago © Nicola Bradbear

1.2 Beeswax © Ole Hertz

1.3 Pollen © NB

1.4 Propolis © NB

1.5 Forests provide excellent resources for bees and beekeeping. Maasai beekeeping in Ngorongoro, Tanzania © OH

1.6 Bees kept by beekeepers are essentially wild animals and are not domesticated in the way of other livestock species. *Apis mellifera* © NB

1.7 Most of the 30 000 or so species of bees do not store appreciable quantities of honey for harvest by man. Here a bumblebee *Bombus terrestris* forages on *Phacelia tanacetifolia* © NB

1.8 *Apis cerana* is one of the honeybee species whose nest consists of a series of parallel combs, built inside a cavity. It is this nesting behaviour that enables these types of bee to be kept inside human-made hives, and encouraged to build the combs within frames (frame hives), or from top-bars (top-bar hives). Bhutan © NB

1.9 *Apis dorsata* is one of the honeybee species whose nest consists of a single comb, built in the open air. Bee species with this type of nesting behaviour will not accept to live inside any type of human-made container. Bangladesh © NB

1.10 *Apis cerana* is one of the honeybee species whose natural nest consists of a series of parallel combs, built inside a cavity. In top-bar hives, as shown here, the bees build each comb suspended from a piece of wood, or top-bar. These top-bars can be lifted form the hive for inspection or honey harvest. Nepal © NB

1.11 *Apis dorsata* is one of the honeybee species whose natural nest consists of a single comb, here, an Apis dorsata nest on a high-rise office building in Bangalore, India © NB

1.12 *Apis dorsata* can also be found nesting in clusters of colonies, as here on cliffs in Tamil Nadu, South India. However, each comb is a separate honeybee colony © NB

2.1 *Apis florea* is one of the honeybee species whose natural nest consists of a single comb, *Apis florea* often nests in sheltered places, such as bushes as here, or in caves, but it cannot be kept inside a container. This Asian species of honeybee has been introduced to Sudan in Africa © NB

2.2 African forests are full of bees. The honeybee species is *Apis mellifera*, with many different races throughout Africa. Here, a log hive with *Apis mellifera* on the slopes of Mount Meru, Tanzania © NB

2.3 Slovenia's forests are home to *Apis mellifera* carnica. Slovenian beekeepers use these bee houses on trailers to move their bees as different sources of forage come into flower © NB

2.4 A honeybee collecting pollen. One of the two pollen 'baskets' on her hind legs containing a pellet of pollen is visible. As she collects pollen from different flowers, the bee transfers pollen from one flower to another, and brings about pollination © OH

2.5 *Apis laboriosa* foraging on hollyhock *Althea rosea* (Nepal) © NB

2.6 In the tropics bees commonly nest in trees, and the largest trees are preferred. In this picture, the bees have made their nest low down, but protected inside the trunk. The Gambia © OH

2.7 Bees as an important part of rural livelihoods: a beekeeper in the Amazon sells his honey © NB

2.8 'Invisible beekeeping': hives in the walls of people's houses, in Northern Iraq © NB

2.9 Natural capital. Everywhere in the world where there are flowering plants, you will find bees – over 25 000 described species. Only a few of these bee species are useful for honey production. Here an African honeybee *Apis mellifera* scutellata forages on Tagetes sp. In Tanzania © NB

2.10 Natural capital. Sunflowers need pollination: to get maximum seed set and maximum oil production from the seeds, there needs to be one bee working on each flower head all the time it is flowering. Many crops are highly dependent upon insects for optimal quality and quantity of yield. Ethiopia © NB

2.11 African women add to their livelihoods by brewing and selling honey beer © OH

2.12 Physical capital Beekeeping projects promoting expensive frame hives will fail where people do not have the capital assets available to support this technology. Here frame hives remain unused because one of the inputs, beeswax foundation used in frame hives is not available locally (Cape Verde) © NB

3.1 Beekeepers benefit from the information, support, and marketing opportunities provided by groups and associations. Boy scout beekeepers in Indonesia © NB

3.2 Beekeeping equipment can be low or no cost: here a beekeeper shows his beekeeping protective clothing, all homemade Tanzania © NB

3.3 A priest in northern Iraq producing excellent harvests of honey from homemade hives. In this case available resources: human skills, old ammunition boxes, and bees, are being harnessed to create food and income © NB

3.4 Cultural value. An Ethiopian beekeeper on his way to his daughter's marriage, carries a calabash with special honey to make Tej (honey wine) for the ceremony © NB

3.5 Honey hunters in The Gambia. The bees are killed by fire during honey hunting at night, and the whole nest is destroyed as honey is removed. The colony does not survive this treatment. If there are plenty of honeybee colonies remaining in the area, the nesting place, with its scent of beeswax, will be attractive to a new swarm, migrating or absconding colony. The honey hunter is opening the bees' nest with an axe. © OH

3.6 A torch on a stick used to burn bees that are nesting out of reach. (The Gambia) © OH

3.7 The hunter-gatherer tribes of Hazabe people in Tanzania sometimes keep bees in hollow trees. The entrance is protected by stones against honey badgers. Most bees are killed during harvesting. This is more 'bee nest site maintaining', with personal ownership of the bees until they are killed during harvest © OH

3.8 This pattern left by combs shows the 'bee space' Tanzania © NB

3.9 Fixed comb hives: basket hives in Uganda © NB

3.10 Fixed comb hives: a log hive and a wall hive in Nepal © NB

3.11 Movable frame hives, here a beekeeper in Albania inspects his movable frame hive © NB

3.12 A top-bar and comb is lifted from a top-bar hive housing *Apis cerana* in Nepal © NB


4.1 Top-bar hive in Amhara, Ethiopia © NB


4.2 Woman beekeeper with a top-bar hive in a calabash. Guinea Bissau © OH


4.3 Cutting comb attachment, Tobago © NB


4.4 Frame being replaced in a frame hive (Egypt) © NB


4.5 A frame hive being examined in Nepal © NB


4.6 Frame hives in Bosnia Herzegovina © NB


4.7 Queen excluder on top of a brood box (Jamaica) © NB

4.8 The spacing between frames must be correct for frame hives to function well © NB


4.9 A home made smoker (Tanzania) © NB


4.10 A home-made veil for beekeeping: simple and effective (Tanzania) © NB


4.11 Hive tool © NB


4.12 Shade provided for frame hives in Oman © NB


5.1 A stand providing shade for bees in hives made from bamboo (Ethiopia) © NB


5.2 Stands for frame hives in Jamaica. The foot of the stand is in a container of oil, to prevent ants from being able to reach the hives © NB


5.3 Top-bar hives hanging in woodland in Uganda © NB


5.4 Working with top-bar hives in Cape Verde © NB


5.5 A torch on a stick used to burn bees that are nesting out of reach (The Gambia) © OH


5.6 The entrance to a stingless bee nest inside a tree © OH


5.7 Log hive with stingless bees at Mount Meru, Tanzania © OH


5.8 Hive box for stingless bees in Trinidad. Most stingless bees are peaceful and hives can be paced outside inhabited houses © OH


5.9 The entrance to the nest of the small “sweat bees” is a narrow tube made of wax and propolis, 2-3 mm in diameter. Outside the tube is sticky, to protect against ants. Just inside the tube sit 3-6 bees to defend the nest against intruders. The Gambia © OH


5.10 Harvest of honey from stingless bees. Mount Meru. Tanzania © OH


5.11 A box hive for stingless bees, in use in Trinidad © OH


5.12 A ‘rational hive’ for stingless bees, in use in Brazil. The bees nest with horizontal combs can be seen © NB

6.1 Boxes for *Melipona beecheii* in El Salvador, protected from theft with barbed wire © NB

6.2 The Promabos Project in El Salvador has promoted stingless bee keeping and marketing of honey © NB

6.3 Mama Christine opens one of her beehives with the help of two other women beekeepers © Paul Latham

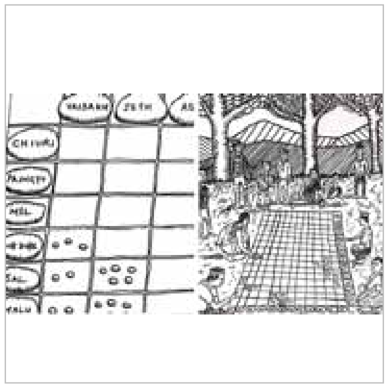
6.4 A beekeeper has placed a hive in one of the last mature trees standing in this area of Rwanda. Deforestation has meant loss of livelihood for beekeepers in many countries © NB

6.5 A bark hive made from *Julbernardia paniculata*. The end of the hive, or door as it is known by Zambian beekeepers, is made from woven grass © NB

6.6 *Koompassia excelsa* with *Apis dorsata* colonies Malaysia. The honey hunter's ladder, constructed from forest bamboo and vines, is visible on the right hand side of the tree © NB

6.7 Beekeeping, pit-sawing timber and panning for gold are the main economic activities within this *Miombo* woodland in western Tanzania © NB

6.8 Forest beekeeping in Tanzania. The hives are made from hollowed-out logs © NB



6.9 Using participatory approaches to create a floral calendar for Jarjarkot in West Nepal ©

6.10 Coconut trees are mainly pollinated by smaller insects but honeybees can improve the harvest (Commonwealth of Dominica) © OH

6.11 A colony of *Apis mellifera* for the pollination of citrus fruits. Commonwealth of Dominica © OH

6.12 Brassica benefits greatly from honeybee pollination. Here *Apis laboriosa* forages on a mustard crop in Bhutan © NB

7.1 *Apis mellifera* colonies loaded on to a trailer ready for pollination work. The Philippines © NB

7.2 Pollination research underway in Poland © NB

7.3 Colonies should have high populations of worker bees for effective pollination © OH

7.4 Wild 'bird cherry' flowers early in the woodlands of Europe (UK) © NB

7.5 An estimate is that there should be one bee for every ten open flowers for optimal pollination of cotton © OH

7.6 All fruits in this picture benefit from bee pollination except for the tuber crops and the bananas (Ghana) © OH

7.7 The result of adequate bee pollination in an orange orchard (The Gambia) © OH

7.8 Room for development of leafcutter bees (Denmark) © OH

7.9 Leafcutter bees ready to leave their leaf cells (Denmark) © OH

7.10 Even herbicides can be dangerous for honeybees when they collect poisoned 'dew' in the morning © OH

7.11 Tin cans holding water for honeybees in The Gambia © OH

7.12 It is easy to obtain pesticides in some developing countries, but much more difficult to obtain information about their correct usage and hazards (Commonwealth of Dominica) © OH

8.1 Bees killed by pesticides in The Gambia © OH

8.2 Mixed farming in traditional agricultural systems: a mixture of crops creates a natural protection against heavy attack of any pests. Here, a colony of *Apis cerana* ensures good pollination of nearby crops in Nepal © NB

8.3 Pic of hive and forager © NB

8.4 A frame of honey stores. The upper part has been covered with a thin covering of wax: this is known as 'capped' honey: this is the bees' food store that will last them until the next flowering season (unless harvested by man). The bees are still working on the lower part of the frame © NB

8.5 Honey is a popular, natural food, known and liked everywhere. India © NB

8.6 Granulated and liquid forms of the same honey © NB

8.7 Honeys of many colours on display in India © NB

8.8 Straining honey combs in Rwanda © NB

8.9 Uncapping a frame of honey UK © NB

8.10 A manual honey extractor UK © NB

8.11 Straining honey through cotton muslin as it runs out of the extractor UK © NB

8.12 When buying honey in the market it is impossible to know whether it might be poisonous because of honey-hunters use of pesticides (Guinea Bissau) © OH

9.1 Beeswax comb © NB

9.2 Honeycomb offered on banana leaf. This is the simplest way to eat freshly harvested honey. The beeswax comb is perfectly safe to eat – it passes through the human gut undigested. South India © NB

9.3 Buckets of honeycomb in Ethiopia. Beekeeping using local style, fixed-comb hives results in greater yields of beeswax since the honeycomb is broken to enable the extraction of honey, and cannot be returned to the hive © NB

9.4 Blocks of rendered beeswax for sale in Uganda © NB

9.5 Useful beeswax can be salvaged even from old comb like this. Cape Verde © NB

9.6 Heating old comb in a pot of water. Cape Verde © NB

9.7 Molten combs heating with water in a water bath made from one metal container inside an oil drum half full of water, heated by fire underneath Tanzania © NB

9.8 Using a ladle to transfer the water and molten beeswax mixture into a piece of hessian sacking Tanzania © NB

9.9 Filtering the molten beeswax and water mixture through hessian sacking Tanzania © NB

9.10 Using sticks to squeeze the bag of molten beeswax and water Tanzania © NB

9.11 Using an embossed roller to make foundation in Iraq © NB

9.12 A honeybee with the corbiculae on her back legs full of propolis UK © NB

10.1 The smooth and shiny surface on the inside of a hive is a thin layer of propolis UK © NB

10.2 The dark colouration is due to bees applying a layer of propolis © NB TRI

10.3 Brood comb of the Asian honeybee *Apis cerana* for sale in a japanese supermarket © NB

10.4 Bees have a cultural history connected with healing. Here in the Gambia, *jujus* contain honeybees © OH

10.5 Afghan beekeepers scrape propolis from frame hives - use in medicines in Afghanistan © NB

10.6 A 'crate' of nine 40 g jars each with a different honey, packed by Cearapi Apicultura e Produtos Orgânicos, Ltda, Brazil © NB

10.7 'Buying Malawian Forest products helps Malawian forests' Five beeswax candles, neatly made and presented for sale by the Wildlife and Environment Society of Malawi. Wrapped in a piece of local fabric and labelled to explain that these candles are made with beeswax from Nyika National Park © NB

10.8 'Honey jam' – a product incorporating honey with dried grapes, pineapple, cardamom, cashew nuts and vanaspati roots, made by Savimadhu in Karnataka, South India © NB

10.9 Honey cakes – enable other sectors to create livelihoods based on the products of bees © NB

10.10 A range of sweets containing honey and/or propolis © NB

10.11 Harvested leaves of Gesho – used for making Tej © NB

10.12 'Body shop' honey shampoo and hair conditioner, coating fair traded honey from Zambia © NB

11.1 Simple labelling and using recycled bottles for effective local honey marketing in Nepal © NB

11.2 Soap made with honey from stingless bees. A product of Meliponarios Pisil Nekmej, Guerra Tialpan, Mexico © NB

11.3 Making value-added products in Dominica. The ingredients for making skin ointments are clean wax, a water bath for melting the wax and vegetable oil © OH

11.4 Filling 35mm film canisters with the molten ointment © OH

11.5 Batik pictures being made in Tanzania. Here Stephen Burton applies the beeswax © NB

11.6 The picture takes shape © NB

11.7 Silk patterned with batik in Malaysia © NB

11.8 Lost wax casting being used to make small metal ornaments for sale to tourists in Ghana © NB

11.9 Beeswax candles made from the wax of *Apis dorsata* by Keystone Foundation, South India. These have been made by rolling sheets of beeswax © NB

11.10 Making candles by the dipping method in Tanzania © NB

11.11 Propolis can be incorporated into many products, and is most well known in products for oral hygiene. These are made by Bee Vital, UK © NB

11.12 Propolis insect repellent spray made by Ilog Maria Honeybee farm, Philippines © NB

12.1 Medicine containing honey for sale in the Gambia © OH

12.2 Sections of honeycomb harvested from frame hives, prepared for sale UK © NB

12.3 Local honey, well packaged. Plastic jars, simple labels with tamper-evident seals Soroti, Uganda © NB

12.4 Glass jars being recycled for honey packing in India © NB

12.5 The most common container for honey retail throughout the Caribbean is the recycled rum bottle. Jamaica © NB

12.6 Roadside marketing of honey in Bosnia Herzegovina © NB

12.7 Honey for sale by the road in Afghanistan © NB

12.8 A sign effectively advertising honey and the benefits of bees in Ghana © NB

12.9 Poor market access: Ethiopian beekeepers walk long distances carrying 20 kg tins of honey to market © NB

12.10 Keystone honey, candles and other secondary products for sale in 'The Green Shop' Kotagiri, South India © NB

12.11 Inserting a miticide strip into an *Apis mellifera* colony housed in a top-bar hive in Tobago © NB

12.12 Examining a colony of *Apis mellifera* for symptoms of American foulbrood (AFB) *Paenibacillus larvae larvae*, Afghanistan © NB

10. PRODUCTION AND TRADE OF BEESWAX

Beeswax is a valuable product that can provide a worthwhile income in addition to honey. One kilogram of beeswax is worth more than one kilogram of honey. Unlike honey, beeswax is not a food product and is simpler to deal with - it does not require careful packaging which this simplifies storage and transport. Beeswax as an income generating resource is neglected in some areas of the tropics. Some countries of Africa where fixed comb beekeeping is still the norm, for example, Ethiopia and Angola, have significant export of beeswax, while in others the trade is neglected and beeswax is thrown away. Worldwide, many honey hunters and beekeepers do not know that beeswax can be sold or used for locally made, high-value products. Knowledge about the value of beeswax and how to process it is often lacking. It is impossible to give statistics, but maybe only half of the world's production of beeswax comes on to the market, with the rest being thrown away and lost.

WHAT BEESWAX IS

Beeswax is the creamy coloured substance used by bees to build the comb that forms the structure of their nest. Very pure beeswax is white, but the presence of pollen and other substances cause it to become yellow.

Beeswax is produced by all species of honeybees. Wax produced by the Asian species of honeybees is known as *Ghedda wax*. It differs in chemical and physical properties from the wax of *Apis mellifera*, and is less acidic. The waxes produced by bumblebees are very different from wax produced by honeybees. Pure waxes from different species of stingless bees are also very different from the other types of beeswax. It is much darker in colour – dark brown, and when it is warmed, it stretches without breaking. It is also sticky and much more difficult to break than beeswax from *Apis mellifera*.

BEESWAX PRODUCTION

Beeswax is made by young worker honeybees. It is secreted as a liquid from four pairs of wax glands on the ventral surface of the abdominal tergites (plates on the underside of a bee's body). The liquid wax spreads over the surface of these plates, and, on contact with air, the wax hardens and forms a single wax scale on each tergite, which can be seen as small flake of wax on the underside of the bee. A worker honeybee produces eight scales of wax every 12 hours. The size of the wax glands depends upon the age of the worker: they are at their largest when the bee is about 12 days old and decline steadily after the eighteenth day until the end of her life.

About one million of these wax scales are needed to make one kilogram of wax. Bees use the stiff hairs on their hind legs to remove the scales of wax and pass them on to the middle legs, and then to the mandibles (jaws) where wax is chewed, and salivary secretions become mixed with the wax. When it is the right consistency, the new wax is used for comb construction or used to seal honey cells. Bees are stimulated to produce wax when there is a surplus of honey to be stored and a lack of honeycomb in which to store it. Around eight kilograms of honey are consumed by bees to produce every one kilogram of wax.

When a swarm of bees settles to establish a new nest, the first thing they do is to start building beeswax combs. To be able to produce the beeswax and build with it, the bees need a high temperature, and the production of the first comb takes place inside the congregation of bees, where the temperature is highest. The bees building a comb join together and make what are known as 'garlands' or 'festoons' – chains of bees. Hanging like this they secrete the wax. When the beeswax is ready on a bee, she moves up the chain to the place where the building is going on, fetches one of the wax scales with her hind legs and brings it to her mouth where it is chewed and mixed with secretions before it is used for building. This is repeated until all eight wax scales are used. During the comb construction, the building bees vibrate the comb by knocking it with their upper jaws. In this way, they seem to be able to judge the thickness of the comb and this guides them to know if some wax has to be gnawed off or if more has to be added.

COMB

The comb provides the structure of the bees' home, used for all the different storage functions needed in a bees' nest: to store honey, to store pollen, as a place to deposit eggs and for development of the young bees. The comb has a hexagonal cross-section. This shape is created by the worker using her antennae to maintain the shape of each cell during its construction. The shape and dimensions of the cells in comb optimise the ratio of size to strength of the materials used in its construction. The six-sided cells and the pyramidal-shaped bottom of the cell also represent a highly efficient use of material with no wax being wasted. There are no empty spaces between the cells while at the same time the highest possible strength from the wax is achieved. The top row of cells that connects the comb with the ceiling of the nesting place (tree wall, hive, frame or the top-bar) can carry more than 1,300 times its own weight in honey plus all the bees working and living on the comb. Only if the inside temperature exceeds +35 °C, the wax will begin to soften and melt, and the combs loose their strength and may collapse. Understanding the properties of beeswax comb brings understanding of the great effort that bees have to make to maintain nest temperature. If a hive is situated without shade, bees will have to expend more effort in working to keep the hive contents cool.

BEE SPACE

In honeybee species whose colonies have multiple combs, the combs are a precise distance apart in order to enable honeybees to work in the combs, to move between them, and maintain temperature. If humans keep bees in hive boxes, then it is necessary to create an environment in the hive that imitates the way the bees build their nest in the wild. Therefore, frames in frame hives must be spaced at the same distance as the combs would be spaced in a natural nest. The distance between the centre of a comb to the centre of the next comb also varies between different races of bees: for example, the space is around two millimetres smaller in the combs of African *Apis mellifera* bees compared to the European races of *Apis mellifera*. The distance permits two worker bees to pass each other when they crawl in the space between the brood combs. In the honey storing areas of the combs, the cells are often built deeper so that only one layer of bees can pass between.

If space allows in a hollow tree or in a wall, the combs of *Apis mellifera* can be more than one metre long, and carrying several kilograms of honey in each comb. Normally a comb is built from the top to the bottom, starting with a small elliptical-shaped comb. A comb consists of a central laminate with the six-sided cells on each side. Each cell is angled slightly upwards, with the opening a little higher than the base. In naturally constructed combs, the dimension of cells also varies according to the species and race of honeybees. The typical dimensions for worker cells built by races of European *Apis mellifera* bees are between 5.13 mm (*Apis mellifera ligustica*) and 5.5 mm (*Apis mellifera carnica*). European races of *Apis mellifera* accept wax comb with 800 cells/dm^2, which allows for cells with a diameter of 5.4 mm. *Apis cerana*, the Asian hive bee, needs a smaller cell size. Cells built for drone brood are larger than are those built for worker brood.

BEEKEEPING FOR BEESWAX PRODUCTION

An important aspect of frame hive beekeeping is the recycling of empty combs (inside frames) to the hive after the extraction of honey, thus maximising honey production and minimising the production of wax. Therefore, beekeeping that uses movable-frame hives (for example, Langstroth hives and Newton hives) results in the harvesting of relatively little beeswax. Using these sorts of hives, the ratio of honey to beeswax production is approximately 75:1.

Beekeeping using local style, fixed-comb hives, or movable-comb (top-bar) hives results in greater yields of beeswax since the delicate honeycomb is broken to enable the extraction of honey, and cannot be returned to the hive. The ratio of honey and beeswax production using fixed comb or movable-comb hives is about 10:1. For this reason, countries in Africa where fixed-comb beekeeping and honey hunting may be the norm, produce significant amounts of beeswax, which provide a valuable export crop for some of these countries. In some situations, wax rather than honey can be the most valued product of beekeeping.

When there is good honey-flow i.e. plenty of nectar coming into the hive, bees are stimulated to make wax to build comb to hold the nectar. During dearth periods beeswax production stops: when necessary bees recycle wax from existing comb to seal their honey and brood cells.

The wax-producing bees need plenty of food: as mentioned above, bees consume around eight kilograms of honey to produce one kilogram of beeswax. When the bees swarm from an old colony and have to build new combs, the wax production and building is undertaken by all ages of worker bees. The young bees have to start wax production sooner than they would in an established colony, and the older bees have to resume beeswax production.

BEESWAX QUALITY

Newly produced wax is clear white, but after manipulation by the bees, it soon turns pale yellow. New honeycomb is nearly white and if it is only used for honey storing it will retain its light colour. When the comb is used for brood it turns darker the longer it is in use. This is due to the larvae's cocoons spun inside the cell before pupation. Some excrement from the larvae is also sealed in the cells.

The colouration of beeswax (shades of yellow, orange and red through to brown) is due to the presence of various substances, especially pollen. This difference in colour is of no significance as far as the quality of the wax is concerned, but subjectively light coloured wax is more highly valued than dark coloured wax. If wax is dark because it has been over-heated then its value is much lower. The finest beeswax is considered to be from wax cappings. *i.e.* the wax seal with which bees cover ripe honeycombs, because this fresh 'virgin wax' is pure and white coloured. In the past, it was common to bleach wax (using bleaches such as sulphuric acid or hydrogen peroxide), but this practice is now considered unnecessary and damaging to the natural wax.

The main quality issues concern authenticity of origin, and contamination from residues of drugs used to control honeybee diseases, mainly the acaricides used to control mite predators. These acaricides are lipophyllic and therefore are soluble in beeswax, and accumulate in it. Other chemicals sometimes used in beekeeping may also accumulate in beeswax; these may include paradichlorbenzene, used to control wax moth, and various wood preservatives used to paint beehives. This contamination of beeswax can be minimised by avoiding the use of synthetic chemicals in beekeeping. The use of these chemicals in beekeeping in industrialized countries makes beeswax harvested from the disease-free colonies of Africa and other developing regions more attractive.

Pure beeswax has a good aroma, and when a wax block is broken, it shows a grainy surface. That is not the case if it has been adulterated with paraffin, fat or other oil. If pure beeswax is chewed, it does not stick to the teeth, and when rolled between fingers it softens but does not stick to the fingers. When paraffin wax is mixed with beeswax, it becomes more transparent and slightly greasy to the touch.

BEESWAX COMPOSITION AND PROPERTIES

Beeswax is a very stable substance, and its properties change little over time. It is resistant to hydrolysis and natural oxidization and is insoluble in water. It is a complex material consisting of many different substances, but predominantly of esters of higher fatty acids and alcohols, pigments mostly from pollen and propolis, as well as minute traces of bee material.

It is solid at room temperature, becomes brittle once the temperature drops below 18 °C and quickly becomes soft and pliable at around 35 to 40 °C, with a melting point of 64.5 °C.

USES OF BEESWAX

Beeswax has hundreds of uses, of which the following are but a few examples.

In cosmetics

Around 40 percent of the world trade in beeswax is used for the cosmetics industry, which requires first class beeswax that has not been overheated, is pure and free from propolis. The world price is usually around US$4-10 per kilogram. At a local level, making skin ointment from beeswax can be one of the most profitable beekeeping activities.

In pharmaceutical preparations

Around 30 percent of world trade in beeswax is used by the pharmaceutical industry that, like the cosmetic industry, requires good quality wax.

Candle making

Around 20 percent of the beeswax trade is used for candle making. Beeswax candles are less common and more expensive than candles made from paraffin wax. In the past church candles had to be made of 100 percent beeswax, and this is still followed in some societies.

Other uses

Around 20 percent of the world trade in beeswax is used for:

- Models and casting in industry and art. Wax is used for to make figures for decoration or sculptures and jewellery before they are placed in a mould for casting in silver, gold or bronze. This method is called lost-wax casting or *cire perdu*.
- To make polish for cars, furniture, shoes and for treatment of other leather products.
- In grafting waxes.
- In lubricants for industrial use.
- Electronics used as insulation in electronic components in the computer industry, and in the manufacture of CDs.
- In poor societies, beeswax is used as a sealant, for example to make air and water-proof sealing of bottles and containers, to repair of broken calabashes, for grafting on branches, etc.
- In batik dying of fabrics.
- In making drawing crayons.
- It is used for confectionery coatings.
- It is used to strengthen threads used in darning and sewing.

In beekeeping

- Beekeepers use large quantities of beeswax for making beeswax comb foundation. Beekeepers harvest, process and recycle their own beeswax and this use is not evident in the trade statistics. In many countries where frame hives are used, it may be the major use of beeswax. It is a common practice for beekeepers to render the beeswax from their own bees into lumps of pure beeswax, and to exchange this for a smaller weight of ready-made sheets of foundation, made by commercial foundation manufacturers.
- Beeswax is used to attract swarms to empty hives, or trap hives, and is one of the most effective attractants for bees.

INTERNATIONAL TRADE

It is not easy to obtain official statistics concerning beeswax production: for example, there are no official figures for beeswax production in EU countries. The EU imports around 6,000 tonnes of beeswax per annum, approximately 50 percent of this coming from developing countries. The main importing countries are Germany, France and the UK. These nations all have significant pharmaceutical and medical industries requiring beeswax.

Tropical countries dominate world beeswax production and export, with industrialized countries needing to import beeswax. This is because, as described above, in local styles of beekeeping both honey and wax are harvested.

TABLE 20
World production and trade in beeswax

World trade in beeswax (tonnes)	Year	Annual production (tonnes)	Export (tonnes)	Import (tonnes)
World	2003		10 336	11 949
Asia	2003		5 213	1 995
Africa	2003		795	258
Europe	2003		2 167	6 873
Angola	2003		0	8
Argentina	2003		0	0
Australia	2003		0	0
Chile	2003		1	22
China	2003		4 814	127
Dominican Republic	2003		39	1
Ethiopia	2003		402	1
France	2003		495	1 243
Germany	2003		919	2 363
Japan	2003		89	713
Kenya	2003		0	1
Mexico	2003		14	71
Portugal	2003		10	32
South Korea[14]	2002	151		
Spain	2003		113	336
Tanzania	2003		0	0
Thailand[15]	2002	50	43	
Trinidad & Tobago[16]	2001	1.1	-	7
Uganda	2003		0	0
United Kingdom	2003		102	731
USA	2003		1 097	2 195
Zambia	2003		33	0

Source: All data FAOSTAT, 2005, unless stated otherwise.

DO NOT WASTE BEESWAX

In areas where most or all of the honey produced is consumed locally, and where there is no local use for beeswax, pieces of wax comb are often discarded. The development of a wax collecting system can, by encouraging each beekeeper in the area to save beeswax and by organising the sale of the combined crop, provide a source of income from an otherwise wasted resource. Both honey hunters and beekeepers should realise that beeswax is a valuable product in addition to honey. If old combs are stored without treatment, especially in the tropics, they will be eaten by wax moths within a few weeks. Old combs can harbour honeybee diseases and if left lying around can cause honeybee disease to be spread from one colony to another. Mice can chew the wax combs and make a lot of damage in a hive, but most animals cannot digest the wax, it just passes thought the gut. Only the various species of wax moth larvae can digest wax, and maybe some birds that have the necessary bacteria in their guts to break down the wax, as ruminants do with cellulose.

[14] Kun-Suk Woo, 2004.
[15] Sureerat Deowanish, 2004.
[16] Ministry of Food production and Marine Resources Report on Apiculture 2002.

ADULTERATION OF BEESWAX

Beeswax is relatively expensive, and there has always been a tendency for people to try to falsify or dilute it with cheaper materials. The melting point of pure beeswax is 64.5 °C, and adulteration of pure beeswax with paraffin wax reduces the melting point and weakens the material. This is important since one kilogram of wax in honeycomb supports 22 kilograms of honey, pollen and brood. It follows that using adulterated wax for the foundation used in frame hive beekeeping will cause unnecessary problems for the bees and the beekeeper.

BEESWAX RENDERING

Cappings (the white covering on sealed honey comb) are the best source of beeswax, but odd scraps of brace or burr comb (odd bits of comb built by the bees as part of the nest structure), old honey combs and old brood combs all yield valuable beeswax harvest. The beekeeper with a just few hives can produce blocks of wax of excellent quality from these sources.

Whatever beeswax is to be used for, it has to be melted and cleaned. As soon as it has been melted and turned to a solid wax block, it can be stored or transported without any problems. The wax block is not eaten by wax moths. There is plenty of expensive equipment available to achieve beeswax rendering. This includes stainless steel solar-wax-melters, steam-wax-melters, wax presses, wax and honey separators and electric melters. However, most beekeepers do not own such equipment and achieve excellent results without spending any money on equipment, and with no risk of it being stolen.

GENERAL RULES WHEN WORKING WITH BEESWAX

- Beeswax must never be heated with a direct flame: always heat it in a container of water. This water bath might be an oil drum or other large container. It is not necessary for the wax to be in a separate container in the water bath. Heat the wax enough to melt it: beeswax melts at 62-64 °C. Heating above 85 °C causes discoloration of the wax, and boiling will ruin it. If beeswax is heated to such a temperature that it burns it is wasted completely.
- The best water to use when working with beeswax is soft, clean rainwater. Hard water contains lime that reacts with the wax and saponifies it.
- Beeswax is slightly acidic and containers made of aluminium, brass, copper, zinc, pewter, tinplate or iron must never be used with beeswax, as they will react with the beeswax and the wax will be stained. Suitable materials to use when working with beeswax are containers made from enamel, stainless steel, nickel, or plastic.
- Combs of the same type should be prepared together. Do not mix dark combs with light combs as this will lower the grade of the best wax.
- It is easy to make a filter for hot wax by completely removing each end of a clean can and stretching a piece of cotton cloth over one end. The string used to hold the cotton in place also serves as a handle.
- Whatever system is used to render and extract the beeswax, it will solidify once it cools down. Regardless of the system used, the recuperated wax will contain numerous impurities. Due to the difference in density between wax and water, the wax will rise to the surface of the water and any impurities will be trapped below it. If the beeswax cools too quickly, a large quantity of these impurities and water will be trapped inside the wax as the block sets and it will have to be rendered again. Once the wax hardens, impurities can be scraped off the underside of the block. To obtain the purest beeswax, the water-wax mixture should cool down as slowly as possible. An easy way to slow down the cooling process is to place the bucket with wax and water mixture in a heat-retaining box (filled with polystyrene pieces, or sawdust) covered with a thick lid. Once the wax has settled and completely cooled, the block is ready to take out of the mould.
- Many containers make convenient moulds for beeswax. Foil-lined drink cartons make convenient, disposable moulds of a useful size. When the wax has solidified completely, the carton can be simply torn away, leaving a lump of beeswax.

TRADITIONAL METHOD OF EXTRACTING WAX FROM COMBS

Materials needed: pieces of honeycomb, water, a pan for melting the wax, a rush bag, or any type of loosely woven bag, cloth material with a fine mesh, soap, a bowl for moulding the wax.

1. Remove as much honey as possible from the honeycombs and soften them by soaking in warm water: pollen and any honey remaining in the combs will dissolve in the water. Repeat this washing process three times.
2. Use clean rainwater if possible. If the water is very alkaline, add a little vinegar (one part vinegar to 1,000 parts water).
3. After washing the combs, break them up into small pieces.
4. Place the pieces of comb in a pan and add clean water to the level of the combs or a little above.
5. Heat the mixture gently and keep stirring all the time, especially when the mixture starts to reach high temperatures. Wax is highly flammable.
6. After the combs have melted fully, pour the mixture into a long bag made of sacking, woven rush, nylon, jute or other heavy cloth, and tie it tightly. Holding the whole thing over a basin or bucket, squeeze the bag with two pieces of wood, to make sure that all the wax is squeezed out of the bag into the bucket underneath. Brood, pieces of wood, grass and other large particles will be removed by this process.
7. Leave the bucket with the mixture of hot water and molten wax to cool, placing it in an area sheltered from high winds and dust: preferably a corner in a clean and cool room. The wax solidifies as it cools, forming a disc of wax on the surface of the water. Any particles that have escaped through the bag will settle below the wax layer.
8. When the mixture is completely cool, remove the wax layer. Scrape off any material stuck to the underside of the wax disc, and re-melt the wax in an equal volume of clean water. This time use a finer cotton cloth to strain small impurities out of the wax. After filtering through the cloth, collect the hot mixture of wax and water in a bowl, preferably enamel, which has been smeared with a film of soapy water – only a very small amount to cover the surface. The bowl should not hold more than about two kilograms of wax. Even bowls made from wood or calabashes can also be used as moulds for beeswax. Do not use fat or oil instead of soap, as these would contaminate the wax. Do not use heavily scented soap.
9. Place the mixture in a cool place free from dust and wind. When the water and wax have completely cooled down i.e. about 12 hours after pouring the mixture into the enamel bowl, a mould of beeswax can be easily shaken out. Any impurities adhering to the bottom of the cake can be scraped off with a sharp knife.
10. Do not disturb the wax until it has cooled for 12 hours. Do not try to hurry the process or you may spoil the wax.
11. Beeswax purified carefully by this method should be in a suitable state for sale and export and does not require any other processing.
12. Store refined beeswax in a clean place, away from any strong-smelling substances.

Another traditional method is to simply put the broken combs into a hessian sack and drop it into a large cooking pot full of water, with the sack weighted so that it sinks. Heat the water. Wax is lighter than water, so that as it melts, the wax will filter through the sack and rise to the surface. Once the combs have all melted, turn off the heat and leave the pot to cool down.

SOLAR WAX EXTRACTOR

The solar wax extractor provides a simple and effective way of melting and purifying beeswax. It uses the sun's heat to melt the wax, and an effective solar wax extractor can be easily ‘home-made’. The temperature inside the extractor needs to rise only to 68-70 °C to melt the beeswax sufficiently: if clean wax is used, just one melting in a solar wax extractor can produce a satisfactory block of top quality wax.

The solar wax extractor consists of a glass or clear plastic-lidded box containing a sloped sheet of metal. Pieces of honeycomb are placed on the metal sheet and as they melt, wax runs down the metal slope to a container. The sheet of metal can be bent at the edges to funnel wax towards the container. A screen of wire mesh prevents pieces of comb and debris from slipping down into the container. Impurities in the wax tend to remain on the metal, and others can be scraped off the final solidified block of wax.

The dimensions of the extractor can vary according to the container size used to make it. The bigger the overall container, the higher the temperature that can be attained inside the extractor.

To retain heat inside the box, the cover of the solar wax extractor is best made either of thick plastic or of two sheets of strong glass with a small gap between them. The rest of the inside of the box should be painted black for maximum heat absorption. Insulating material underneath the metal sheet will also help to retain heat. There must be no draught-creating cracks or gaps in the box, as they will encourage heat loss, and if large enough would allow robber bees into the box. Do not fix the collecting tray in the bottom of the extractor: it needs to be removable for cleaning.

Ideally, the solar wax extractor is positioned regularly during the day so that it is always facing the sun, and tilted so that the glass is at right angles to the sun's rays. If this is not possible, fix supporting legs under the extractor to achieve a slope of about 40° to the horizontal, and face the extractor towards the sun. Shadows from trees and buildings or passing clouds soon lower the temperature inside the extractor.

HARVESTING WAX FROM VERY OLD, BLACK COMBS

Even very old, black scraps of comb can be of some value to obtain beeswax. However, beeswax cannot be obtained from them using a solar wax extractor. This is because such combs contain large numbers of cocoons and pupa cases discarded by successive generations of developing honeybees, and these soak up the wax as it is melted. Wax from such combs can be obtained by breaking them up, and soaking them in water for 24 hours, then tying the combs in a piece of sacking and boiling this in a container full of water. Some wax will float to the surface, but the bag of wax must be agitated to obtain the maximum harvest. If left to cool overnight, a round cake of solid beeswax will form on the surface of the water.

METAL FOIL METHOD

A very simple way to melt small scraps of comb is to place them on a piece of aluminium foil or other shiny metal foil, and leave in the sun. In strong sunlight, the wax will soon melt and can be poured into a container.

EXTRACTION WITH BOILING WATER AND A WAX PRESS

Pieces of comb are placed in a large container (around 100 litres), about one third full of boiling water and allowed to melt. When all the wax has melted pour the contents of the containers into a jute-lined wax-press. When pressure is applied, the wax runs out. After the first pressing, the content can be stirred and then pressed again, and this process repeated until all the wax is extracted. Once again, the water and molten wax run into a container, where, as the mixture cools, the wax rises to surface because of its lower density than water.

STEAM EXTRACTION

Steam extractors all work on the same principle: two connected tanks are fixed, one inside the other or one on top of another. The combs or cappings are put in an openwork metal basket inside the main tank. Steam extraction is a good method for cappings but is less suitable for melting down old combs as it yields only around 80 percent of the wax.

Cleaning the wax in the ways described above will satisfy most wax users. If very pure beeswax is required for special purposes the wax has to be refined.

REFINING BEESWAX

The refining process is achieved by:

1. The wax is washed in hot water to remove honey and to allow dirt to settle out and fall to the bottom.
2. The wax is mixed with fuller's earth (clay) and activated carbon: this starts a bleaching process.
3. The resulting mixture is filtered through a filter-press.
4. The wax is cooled before being formed into slabs or pellets.

The washing and refining process can take up to 30 hours at a temperature of 90 °C.

SLUM GUM

Slum gum is the black residue remaining after the wax rendering process. It is composed of cocoons from the bees' brood cells, wax moth cocoons, excrements from larvae and some leftover wax. If the slum gum still contains a lot of wax, it will form a solid cake when cool. If it is low in wax, it crumbles when dry. Most often slum gum is discarded. It burns well and can be used for firewood in cooking, and to make firelighters. In daytime, it can attract many bees if too much wax is left in it, so if it is used for fires in the open, it is better to use it after dark.

MARKETING BEESWAX

In North West Zambia, beekeepers are harvesting honey and beeswax from bark hives, with both commodities serving as a cash crop for export to Europe. In this system, farmers harvest the honey and the wax at the same time. When groups of beekeepers combine their beeswax harvests, they can accumulate enough quantity to sell. Beeswax for export should be clean and heated as little as possible. Little processing is required: it can be moulded into blocks, the broken into smaller pieces, which can then be placed in hessian sacks for export. The wax is broken into smaller pieces to prove its purity and to show that no bricks are concealed in the centre of the lump!

MAKING BEESWAX FOUNDATION

Tray-style foundation press

This is a press into which molten beeswax is poured and moulded on each side with the pattern of foundation. These presses can be made of metal, plaster of Paris, or plastic, and tend to produce rather thick sheets of foundation.

Roller methods

A flat sheet of wax is run through embossed rollers, resembling the clothes mangles used in laundries. Some commercial foundation manufacturers have sophisticated machines in which liquid beeswax is poured straight on to a water-cooled roller embossed with the hexagonal cell pattern. The wax is solidified and printed simultaneously. The sheets of embossed wax are then cut into the rectangular sizes needed for frame hive beekeeping.

11. OTHER PRODUCTS FROM BEES

POLLEN

What pollen is

Pollen grains appear as tiny, white or golden specks, produced in thousands inside flowers. Each pollen grain is a microspore containing a male gametophyte.

Pollination

When the pollen grain reaches the female part of a plant – the stigma within the same flower, or in another flower, the pollen grain germinates and a pollen tube develops into the stigma, allowing the male nuclei from the pollen to reach the eggs within the flower's ovules. This is the way that plants achieve fertilisation, and viable seeds can develop (see Chapter 3).

Because plants are literally rooted to the spot where they grow, to achieve cross fertilisation between plants, it is necessary for some part of the plant to be able to travel. This is achieved by the male pollen grains being dispersed to reach the female stigmas of other flowers. Different plants depend upon different 'pollination agents' to achieve this transport of pollen, or dispersal. Grasses usually depend upon wind power to disperse their pollen far and wide. Insect-pollinated plants depend upon bees and other insects to transfer their pollen. The reasons why bees are especially effective pollinators are outlined in Chapter 3. Other pollinating agents include water, birds, bats and other mammals.

The value of pollen for bees

Plants that need bees to transfer their pollen must provide incentive for the bees to do so, and nectar and pollen are the incentives that flowers use to encourage bees to visit them. Nectar and pollen are honeybees' only food sources: nectar is mainly a source of carbohydrate for honey production, while pollen provides all the other nutrients essential for honeybee development and growth. The anatomy of honeybees is beautifully adapted for collecting pollen and packing it into the 'baskets' on the back legs of forager bees for carrying back to the nest. Once inside, the forager may perform a dance to inform other bees how to locate her source of pollen, she then unloads her bounty into a cell, usually near to developing bee larvae. Many experiments have been done to analyse the pollen loads of honeybees as they arrive back at their nest or hive. These experiments show that although each honeybee is collecting pollen from just one plant species, the honeybee colony as a whole is collecting pollen from a great variety of plants, and thus ensuring that the colony has a diverse diet.

Like honey, pollen stored in beeswax cells is a safe and stable food store. It is eaten mainly by worker bees during their first days of adult life, and used by them to create brood food for developing bee larvae.

Pollen as food for humans

Some people regard pollen as a highly valuable nutritional supplement for humans, because of the range of constituents, including the minor constituents it contains. It consists of around 30 percent protein, including all the essential amino acids, a full spectrum of vitamins and minerals, lipids, trace elements, hormone precursors, enzymes, vitamins, carbohydrates and fatty acids, flavonoids and carotenoids, and many minor constituents, depending upon which plants the bees have been foraging. There can be no standard definition of pollen, in the same way that there can be none for honey: it depends upon the forage sources available to, and selected by, bees.

Other uses

Pollen is also harvested for other reasons than human nutrition: for use in plant breeding programmes, for pollination, for storage and subsequent feeding to bees in times of dearth, for use in the study of allergic responses such as hay fever, and increasingly for monitoring for environmental pollution – most especially for the presence of heavy metals or residues.

Harvesting pollen

After bees gather pollen from flowers they carry it back to their nest as pellets of pollen stored in hair 'baskets' on their back legs. It is possible to harvest these pollen pellets by placing a wire mesh at the hive entrance. As these results in little pollen being brought into the colony, bees must continue to forage for pollen, and therefore the honey production from this colony will be reduced. Pollen traps can only be left on the hives for short periods, as it is essential that the colony is able to bring in a sufficient volume of pollen to feed the developing bees. A bee colony collects yearly, for its own consumption, an average quantity of between 20 and 40 kilograms of pollen. The beekeeper must be careful not to over harvest (two to four kilograms at most), as pollen is essential for the bees survival.

After collection from a pollen trap, pollen must be air-dried for a ten-hour period, using a dry, warm airflow: the maximum air temperature should not exceed 40 °C. The objective is to reduce the water content to four percent, at which point the pollen will be conserved without the growth of yeasts. The best way to dry pollen is to use a pollen drier: this consist of trays on which the pollen is spread thinly, with a gentle airflow at 40 °C. This should be in the dark or lit with infrared. After drying, the pollen must be checked for any impurities that must be removed (insects, bee fragments, scraps of wood, etc.), and then stored cool and dry, to avoid insect or mite development. This method provides marketable pollen that is attractive, easy to store and sell. Pollen may be marketed in either this freshly dried form, or further dried and marketed in capsules. Drying allows pollen to be kept at normal temperatures, but it may also deprive pollen of many useful compounds, mainly anti-oxidants, enzymes, volatile components and some vitamin content. Other more exacting procedures are available which are claimed to conserve these properties. Pollen can also be frozen and sold in vacuum-sealed packs: this procedure may allow the preservation of more active ingredients. There are also other pollen processing methods, mainly used to prepare other pharmaceutical forms of pollen, such as tablets, granules and mixtures with honey.

Honey always contains some pollen that can cause the honey to look cloudy. To prevent this, some processors filter honey to remove all pollen – however, many consumers prefer to have honey that has not been treated in this way and retains its natural pollen content. See Chapter 11 for information concerning the immunotherapeutic potential of honey containing pollen.

Marketing pollen

Pollen can be a useful crop to harvest and market. Commercialised harvesting of pollen tends to be especially successful in dry areas: in humid climates, special effort is needed to prevent pollen from becoming mouldy. Significant amounts of pollen are harvested in Australia, Argentina, Brazil, China, Spain, Vietnam and many other countries.

TABLE 21
Production and trade in pollen

	Year	Annual production tonnes
South Korea[17]	2002	659*

* Retail price of US$10.41 per kg.

PROPOLIS

What propolis is

Apis mellifera honeybees collect resins and gums from buds or injured areas of plants. This glue-like substance, usually dark brown in colour, is called propolis. Just as with honey and pollen, propolis differs in composition according to the plants from which bees have been collecting. Propolis is usually coloured dark brown, but it can also be yellow, green or red.

Stingless bees use large amounts of resin in their nest construction. The constituents of these materials remain unknown and this 'propolis' cannot be used by the pharmaceutical industry.

[17] Kun-Suk Woo, 2004.

BOX 11
Where does propolis come from?

Plants are rooted to the spot where they grow and this means that if attacked by an enemy, plants cannot escape. Plants have therefore evolved chemical defence systems to protect themselves. These include toxins, bitter tastes and stinging repellents, which serve a prophylactic function for plants. Tender buds provide highly nutritious snacks for insects and need to be protected: often a plant protects its buds with sticky gums. When a tree is wounded, it secretes resin around the wound as the first stage of the healing process.
Humans also derive great benefit from these powerful plant chemicals: there are thousands of examples. Everyday substances include aspirin (from willow trees), penicillin (from a fungus), caffeine (from coffee) and menthol (from mint plants). Many medicines are derived from plants. Like humans, bees also harvest powerful plant chemicals. They do it by collecting tree gums and resins and placing them in their nest.

Foraging by bees
The bee bites off scraps of plant resin with her mandibles and packs them into the corbiculae (pollen baskets) on her hind legs. Each corbicula can carry about 10 milligrams of propolis. Because of its stickiness, propolis gathering is a slow business: it can take an hour to fill both baskets. Back at the hive, unloading can take another hour. Propolis is only collected when the temperature is above 18 ºC.

Sometimes bees collect man-made materials and use these in the same way as 'real' propolis. For example, bees will collect drying paint, road tar or varnish. Presumably, to bees these substances have a consistency and strong odour similar to plant resins.

It was generally believed that bees collected resins and gums without altering their composition. However, recent research has shown that bees' enzymes do indeed transform some components of propolis.

The uses of propolis by bees
Apis mellifera honeybees use propolis to keep their homes dry, draught proof, secure and hygienic. When *Apis mellifera* nest in the wild, for example in a hollow tree, the inside walls of the tree appear smoothly varnished with propolis. In this way, propolis is used to seal up any cracks where microorganisms could flourish, and its volatile oils most likely serve as a kind of antiseptic air-freshener. In addition, bees use propolis:

- As building material to decrease the size of nest entrances and to make the surface smooth for passing bee traffic.
- In thin layers to varnish inside brood cells before the queen lays eggs into them, providing a strong, waterproof and hygienic unit for developing larvae.
- To embalm bodies of mice or other predators too large for bees to eject from the nest, which would otherwise decay and be a source of infection.

Apis florea, one of the Asian honeybee species, places rings of plant resins (like grease bands) around the branch from which its single-comb nest is suspended, in order to deter predators, particularly ants. Different races of *Apis mellifera* use propolis to different extents: the Caucasian race is a particularly enthusiastic collector, and not all species of honeybees use propolis: *Apis cerana* is one species that does not. It is not known why propolis should appear so essential for one species of honeybees and yet not for another.

Use of propolis by humans
Propolis has antiseptic and anaesthetic properties and is commonly used as an ingredient in medicines, toothpastes, oral sprays and chewing gums, and in shampoos, soap, skin ointments and cosmetics. It is most commonly sold as a tincture of propolis made by dissolving it in alcohol.

In forest societies, propolis is still used for many purposes. Kikuyu beekeepers in Kenya carry with them a lump of propolis to rub inside empty hives to make them attractive to a colony in search of a nesting place. Propolis is used as part of traditional medicines, and also as an effective glue to mend or seal containers (wood, metal or clay), and to seal up knots in wood.

Propolis has long been used for making wood varnishes. One famous use was as a varnish for violins made by Stradivarius, in Cremona in Northern Italy. The propolis in this region is gathered by bees from poplar trees.

Characteristics of propolis

Propolis quality

Propolis is extremely sticky when warm, but when cold is shiny, hard and brittle. Its physical properties make it an excellent sealant for sealing gaps and cracks in bees' nesting places.

Colour

The pigments in propolis make it usually appear dark brown, red, orange, and yellow or green, although like honey, propolis has been occasionally reported in all sorts of colours.

Constituents of propolis

The constituents of propolis depend upon the plants on which the bees have been foraging, and it is therefore difficult to state a standard definition for propolis, although some countries have endeavoured to do this. Propolis commonly contains over 300 constituents: major substances present in propolis include, flavonoids, organic acids and aldehydes, various alcohols and other organic molecules, minerals, sterols and steroids, sugars, and amino acids. These constituents mean that propolis does not dissolve in water: solvents for propolis include ethanol and other alcohols and organic solvents.

Categorisation

Generally propolis can be categorised into the 'European type', rich in flavonoids (which occurs in China, Japan, Uruguay and Argentina), and the 'Brazilian type', rich in artepillin C[18]. Tree species whose resins frequently occur in propolis include *Alnus* spp., *Bacchalis dracunclifolia*, *Betula* spp. and *Populus* spp.

Harvesting propolis

Propolis can be scraped from the hive and collected until there is sufficient volume to sell. For the commercial harvest of propolis from *Apis mellifera* kept in frame hives, a plastic sheet with multiple small slots (each less than six millimetres) is placed in the hive. The bees seal these gaps with propolis. The sheet is subsequently removed from the hive. If placed in a freezer, when cold enough it is easy to flex the sheet and release the many small pieces of propolis.

Propolis is usually kept in dark containers, protected from light and heat. Propolis can be lyophilised (freeze-dried) and this procedure maintains the physical and chemical properties. A method widely used in Eastern Europe is to dissolve propolis in ethyl alcohol. This extract is then dissolved in organic amine solution. The resulting solution is then filtered and the wax residues removed. It is then soluble in aqueous solution and can be freeze-dried.

Marketing propolis

In some countries, there is a good local market for propolis amongst manufacturers of health products. Elsewhere it can be difficult to find a buyer, and the best recourse is to contact one of the major companies buying propolis, who advertise for propolis in some bee journals (for example, *Bees for Development Journal*) and on the internet.

Propolis can be a useful income source. Current world price for propolis is around a minimum of US$10 per kilogram. For beekeepers in remote areas, gaining access to a market for propolis is much more of a problem than harvesting the product.

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[18] Fujimoto, T. *et al* (2001).

TABLE 22
Production and trade in propolis

	Year	Annual production tonnes
South Korea[19]	2002	63*

* Retail price of US$41.60 per kg.

ROYAL JELLY

What royal jelly is

Royal jelly is a milky white liquid. It is a food for bee larvae, secreted from a complex of glands known as the "salivary gland complex" - the chief one of which is the hypopharyngeal gland of nurse worker bees (worker bees attending the brood). It also contains some sugars and proteins added from the worker bees' stomachs. A larva destined to become a queen bee develops in an especially large wax cell inside which worker bees place lavish amounts of royal jelly. Royal jelly contains many insect growth hormones and is valued as a medicine, tonic or aphrodisiac by people in some parts of the world. Royal jelly has many different components including proteins, sugars, fats, minerals and vitamins.

Royal jelly production

In some countries, especially China, Taiwan and Thailand, royal jelly is harvested and marketed commercially. Honeybee colonies are manipulated to start producing great numbers of queens, perhaps 50 or more, to produce royal jelly for harvest. Worker bees therefore produce vast amounts of royal jelly (feeding extra sugar to the colony is needed to achieve this) and place it in the queen cells. However, instead of the larvae feeding on this and developing into queen bees, the larvae are removed and the royal jelly is harvested. The harvesting and subsequent processing and packaging require skilled techniques for honeybee colony manipulation and hygienic protocols. Royal jelly deteriorates quickly after harvest and must be kept frozen or freeze-dried during handling, storage, transport and marketing.

Royal jelly quality

Some countries have introduced standards for royal jelly, for example, the Food and Drug Administration of Thailand has introduced standards based on the protein content and amount of 10-hydroxy-decanoic acid, a fatty acid unique to royal jelly.

The market for royal jelly

The main market for royal jelly is Japan, with lesser amounts imported by other industrialized countries.

TABLE 23
Production and trade in royal jelly

	Year	Annual production tonnes
South Korea[20]	2002	108*
Syria[21]	2003	0.3**
Thailand[22]	2002	5-6

* Retail price US$29.10 per 50 grams.
** Retail price €2 per 1 gramme.

[19] Kun-Suk Woo, 2004.
[20] Kun-Suk Woo, 2004.
[21] Fert, 2004.
[22] Deowanish, 2004.

MINOR PRODUCTS

Bee brood

In a few world areas, people eat the brood (eggs, larvae and pupae) of honeybees. For example, in Africa honey hunters often eat the bee brood as they plunder the colony. In Asia, eating of the brood of *Apis florea*, *Apis cerana*, and other species occurs widely. In Asia bee brood is also lyophilised and marketed as a powder for health foods and drinks.

Bee venom

Venom is harvested from honeybees for use in therapy against bee sting allergy, and for use in apitherapy, especially for treatment of rheumatism and arthritis. Venom is harvested by submitting bees to electric fields: when they feel the electric shock bees sting into metal gauze, behind which is a glass sheet. This is left in place in the hive for a few hours, after which dried venom is scraped from the glass sheet. It is possible to harvest one gramme of venom (equivalent to about 10 000 bee stings).

Most apitherapy practitioners would prefer to use live bees to administer stings (see Chapter 11), and may argue that dried venom has lost volatile, active ingredients.

TABLE 24
World production and trade in bee venom

	Year	Annual production
South Korea[23]	2002	8 kg*

* Retail price of $US81 per gramme.

[23] Kun-Suk Woo, 2004.

12. APITHERAPY

Apitherapy – bee-therapy – is treatment with bees and their products. It has ancient origins: the first known prescription using honey was written on a clay tablet, found in the Euphrates valley and dating from somewhere between 2100 and 2000 BC. There are records from ancient Egypt and ancient India of using honey in treating wounds. Hippocrates, the ancient Greek physician and 'father of medicine' listed the physical effects of honey: "It causes heat, cleans sores and ulcers, softens hard ulcers of the lips, and heals carbuncles and running sores" (Manjo, 1991). Important religious texts all refer to honey and its healing powers. For Jewish people the Promised Land is described as "a country which abounds in olive oil and in honey" (Deuteronomy 8:8). In the Sanskrit Veda of ancient India, honey is a remedy for many disorders. For Christians, the Bible has many references, and in Islam, honey is a precious medicine. Sura 16 of the Koran mentions the origin of honey and its therapeutic qualities, "It comes forth from their bellies: a liquid of various colours, with healing for mankind".

Therefore, honey and bee products have a heritage of use as medicine. Today, the virtues of bee products are extolled by some, especially those interested in alternative and complementary medicines, who describe the use of honey, pollen, propolis, wax, royal jelly and venom for medicinal purposes as apitherapy. Others will say that claims for the therapeutic benefits of bee products have not been subject to critical, scientific scrutiny.

The Apimondia Standing Commission for Apitherapy works to promote the use of bee products for apitherapy and proposes the following definition:

'Apitherapy is a medical concept, based on scientific foundations corroborating traditional knowledge, including:

- *Bee production procedures aimed at medical development;*
- *Transformation of hive product procedures, alone, or in association with medicinal plants and their derivatives (api-pharmacopoeia); and*
- *Clinical protocols incorporating the use of the api-pharmacopoeia and/or of the bees (api-medicine).'*

Much has been written about apitherapy and a number of organizations exist to promote this cause: see Further Information in Chapter 16 for details. This Chapter gives a brief outline of the bee products used within apitherapy.

HONEY AS MEDICINE

Honey has traditionally been regarded as a medicine or tonic, rather than an everyday food. Today honey is once again increasingly recognised for its healing and anti-bacterial properties when taken orally, or applied as a treatment for wounds and burns.

For example, many societies know honey and lemon as an elixir to relieve sore throats. Today there is scientific explanation: the vitamin C of the lemon has immune stimulating and anti-infective effects, while the honey has medicinal power. The most common bacterium known to cause sore throats is *Streptococcus pyogenes*, and laboratory experiments have proved that some honeys can inhibit the growth of this bacterium. Another bacterium that honey has been shown to inhibit is *Helicobacter pylorum* – a causative factor in ulcers. Honey has a number of constituents and properties that can result in healing properties. These include its acidity, enzymic activity, hydrogen peroxide and high osmotic potential. One of the enzymes present in honey is glucose oxidase. This enzyme is produced by the bees' hypopharyngeal (head) glands. When honey is diluted, the enzyme is activated and oxidises glucose to generate gluconic acid and hydrogen peroxide. The high osmotic potential of honey is due to its high sugar concentration: this means that it has an osmotic effect, which can lead to the breakdown of bacterial membranes, thus inhibiting microbial growth. Honey can be also put to use in healing skin and drying out wounds: its anti-bacterial properties and physical composition, maintaining moist conditions and allowing oxygen to pass, is good for preventing infections, reducing inflammation and promoting rapid healing. Honey also contains compounds derived from the flowers on which bees were foraging: these may be flavonoids and active phenols, well known for their antibacterial properties. Many studies established that the dark honeys of the coniferous forests have a strong antibacterial activity. Examples of antibacterial honeys are the Australian honey of *Leptospermum polygalifolium* and the well-known manuka honey *Leptospermum scoparium* of New Zealand. More information about honey's healing properties can be found in Molan, 1999.

NATURALLY OCCURRING ANTIBIOTIC IN HONEY[24]

In 2003, two consignments of honey being brought in to the EU from Zambia were found to contain low levels of the antibiotic streptomycin. According to the *Codex Alimentarius* definition (see Chapter 9), honey must not contain any antibiotics. Within the EU, antibiotics such as streptomycin, tetracyclines, penicillin and sulphonamides are illegal for use in beekeeping. Tetracyclines can be used to treat the honeybee disease European Foulbrood, but only under veterinary control and supervision, and procedures must be followed so that any honey produced during the treatment period cannot enter the honey market.

The imported honey was harvested by beekeepers living and working in the forests that cover Zambia's remote North West Province. It is very unlikely that these beekeepers are using antibiotics in their beekeeping. The honey is harvested from local style hives made from cylinders of bark and placed high in trees of the miombo woodland. No honeybee diseases are known, and beekeepers do not have the resources, possibility or necessity to use antibiotics in their beekeeping.

So how could streptomycin have become present in the honey? Is it possible that it is a natural constituent of honey, carried into the hive by foraging bees? Streptomycin is produced by bacteria belonging to the genus *Streptomyces:* these bacteria are common and widespread. Streptomycetes have been discovered in samples collected from the miombo woodland, in places frequented by bees, such as hollows in trees, water holes and leaf mould.

Early indications are therefore that the streptomycin could indeed be occurring naturally. This has implications for honey legislation and the world honey trade, as well as for understanding of honeybee biology and honey's long-known role in health and healing.

It is also known from research that ants and Streptomycetes have a highly evolved relationship: some leaf cutter ants have white spots on their bodies – these spots are colonies of a *Streptomyces* species, producing an antibiotic to protect the ant colony's food sources from other pathogens. Could bees also have evolved a way to harness the benefits of the antibiotic streptomycin?

Clearly, research was needed to investigate this amazing discovery, and to provide scientific data concerning the streptomycin and its possible origin. Bees *for* Development is now researching this, in cooperation with the University of Warwick, towards proving the genetic origin of the streptomycin in the Zambian honey.

HONEY TO REDUCE ALLERGIC RESPONSES

As mentioned in Chapter 11, beekeepers have long been aware of local customers who like to purchase local, unfiltered honey in the belief that regular consumption of honey containing pollen helps to reduce their allergic reactions ('hay fever') to these pollens. Recent research on allergic diseases appears to support this belief.

BEESWAX

In the past beeswax was used in medicine, mainly as a carrier for other ingredients, and in salves and poultices. Today beeswax is used extensively in the pharmaceutical and cosmetics industries in ointments, skin creams and pills. Within the field of alternative medicine, beeswax is once again forming part of various medicines. There are some claims that it has antibiotic properties, and can be used in the treatment of arthritis and nasal inflammations.

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[24] Bradbear *et al*, 2004.

POLLEN

Pollen is certainly very important in the nutrition of honeybees, and some people make great claims for the nutritional value of pollen as being one of the most complete foods in nature. It certainly has all the right ingredients, containing around 30 percent protein and including all the amino acids essential for human diets, a full spectrum of vitamins and minerals, trace elements, hormone precursors, carbohydrates and fatty acids. It is possible that pollen provides valuable trace elements to supplement deficient diets. 'Believers' in pollen say that it gives them energy, fights exhaustion and depression, and ensures resistance against colds and flu.

For use in apitherapy, practitioners prefer to have pollen that is as fresh as possible: pollen that has been dried and stored for some time is thought to have a lower therapeutic value.

PROPOLIS

As described in Chapter 11, propolis contains the gums and resins bees collect from plants, and in many cases these compounds are the plants' own response to injury, or otherwise protecting the plants from predators and pathogens. It is therefore not surprising that propolis has anti-fungal, anti-inflammation and anti-bacterial properties. Propolis is particularly valued as a remedy for toothache, and is sold in toothpastes and chewing gums. One possibility is that it works by inhibiting the enzyme glucosyltransferase of the bacterium *Streptococcus mutans*. This bacterium produces lactic acid in the mouth that decays tooth enamel.

ROYAL JELLY

Worker bees and queen bees start life as identical eggs laid by the parent queen. Whether an egg develops into a worker bee or a queen bee is determined by the way it is fed. Queen bee larvae are fed with copious amounts of royal jelly, and subsequently adult queen bees differ in many respects from adult worker bees: the queen alone is fertile, will mate and will lay eggs very prolifically. She will live much longer than her sister worker bees. Royal jelly is therefore a potent food as far as developing honeybees are concerned. Some people credit royal jelly with remarkable powers for humans and other animals too: however, opinions differ and some people argue that there is no scientific support. Certainly, royal jelly is a concentrated source of many nutrients, including all the B vitamins, as well as vitamins A, C, D and E and essential fatty acids.

BEE VENOM THERAPY

This is therapy using live bees, applied directly to the patient. Hippocrates referred to the medical use of bee venom, and still today, many beekeepers believe that bee stings are beneficial for the treatment of rheumatoid arthritis: it is often stated that few beekeepers suffer from this disease. However, this is anecdotal evidence. Despite the lack of scientific confirmation that sting therapy benefits chronic, incurable diseases, some sufferers of multiple sclerosis and rheumatoid arthritis are convinced that it does help. Venom therapy is also claimed beneficial for the relief of pain from tendon injuries, repetitive strain injury and other muscle injuries. Bee venom (harvested as described in Chapter 11) is now marketed in capsule form, making venom therapy available without the patient having to receive bee stings.

One explanation for the beneficial effects of bee stings may be that it is a form of acupuncture. Indeed, some Chinese practitioners combine the two sciences into api-acupuncture. Acupuncture is widely recognised as a useful technique for relieving pain: it is believed that the acupuncture needles stimulate nervous pathways that cause the release of endorphins that are pain-relieving opioid substances. It seems possible that a bee sting could cause stimulation of endorphin production in a way similar to an acupuncture needle.

Venom is a complex mixture of proteins and amino acids, enzymes, sugars and lipids. One polypeptide, melittin, is a major component of venom, and in humans it has the effect of stimulating the adrenal cortex (part of the adrenal gland) to release cortisol, a hormone associated with reducing inflammations and healing responses. This may also in part explain venom's apparent success in easing inflammatory ailments.

13. VALUE-ADDED PRODUCTS

VALUE-ADDITION

Value-addition takes place when enhancement is added to a product or service by a company before the product is offered to customers. In the case of bee products, they can be considered value-added if the original raw product, such as honey or beeswax, is somehow modified, changed or enhanced to increase in value. This incorporates them into other 'secondary' products that have higher net worth, so that each unit of the product can be sold at a higher price and achieves a higher return. To give an example from beekeeping, let us suppose that 0.5 kilograms of honey sells at US$5. However, just a few grams of honey (worth just a few cents of that US$5), if mixed with some other ingredients – that are in isolation also worth just a few cents each – may be combined to create a sweet-smelling cosmetic which, if attractively packaged and well marketed, may also sell at US$5. The selling price of each gramme of honey has been greatly increased: value has been added.

Reasons for developing value-added products

- Increase sales by creating product diversity.
- Stabilise income by allowing income creation during off-seasons.
- Increase the profitability of beekeeping.
- Provide opportunities for other groups or sectors to create income from the products of bees.
- Provide an outlet for other creative talents.
- Make use of excess produce.

ADD PROFIT BY INCREASING PRODUCT DIVERSITY

Value-added products enable the beekeeper to increase sales by creating product diversity, and to increase and stabilize income. Product diversity is about offering a range of products that differ from one another, satisfy the needs of different market sectors, and involves differentiating products from those of competitors. The physical product need not change: changes may just be in packaging or a change in advertising theme. However, diversity may be achieved by changing the product in some way.

The objective of this strategy is to develop a position that potential customers will see as unique. If your target market sees your product as different from the competitors', you will have more flexibility in developing your marketing mix. A successful product differentiation strategy will move your product from competing based primarily on price, to competing on non-price factors such as product characteristics, distribution strategy or promotional variables.

Product development is needed to achieve product diversity. To discover what might be popular products, talk to existing and potential customers: these are the best sources of information if the product is aimed at new markets. In addition, talk with competitor's customers: they provide a good source of information on the strengths of the competitor's products and why they do not buy from you. Lead customers are those who are the most advanced users of the product, who are already adapting an existing product to their own uses. During discussions with customers, it is essential to identify the basic customer needs. The objective is to understand their purchase decisions and how their particular needs are satisfied. Maybe customers are already using honey to make another, secondary product: in this case, the beekeeper could begin to create that secondary product, ready-made for the customer and no doubt others.

Creating products to sell to tourists

Beekeepers in some areas of some developing countries have good opportunities to sell their products to tourists. Tourists do not want to carry home a jar of honey – it is relatively heavy and breakage has bad consequences! Therefore, beekeepers need to look for ways to capture more of the tourist dollar by selling products other than just the usual jars of honey. Small, attractive and unbreakable packaging of honey can work, and candles and skin ointments can be successful for this trade.

Stabilise income

The manufacture of secondary products – especially those products made using beeswax, can be done when time allows, and therefore can help to even out any 'dips' in beekeepers' income. Having a wider range of skills to make secondary products therefore helps to stabilise income and make people's livelihoods more resilient. Out of season months present a problem for beekeepers who rely on direct marketing.

Allow control over pricing

As is the case with the sale of any raw commodity, if the producer can be responsible for adding value, it gives the producer much greater control over pricing and choice of sales outlets, because their product is no longer easily comparable with the competitors' products.

CREATE EMPLOYMENT FOR OTHER SECTORS

Many beekeepers find that developing a value-added product provides a creative outlet that maybe gives another family member or other person a chance to be involved in the business. Creativity can be used to generate good labelling and packaging as well as to create attractive new products. The production of value-added products opens up income-creation from apiculture to many new sectors – cooks who can make food products from honey, or cosmetics using beeswax and/or honey, dextrous people who are good at making neat and functional candles or other wax models, carpenters who can make tiny wooden 'crates' to package small jars of honey. Traditional skills involving the use of beeswax include batik, and lost wax casting, both of which processes are described below.

A WAY TO USE EXCESS PRODUCE

For example, fruits often ripen at the same time and may go to waste if they cannot be used in some way. Some beekeepers have developed methods to incorporate fruit with honey to create value-added products, which provide an excellent way to use up any 'less-than-premium-quality' fruit. In todays competitive and cosmetic supermarket culture, less than perfect fresh fruit often goes unwanted. Farmers that sell fruit to markets and restaurants that specialize in high quality, perhaps organic produce, know that fruit and vegetables must be in perfect condition. However, many fruits are not cosmetically perfect enough to sell, although the blemishes are minor and do not affect the quality of the fruit. Making use of these fruit for value-added honey and fruit products can be a way to save produce and create income. Fruit should be dried until it has as low a moisture content as possible before it is mixed with honey, but it should still be soft. Fruit may be placed whole, or as pieces of fruit into the honey, however if fruit still has too high a juice content, it will introduce too much water to the honey and cause fermentation. Pasteurization of both fruit and honey will improve hygiene and storage possibilities, and will reduce the risk of fermentation, but may adversely affect the flavour.

COSTS OF DEVELOPING VALUE-ADDED BUSINESS

Very small producers can use home equipment, but if the business is successful, middle-sized producers can find it difficult to secure appropriately sized equipment. Many of the additional costs will be extensions of normal operating costs, however, there will inevitably be new costs. In countries where consumer safety, product standards, sanitary and phyto sanitary conditions and Hazard Analysis Critical Point Control (HACCP) quality control systems are enforced, then kitchens will need to be installed according to government standards for food preparation and sanitations, and the necessary initial capital outlay will increase. In addition, there are potentially additional costs such as leasing of buildings, insurance and market fees. Government bylaws or regulations may be a determining factor in whether a beekeeper can or should expand their business to include new value-added products.

MARKETING VALUE-ADDED PRODUCTS

As is true for beekeeping, producing the product is the easy part of the equation. The hard part is trying to break into and keep up with good markets. Marketing is costly in time and effort, and in materials. Design work also is demanding in time and money, as design and logos are an essential component of marketing strategy.

A good logo can be important, and to keep an image fresh, it must be reviewed frequently to make minor adjustments. Each time beekeepers modify an aspect of their product or create a new one, they must reconceptualise their design. For example, if product diversity is increased by introducing new honey jar sizes, the labels will need to be reworked to fit with the proportions of the new sizes. Marketing efforts require plenty of time, energy and hard work. Beekeepers often develop personal relationships with their customers, who tend to be regular and loyal. However, on the open market they must compete with commercial businesses that may seem anonymous. Beekeepers have to market strongly and be proactive in explaining exactly the trees or area from which the honey is produced by their bees, how it is harvested, and why it is better than sugar, jam or another product that might cost less. Whether it is providing honey-taste tests, customer testimonials or offering photographs, beekeepers must pay attention to what works well and repeat it!

Pricing value-added products

Beekeepers can establish a price for their value-added products with experience and analysis of the overall market. People also have an intuitive sense of how much their product is worth, and they use this information to set their price. An artisan-made, value-added product will be priced higher than the supermarket equivalent, and people know that quality is worth the extra dollars. Part of knowing what to charge is knowing the customer-base. Beekeepers' Associations in many countries acknowledge that part of their role is consumer education. The general public need to be informed about the environmental value of bees and beekeeping, and that honey is a very special, local product that should not just be compared to other products on the supermarket shelf.

USE OF HONEY IN VALUE-ADDED PRODUCTS

The following text provides examples of the many types of products that can be made incorporating honey. There are many excellent books giving numerous recipes including honey: see further reading below and Chapter 16.

Honey in prepared foods

Honey can be used in place of sugar (sucrose) in almost any recipe. Because of honey's high fructose content, less honey is usually needed to reach the desired sweetness. The flavour of honey is best retained in foods that are not heated, such as salad dressings and sauces, and ice creams.

Honey in baked goods

There are many ancient recipes for different versions of cakes made with honey. Widely known today are the decorated 'gingerbread house' cakes of central Europe, pain d'épice (France), lebkuchen (Germany and Switzerland), Couques de Dinant (Belgium), basler Leckerli (Switzerland), baklava (Greece and Turkey), and many others.

The moisture-retaining properties of honey improve the keeping qualities of bakery products, and (depending on the honey used) can give a good colour and depth of flavour. It can be helpful to reduce baking temperate a little, to prevent over browning and retain the honey flavour.

Honey in confectionary

Another ancient food that is still popular today is the sweetmeat containing honey, nuts, dried fruit and egg whites. Variations on this theme are halvah (Turkey and Greece), nougat (France), pasteli (Greece), torrone (Italy), and turrón (Spain).

Honey in alcoholic drinks

World-wide there are many alcoholic drinks made with honey. Perhaps the most widespread use is to make honey beer:

CASE STUDY 10 - HOW TO MAKE ZAMBIAN HONEY BEER

Bob Malichi, North West bee products, Kabompo, Zambia

What you need: A calabash (gourd) or any other container (a calabash speeds up the fermentation process).

Ingredients (in parts by weight)
0.5 part sprouted maize or millet
0.5. part crushed brood comb
1 part comb honey or liquid honey
4 parts water
Procedure
Pound lightly the sprouted maize and pour the contents in the calabash.
Brewers brew can also be used though fermentation is slow and takes longer, some use roasted maize grit.
Add some crushed brood comb or bee milk or royal jelly.
Add 1 part water.
Leave overnight in a warm place to activate the fermentation process.
Then
Add 4 parts warm water.
1 part sealed comb honey (crushed).

Put the calabash with its contents in a warm place.
After 2 hours the fermentation should start. You can tell if the fermentation is taking place by observing rapid bubbles coming out of the calabash. The broth should appear boiling.

N.B. The first and second batches of honey beer are slower in fermentation since the starter or inoculant (sprouted maize/brood comb) is still building up. Reusing the starter and the calabash will allow much faster fermentation.

The first honey beer brew takes about 12 hours to be ready. The second beer brew takes about 10 hours. Continuous brewing of the honey beer using the same calabash reduces the time when the honey beer is ready to 6-8 hours. The starter can only be replaced after 3 months of continuous use of the calabash. Alternatively, you can add more starter when the fermentation process slows down.

Things to note

The mixtures should be in correct proportions as described above.
Using calabash assures you 90 percent good results.
Too much brood can cause acidity and off flour in the beer.
Too much sprouted maize can make the honey beer sour and rendered useless.
Using ordinary buckets prolongs the fermentation process to days or even weeks and there is no guarantee that you will get good results.
Too much honey in the mixture may slow down the fermentation process until the brew becomes sour or remain too sweet for days.
Too much water causes the beer to be very sour and set your teeth on edge.
The water for the mixture should be lukewarm.
Too hot water will spoil the broth and the fermentation will not take place and the brew becomes sour.
Too cold the water for the mixture slows down the fermentation process until the honey beer becomes sour and useless.

Honey beer is used or taken

- During the initiation ceremonies when boys/girls reach mature age.
- During traditional chiefs ceremonies.
- As in kind payments for cultivating or harvesting fields.

- When on a long walking journey.
- After a day's hard work.

Some people go to bed early and start drinking honey beer at 3.00 in the morning and by 6.00 they are ready for physical or manual work.
Honey beer cannot be stored for more than 48 hours.
It is advisable not to go for beehive cropping after you have taken honey beer. Local communities say that the smell of the honey beer from your mouth can irritate the bees so much that they will start attacking you straight away.
Women are the best-known honey beer brewers and sellers in Kabompo, Zambia.

Tej

In Ethiopia, honey is not made into beer but into *Tej*, which is honey wine. Tej is a very important drink in Ethiopian cultural life, served at traditional gatherings and special religious ceremonies. Tej is not necessarily alcoholic – often it is drunk before the brew has started to ferment, when it still has a strong yeasty flavour. This drink is called *birz* and is popular with children and, being non-alcoholic, is acceptable to Muslims.

Tej is made in huge wooden barrels, which are cleaned and then scoured with special leaves. The barrel is then filled, one part of honey with five parts of water. The barrel is covered with a clean cloth and left for a few days: fermentation begins. Now some very special leaves are added: these are *gesho*, leaves of *Rhamnus prinoides*, which have been chopped up and then boiled. About five kilograms of this boiled leaf is added to each barrel. After *gesho* is added, the sugars in the honey are converted to alcohol and the Tej increasingly acquires its distinctive dry and bitter flavour. Finally, just before serving, a further half bucket of honey is tipped in to give sweetness to the final brew.

Tej is served in special glasses called *birrille*. These are like small glass vases with bulbous base and narrow neck. For drinking, the *birrille* is held in a special and rather dainty way between the first two fingers and thumb. Tej has a good flavour, something like cloudy, strong mead. The quality and amount of *Tej* served at a marriage or other celebration is directly linked with the wealth of the host. Evelyn Waugh (1931) reported, "The Emperor's *Tej* was a very different drink, quite clear, slightly brown, heavy, rich and dry. After luncheon we were given some of the liqueur distilled from it – a colourless spirit of fine flavour and disconcerting potency".

In Africa it is usually women who brew beer, make Tej, and sell these products. There are no statistics on the extent of these activities, the volume of honey involved to the numbers of people making income in this way. Beekeeping text books often dismiss beer brewing as a 'waste' of honey – since the honey used is indeed often of very low quality – however these drink making activities must create significant income.

Beer making from honey is not restricted to Africa of course – it is made in many countries, as are honey wines and other honey based liqueurs. Honey wine in many countries is known as *mead* (in English) (*met* in Germany, *madh* in Hindi, *mede* in the Netherlands, *mede* in Welsh, etc.) and if herbs are added, *metheglin*.

Honey in medicines

The reasons for honey's use in medicine are described more in Chapter 12 on Apitherapy. Many thousands of tonnes of honey are used to make honey remedies for colds and flu; mixed with aspirin or other drugs to make hot drinks, in sweets and cough medicines, and in cures for hangovers. Honey is also used as a dressing for wounds, and Manuka honey from New Zealand is the ultimate example of successful value-addition: a honey that has created a strong unique selling point and is now sold at very high prices because of its medicinal value.

Honey in soaps and cosmetics

Honey cleansers, face packs and hand cream are just some examples of many possible products, the use of beeswax in cosmetics is described below. Honey water (a few spoons of honey mixed with rainwater) is an old recipe for rinsing hair, and today honey is incorporated into many shampoos and soaps.

USE OF BEESWAX IN VALUE-ADDED PRODUCTS

Beeswax in cosmetics, soap and ointments

Top quality, pure beeswax can be used to make fine soap, shampoos, skin ointments and cosmetics. If used this way, it is possible for beeswax from just one bee colony to generate more income than from all the honey harvested from the same hive. Scrupulously clean, careful, neat and attractive packaging are essential for success with these value-added products.

Basic method for making skin cream

Melt a piece of clean wax in a small, clean container floating inside a cooking pot with water. Mix the melted beeswax with hot almond oil, groundnut oil, coconut oil or edible oil. One cup of beeswax should be mixed with three cups of the oil. For softer ointment add more oil, and use more beeswax to make it more solid. Add a few drops of rose oil, geranium oil, or another perfume or menthol to give the ointment a good scent, and stir it. While the mixture is still hot and liquid, pour it into the final small containers. These containers can be small jars, empty 35 mm film containers, or whatever is available. The price depends partly on how nice the product looks in the market, so the more attractive the container, the better the price it will demand. Put the lids on the containers and let them cool. Never touch the surface of the ointment once it has set. Experiment with different types of oils, different perfumes and colours for the final products. For women, floral and sweet smelling fragrances can be used. For ointments to be used my men, more savoury fragrances might be used: menthol, lemon balm or sandalwood.

Batik

Batik is a craft traditionally known and practised in many developing countries, whereby pictures or patterns are created on material by dyeing it while selectively applying or removing layers of beeswax to create patterns.

Lost wax casting or cire perdue

This method has been used for centuries to make small metal jewellery, ornaments and other items. It has been used by artisans working in the great civilizations of Mesopotamia, Africa, China and Greece. Lost wax casting, also known as *cire perdue*, is the process of metal casting that may be used to create hollow and solid metal items. The sculptor makes a model in plaster or clay that is then coated with wax. If the finished item is to be very small, the whole model can be made from wax. This model is then covered with a plaster or clay mould, which has somewhere in it a hole or outlet pipe. When heated, the wax melts and the mould "loses" the wax when it is run out of the hole or pipe in the plaster. Molten metal is then poured into the space formerly occupied by the wax. After the item cools, the sculptor breaks the mould, removes the plaster core if there is one, and finally polishes the metal product. The advantage of the lost-wax method is that it eases the casting of any sculpture with intricate shapes and elaborate curves.

Wax candles

Before starting candle production, consider if it is not more income generating to use the wax for making ointments or other more expensive products. The local price of candles produced from paraffin wax is often very low, and it will be a waste to make beeswax candles if they are to be sold at the same low price.

There are three basic types of candles: moulded, dipped or rolled. It is possible to buy expensive silicon moulds to make candles of various sizes, shapes and patterns that can generate a good price. If candles have to be produced in a village without equipment, the simplest way is to make 'dipped candles'. This is where one or more cotton strings are repeatedly dipped into a container of melted wax. The wax has to cool on the wick before it is dipped again. The dipping is continued until the candle has reached the desired thickness. Another way is to place the wick centrally in a mould and pour in molten wax. The mould can be made from a piece of papaya stem or piece of bamboo. The wick is kept in place by some small sticks. When the wax is solid, the mould can be opened and the candle is ready for use. The fastest way to make a candle is to pour molten wax over a metal plate that has been smeared with soapy water. The wax will cool immediately to a thin layer that can be easily removed because of the soap. The wax layer can then be rolled around a wick. The wick can be made of a cotton string or pieces of cotton cloth. Nylon cannot be used. The thickness of the wick is important; it determines how fast and well the candle will burn, and how much light it will give. Best of all is to use properly made candlewicks, using the right size for the diameter of the candle. Beeswax candles do not smoke as most other candles do, and have the very best aroma as they burn, that some people are willing to pay for. For people who appreciate the beauty and aroma of a beeswax candle, burning a paraffin wax candle can deign to seem like lighting an old car tyre in the house!

Beeswax furniture polish

This is the best polish for any wood. The simplest recipe for polish is to mix beeswax with a suitable solvent such as white spirit or turpentine. Proportions should be 200 grams of beeswax with 0.5 litre of solvent: the proportions can be varied to give the consistency required. If less solvent is used, the mixture will be more of a paste than a liquid. The method is to heat carefully the solvent in one pan, and the beeswax in a separate pan, until the beeswax melts. With both liquids at the same temperature, pour the solvent into the wax and stir very well. Pour into prepared glass jar or tin containers.

If it is available, carnauba wax (from leaves of the fan palm *Copernicia prunifera*) makes an excellent ingredient for polish and removes the slight stickiness of beeswax. Carnauba wax has a high melting point (83-85 °C), gives hardness and a high gloss finish. If this was is available, substitute 50 grams of the beeswax in the above recipe with carnauba wax.

USE OF PROPOLIS IN VALUE-ADDED PRODUCTS

Propolis tincture

Collect scraps of propolis: as far as possible ensure they are just pure propolis. Mix it with an equal volume of 100 percent alcohol (vodka or grain alcohol). Put in an ovenproof jar with a lid and heat very gently in an oven. Do not allow the temperate to rise above 80 °C, and keep shaking the bottle every 15 minutes or so until the propolis is dissolved. When it has dissolved, allow the mixture to cool, strain it through a filter and then bottle – the best container for tincture is a dark-coloured ‘dropper’ bottle, if these are available. Using this type of bottle it is easy to apply a drop or two of the tincture on to any minor skin cut or abrasion.

Propolis cream

Instead of making tincture, prepare a medicinal and soothing cream by melting gently together one part beeswax, four parts liquid paraffin, one part grains of propolis and one part honey. Stir the mixture continuously until it is melted and combined, and continue stirring as it cools and thickens.

Further information

There are many books with recipes for using various bee products[25].

[25] Two of the best are: Krell, R. 1996. Value-added products from beekeeping, *FAO agricultural services Bulletin* No. 124, FAO Rome. This text is also available on the internet at: http://www.fao.org/docrep/w0076e/w0076e00.htm. This book gives hundreds of recipes incorporating every bee product. It is available free of charge on the internet, and is highly recommended as a source of recipes, further references and information. Also White, E.C. (1993) Super formulas, p. 120. The formulas in this book are not just recipes for food items, but for making other products. Some are familiar as candles, mead, and vinegar. Others are less thought of as containing bee products: beard softener, mascara, paint stripper and theatrical grease paint.

14. HONEY MARKETING AND INTERNATIONAL TRADE

LOCAL MARKETING OF HONEY

This chapter explains that the world honey market is not necessarily an easy one to enter. Exporters have to be up to date with legislative criteria and able to meet them. Beekeepers face the lowest risks if their honey does not need to cross international borders: if they can sell directly to consumers then they should achieve a good price and in a simple way. Fresh, local honey is often (although not always) more highly valued than imported honey, and many beekeepers sell their product directly to consumers. Honey is often used as a barter commodity in villages, especially in remote areas, and can become a highly significant commodity in places isolated by war or sanctions.

Packaging

Beekeepers sell their honey in villages and town markets in whatever containers are available. In poor places, this may be in drink bottles. Containers for marketing honey must be lightweight and of low cost, and preferably see-through so that customers can see the product.

Glass is often used as a container for selling honey but glass jars are heavy, breakable and cannot be stacked together when empty. Plastic containers are much lighter and stack well, but in many countries, they are difficult to obtain. Tamper evident seals are useful – a printed-paper will serve this function. Honey is most commonly packed in glass jars of 450 or 500 grams, or of one-pound weight, and different nations have their own norms for honey marketing. In central and eastern Europe honey is sold in one kilogram jars, and in the Caribbean, recycled rum bottles are the accepted norm for honey marketing. Small amounts are often sold in foil or plastic containers of about 25 grams, principally for the catering trade. This is also a popular way to sell honey to people who cannot afford to buy larger volumes.

Transporting honey in larger volumes

Honey in larger volumes is often carried in plastic jerry cans or 20 litre tins. These are not suitable for honey as they have a narrow neck. The best options for processing and transporting honey are stackable, plastic buckets with tight fitting lids. Using these buckets, beekeepers can sort honey into first and second quality at time of harvest, and they can be used for the sieving and filtration steps of processing. Suitable buckets are not always readily available but can usually be tracked down in main cities, and suitable, lidded buckets are used widely in the food industry and catering services.

Labelling

Honey is a product that sells according to its looks and the information given on the label. This is usually all the information that the consumer has to go on in deciding whether to buy the product. For example, it is not possible for the consumer to know, just by looking, whether the product is authentic honey. So attractive, informative and effective labelling is important. It is best to market honey indicating its exact geographical origin: this gives the consumer confidence in the product, and he or she can to some extent visualise and feel identification with a blossom or a region.

In addition to attracting customers to the product, the label on honey should give the following information:

1. Contents: Honey.
2. Source of the honey for example: sunflower, mixed blossom, forest honey.
3. The country and district where it was produced.
4. Name and address of the beekeeper.
5. The weight of honey in the container.
6. The date of packing (or the beekeeper’s own code).

It is an accepted wisdom that pictures of bees do not attract customers to buy honey: many people are scared of insects! It is often valuable to provide additional product information for the consumer. For example, for comb honey, it is useful to remind the purchaser that the whole comb including the beeswax is completely edible, or for selling strained honey, it is sometimes necessary to provide an explanation of granulation. This is because many consumers believe that crystallisation is a sign of honey having been adulterated with added sugar.

The EU and other markets stipulate the size of lettering required on honey labels. However, packaging requirements of importing countries do not often affect exporters, as it is usually the importers who are responsible for the final packaging.

Roadside marketing

Selling honey at a roadside stall or market can bring the advantages of long opening hours and plenty of passing trade, without the overhead costs of a shop. Roadsides are dusty places, and the containers and lids usually benefit from a quick polish every day. Since customers will be travelling in a vehicle, maybe they would buy a larger container of honey. Try offering 'family size' 2 or 5 kg 'economy' packs.

BOX 12
Tips for honey marketing

1. A bold, bright sign is essential. The lettering must be large and clear enough to read from a passing vehicle. The minimum height for lettering is 15 centimetres. Keep the message simple: 'HONEY' or 'HONEY FOR SALE'.
2. Honey for sale must always be of top quality and pure: no bees' legs, scraps of beeswax, or any contaminant specks at all.
3. Honey containers must be perfectly clean. Jars must never be sticky with honey. Sticky containers will also attract bees and other insects: a discouragement to most customers. Nobody wants to buy honey in a sticky or dusty container.
4. Local purchasers can become regular customers if they know and trust the brand of honey they are buying. If they like the honey, they will come back for more. Explain about the honey, which plants it is from, and how it is harvested from the bees. Make customers feel good about finding such an excellent supply of local honey! Emphasise the extra freshness of the product: the buyer rightly wants to have bought something freshly harvested.
5. Offer both liquid and granulated honey for sale if possible. Explain to customers the difference between these products. Replace any jars on display that are starting to granulate in an irregular way.
6. Improve sales by offering different sizes and styles of packaging. However, never compromise on quality of packaging.
7. Pay attention to the display. Customers feel more encouraged to buy from a stack of attractive jars than from just a few tired-looking jars. Always arrange jars with the labels facing the front.
8. Link honey with other products. Sell honey with, for example, a pack of lemons and give a recipe leaflet for honey lemonade. Other combinations of seasonal produce and recipes could be: honey & almonds, honey & oranges, honey & dates, honey & spices. Think a few weeks ahead. Plan promotions with the season and cultural or religious festivals.
9. Do not forget tourists. Local honey can be a popular gift item. Attractive labelling is essential here and must convey the local or national nature of the honey. Unusual, locally made containers filled with honey can attract a premium price. A good product can be pairs of jars, packed inside a small, locally made wooden crate or basket. Tourists are more likely to buy smaller units: tourists do not want to carry large, heavy jars of honey home.
10. If supplying a local market, the supplier must ensure that it is kept constantly stocked. This may mean sometimes buying honey from another local beekeeper. However, never let the authenticity, quality of the product, or its presentation fall. Once a products' reputation is lost it can be impossible to recover.

MARKETING CONSTRAINTS

Constraints faced by individual beekeepers and honey hunters

Beekeepers and honey hunters living in or near to forest, or working in other remote and poor areas are likely to encounter many constraints when it comes to finding a market for their products. These constraints are likely to include some of the following:

- Lack of access to suitable containers for storing, transporting and marketing honey.
- Poor diversity of retail packaging materials.
- Lack of roads.
- Lack of transport.
- Lack of communication possibilities.
- Lack of bargaining power.
- Lack of organizational support.
- Lack of training and technical advice, or poor quality training.
- Poor market access.

- Lack of appropriately-trained support personnel or information materials.
- Low product prices.
- Few social linkages with other producers.
- Few social linkages with potential buyers.

Issues faced by traders

In turn, traders who deal in honey (or beeswax), find it difficult to buy from a scattered population of small-scale producers. These are the constraints typically faced by traders:

- Lack of access to products of sufficient quality.
- Lack of access to products of sufficient quantity.
- No linkages between producers and buyers.
- Lack of access to, or non-availability of credit.
- Poor diversity of retail packaging materials.
- Different buyers having differing quality requirements.

Honey retailers in cities are often hesitant to pay cash on delivery: traders providing honey for retail sale must wait until their honey is sold before they receive payment. This explains why traders sell honey where they can - even though the price paid is low, immediate payment can be essential for resource-poor sellers.

CONSTRAINTS FOR THE INDUSTRY AS A WHOLE

For reasons touched upon in Chapter 1 and 4, apiculture as a sector tends to be poorly recognised and with little lobbying power. In poor countries, the producers are likely to be amongst the most remote and most poor people, and the apiculture sector is not easily identifiable or recognisable. These are some of the reasons and consequences:

- Lack of appropriate extension material.
- Lack of appropriate marketing information.
- Lack of appropriately-skilled trainers.
- Lack of strong organizations representing the interests of beekeepers.
- Poor linkages between producers and buyers.
- Little coordination between beekeeping and other sectors, including the horticulture, forestry, health, and environment sectors.
- Little or no product promotion.
- Few developing countries have beekeeping policies for protection of the industry.
- No global agreement on honey criteria.

For all of the above reasons, beekeepers and honey hunters can gain much by forming groups or cooperatives.

ORGANIZING HONEY HUNTERS AND BEEKEEPERS INTO GROUPS FOR MARKETING

Beekeepers working individually tend to receive low payment for their products. They are constrained in how much they can earn by lack of adequate containers to enable harvesting and processing of good quality products, and the difficulty of transporting this honey to places with access to traders where they can market it. This makes individual beekeepers and honey hunters highly susceptible to low prices offered by dealers who have transport. Beekeepers and honey hunters working in poor and remote rural areas can benefit greatly from interventions that improve possibilities for the successful collective marketing of their products.

ORGANIZING HONEY COLLECTION CENTRES

These are centres where beekeepers can bring their products and be certain of a market. When significant volumes of good quality honey and beeswax are available in one place, traders will be interested to travel to remote areas, being certain of the volume and quality they will be able to collect.

Centres function as a means of collecting honey and beeswax from beekeepers and then arranging its onward sale, either locally, within the nation, or for export. Collection centres may be owned and managed by a co-operative, an NGO or private sector.

The centres sometimes help beekeepers by providing them with lidded plastic containers for honey and beeswax collection (that remain the property of the centre). Depending on the area covered, the centre may need to organise the collection of buckets from specified collection sites throughout the area. This means that the centre must own or hire vehicles to reach the collecting sites. Depending upon the market available for the honey and beeswax, the centre may carry out further processing of the products, sell to dealers, or package honey for retail sale. Beekeepers will be paid set prices according to the weight and quality of their products.

Centres need secure storage space for honey and beeswax, buckets, weighing scales, honey refractometers, simple processing equipment, and transport and communication facilities. Personnel are required to manage the centres, with skills in measuring honey quality and handling of honey and beeswax, and with extra staff during the honey buying seasons.

Beekeepers' co-operatives, where beekeepers are the member-owners, need legal establishment. Their honey and wax may be eligible to receive international registration concerning 'Fair Trading'. It may also be possible to register the honey and beeswax from forests as recognised organic products. These are all benefits that can become feasible when beekeepers form themselves into groups or cooperatives.

Difficulties can arise for honey buying centres that may not always be able to buy sufficient honey and wax to generate income to continue operation. There may be periods when little honey and wax are available, or when other buyers begin offering better prices to beekeepers. It may also be that beekeepers cannot be paid for their products immediately. In this case, the risk is that the beekeepers would rather accept a lower price from other buyers to receive cash in hand. Another risk concerns international markets for honey and beeswax: currently these are strong, and are generally steady markets, but legislative criteria for honey tend to change and increase each year. As countries become wealthier their demand for honey and beeswax increases.

MULTIPLIER EFFECTS

In many societies honey is not a highly visible commodity. Better quality honey, presented in attractive containers for sale will stimulate local trade and this in turn leads to an increase of beekeeping activities.

CASE STUDY 11 - HONEY: INDIGENOUS COMMUNITIES BEGIN TO PRODUCE HONEY IN MATO GROSSO[26]

The honey produced in the Xingu region is now being sold outside the state. This month, the indigenous communities will send a shipment of honey to three Sao Paulo supermarkets. They are negotiating with the Pão de Açúcar supermarket chain, which has shops in twelve states of Brazil. The communities currently produce 1,500 kilograms of honey per month. They are beginning to increase production. The deal with the Pão de Açúcar Group could open the doors to the international market.

The product has strong commercial appeal as it is produced by Indians. The honey has organic certification from the Biodynamic Institute. The certificate is only awarded to products that are produced by sustainable practices that do not harm the environment. The honey is the first indigenous product to receive a Federal Inspection Seal from the Ministry of Agriculture, which means that the honey is produced in accordance with health and safety legislation. The seal authorises the sale of the honey in other states.

[26] Source: *Amazon News*, 17 July 2003, cited in FAO's NWFP-Digest-L No. 7/03.

CREDIT REQUIREMENTS OF INDIVIDUALS AND GROUPS

Lack of credit is a major constraint for everybody concerned with selling and buying honey. Beekeepers and honey hunters expect honey collection centres or private sector traders to pay cash when they bring honey, otherwise they prefer to sell their honey "by the spoonful in the market" for an instant, albeit lower cash return. Those buying honey have problems in accessing the credit they need. Therefore, in poor rural areas without collection centres, there tend to be few places where significant volumes of honey are available for sale.

Honey collection centres need a cash float in time for the start of the honey-buying seasons. It is important that collection centres have sufficient working capital to buy honey and wax so that they have viable quantities to interest traders. Once beekeepers have confidence in the centre then beekeeping can be seen as worthwhile business. Avaiable and sustainable financial system for buying honey and beeswax can be a key element towards apicultural development.

CASE STUDY 12 - NORTH WEST BEE PRODUCTS ZAMBIA

The beekeepers of Zambia's remote North West Province might be regarded as some of the poorest people on earth: they are forest dwellers with little or no sources of cash income other than that earned from their honey and beeswax. North West Bee Products (NWBP) is a company with 6,500 members, who own the company and ensure its management. In this Zambian province, NWBP is the largest employer after the Government. All of their honey and beeswax is produced by bees housed in local-style bark hives. Their honey is organic certified (from the UK Soil Association), has fair trade certification from Germany, and meets the EU's stringent import requirements. It is the organic and fair trade certification, and 'uniqueness' of the forest-produced honey that gives this honey its comparative advantage on the world market; otherwise these relatively small honey producers could not compete on price with the world's major, large scale producers of honey (for example China, Mexico, Argentina). NWBP began in 1979 with support from GTZ (German Government development organization), and subsequently received support from a variety of donors over the years. The company could not have managed without this support from donors in some years, but is now self-sustaining and successful, with beekeepers annually increasing production, confident in the market for their products. In 2003, NWBP exported 144 tonnes of honey to the EU[27].

The success of this intervention can be attributed to the people's access to all the types of resources needed to make their livelihoods sustainable:

- natural resources (strong populations of healthy bees and abundant forest);
- physical resources (lorries able to navigate rough forest tracks and to enable honey to be transported from the producers to the collection centre, buckets with lids allowing clean honey to be transported);
- social resources (the strong organization, owned and run by the producers and with access to market knowledge);
- human resources (the beekeepers skills at beekeeping and honey and beeswax harvesting); and
- financial resources (access by the company to credit when needed).

[27] For more details see Wainwright, 2002.

HONEY TRADE REQUIREMENTS

Honey authenticity

Honey authenticity has two different aspects. The first of these is authenticity in terms of its content i.e. that it is 100 percent real honey and has not been contaminated with sugar syrup. The second is authenticity concerning its description: geographical and botanical origin. Both aspects, content and origin are required for honey to be authentic. In addition, honey may have other categories assigned to it, such as organic, fairly traded, unfiltered, raw, etc.

Honey adulteration

Honey is a target for adulteration, with acid-inverted sugar syrups, corn syrups, and syrups of natural origin (such as maple, cane sugar, beet sugar, molasses, etc.) added to honey. Informed consumers are able to taste the difference between these and real honeys, but laboratory tests are needed to prove the difference. This is why honey marketing is so dependent upon building consumers' trust that the product they are buying is real honey.

Honey legislation

TABLE 25
Honey standards of the Codex Alimentarius and the EU Honey Directive[28]

Compositional criteria	Value
Sugar content Fructose and glucose content (sum of both) - blossom honey - honeydew honey, blends of honeydew and blossom honey	 not less than 60 g/100 g not less than 45 g/100 g
Sucrose - in general - False acacia *(Robinia pseudoacacia),* alfalfa *(Medicago sativa),* Banksia *(Banksia menziesi),* French honeysuckle *(Hedysarum),* red gum *(Eucalyptus camaldulensis),* leatherwood *(Eucryphis lucida, Eucryphia milliganii),* Citrus spp. - Lavender *(Lavandula* spp.*),* borage *(Borago officinalis)*	 not more than 5 g/100 g not more than 10 g/100 g not more than 15 g/100 g
Moisture content - in general - heather (*Calluna*), EU, CA; bakers' honey, EU - bakers' honey from heather (*Calluna*), EU	 not more than 20 % not more than 22 % not more than 25 %
Electrical conductivity - honey not listed below, and blends of these honeys - honeydew honey and chestnut honey and blends of these except those listed below Exceptions: strawberry tree *(Arbutus unedo),* bell heather *(Erica),* eucalyptus, lime *(Tilia* spp.*),* heather *(Calluna),* manuka or jelly bush *(Leptospermum),* tea tree *(Melaleuca* spp.*)*	 not more than 0.8 mS/cm not less than 0.8 mS/cm
Free acid - in general - bakers' honey (only EU Directive)	 not more than 50 meq/kg not more than 80 meq/kg
*Diastase activity** (Schade units) In general; except bakers' honey (EU) Honey with low natural enzyme content (e.g. citrus honey) and an HMF content of not more than 15 mg/kg	 not less than 8 not less than 3
*HMF*** (mg/kg) In general; except bakers' honey (EU Directive) Honey of declared origin from regions with tropical climates and blends of these honeys	 40 80

* Honey buyers often require a maximum of 20 mg/kg.
** Determined after processing and blending.

Certification

All honey traders and importers require certification for the honey they intend to buy. The EU honey market requires imported honey to be certified that it is free from chemical, antibiotic and other residues: these are the most stringent criteria that are constantly updated as new contaminants are

[28] Modified from Bogdanov, S. & Martin, P. 2002. Honey authenticity. Mitt. Lebensm. Hyg. 93, 232-254.

discovered in honey on the world market. While this makes the EU the hardest market for potential exporters to access, it also makes it a worthwhile market for producer groups with high quality product.

The growing demand for residue-free honey

BOX 13
Residue-free honey

Residues may be present from the following:
Arising from the environment
Heavy metals
Radioactivity
GM pollen
Pesticides (currently the EU has no legislation specifically concerning pesticide residues in honey, although individual EU Nations do have such legislation)
Bacteria

Introduced by the beekeeper:
Medicines to control the Varroa mite (predator of honeybees)
Antibiotics (used to control bacterial diseases of bees, mainly American foulbrood, but also European foulbrood)
Residues of wood preservative
Chemicals used in honey harvest (rarely used)
Chemicals to control other bee pests and predators

The residues most likely to be present in honey are due to the use of medicines to treat honeybee diseases, introduced during some form of honeybee management, or from environmental pollution. Residues detected in honey have included aminoglycosides, tetracycline, streptomycin, sulphonamides, chloramphenicol, naphthalene and many others.

This demand for residue-free honey opens opportunities for honey producers in the poorest countries. In addition, it is often the most poor and most remote people of these countries, with few other livelihood options, who practise beekeeping. It is in these parts of the world that honeybees remain relatively disease free, and environments may be relatively unpolluted, therefore these people can harvest honey and beeswax that are of excellent quality, and especially now, because these products are residue-free, they can achieve good prices on western markets, if they are able to gain access. EU market access depends upon honey meeting EU import criteria.

In February 2002, the world honey market was strongly affected by an EU ban on Chinese honey, following the identification of antibiotics in samples of Chinese honey. Since China was Europe's largest supplier of honey, this immediately led to a shortage of honey meeting EU criteria, and honey prices increased rapidly. The prevailing market conditions present an ideal opportunity for small producer nations to get a toehold in the market, yet producer groups in developing countries remain unaware of the changing market situation and the potential sales available to them. The market gap left by China could be filled by other developing countries if they were sufficiently informed and organised to do so. However, African honey is almost absent amongst EU honey imports, although large quantities of honey are produced by small-scale beekeepers in Africa. The EU currently represents an excellent market opportunity for small producer groups, with European and other buyers interested to buy more honey if it can meet EU criteria.

CASE STUDY 13 - CHINA ATTACKS EUROPE OVER HONEY BAN

BBC News Friday, 12 July 2002, Nicola Carslaw, BBC consumer affairs correspondent in China

A leading Chinese agriculture official has launched a bitter attack on the European Union for imposing a ban on Chinese food imports. The Chinese authorities say it has led to trade losses totalling several billion pounds and is causing widespread hardship in rural areas that depend on overseas companies buying their produce. EU inspectors recommended the ban because they were so concerned about the routine use of antibiotics and hormone growth promoters in Chinese food production – and because of the lack of regulation governing the trade in veterinary medicines. From Europe's point of view, the biggest impact of the ban, imposed earlier this year, has been on stocks of honey. Chinese blends were widely used in the brands most commonly on sale.

Fit for emperors

I was given unprecedented access to Chinese food producers, who have sent an urgent plea to the European Union to restore trade, and I was escorted by officials to the eastern Shandong Province. The slopes of sacred Mount Tai, a place of retreat and pilgrimage for China's emperors, are dotted with beehives. The sound of crickets competes with the honeybees. Until the ban, the highly fragrant honey collected here was destined for the European Union. It used to be a product deemed fit for the emperors. But now, with the detection of illegal drugs in Chinese honey, it is not fit even for the European Union. Its reputation is ruined - its purity in doubt.

Unfair ban

I was taken to meet a beekeeper whose livelihood depends on supplying the big honey exporters. He said he could not understand why he was being penalised. "This ban's totally unfair" he said. "The environment here is so clean my bees don't get sick and so don't need medicines. If these European inspectors found antibiotics, then it's nothing to do with my honey." Yet, on any High Street, chemical pesticides and veterinary drugs are freely available. Anyone can buy antibiotics such as Chloramphenicol, banned for use in food in Europe because it is potentially harmful to human health. Traces of it and other illegal medicines were found by EU inspectors not just in Chinese honey but in poultry, shrimps and rabbit meat.

Lost trade

Chinese officials took me to a rabbit-breeding centre that used to supply three thousand tonnes of meat to Europe. Now it has had to lay off two thirds of its staff and stop its expansion plans. Anxious to show no illegal drugs are used here, the owner, Luo Dong, told me he was furious with the European Commission, accusing its inspectors of acting purely to protect Europe's own markets. He said: "China's so keen to conform to world trade regulations yet now, because of a few industry rogues, well-run companies like mine are being punished by an over zealous ban." The overriding message to the EU is that the ban is making the poor even poorer. The Chinese government says it has led to billions of pounds of lost trade.

Drug ban stays

The top official at the ministry of agriculture in Beijing has condemned the ban as hasty and irresponsible. But he acknowledged that there were flaws in the system: "The government has now banned some twenty of the drugs that were routinely used and has stripped hundreds more of their licences. We have also sent out more than 22,000 teams of inspectors across China to monitor the food production methods of those who supply exporters."

In the meantime, European inspectors say they are not convinced. They have said that until honey and other foods are drug free the ban will stay. But the Chinese government said this was just a fraction of the total losses because in the wake of the EU action, other trading blocks had followed suit with their own bans, including North America and Canada.

Residue Monitoring Schemes

For a country to be eligible to export honey to the EU, it is essential for the nation's name to be added to the EU's list of 'third countries' eligible to do so[29]. To achieve this it is necessary to show that the nation has a 'Residue Monitoring Scheme' established for the analysis of honey for residues of antibiotics, sulphonamides, pesticides and heavy metals as defined in Decision 2001/159/EC and modified in 2001/487/EC. This legislation denies access to EU markets for most African countries, even though chemical residues are not a problem in African honey. This is because beekeepers in rural areas of Africa still harvest from stocks of indigenous, wild honeybees, uncontaminated by the diseases and exotic predators that now afflict bees in most other world regions. For this reason, African beekeepers do not apply medicines to their bees and are able to harvest the residue-free honey that is currently in short supply on the world market. Producer groups and relevant government departments need technical awareness on how to set up cost effective monitoring schemes to meet the standard required by the legislation. In smaller exporting countries these can take the form of an industry self-regulating scheme, organised and monitored by a competent authority acceptable to the EU. It is not necessary for each exporting country to have its own laboratory for authentication and certification: only to establish an acceptable protocol and procedure for taking honey samples and submitting them to EU-accredited labs.

At present honey with any detectable level of any antibiotic cannot be imported into the EU because no Maximum Residue Limits (MRL) have been set, and the EU requires that antibiotic levels in honey must be zero. However, some European traders, arguing that it is impossible to measure a zero presence, have been requesting that a minimum measurable level should be set, as is the case for other food stuffs. The levels of antibiotics when found in honey are typically around only 30 parts per billion, and are far below EU permitted levels for antibiotics in milk and other foods.

Organic honey

In industrialized countries, honey remains one of very few totally natural and unaltered foods available to consumers. Part of honey's image and reputation is as a wholesome, natural food, and there is therefore much interest to have sources of honey that are organic certified. There is a premium price available to beekeepers who can supply organic certified honey, which is in especially strong demand within EU countries. As mentioned above, bees commonly forage within a range of two kilometres from their nest or hive i.e. over an area of 12.6 km^2. To ensure that honey is organic, this entire area must be organic, and the regulations stipulate land within three kilometres (EU) or four miles (UK).

Beekeeping was added to the EU law (regulation 2092/91) governing livestock production in 2000. This means that within the EU, honey may be labelled and sold as organic only if it is produced, inspected and certified in accordance with the requirements detailed in this law. The regulation also applies to organic honey imported from outside the EU, which must be demonstrated to have been produced and controlled to equivalent strict standards.

Some EU countries, for example, the UK and the Netherlands, have introduced organic standards for honey. In the UK, The Soil Association (a charity founded in 1946 to promote organic food and farming for environmental and health benefits) has set organic standards for honey since 1967 – these now comply with EU regulations. In the Netherlands, the term "biologisch" (organic) is protected by law and can only be applied to products certified by the Netherlands' SKAL organization. For the certification of organic honey, SKAL-norm 995 specifies the conditions to be met in the production and harvesting of honey by beekeepers and in its preparation and packaging. Information on joining an organic scheme can be obtained at SKAL (see Chapter 16 for contact details). For information on organic honey in the United States, see Schell, 2003.

Each EU market has one or more approved organic inspectorates. A small number of inspectorates in non-EU countries (for example Australia, Argentina, India, Israel and Switzerland) are recognised as equivalent. If there is no nationally approved inspectorate, the production unit and products must be inspected and certified by an outside-recognised inspectorate. In this regard, the UK's Soil Association, the Netherlands' SKAL, and other inspectorates are active worldwide.

[29] *Official Journal of the European Communities*, Commission Decision of 12 February 2001. (2001/158/EC).

The requirement to have large areas of land free of pollution is difficult or impossible in most industrialized countries, but this opens the door to beekeepers working in areas with indigenous vegetation, uncultivated land and extensive agriculture. In this way, beekeepers in North West Zambia are able to benefit – see Case Study 12, and their honey is certified organic by the UK Soil Association.

Other countries currently producing certified organic honey include Australia, Scotland, Turkey, Mexico, Nicaragua and New Zealand.

Organic regulations include:

- Siting of apiaries – they must be on certified organic land and must not be treated with herbicides, pesticides, etc.
- Hive construction – must be of natural, untreated materials.
- The conversion period for changing from 'conventional' to organic beekeeping is 12 months, during which time the beeswax must be changed to organic.
- Origin of bees – 10 percent of the colonies in an apiary can be replaced/increased using non-organic queens or swarms, if organic beeswax (i.e. from hives managed organically) is used. In this case, the twelve-month conversion period does not apply.
- Foundation and comb – must be made of organic beeswax, except when an apiary is first converted and organic beeswax is not available.
- Foraging – for a radius of three kilometres (EU regulation) or four miles (UK Soil Association standards) around an apiary, nectar and pollen sources must be essentially either organic or wild/uncultivated. This area must not be subject to significant sources of pollution from roads, industry or urban centres.
- Any feeding of bees must be with organic honey or organic sugar and this may take place only after the last honey harvest, or 15 days before the first nectar flow.
- Disease control: homeopathic and herbal treatments and natural acids (lactic, acetic, formic, oxalic) may be used without restriction. Other medication requires veterinary prescription, the beeswax must be replaced and there must be a withdrawal period of one year.
- Clipping of queens' wings is prohibited.
- Extraction and bottling – no requirements beyond the normal measures to ensure separation and product integrity.

For many small beekeeper groups, the administrative procedure concerned with organic certification is too expensive to be feasible (see Case Study 14). Nevertheless, the organic standards describe good beekeeping practice that can be adopted by beekeepers everywhere.

CASE STUDY 14 - DEVELOPING MARKETS FOR TRIBAL ORGANIC PRODUCTS – EXPERIENCE FROM THE BLUE MOUNTAINS, NILGIRIS, INDIA

Keystone is an NGO working in South India, in the Northwestern part of Tamil Nadu near the borders with the neighbouring States of Kerala and Karnataka.

The Nilgiris Mountains consist of one of the most ecologically fragile areas in India. The hills are steep and traditional forests have been depleted and are under further threat, because of the increase in large tea plantations and substantial destruction of natural vegetation by the Forest Department, through introduction of exotic commercial tree plantations. Consequently, soil erosion is rampant. Tea and coffee plantations have replaced large parts of the original vegetation and marshes have been converted into agricultural fields: 50 percent (30,000 hectares) of all cultivated areas consist of tea plantations. Although no hard figures are available, it is common knowledge that conventional tea plantations make heavy use of chemical fertilizers and pesticides and reduce the water retention capacity of the soil. The remaining forests are crucial for conservation of the flora and fauna and the sustenance of water bodies, consisting of the two major rivers Bhavani and Moyar and their numerous tributaries. They irrigate large areas and generate hydropower.

However, there are still good tracts of forests, representing the original Nilgiris' vegetation. Here, people live in harmony with the forest and collect non-timber forest produce (NTFP) like wild nutmeg, cinnamon, sugarcane, pepper, honey and herbal plants.

In 1995, Keystone began work with the tribal communities living here, and one of the primary concerns was to provide support for marketing. Our entry point for work was bees – the Kurumba and Irula communities are traditional hunter-gatherers and slash and burn agriculturists. Honey hunting is an important part of their tradition and nearly two to three months each year are spent in this activity.

The immediate concern was to help raise the procurement prices as the rates being offered by traders and middlemen were very low. Coupled with that were irregular payments and measurements. However, the tribals slowly started trickling in with their products and soon we had a whole range of products – honey, coffee, pepper, mustard, silk-cotton and beeswax. All the food products were organic but there was no certification for these products. With problems similar to those faced by small growers in many parts of the world – of high costs, poor accessibility, no documentation, etc. – these same hurdles stood in our way.

Honey - standards and geographical limitations

As soon as we started marketing honey, the local market appreciated it immediately – they knew it was genuine, unadulterated honey. The cool temperatures at this elevation meant that honey was a part of their traditional diet. However, for many other outside customers, they raised questions whether it was certified by AGMARK (an agriculture certifying agency of the Indian Government). Their standards were for processed honey and not wild honey. These standards, for example stipulating a moisture content of 18 percent, would have meant that we would have to heat the honey to reduce the moisture. This would also kill the enzymes, which would mean a change in the natural character of honey. Honey naturally available in the tropical temperature has a moisture content ranging above 20 percent, depending on the area, rainfall, humidity and other factors.

If honey is harvested hygienically, it can remain good for years without being spoilt. We have continued to market the honey without heating, based on its quality. We do not mix different batches of honey and so are able to take advantage of different flavours.

For organic certification, we got in touch with a certifying agency, but again problems of cost, accessibility, and the migratory behaviour of wild bees became an issue, and the matter rests there.

We developed an internal monitoring system to check the quality of products where the four main features are:

- raw material;
- processing;
- packaging and distribution; and
- consumption and disposal.

Though this does not look specifically at the organic aspects, it is an attempt to control the entire process and put in place a system of checks and balances to improve the quality of the products. For more information see Keystone Foundation (1998) and Roy (2002).

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[29] *Official Journal of the European Communities*, Commission Decision of 12 February 2001. (2001/158/EC).

Mr Obanya is a honey trader from Arua. He prefers to take his honey to Nairobi to sell because he receives cash: in Kampala he says, honey is expected to be supplied on credit.

Therefore, some Ugandans are travelling to Kenya to sell honey, others to buy honey. Meanwhile Kenyan traders are also visiting Uganda to buy honey. Perhaps this emphasises honey's value as a useful cash resource amongst even the poorest of rural people. What other product can they easily produce from few resources in rural areas, which is non-perishable, popular, and legal and has steady value as a cash and export crop?

World trade

An amount of566,000 tonnes enters the world market and is traded internationally. China, Argentina and Mexico together produce about 60 percent of world-traded honey. The EU, USA and Japan account for about 70 percent of the import trade.

TABLE 26
Recorded world production and trade in honey

	Year	Number of *Apis mellifera* colonies	Annual production (tonnes per annum)	Import	Export (tonnes per annum)
Argentina	2001 2003[31]		80 000	–	78 000 87 000
Australia	2001		19 000	67	11 000
Canada	2001		32 000	196	20 000
China[32]	2001	6 million	200 000		106 666
Cuba	2002		9000		6000
Germany	1984	900 000	20 000	75 000	10 000
Mexico	2001		56 000		50 000
Syria[33]	2004	365 000	1 750		30
Turkey	2001	4 million	71 000		
United Kingdom	2003	200 000	1 500	20 000	1 000
Thailand[34]	2002	300 000		3 327	1 979
Trinidad & Tobago[35]	2003	12 400			
Philippines[36]	2003	50	300	–	–
USA	1984		75 000	58 608	2 942

Honey consumption

Honey consumption per capita per year is highest in some countries of central Europe, for example Austria, Germany and Switzerland where annual consumption per *capita* exceeds one kilogram.

The EU market

The European Union (EU) is dependent on imports to supply the demand for honey. The total, annual honey production within the EU is around 100 000 tonnes. France, Spain, Greece and Italy are the main producing countries.

[31] Hornsby, 2004.
[32] Gu Youynan, Personal communication, 2002.
[33] Fert, G. 2004. *Bees for Development Journal* 71.
[34] Sureerat, 2004.
[35] Tobago Apiculture Society, 2004.
[36] Nemenzo, R. *et al,* 2004.

- Lack of appropriately-trained support personnel or information materials.
- Low product prices.
- Few social linkages with other producers.
- Few social linkages with potential buyers.

Issues faced by traders

In turn, traders who deal in honey (or beeswax), find it difficult to buy from a scattered population of small-scale producers. These are the constraints typically faced by traders:

- Lack of access to products of sufficient quality.
- Lack of access to products of sufficient quantity.
- No linkages between producers and buyers.
- Lack of access to, or non-availability of credit.
- Poor diversity of retail packaging materials.
- Different buyers having differing quality requirements.

Honey retailers in cities are often hesitant to pay cash on delivery: traders providing honey for retail sale must wait until their honey is sold before they receive payment. This explains why traders sell honey where they can - even though the price paid is low, immediate payment can be essential for resource-poor sellers.

CONSTRAINTS FOR THE INDUSTRY AS A WHOLE

For reasons touched upon in Chapter 1 and 4, apiculture as a sector tends to be poorly recognised and with little lobbying power. In poor countries, the producers are likely to be amongst the most remote and most poor people, and the apiculture sector is not easily identifiable or recognisable. These are some of the reasons and consequences:

- Lack of appropriate extension material.
- Lack of appropriate marketing information.
- Lack of appropriately-skilled trainers.
- Lack of strong organizations representing the interests of beekeepers.
- Poor linkages between producers and buyers.
- Little coordination between beekeeping and other sectors, including the horticulture, forestry, health, and environment sectors.
- Little or no product promotion.
- Few developing countries have beekeeping policies for protection of the industry.
- No global agreement on honey criteria.

For all of the above reasons, beekeepers and honey hunters can gain much by forming groups or cooperatives.

ORGANIZING HONEY HUNTERS AND BEEKEEPERS INTO GROUPS FOR MARKETING

Beekeepers working individually tend to receive low payment for their products. They are constrained in how much they can earn by lack of adequate containers to enable harvesting and processing of good quality products, and the difficulty of transporting this honey to places with access to traders where they can market it. This makes individual beekeepers and honey hunters highly susceptible to low prices offered by dealers who have transport. Beekeepers and honey hunters working in poor and remote rural areas can benefit greatly from interventions that improve possibilities for the successful collective marketing of their products.

ORGANIzING HONEY COLLECTION CENTRES

These are centres where beekeepers can bring their products and be certain of a market. When significant volumes of good quality honey and beeswax are available in one place, traders will be interested to travel to remote areas, being certain of the volume and quality they will be able to collect.

Tariffs and quotas
The European Union applies the Common Customs Tariff to imports from non-EU sources. Imports of honey originating in ACP countries or in least developed countries (LDCs) are given import exemptions. However, this exemption only applies when consignments are accompanied by an official certificate of origin. For current information, contact the local Trade Promotion Office.

Trade fairs
In the world of bees and honey, the main event is Apimondia, a large Congress that takes place every second year. Recent Congresses have taken place in Antwerp, Vancouver, Durban, Ljubljana and Dublin. Honey buyers and sellers from many countries attend this event, and specialist symposia and meetings of trade associations take place. See Chapter 15 for further details of Apimondia.

The contract
Standard, worldwide-accepted contracts are common in the trade of honey[37].

BOX 14
Standard of contract in the trade of honey

Details that must be mentioned in a contract are:

1. The contract parties: the seller, the buyer, the broker and/or buying/selling agent. All names and addresses must be correct.
2. The product, price and quality of the product are sufficiently specified, so that no misunderstandings can arise.
3. The quantities must be stated. If the buyer and the seller agree to more or less than the agreed quantity, this is to be specifically mentioned.
4. The delivery terms are mentioned according to the description of the Incoterms 1990 (available at the International Chamber of Commerce).
5. The payment terms are to be given in detail.
6. The delivery time is a vital piece of information on which the seller and the buyer will have to agree.
7. Packaging details, including measurements and weights.
8. If one of the parties has negotiated special conditions, this is to be mentioned in the contract.
9. What will be done if the two parties disagree with each other? Which arbitration court/district will be used?

Trading relations between exporter and importer are based on trust, and can only be built up by meeting the high expectations of the importer. If the product does not meet the expectations of the importer, this will immediately backfire on the business relationship with the exporter. A prospective long-term relationship may be damaged. The complaints most often heard are:

- Not meeting the delivery date.
- Payment problems.
- Not satisfying the high quality requirements of the importing nation or region.

The contract must state that the goods have to be delivered in a condition that is in full accordance with the importing nation or region regulations. If there is any objection at the customs, the whole consignment may be rejected by the customs authority responsible for clearing goods at the time of import.

PAYMENT METHODS AND DELIVERY TERMS
The determination of payment conditions for a regular export transaction is part of the package of negotiations between seller and buyer, who commonly have more or less opposing interests. Sellers want to have the best guarantee of financial coverage for the goods they have to supply according to the sales contracts. Buyers want to be sure about the availability, quantity and quality of the goods they buy, before they pay the agreed price.

For importers of honey and beeswax, the most popular payment methods for traders are LC and cash against documents (D/P or CAD). Terms of delivery, whether on CIF or FOB basis, form a subject for negotiation and arrangement between supplier and importer.

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[37] Honey and beeswax: a compact survey of the Netherlands and other major markets in the European Union, 1999, compiled for CBI by ProFound Advisers In Development.

BOX 15
General methods and terms of payment

Clean payment
The process is fast and reliable, depending on the credit worthiness of the importer. The bank carries out the transactions through swift electronic data system and the transfer costs are not high.

Documents against payment (D/P)
Also known as cash against documents (CAD). The buyer takes possession of the goods only after payment. Although this method is not very popular, it is very safe and the costs amount to one pro mille. One can also make use of a 'documents against acceptance of a bill of exchange'. However, the bill of exchange is not commonly used in the European Union and it does not guarantee that the bill will be paid; it is less secure than the D/P.

Letter of Credit (LC)
The irrevocable LC is very often used at the beginning of a business relationship when the importer and exporter do not yet know each other well. The LC is irrevocable and will always be paid. The costs are higher than the D/P method, namely five pro mille. This method is widely used in the European Union when dealing with exporters from outside Europe.

Bank guarantee
The buyer's bank will present a bank guarantee for the amount of the invoice.

Cheques
Bank guaranteed cheques are generally no problem although cashing may take some time, up to six weeks. Not all personal cheques are accepted.

Most common delivery terms:

- **FOB** (*Free On Board*): The buyer arranges for transportation and insurance. FOB must specify the port of departure.
- **CFR** (*Cost & Freight*): The exporter pays the freight, the buyer arranges for the insurance.
- **CIF** (*Cost, Insurance & Freight*): The exporter pays the freight and the insurance.

15. CONSTRAINTS TO DEVELOPMENT

THE NATURE OF CONSTRAINTS FACING BEEKEEPERS IN DEVELOPING COUNTRIES

Beekeepers worldwide face increasing constraints, and the extra challenge for beekeepers in developing countries is how to address them with fewer resources to do so. Constraints facing the sector may be broadly categorised as biological, technical, trade and institutional.

BIOLOGICAL CONSTRAINTS

Biological constraints include the introduction of exotic species and races of honeybees, honeybee diseases, predators and parasites, the loss of indigenous species and habitat diversity, and problems arising because of pesticides use. Some of these aspects are also discussed in Chapters 2, 4 and 8.

The legislation of industrialized countries to prevent the introduction of undesirable honeybee pests and predators, and to protect species and races of honeybees is increasingly sophisticated, yet as we have seen, it has proved inadequate to prevent the spread of honeybee diseases and parasites throughout the developed world. For example, developing countries of sub-Saharan Africa contain the last populations of *Apis mellifera* (the honeybee species most widely used in beekeeping industries world-wide) that are as yet relatively uncontaminated by introduced diseases and parasites, or introduced exotic bee species or races, yet few of these countries have legislation in place to protect their indigenous bee populations. These indigenous bees deserve preservation, not only for biodiversity reasons, but also because they represent the last stocks of uncontaminated *Apis mellifera* bees, and are resources that may in the future be needed by, and be valuable to, the world beekeeping industry, for example in the provision of virus-free stock.

The pathology of diseases and parasites affecting non-European species and races of honeybees are poorly understood. Populations of these less-known bee species may be threatened because of over-exploitation, or because of competition from introduced races and species of honeybees. The trend has been for these diseases and predators to remain little known or researched until they have been introduced to *Apis mellifera* stocks (for example, *Varroa* spp., *Tropilaelaps* spp., and most recently, small hive beetle). Of course, it is the absence of understanding by beekeepers, combined with lack of regulations and enforcement that has enabled the increasingly rapid spread of pathogens during the past thirty years. The main pests and predators affecting beekeeping world-wide are summarised below.

TABLE 27
Honeybee pests, predators and diseases

HONEYBEE PREDATORS	HONEYBEE DISEASES	OTHER PROBLEMS
Mammals Humans Rodents Honey badgers Bears **Insects** Moths Ants Small hive beetle **Mites** *Acarapis woodi* *Tropilaelaps clareae* *Varroa destructor* **Spiders and pseudo scorpions** **Birds**	**Viruses** Sacbrood Thai sacbrood Chinese sacbrood Chronic paralysis virus Kashmir bee virus Deformed wing virus **Fungi** Chalkbrood Bacteria American foulbrood European foulbrood Protozoa Nosema Amoeba	Dysentery Chilled brood Laying workers Drone-laying queens Pollen shortage Honey shortage Pesticide poisoning

Not all of the above are significant everywhere in the world; for example, honey badger is a major predator of honeybee colonies in east Africa, but not in West Africa. In recent years, the main problems for the beekeeping industry have been the spread of *Varroa destructor,* and most recently, the small hive beetle. These are both predators that have been spread outside their natural distribution, and that can have fatal effect upon the new host races or species of bees. As these predatory species have been spread rapidly around the world, the world's apiculture researchers endeavour to learn about them and find effective and sustainable methods to control them. Few beekeeping textbooks are completely up to date with current methods of control, and for many beekeepers gain their main knowledge from attending beekeeping meetings and conferences, and from the internet. Please see Chapter 16 for such sources of further information. The following sections introduce the main pathogens, pests and predator problems faced currently by beekeepers. In industrialized countries, legislation controls the way that beekeepers are permitted to manage some of these problems. Only few developing countries have legislation concerning beekeeping methods, and lack of regulation means that in many poor countries honeybee diseases are treated often with chemicals that would be illegal elsewhere. The presence of residues of these chemicals in honey is dangerous for human health and if detected, will lead to loss of trade, as outlined in Chapter 14.

Parasitic mites

Several parasitic mites are important pests of *Apis mellifera*: *Acarapis woodi, Varroa destructor* and *Tropilaelaps clareae*. The natural host species of *Varroa destructor* is one race of *Apis cerana, and t*he natural honeybee host species of *Tropilaelaps clareae* is *Apis dorsata.* In Asia, indigenous honeybees have evolved in the presence of *Varroa* and *Tropilaelaps* mites and have natural host-predator relationships where neither the host species (the bee) nor the predator (the mite) is wiped out completely. By contrast, *Apis mellifera* has not evolved in the presence of these mites and has no natural resistance. *Apis cerana* has a range of methods including grooming of its body, to rid itself of *Varroa* spp. Beekeepers have increased the distribution of these mites outside their natural range, by moving bee stocks throughout the world.

Varroa destructor

During the past twenty years, this ecto-parasitic mite has had a significant effect upon beekeeping industries in many countries. It is now present throughout most of Europe, North, South and Central America. In Africa, it is present in all countries bordering the Mediterranean and is present in South Africa. Recently it has been spreading north of South Africa and was identified in Zimbabwe in April 2003 and in Botswana later the same year[38]. The female mite is red coloured with four pairs of legs whilst the male is much smaller and white. In one batch of eggs, the (single) male hatches before the females and mates with the females before the females emerge from the cell. Only females are long-lived and feed on the haemolymph of adult bees by squeezing under the tergites of the abdominal segments.

Symptoms

This mite feeds on brood and adults: when the larvae in the brood are attacked young bees emerging from the cells are deformed (the extent depending upon how many mites were in the cell). If too many, the bee will fail to live to emergence.

Life cycle

The mated female mite enters the brood cell before it is capped, and lays eggs on the young bee larvae on day 10 of the bee life cycle. Male mites hatch first and mate with females. As the bee pupa develops, the mites develop. When the worker emerges, she is already infested with mites. The worker bee takes 21 days to develop whilst the drone takes 25 days. Consequently, drone brood usually contains more mites. The mites are able to select drone brood, and therefore one method of control is to selectively remove drone cells. The *Varroa* mite can survive on adult bees, but the parasitic effect of the mite on an adult bee is not so important – the mite is sucking haemolymph, but the bee is able to survive this as long as there are not more than three mites per bee. Most dangerous for the colony is the number of mites parasitising on brood. If there are two mites per larva, the larvae will die in brood cells. With one mite present on a bee at its pupal stage, these are the resultant changes in behaviour:

[38] *Bees for Development Journal* 72, 2004.

- the adult bee changes abnormally quickly from a nest bee to a foraging bee (this is influenced by damaged food glands);
- lower resistance to pesticides (because the bee's fat body is not so well developed);
- orientation ability is reduced;
- cleansing instinct is lowered;
- brood care is less; and
- guarding service is reduced.

It is not just the effect of the mite itself that kills *Apis mellifera* colonies – the mite carries viruses, and it is these that kill the colony. Pesticide is more dangerous for bees if *Varroa destructor* is present and the symptoms of chalkbrood and sacbrood become more obvious. Bees are very easily robbed, and when the colony is collapsing, the bees fly with the robber-bees back to their hive. In colonies that have died out because of *Varroa*, the beekeeper will often find an empty hive. This is because the bees, and the mites they are carrying, have moved to a healthy colony, which now has more bees and many mites. Even when beekeepers are treating colonies properly, after one month, 5,000 'new' mites can have arrived on bees arriving from collapsing colonies. Therefore, it is helpful if beekeepers can work together in controlling *Varroa* populations.

Many different medicines have been developed to treat *Varroa*. None of these is of any use unless they are connected to management. Mites quickly develop resistance to any chemical used to control them, and beekeepers need to use integrated methods of control. There is no single 'magic bullet' way to control *Varroa*.

Tropilaelaps clareae
This is also a mite predator of bee brood, but it can easily be controlled by removing brood cells. In countries or areas with cold winters and therefore a natural break in the colony's brood rearing, the mite population is naturally controlled in this way. However, for beekeepers in tropical countries this mite could be a problem when the mite population becomes large. A break in the brood cycle of three days is necessary to prevent *Tropilaelaps clareae* surviving.

Nest symbionts
Braula coeca is the bee louse, which is often mistakenly identified as one of the bee mite species. It is a wingless fly that lives in bee nests, and it is not a problem for the bees.

Observation of mite populations
Collect a sample of bees, and using plastic sheeting, make a funnel to pour the bees into a jar containing petrol or paraffin. The mites float on the surface of the liquid. Filter the liquid and identify the mites.

BACTERIAL DISEASES
American foulbrood
The causative agent of American foulbrood (AFB) is *Paenibacillus larvae larvae.* As far as is known, this disease only affects colonies of *Apis mellifera,* and it is one of the most dangerous diseases for honeybee colonies, being difficult to eliminate since the bacterial spores survive for at least 50 years. Spores of AFB can be found in honey samples, even though the colonies from which these samples are collected may not yet be showing symptoms of the disease. There is no cure for AFB, and quarantine measures are difficult to implement. Once the symptoms are identified in a colony, the only answer, which has been recommended for many years to prevent this disease spreading to other *Apis mellifera* colonies, is to burn all infected colonies and boxes. In addition, it has been recommended that all clothes and tools should be destroyed. In recent years, the Danish researchers Hansen and Brodsgaard have been advocating 'The shaking method' to control AFB (Hansen and Brodsgaard, 2005). In this method, a colony is shaken from its hive into a screened box, left in a cool place for three-four days, and then re-housed in a new hive with completely new frames and equipment. In this way the pathogen is reduced to a level at which it does not provoke clinical symptoms of the disease.

Symptoms
The disease is present in brood comb only. Larvae affected by the bacteria die after the cell is sealed. There is a bad, unhealthy smell, and the brood comb looks like a destroyed mass with broken cappings, sunken cappings, and holes in sunken capping or "pepper pot" brood with many empty cells. The disease affects larvae soon after hatching but the larvae continue to develop and die as pupae. The resulting dead pupae dry out as a dark scale that becomes stuck to the side of the bottom of the cell and is very difficult to dislodge. If a pupae dies and is held vertically in the cell, very often the labrum (the bee's "tongue") sticks out. Prior to these well-developed terminal symptoms being seen, if a match stick is inserted into an infected cell, on withdrawing it slowly, about an inch of ropey brown foul-smelling liquid is withdrawn attached to the matchstick.

Beekeepers do well to form local associations in order to obtain and share information and to produce their own wax foundation material. Imported wax foundation is a potential source of infection. Unnecessary import of inputs should be avoided. A good beekeeper detects AFB and treats colonies for it, and the real source may be never identified. Spores of AFB are very widely spread: they can be present in a colony that does not yet show symptoms of AFB.

European foulbrood
The causative agent of *European foulbrood (EFB)* is *Melissococcus pluton*. This disease is quite different from American Foulbrood, and is less dangerous since it is less contagious, and colonies with EFB can be treated and cured of the disease. The smell of EFB is distinct from that of American Foulbrood. EFB affects mainly unsealed brood.

Symptoms
A normal, healthy honeybee larva is curved and lies relatively still, whereas a diseased larva is straight and writhes about. The larva dies before the cell is capped, and consequently it is possible to see dead larvae in cells. Unlike American foulbrood, there is no sunken or punctured capping, and no drawn out ropes of liquid when a matchstick is inserted and then withdrawn from infected cells. The dead larva turns black in the bottom of the cell, but does not adhere to the side of the cell and is easy to remove with a toothpick.

Interventions
Some beekeepers burn and destroy the colony and the hive. However, worker bees remove diseased larvae outside the hive and a colony with EFB can sometimes survive without intervention from the beekeeper. Strong colonies are more resistant to this disease. The disease will be more common in small colonies that are stressed, for example, colonies belonging to migratory beekeepers, and those that are short of water. Some beekeepers treat bees with antibiotics such as *Terramycin* (tetracycline), which merely suppress the bacteria population – the antibiotic is mixed with sugar and spread on to the colony or diluted with syrup and sprayed on to the colony with a six-week post-application interval prior to harvesting the honey.

If bees are continuously fed antibiotics, the symptoms of the disease will never show. The use of antibiotics in this way is not an environmentally sound procedure and is banned by law in many countries. Excess use of antibiotics allows them to enter the food chain and risks selecting resistant disease-causing organisms within the human population, thus making these compounds useless in controlling important human diseases.

BOX 16
Viral diseases

There is no cure for viral diseases.

SACBROOD VIRUS AND THAI SACBROOD VIRUS
Symptoms
Sacbrood virus affects the sealed brood of *Apis mellifera*, while Thai sacbrood affects the sealed brood of *Apis cerana.* When diseased larvae are removed from the cell with tweezers, the larva looks like a wet bag of white sap. The cappings of the cell are perforated.

Interventions
Strong colonies survive best. Small, stressed colonies are susceptible to viral diseases. If the colony is requeened and transferred to a new, clean box, the colony may overcome the attack.

OTHER VIRAL DISEASES
There are many diseases of bees that have recently been recognised as of viral origin. Many of these change the behaviour of bees, for example, the bees crawl on the ground and do not attempt to fly. Parasitic mites such as *Varroa destructor* serve as vectors for these viruses.

- Bee paralysis virus
- Chronic bee virus
- Black queen cell virus and many others still being identified.

PROTOZOAN DISEASES
Nosema disease - diarrhoea: the causative agent is *Nosema apis.*

Symptoms
Brown faecal spots are seen at the entrance to the hive. This often occurs when artificial feeding is taking place.

Cure
Keep the bee colony strong, and stop feeding the bees.

FUNGAL DISEASES
Chalkbrood
This is a fungal disease affecting sealed brood, caused by a fungal organism: *Ascosphaera apis*. The cell cappings are perforated, and the larvae become solid and white – 'mummified' and chalk coloured. Nurse worker bees remove affected larvae from the hive and the disease is not a problem in strong colonies. Severely affected colonies should be requeened.

PESTS OF BEES AND BEE NESTS

Moths

Several moth species feed upon the products of honeybee colonies: honey, pollen and beeswax. Most well known to beekeepers are the wax moths, and more rarely, death's head hawk moths, *Acherontia* spp.

Wax moths

The greater wax moth, *Galleria mellonella*, can be found in association with *Apis mellifera* and the Asian honeybee species. It seems to be a more severe pest in the warm climates of the tropics and subtropics. The lesser wax moth, *Achroia grisella,* is more commonly found in temperate zones. The greater wax moth may be to three centimetres long – the lesser wax moth is around one centimetre long. Larvae of these moths (and several other species) feed on wax. They are adapted to the life cycle of bees, and in nature, feed on empty, and abandoned outer combs during the winter or non-flowering period when the colony size contracts and the bees occupy only the central combs in the nest. Wild bees thus build fresh combs each year, and wax-feeding moth larvae perhaps fulfil a valuable role in nature by removing old and diseased comb in wild nests: they do not in general feed on occupied comb. Wax moths can be a problem for weak colonies in hives, and in unoccupied comb or foundation stored in hives during the non-flowering period. The moth can be repelled from empty supers and boxes of wax comb or foundation by the use of naphthalene or paradichlorbenzene sprinkled on sheets of newspaper placed between the supers when stored one on top of another vertically. The stack should be placed on newspaper. If paradichlorbenzene has been used, before reusing the boxes and supers with bees, they must be aired so that there is no trace of the smell of the chemical, since it will also flavour and ruin any future honey produced in boxes stored in this way. Mechanical control of the larvae can be made of infested comb, and badly infested comb burnt. If neglected, bad infestations of the larvae will also attack and damage the boxes.

Small hive beetle

The small hive beetle *Aethina tumida* is not considered a very serious pest of honeybee colonies in Africa: *Apis mellifera* African honeybees rarely allow the beetles to multiply to an extent where they are harmful to the colony. Beekeepers are accustomed to seeing a few of the beetles (as well as the large hive beetle) in colonies, but numbers remain low. In 1998, small hive beetle was reported from Florida in the US. This was the first recoding outside Africa. The introduced European races of *Apis mellifera* are not accustomed to these beetles, which are able to multiply greatly within the colonies. The beetles spoil the honey in combs, cause it to ferment, and damage the combs. The colony is weakened, eventually dying out or absconding.

Predatory birds

It is said that so-called Bee-eater birds (*Merops* spp.) and others prey on bees. However, certainly in the case of the Bee-eater it has been shown that it is in fact a beneficial species for bees, preferring hornets to bees: hornets are in some areas harmful predators of honeybees and regularly take bees from the entrance of hives.

TECHNICAL CONSTRAINTS

Technical constraints facing beekeepers in developing countries concern lack of knowledge of appropriate methods for managing tropical bee races and species, lack of appropriately skilled trainers, materials and training possibilities, and lack of dissemination of new research information, especially as described above, relating to disease control. Few developing countries have laboratories with resources to identify honeybee pathogens, or to identify the residues as described below. There are only a handful of laboratories world-wide with the necessary skills and resources to identify honeybee viruses.

TRADE CONSTRAINTS

Constraints faced by producer groups in developing countries often include problems arising because of the remoteness of producers from suppliers, traders and technical advisers, the often-small volumes of products, and difficulties of obtaining pre-finance for honey purchase, packaging and marketing. A major constraint is the increasing requirement for bee-products to meet international standards. As described in Chapter 14, the world market demands increasingly that honey be certified free from chemical, antibiotic and other residues. These residues are likely to be present in honey due to the use of medicines to treat honeybee diseases, introduced during some form of honeybee management, or from environmental pollution. This demand for residue-free honey opens opportunities for honey producer organizations in the poorest countries. It is often the most poor and most remote people of these countries, with few other livelihood options, who practise beekeeping. These people can harvest honey and beeswax that are of excellent quality, and especially now, because these products are residue-free, they can achieve good prices on world markets, if they are able to gain access. World market access depends upon honey meeting the import criteria of the world markets, and this is where producer organizations' problems begin.

Currently only five African nations[39] are able to conform with EC import requirements relating to antibiotic and other residues. These are Kenya, South Africa, Tanzania, Uganda and Zambia. Only four Asian countries (China, India, Taiwan and Vietnam) meet EC import requirements.

Therefore this legislation denies access to EC markets for most African countries, even though chemical residues are not a problem in African honey. Beekeepers in rural areas of Africa still harvest from stocks of

[39] Last amendment of Commission Decision 2004/432/EC of 29 April 2004 on the provisional approval of residue plans of third countries according to Council Directive 96/23/EC (Last amendment = Decision 2005/233/EC).

wild honeybees, uncontaminated by the diseases and exotic predators that now afflict bees in most other world regions. For this reason, African beekeepers do not apply medicines to their bees and are able to harvest the residue-free honey that is currently in short supply on the world market.

At present honey with any detectable level of any antibiotic, including streptomycin, cannot be imported into the EC because no Maximum Residue Limit (MRL) has been set, even though streptomycin is permitted in other animal products and does not represent a public health issue. Bees *for* Development[40] has undertaken research funded by the UK Department for International development (DFID) towards proving that streptomycin can occur naturally at low levels in honey, and is not necessarily a contaminant.

Honey regulations are effective at different levels: see Table 28 below:

TABLE 28
Honey criteria and legislation

Level of influence	Organization
Global	Codex Alimentarius
Regional	e.g. European Community (EC) Regulations Directives
National	Honey laws Beekeepers' Associations Supermarket chains Honey exporters Honey importers Honey packers Consumers

Globally, Codex Alimentarius sets a definition and gives chemical standards for honey, and this definition is widely used and accepted. The EC criteria for honey are regional, but at the national level, honey regulations may be more or less strict, and supermarket chains in industrialized countries set their own criteria that may well be more prescriptive than other honey standards. Honey coming into the EC from third countries has to meet EC honey criteria – but of course as honey is a natural product – honey arising (for example) from tropical areas is likely to be very different from honey created from European flora. Where these differences are proved to be due to natural reasons, then EC honey standards are modified accordingly.

One area where there is a significant difference is in the EC definition of honey, which, unlike the Codex Alimentarius, states that honey is the product of *Apis mellifera* honeybees. This means that honey produced by other honey-producing bees such as the Asian honeybee species, or by stingless bees, would not qualify as honey for the EC.

INSTITUTIONAL CONSTRAINTS

These include the weakness of producer organizations, and lack of resources (personnel, laboratories) to support the industry: to analyse products, certify for export, identify bees and their diseases and parasites. As mentioned above, there is a lack of policies that protect the industry and prevent the introduction of bees diseases and parasites. Infrastructure to monitor, certify and enable trade in honey and beeswax is also lacking in the majority of developing countries. This has implications for the apiculture industry as so much honey and beeswax tend to be traded informally and never reach official trade statistics.

Beekeepers in developing countries need regulatory and organizational services and support to create market links and meet trade criteria, and ultimately to maintain their precious stocks of healthy, indigenous bees[41].

[40] Bees *for* Development Journal 72, 2004, 3.
[41] For more references: ARC Plant Protection Research Institute Honey Bee Research, Stellenbosch, South Africa, www.arc.za/institutes/ppri/main/divisions/beekeeping/honeybeeresearch.htm

16. SOURCES OF MORE INFORMATION

CHAPTER 1

General information on apiculture
Organizations and networks

Apimondia
Apimondia is the World Federation of Beekeepers' Associations. Apimondia's Secretariat is based in Rome. The Members of Apimondia are beekeeping organizations. One of the main activities of Apimondia is convening the Apimondia Congress, which takes place every second year, and is the major international event in the apicultural calendar. Apimondia also organises other specialized Symposia and meetings, publishes a quarterly journal, *Apiacta*, communicating the results of bee research to beekeepers. Further information from:

Apimondia
Corso Vittorio Emanuele II, 101
00186 Rome, Italy
Fax +39 06685 2287
E-mail: APIMONDIA@MCLINK.IT
www.apimondia.org

Asian Apiculture Association (AAA)
AAA operates a network between Asian apiculturalists and organises a Conference within Asia every second year (alternating with the Apimondia Congress).

Honeybee Science Research Centre
Tamagawa University
Machida - Shi
TOKYO 194 8610, Japan
Fax +81 427 398 854
E-mail: HSRC@agr.tamagawa.ac.jp
www.tamagawa.ac.jp/HSRC/aaa

Bees for Development (BfD)
Bees *for* Development works to assist people in poor countries to create livelihoods involving bees, in ways that are sustainable and environmentally beneficial. The organization organises training, manages research and development projects and provides information on beekeeping development worldwide. For example in year 2004, BfD responded to over 3,500 technical enquiries. **Bees *for* Development Journal** is published quarterly and distributed worldwide. Bees *for* Development is supported by a Charity registered in the UK, the Bees *for* Development Trust. The website carries a wealth of up-to-date information on sustainable beekeeping, and website store makes available hard-to-find publications on beekeeping in developing countries.

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www.beesfordevelopment.org

On-line resources
There are many web sites giving useful information about apiculture, but few give information relevant to the apiculture situation of developing countries.

www.apimondia.org
www.apiservices.com
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www.beedata.com
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www.beesource.com

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Freitas, B. 1999. A vida das abelhas. Universidade Federal do Ceara, Fortaleza CE, Brazil.

DVD

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Online resources

DFID Livelihoods Connect: http://www.livelihoods.org.uk

Inter-agency Experiences and Lessons: DFID/FAO Forum on operationalizing sustainable livelihoods approaches: http://www.fao.org/docrep/x7749e/x7749e01.htm

International Fund for Agricultural Development http://www.ifad.org/poverty

Overseas Development Institute: http://www.oneworld.org/odi.nrp.html

UN Food and Agriculture Organization: http://www.fao.org/waicent/faoinfo

UNDP Sustainable Livelihoods Unit: http://www.undp.org/sl/index.htm

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CHAPTER 7

Organizations and networks

FAO's NWFP-Digest-L
Back issues of the Digest may be found on FAO's NWFP home page:
www.fao.org/forestry/FOP/FOPW/NWFP/Digest/digest-e.stm

FAO Forestry Department

Address:	Viale delle Terme di Caracalla, 00100 Rome, Italy
Telephone:	(39) 06 57054778
Telefax:	(39) 06 57053024
E-mail:	FAO-Registry@fao.org
Internet:	http://www.fao.org/WAICENT/FAOINFO/FORESTRY/forestry.htm

On-line resources

The European Commission website for tropical forests and environment includes information on previously funded projects; a page on 'who does what' i.e. the role of different EC directorates; procedures; links to relevant official documents; and more. A useful page for those interested in EC policies and actions on (tropical) forests, environment and development.

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www.apitherapy.com
www.apitherapy.org
www.apitherapie.de

Books

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Online resource

The complete text of the book *Value-added Products* by Krell (listed below) is available on-line at http://www.fao.org/docrep/w0076e/w0076e00.htm

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Video

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CHAPTER 14

Organizations and networks

Internationalisation Standardisation Institute (ISO)

Address: Rue de Varembé 1, P.O. Box 56, CH-1211 Geneva 20, Switzerland
Telephone: (41) 22-7490111
Telefax: (41) 22-7333430
E-mail: central@isocs.iso.ch
Internet: http://www.iso.ch

UN

Trade Division - Agricultural Standards Unit
Address: Palais des Nations, 1211 Geneva 10, Switzerland
Telephone: (41) 22-9171234
Telefax: (41) 22-9170123
Internet: http://www.unog.ch

Secretariat of the Joint FAO/WHO Food standards Programme

Address: FAO, via delle Terme di Caracalla, 00100 Rome, Italy
Telephone: (39) 06 52251
Telefax: (39) 06 52253152/52254593
E-mail: codex@fao.org
Internet: http://www.fao.org

Comité Européen de Normalisation (CEN)
European Normalisation Committee
Address: Third countries Unit, Rue de Stassart 36, B-1050 Brussels, Belgium
Telephone: (32) 2-5500811
Telefax: (32) 2-5500819
E-mail: infodesk@cenclcbel.be
Internet: http://www.cennorm.be

FAO (UN Food and Agriculture Organization)
Publisher of '*Monthly Bulletin of Statistics*', '*Commodity and Market Review*', and '*Food Outlook*'
Address: Via delle Terme di Caracalla, 00100 Rome, Italy
Telephone: (39) 06-57051
Telefax: (39) 06-57053152
E-mail: publication-sales@fao.org
Internet: http://www.fao.org

Federation of European Honey Importers and Packers (FEEDM)
Address: Grosse Däckerstrasse 4, 20095 Hamburg, Germany
Telephone: (49) 40-3747190
Telefax: (49) 40-37471919

British Honey Importers and Packers Association
Address: St. George Square, London SW1V 2HX, United Kingdom
Telephone: (44) 171-23354000
Telefax: (44) 171-2335401
E-mail: 101572.503@compuserve.com
Internet: http://www.honey_bureaudemon.co.uk

International Trade Centre (ITC)
Address: Palais des Nations, P.O. Box 10, 1211 Geneva 10, Switzerland
Telephone: (41) 22-7300111
Telefax: (41) 22-7334439
E-mail: itcreg@intracen.org
Internet: http://www.intracen.org

International Federation of Organic Agricultural Movements (IFOAM)
Address: Ökozentrum Imsbach, 66636 Tholey-Theley, Germany
Telephone: (49) 6853-5190
Telefax: (49) 6853-30110
E-mail: ifoam@t-online.de

Fairtrade Labelling Organizations International (FLO)
Address: Popelsdorfer Allee 17, 53115 Bonn, Germany
Telephone: (49) 228 949230
Telefax: (49) 228 2421713
E-mail: coordination@fairtrade.net

European Commission
Address: Directorate General for External Relations, 200, Rue de la Loi, 1049 Brussels, Belgium
Telephone: (32) 2-2991111
Telefax: (32) 2-2969931
Internet: http://europe.eu.int

EUROSTAT
Statistical Bureau of European Union
Address: Data Shop, 2, Rue Jean Ingling, 1466 Luxembourg
Telephone: (352) 43352251
Telefax: (352) 433522221
E-mail: dslux@euroshop.datashop.lu
Internet: http://europa.eu.int/eurostat.html

GERMANY
Institut für Honiganalytik
Address: Flughafendamm 9a, 28199 Bremen, Germany
Telephone: (49) 421-594770
Telefax: (49) 421-594771

CD
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GLOSSARY OF APICULTURE TERMS

Absconding	Absconding occurs when all adult honeybees permanently leave their nest. This usually occurs because the colony is stressed: possible causes are poor ventilation, too much heat, moisture, predators such as mites, moths, ants, or beetles, lack of food, or other intolerable problems.
Acarapis woodi	Causes ‘acarine disease’ – the problems bees experience when they are infested with these tracheal mites.
Achroia grisella	The lesser wax moth: a serious pest of honeybee colonies in the tropics.
Aethina tumida	Small hive beetle, a natural pest of *Apis mellifera* honeybee colonies in Southern Africa, which is now spreading outside its natural distribution range and is a fatal pest for *Apis mellifera* colonies that have not evolved in its presence.
Africanised	Honeybees descended from those African *Apis mellifera* honeybees introduced to Brazil from Africa in 1956.
American Foulbrood (AFB)	A disease of honeybee brood caused by the bacterium *Paenibacillus larvae larvae*.
Anther	The part of a flower's stamen that produces pollen.
Apiary	The location of a number of colonies.
Apiculture	The science and art of bees and beekeeping.
Apimondia	The World Federation of Beekeepers' Associations.
Apis	The genus to which honeybees belong.
Apis andreniformis	An Asian honeybee, it builds a single combs and is similar in appearance to *Apis florae.*
Apis binghami	An Asian honeybee species, it builds a single comb and is similar in appearance to *Apis dorsata.*
Apis breviligula	An Asian honeybee species, it builds a single comb and is similar in appearance to *Apis dorsata*
Apis cerana	An Asian species of honeybee that builds a series of parallel combs and can be kept inside hives.
Apis dorsata	The giant or rock honeybee, indigenous to Asia. Build a single comb and cannot be kept inside a hive.
Apis florea	An Asian species of honeybee, sometimes called the little honeybee. It has a small colony size and builds a very small, single comb.
Apis koschevnikovi	An Asian species of honeybee that build a series of parallel combs and can be kept inside hives.
Apis laboriosa	An Asian species of honeybee nests on a single comb and is found at high altitude in the Himalayas.
Apis mellifera	The honeybee species indigenous to Africa, Europe and the Middle East. Widely introduced to other areas including the Americas, Asia, Australasia and the Pacific.
Apis nigrocincta	An Asian species of honeybee that build a series of parallel combs and can be kept inside hives.
Apis nuluensis	An Asian species of honeybee that build a series of parallel combs and can be kept inside hives.
Appropriate hive	A hive that is technologically appropriate to the resources available, for example materials, human skills, and bee species.
Bait hive	An empty hive placed so that it will be occupied by a swarm of bees, often baited with beeswax or herbs to attract bees.
Bark hive	A hive made from the bark of trees.
Batik	A technique for producing designs on cloth by covering with wax. During successive dipping, different parts of the cloth are protected from the dye by beeswax.

Bee	An insect belonging to the super-family *Apoidea*. Over 30,000 species of bees have been described.
Bee bread	Pollen collected by bees, that is mixed with other liquid and then stored in cells for later use as a high protein food for larvae.
Bee space	A gap large enough for bees to walk and work, for example the space between two parallel combs or between a comb and the wall of the hive.
Bee veil	Netting usually combined with a hat to protect a beekeeper's face and head from stings.
Beehive	The container provided by the beekeeper for a colony of honeybees to live inside. Only hive-nesting species of honeybee can be kept inside hives.
Beeswax	Wax produced by honeybees (secreted by special glands on the underside of the abdomen) and used to build comb.
Biological diversity	The variability among living organisms from all sources, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part: this includes diversity within species, between species and of ecosystems. It includes cultivated species and varieties and agricultural ecosystems as well as natural ecosystems and their components.
Bottom board	The bottom board of a hive.
Box hive	One of the many types of hives used as houses for bees.
Brace comb	These are the pieces of comb that bees build to connect hive parts together. It can be removed by the beekeeper and the beeswax harvested – it is usually fresh, good quality beeswax.
Braula	Abbreviated name for a species of wingless fly, for example *Braula coeca*, often known as bee louse. Harmless to honeybees.
Brood	All stages of immature honeybees: eggs, larvae and pupae.
Brood chamber	The part of a hive where the queen is laying eggs and brood is being raised.
Brood nest	The area of the colony where brood is being reared.
Burr comb	Any extension pieces of comb built by the bees on to the edges of frames. As with brace comb, these can be removed and the beeswax harvested.
Capital asset (e.g. social, human, financial, physical and natural) assets	People's strengths that can be converted into positive livelihood outcomes. Although the term 'capital' is used, not all assets are capital stocks in the strict economic sense of the term in which capital is the product of financial investments, which yield a flow of benefits over time. Literature on livelihoods sometimes uses a number of different terms inter-changeably, which can be confusing. These terms include asset, capital, endowment and resource.
Capped brood	Cells that have been capped with a wax cover, while the larvae inside spin cocoons and turn into pupae.
Caste	The types of female bees (workers and queens) and male bee (drones).
Cell	A single hexagonal wax compartment, the basic unit of comb. Each honeybee develops within a single cell, and honey and pollen are stored within cells.
Chalkbrood	A disease of honeybee colonies caused by a fungus *Ascosphaera apis*.
Cluster	A mass of bees, such as a swarm, or when bees cluster together to maintain heat during cold weather.
Colony	Honeybees are social insects. Each honeybee can live only as part of a colony and not individually. Each colony of honeybees contains one queen bee who is the female parent of the colony, a few hundred drone bees and thousands of worker bees.
Comb	The wax structure made of hexagonal cells in which honeybees rear young and store food.
Contextual	Data collection methods are contextual when they attempt to understand social issues or poverty within the social, cultural, economic and political environment of a locality.
Corbicula	The pollen basket on each hind leg of the worker honeybee.

Cross-pollination	The transfer of pollen between flowers of different plants of the same species. Plants that are not self-fertile must be cross-pollinated before they can develop seeds. Many crops depend upon cross-pollination by insects.
Crystallization	The process by which honey granulates and becomes a solid – as water crystallizes to ice.
Cut comb honey	Pieces of honey comb containing honey and presented for sale in this way, *i.e.* the honey has not been extracted from the comb.
Dadant hive	A design of American, single wall, movable frame hive.
Dancing	One of the ways that bees communicate – in this case to inform others about sources of forage.
Development	The attainment of sustainable improvements in economic growth and the quality of life that increase the range of choices open to all, achieved by people's own efforts in the private sector or through voluntary activity, supported by government.
Diversity	For beekeeping: the number of species (plant and animal) in any given area. For development: difference at the local level (e.g. in people's livelihood activities, beekeeping practices, etc.).
Drawn comb	A sheet of beeswax foundation upon which the bees have already built up the walls of the cells.
Drifting	Honeybees entering nearby hives instead of their original home – it occurs more if many colonies are placed close together and with few distinguishing features.
Drone	A male honeybee. As far as humans can tell, drones undertake no work within the hive, and their apparent sole function is to fertilise the queen.
Egg	The first stage of a bee, before metamorphosis into a larva.
European foulbrood	A disease of honeybee brood caused by the bacterium *Melissococcus pluton.*
Extension	Providing research findings and instruction to working people.
Extractor	The centrifugal machine in which honey is spun out of cells within comb.
Feeder	A device for giving food in the form of sugar syrup to honeybees.
Feral bee colony	A colony of a species that was previously living inside a hive an managed by a beekeeper, but is now living in the wild – may or may not be of different species or race to local, indigenous honeybee populations
Fixed-comb hive	A hive in which bees build their nests with the combs attached to the wall of the hive, and therefore fixed (the combs cannot be removed from the hive without breaking them from their attachment).
Forage	Flowering plants that provide nectar and/or pollen for bees.
Forager	A worker honeybee that collects pollen, nectar, water or propolis for the colony.
Foulbrood	Bacterial diseases of honeybees. AFB, American foulbrood is caused by *Paenibacillus larvae larvae*; European foulbrood is caused by *Melissococcus pluton.*
Foundation	A thin sheet of beeswax embossed with the hexagonal pattern of comb. In frame hive beekeeping, a sheet of foundation is placed in each wooden frame and this serves as a base upon which honeybees build their comb. This quickens the process of comb construction. Without foundation, honeybees would not necessarily build their comb in the orientation required by the beekeeper.
Frame	A wooden rectangular frame that holds a sheet of wax foundation. A number of frames hang parallel to one another inside the hive.
Frame hive	A hive that contains frames. The honeybees are encouraged to build their comb within these frames. The frames then enable combs to be lifted from the hive for examination, and allows for the recycling of comb.
Galleria mellonella	The greater wax moth, found everywhere that bees are kept. It feeds on comb.

Gender	Sex is the biological difference between men and women; this is a fact of human biology, gender is not. The experience of being male or female differs dramatically from culture to culture. The concept of gender is used by sociologists to describe all the socially given attributes, roles, activities, and responsibilities connected to being male or female in a given society.
Grafting	One of the techniques involved in queen rearing: when a beekeeper moves a worker larva from her cell to a queen cup. Under the right conditions, this larva will develop into a queen bee.
Granulated honey	Honey in which the sugar has formed crystals.
Hive	Any container provided by humans for bees to nest inside.
Hive tool	A piece of strong metal, used by beekeepers to prise apart pieces of beekeeping equipment – that may have been 'glued' together by bees.
Honey	Nectar or plant sap ingested by bees, concentrated by them and stored in combs. See official definitions in Chapter 8.
Honey flow	The time when an abundance of nectar is available to the bees.
Honey hunting	Plundering wild bee colonies for their honey.
Honeybees	Species of bees belonging to the genus *Apis*. All are social bees that store significant quantities of honey.
Honeycomb	Comb full of honey.
Honeydew	Insects such as aphids feed on large quantities of plant sap that they excrete almost unchanged (except for protein content). This sap collects on the leaves of plants and if collected by honeybees is known as honeydew.
Inputs	Refers to items that are needed for beekeeping. The basic inputs (which may be free) are bees, pollen and nectar, water. Other inputs may not be free, for example equipment and transport.
Kenya top-bar hive	One style of top-bar hive, with deeply sloping sides and the entrance in the middle of the long wall, developed in Kenya during the 1960s.
Langstroth hive	A design of frame hive. The inventor, Reverend Lorenzo Langstroth recognised the importance of bee space and this allowed him to design the movable-frame hive.
Larva	The second stage in the development of the bee.
Laying worker	A worker bee that has started to lay eggs. Because these are not fertilised, they always develop into drone bees.
Livelihood	To make a living, way of making a living.
Livelihood strategy	The range and combination of activities and choices that people make/undertake in order to achieve their livelihood goals (including productive activities).
Lost-wax casting	A technique for making a replica of an object by casting it in molten metal. The model is created in wax then covered with a shell of clay. The wax model and its clay coat are then fired to harden the clay and melt the wax. The wax is then poured out and replaced by molten metal.
Low-technology hive	A hive that is simple, cheap, reliable, and mendable.
Mandible	The jaw of an insect.
Meliponinae	The subfamily to which all stingless bees belong.
Migration	Seasonal movements of whole honeybee colonies, leaving no brood behind in the nest. Tropical races of honeybees migrate, and little is known about this aspect of their biology and behaviour. Temperate-zone races of honeybees do not migrate.
Migratory beekeeping	Beekeepers moving colonies of honeybees to take advantage of honey flows in other areas.

Mite	Tiny, eight-legged creatures many species of which have been identified in honeybee colonies. Most of these feed on pollen or hive debris, but some species feed on the bees directly. *Acarapis woodi*, *Varroa destructor* and *Tropilaelaps clareae* are the main problem-causing species.
Morphometry	The measurement of form.
Movable-frame hive	A hive containing frames.
Nasanov pheromone	A substance produced by a bee's Nasanov gland to attract other bees, for example to a source of water.
Nectar	A sweet liquid secreted by flowers, a watery solution of various sugars.
Nectaries	The glands within plants that produce nectar.
Nest	The home of a bee colony where they live on their comb or combs.
Nosema	A disease of honeybees caused by a single cell organism *Nosema* spp. In *Apis mellifera,* the species is *Nosema apis*.
Nucleus	A small colony of bees created by a beekeeper from an existing colony or colonies. Used to increase colony numbers or in queen rearing and bee breeding.
Nuptial flight	The recently emerged virgin queen leaving the nest to mate with one or more drone bees.
Nurse bees	Young adult worker bees who feed the larvae.
Organic honey	Generally taken to mean honey that is free from any residues of pesticides, fertilisers, drug treatments or heavy metals.
Package bees	Supplies of bees produced for sale. Sold by weight, including a caged queen but without combs. Supplied in a box with wire mesh forming two sides.
Parthenocarpic	In fruit: the ability to produce fruit without fertilisation of the flower.
Parthenogenesis	In bees: reproduction in which eggs develop normally but without being fertilised. This is how drones develop.
Participatory approach	Involving both primary and secondary stakeholders in a process that is capable of influencing policy and practice. A distinction can be made between participation as a philosophy (that ‘outsiders’ need to learn about situations from the ‘insiders’), participation as a right (people have the right to be consulted, to make decisions, and to ‘own’ change that effects their lives), and participation as a series of methods for carrying out participatory research (see PRA).
Participatory Assessment (PRA)	A form of qualitative research used to gain an in-depth understanding of a community or situation.
Participatory Technology Development	Combining local skills and experience with research knowledge from elsewhere to identify, practice and apply new techniques.
Pheromone	A chemical substance produced by a bee (or any animal) to convey a precise message to another of the same species.
Pollen	The fine dust-like substances that are the male reproductive cells of flowering plants. Collected by bees as a food source.
Pollen basket	Areas of stiff hairs on the hind legs of worker honeybees where they carry pollen. See *Corbicula.*
Pollen trap	A device for harvesting pollen from bee hives.
Pollen tube	The tube formed when a pollen grain germinates. The male gametes travel down the tube to the egg.
Pollination	The transfer of pollen from the anther of a flower to the stigma of that or another flower.
Pollination agent	Bees act as pollination agents when they transfer pollen from one flower to another. Apart from insects, other agents that may bring about the transfer of pollen are wind (cereals are pollinated by the wind), gravity, nectar-seeking birds and bats.

Poverty	What is meant by poverty is far from evident and definitions attach different meanings to the concept. One definition is 'the inability to attain a minimal standard of living'. Another definition is 'a state of want and disadvantage'. Both of these definitions indicate that poverty is a relative concept. These definitions associate poverty with deprivation in relation to a norm. They indicate that poverty is relative; the context in which it is being judged then becomes very important. Another way to define poverty is in absolute terms, for instance starvation and hunger relate to an absolute notion of poverty. Understanding poverty, its dimensions and its causes requires a large variety of types of information: economic, cultural, political, and social. This information needs call for different methods of data collection: quantitative and qualitative (including participatory). Quantitative measures (e.g. based on how much people earn or how much they consume) tell us how many people are poor. Qualitative data helps to communicate *what it means* to be poor and why people are poor.
Proboscis	The mouthparts of an insect.
Process approach	In a process approach – where people are the principal agents of development – the products of the project cannot be fully known in advance. This contrasts with a blueprint approach in which the products are clearly defined. E.g. if a beekeeping project took a process approach the emphasis would be on involving people and helping them to identify outputs that would be of value; in contrast, a blueprint approach would start with set outputs such as the need to increase numbers of beehives.
Propolis	Plant resins collected by honeybees and used by them to seal cracks and gaps within the hive. It is also used by bees to line the nest, and line brood cells – it has anti-microbial properties.
Protective clothing	Clothing to protect beekeepers from being stung by bees.
Pupa	The third and final stage in the immature honeybee's metamorphosis before it emerges from the cell as honeybee.
Qualitative research	A flexible, open-ended method of building up an in-depth picture of a situation, community, etc.; methods used include observation and discussion.
Quantitative research	Used to collect data that can be analysed in a numerical form: things are therefore either measured or counted, or questions are asked according to a defined questionnaire so that the answers can be coded and analysed numerically.
Queen	The female parent of the honeybee colony, the only sexually developed female.
Queen cell	The large wax cell containing a developing queen.
Queen cup	This is a descriptive term for the cup-shaped wax structures built by bees. If the queen lays an egg into one of these structures then, once the egg has hatched and the larva is developing, the worker bees extend the cup into the large queen cell in which the larva can develop into a mature queen bee. For royal jelly production, artificial queen cups made of plastic are used.
Queen excluder	A precisely spaced grid. It is used to separate the queen form the area of honey stores, to prevent eggs being laid in honeycomb. The grid is of exactly the right size to allow worker bees to pass through freely, while queen and drones are not able to do so.
Queen rearing	This term is taken to mean the raising of queen bees as a result of management by the beekeeper.
Queen substance	The pheromones secreted by a queen, and passed amongst a colony to keep them informed of the queen's presence or otherwise.
Queenlessness	A colony is queenless when it contains no queen or developing queens or brood from which a queen could be reared.

Rafter beekeeping	*(Tikung in Indonesia)* A wooden board or plank underneath which a colony of the giant honeybee *Apis dorsata* builds its nest. The nest of *Apis dorsata* consists of one single, large comb, within which are stored honey, pollen and brood.
Refractometer	An instrument that can be used to measure the refractive index of honey from which the sugar concentration and water content can be calculated.
Resource	A stock or reserve upon which one can draw when necessary. Natural resource: a resource occurring naturally within the environment.
Risk	Uncertain events that can damage well-being (e.g. the risk to become ill).
Risk exposure	Measures the probability that a certain risk will occur.
Robbing	Stealing of honey by other bees.
Royal jelly	The substance that is secreted from glands of a worker and is used to feed brood. Larger quantities are used to feed developing queen bees.
Scout bees	The worker bees that search for new sources of nectar, pollen or a new nesting place.
Shock	An event that threatens well-being or increases vulnerability.
Small hive beetle (SHB)	See *Aethina tumida.*
Smoker	A tool with bellows and a firebox, used to produce thick, cool smoke. The smoke makes colonies easier to manage.
Social	Capable of being associated with others through particular types of relationships and forms of organization (bees and humans).
Social analysis	Concerned with how people and groups understand order and value their social relationships and systems of social organization. From a development perspective, the purpose of such analysis is to help to ensure that the human and financial commitments, which make up development projects, do actually bring about the intended benefits.
Socially embedded	The way in which a particular form of technology (e.g. type of beehive) and means of production (type of beekeeping) are rooted in local social institutions (e.g. forest beekeeping in Tanzania that is organised according to particular relations of kinship and marriage).
Sting	The barbed, pointed end of the adult female worker bee that, inserted into the victim, pumps out venom and thus delivers the sting.
Supercedure	The natural occurrence of a colony replacing an old queen with a new queen.
Sustainable	Supportable, maintainable.
Sustainable Livelihoods Approach (SLA)	A way of thinking about objectives, scope and priorities for development. It is a process-oriented approach to understanding the nature of poverty and to implementing and assessing poverty reduction interventions. The SLA provides a framework for policy analysis and implementation, which draws on thinking and practice on poverty reduction strategies, sustainable development, participation and empowerment processes. This approach takes a holistic view and starts from the premise that development interventions need to focus on people's livelihoods, rather than on different development sectors, and to build on people's strengths not their needs.
Swarm	Bees and a queen that have left one nest and are in search of a new nesting place. Bees typically leave behind about half of the original colony and the possibility for a new queen, a young queen or queens about to emerge from queen cells.
Swarming	The process by which one colony of bees divides into two or more. This usually happens when the parent colony had become too large for the nesting place (hive), and when the conditions for swarming are favourable – i.e. the swarm has a good chance of survival.

Targeting	The art of structuring the rules of access to project resources so that they reach certain groups rather than others. Designing projects so they respond to the expressed needs of the target group is an effective way of ensuring that those intended to benefit from a project do so. The key is understanding the constraints on a beneficiaries involvement in a project.
Top-bar	The top-bar, one of a series used in a top-bar hive, see above. Also sometimes used to refer to the top-bar of a frame.
Top-bar hive	A hive in which the bees are encouraged to build their comb from the underside of a series of top-bars. Top-bars and the comb attached to them may then be easily lifted form the hive for inspection, management or honey harvest.
Tropilaelaps clareae	A species of mite whose natural host species is *Apis dorsata,* that kills colonies of *Apis mellifera.*
Uncapping knife	A knife used to slice the wax capping off honey comb before the honey is extracted
Varroa destructor	A species of mite whose natural host species is *Apis cerana,* that kills colonies of *Apis mellifera.*
Vulnerability	According to a livelihoods approach, the degree of resilience against a shock, i.e. the likelihood that a decline in well-being will take place as a result of a shock. People's capacity to prevent vulnerability is primarily a function of a household's endowment of capital assets and insurance mechanisms. Vulnerability and poverty are two aspects of deprivation. However, the difference between them is brought out if we consider their opposites. The opposite of poverty is wealth, while the opposite of vulnerability is security. While poverty can be reduced by borrowing and investing, this does not reduce vulnerability. Indeed, borrowing increases vulnerability.
Vulnerability context	The political, social, economic and physical environment in which people live.
Worker bee	The female honeybee that constitutes the majority of the colony's population. Worker bees do most of the chores for the colony (except egg laying which the queen does).

APPENDICES

Appendix A
Codex alimentarius information on honey

REVISED CODEX STANDARD FOR HONEY
CODEX STAN 12-1981, Rev.1 (1987), Rev.2 (2001)[42]

The Annex to this Standard is intended for voluntary application by commercial partners and not for application by Governments.

1. SCOPE

1.1 Part One of this Standard applies to all honeys produced by honey bees and covers all styles of honey presentations which are processed and ultimately intended for direct consumption. Part Two covers honey for industrial uses or as an ingredient in other foods.

1.2 Parts Two of this Standard also covers honey which is packed for sale in bulk containers, which may be repacked into retail packs.

PART ONE

2. DESCRIPTION

2.1 DEFINITION

Honey is the natural sweet substance produced by honey bees from the nectar of plants or from secretions of living parts of plants or excretions of plant sucking insects on the living parts of plants, which the bees collect, transform by combining with specific substances of their own, deposit, dehydrate, store and leave in the honey comb to ripen and mature.

2.1.1 Blossom Honey or Nectar Honey is the honey which comes from nectars of plants.

2.1.2 Honeydew Honey is the honey which comes mainly from excretions of plant sucking insects (*Hemiptera*) on the living parts of plants or secretions of living parts of plants.

2.2 DESCRIPTION

Honey consists essentially of different sugars, predominantly fructose and glucose as well as other substances such as organic acids, enzymes and solid particles derived from honey collection. The colour of honey varies from nearly colourless to dark brown. The consistency can be fluid, viscous or partly to entirely crystallised. The flavour and aroma vary, but are derived from the plant origin.

3. ESSENTIAL COMPOSITION AND QUALITY FACTORS

3.1 Honey sold as such shall not have added to it any food ingredient, including food additives, nor shall any other additions be made other than honey. Honey shall not have any objectionable matter, flavour, aroma, or taint absorbed from foreign matter during its processing and storage. The honey shall not have begun to ferment or effervesce. No pollen or constituent particular to honey may be removed except where this is unavoidable in the removal of foreign inorganic or organic matter.

3.2 Honey shall not be heated or processed to such an extent that its essential composition is changed and/ or its quality is impaired

3.3 Chemical or biochemical treatments shall not be used to influence honey crystallisation.

[42] Secretariat Note: The Revised Codex Standard for Honey was adopted by the 24th Session of the Codex.

Alimentarius Commission in 2001. At the time of the adoption the Commission agreed that further work would be undertaken on certain technical issues, particularly the provisions concerning Moisture Content.

3.4 MOISTURE CONTENT
(a) Honeys not listed below - not more than 20%
(b) Heather honey *(Calluna)* - not more than 23%

3.5 SUGARS CONTENT

3.5.1 FRUCTOSE AND GLUCOSE CONTENT (SUM OF BOTH)
(a) Honey not listed below -not less than 60 g/100g
(b) Honeydew honey, -not less than 45g/100g blends of honeydew honey with blossom honey

3.5.2 SUCROSE CONTENT
(a) Honey not listed below -not more than 5 g/100g
(b) Alfalfa (*Medicago sativa*), Citrus spp., False -not more than 10g/100g Acacia (*Robinia pseudoacacia*), French Honeysuckle (*Hedysarum*), Menzies Banksia *(Banksia menziesii*), Red Gum *(Eucalyptus camaldulensis*), Leatherwood (*Eucryphia lucida*), Eucryphia milligani
(c) Lavender (*Lavandula spp*),Borage *(Borago* -not more than 15 g/100g *officinalis*)

3.6 WATER INSOLUBLE SOLIDS CONTENT
(a) Honeys other than pressed honey -not more than 0.1 g/100g
(b) Pressed honey -not more than 0.5 g/100g

4. CONTAMINANTS
4.1 HEAVY METALS [43]
Honey shall be free from heavy metals in amounts which may represent a hazard to human health. The products covered by this Standard shall comply with those maximum levels for heavy metals established by the Codex Alimentarius Commission.

4.2 RESIDUES OF PESTICIDES AND VETERINARY DRUGS
The products covered by this standard shall comply with those maximum residue limits for honey established by the Codex Alimentarius Commission.

5. HYGIENE
5.1 It is recommended that the products covered by the provisions of this standard be prepared and handled in accordance with the appropriate sections of the Recommended International Code of Practice - General Principles of Food Hygiene recommended by the Codex Alimentarius Commission (CAC/RCP 1-1969, Rev 3-1997), and other relevant Codex texts such as Codes of Hygienic Practice and Codes of Practice.

5.2 The products should comply with any microbiological criteria established in accordance with the Principles for the Establishment and Application of Microbiological Criteria for Foods (CAC/GL 21-1997).

[43] These levels will be established in consultation between the Codex Committee on Sugars and the Codex Committee on Food Additives and Contaminants as soon as possible.

6. LABELLING

In addition to the provisions of the General Standard for the Labelling of Pre-packaged Foods (CODEX STAN 1-1985, Rev 2-1999), the following specific provisions apply:

6.1 THE NAME OF THE FOOD

6.1.1 Products conforming to Part One of the Standard shall be designated 'honey'.

6.1.2 For products described in 2.1.1 the name of the food may be supplemented by the term "blossom" or "nectar".

6.1.3 For products described in 2.1.2 the word "honeydew" may be placed in close proximity to the name of the food.

6.1.4 For mixtures of the products described in 2.1.1 and 2.1.2 the name of the food may be supplemented with the words "a blend of honeydew honey with blossom honey".

6.1.5 Honey may be designated by the name of the geographical or topographical region if the honey was produced exclusively within the area referred to in the designation.

6.1.6 Honey may be designated according to floral or plant source if it comes wholly or mainly from that particular source and has the organoleptic, physicochemical and microscopic properties corresponding with that origin.

6.1.7 Where honey has been designated according to floral or plant source (6.1.6) then the common name or the botanical name of the floral source shall be in close proximity to the word "honey".

6.1.8 Where honey has been designated according to floral, plant source, or by the name of a geographical or topological region, then the name of the country where the honey has been produced shall be declared.

6.1.9 The subsidiary designations listed in 6.1.10 may not be used unless the honey conforms to the appropriate description contained therein. The styles in 6.1.11 (b) and (c) shall be declared.

6.1.10 Honey may be designated according to the method of removal from the comb.

(a) Extracted Honey is honey obtained by centrifuging decapped broodless combs.
(b) Pressed Honey is honey obtained by pressing broodless combs.
(c) Drained Honey is honey obtained by draining decapped broodless combs.

6.1.11 Honey may be designated according to the following styles:

(a) Honey which is honey in liquid or crystalline state or a mixture of the two;
(b) Comb Honey which is honey stored by bees in the cells of freshly built broodless combs and which is sold in sealed whole combs or sections of such combs;
(c) Cut comb in honey or chunk honey which is honey containing one or more pieces of comb honey.

6.1.12 Honey which has been filtered in such a way as to result in the significant removal of pollen shall be designated filtered honey.

6.2 LABELLING OF NON-RETAIL CONTAINERS

6.2.1 Information on labelling as specified in The General Standard for the Labelling of Pre-packaged Foods and in Section 6.1 shall be given either on the container or in accompanying documents, except that the name of the product, lot identification and the name and address of the producer, processor or packer shall appear on the container.

7. METHODS OF SAMPLING AND ANALYSIS

The methods of sampling and analysis to be employed for the determination of the compositional and quality factors are detailed below:

7.1 SAMPLE PREPARATION

Samples should be prepared in accordance with AOAC 920.180.

7.2 DETERMINATION OF MOISTURE CONTENT[44]

AOAC 969.38B / J. Assoc. Public Analysts (1992) **28** (4) 183-187 / MAFF Validated method V21 for moisture in honey.

7.3 DETERMINATION OF SUGARS CONTENT[45]

7.3.1 FRUCTOSE AND GLUCOSE CONTENT (SUM OF BOTH)

Determination of sugars by HPLC - Harmonised Methods of the European Honey Commission, Apidologie – Special Issue **28**, 1997, Chapter 1.7.2

7.3.2 SUCROSE CONTENT

Determination of sugars by HPLC - Harmonised Methods of the European Honey Commission, Apidologie – Special Issue **28**, 1997, Chapter 1.7.2

7.4 DETERMINATION OF WATER-INSOLUBLE SOLIDS CONTENT

J. Assoc. Public Analysts (1992) **28** (4) 189-193/ MAFF Validated method V22 for water insoluble solids in honey

7.5 DETERMINATION OF ELECTRICAL CONDUCTIVITY[46]

Determination of electrical conductivity - Harmonised Methods of the European Honey Commission, Apidologie – Special Issue **28**, 1997, Chapter 1.2

7.6 DETERMINATION OF SUGARS ADDED TO HONEY (AUTHENTICITY)[47]

AOAC 977.20 for sugar profile
AOAC 991.41 internal standard for SCIRA (stable carbon isotope ratio analysis).

[44] These methods are identical.
[45] Subject to endorsement by CCMAS.
[46] Subject to endorsement by CCMAS.
[47] CCS noted that a screening method for the detection of cane sugar adulteration of honey was available.

ANNEX

This text is intended for voluntary application by commercial partners and not for application by governments.

1. ADDITIONAL COMPOSITION AND QUALITY FACTORS

Honey may have the following compositional and quality factors:

1.1 FREE ACIDITY

The free acidity of honey may be not more than 50 milliequivalents acid per 1000g.

1.2 DIASTASE ACTIVITY

The diastase activity of honey, determined after processing and/or blending, in general not less than 8 Schade units and in the case of honeys with a low natural enzyme content not less than 3 Schade Units.

1.3 HYDROXYMETHYLFURFURAL CONTENT

The hydroxymethylfurfural content of honey after processing and/or blending shall not be more than 40 mg/kg. However, in the case of honey of declared origin from countries or regions with tropical ambient temperatures, and blends of these honeys, the HMF content shall not be more than 80 mg/kg.

1.4 ELECTRICAL CONDUCTIVITY

(a) honey not listed under (b) or (c), and blends of these -not more than 0. 8 mS/cm honeys
(b) Honeydew and chestnut honey and blends of these -not less than 0.8 mS/cm except with those listed under (c)
(c) <u>Exceptions</u> : Strawberry tree (*Arbutus unedo)*, Bell Heather (*Erica*), Eucalyptus, Lime (*Tilia spp*), Ling Heather (*Calluna vulgaris*) Manuka or Jelly bush (*Leptospermum*), Tea tree (*Melaleuca spp*).

2. METHODS OF SAMPLING AND ANALYSIS

The methods of sampling and analysis to be employed for the determination of the additional compositional and quality factors set out in Section 1 of this Annex are detailed below:

2.1 SAMPLE PREPARATION

The method of sample preparation is described in section 7.1 of the Standard. In the determination of diastase activity (2.2.2) and hydroxymethylfurfural content (2.2.3), samples are prepared without heating.

2.2 METHODS OF ANALYSIS

2.2.1 DETERMINATION OF ACIDITY

J. Assoc. Public Analysts (1992) **28** (4) 171-175 / MAFF validated method V19 for acidity in honey

2.2.2 DETERMINATION OF DIASTASE ACTIVITY

2.2.6.1 AOAC 958.09
or Determination of diastase activity with Phadebas - Harmonised Methods of the European Honey Commission, Apidologie – Special Issue **28**, 1997, Chapter 1.6.2

2.2.3 DETERMINATION OF HYDROXYMETHYLFURFURAL (HMF) CONTENT

AOAC 980.23
or
Determination of hydroxymethylfurfural by HPLC - Harmonised Methods of the European Honey Commission, Apidologie – Special Issue **28**, 1997, Chapter 1.5.1

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Harmonised methods of the European Honey Commission, Apidologie - special issue, **28**, 1997.

NOTE: CCS asked CCMAS to consider retaining only those essential references.

Appendix B
EU regulations for organic honey

This text is intended for voluntary application by commercial partners and not for application by Governments.

1. ADDITIONAL COMPOSITION AND QUALITY FACTORS

Honey may have the following compositional and quality factors:

1.1 Free Acidity

The free acidity of honey may be not more than 50 milliequivalents acid per 1 000 g.

1.2 Diastase Activity

The diastase activity of honey, determined after processing and/or blending, in general not less than 8 Schade units and in the case of honeys with a low natural enzyme content not less than 3 Schade Units.

1.3 Hydroxymethylfurfural Content

The hydroxymethylfurfural content of honey after processing and/or blending shall not be more than 40 mg/kg. However, in the case of honey of declared origin from countries or regions with tropical ambient temperatures, and blends of these honeys, the HMF content shall not be more than 80 mg/kg.

1.4 Electrical Conductivity

(a) honey not listed under (b) or (c), and blends of these honeys (not more than 0.8 mS/cm)
(b) Honeydew and chestnut honey and blends of these except with those listed under (c) (not less than 0.8 mS/cm)
(c) Exceptions : Strawberry tree (*Arbutus unedo)*, Bell Heather (*Erica*), Eucalyptus, Lime (*Tilia* spp), Ling Heather (*Calluna vulgaris*) Manuka or Jelly bush (*Leptospermum*), Tea tree (*Melaleuca spp*).

2. METHODS OF SAMPLING AND ANALYSIS

The methods of sampling and analysis to be employed for the determination of the additional compositional and quality factors set out in Section 1 of this Annex are detailed below:

2.1 Sample preparation

The method of sample preparation is described in section 7.1 of the Standard. In the determination of diastase activity (2.2.2) and hydroxymethylfurfural content (2.2.3), samples are prepared without heating.

2.2 Methods of analysis

Determination of acidity

J. Assoc. Public Analysts (1992) **28** (4) 171-175 / MAFF validated method V19 for acidity in honey.

Determination of diastase activity

2.2.6.1 AOAC 958.09
or
CODEX STAN 12-1981 Page 6 of 7
Determination of diastase activity with Phadebas - Harmonised Methods of the European Honey Commission, Apidologie – Special Issue **28**, 1997, Chapter 1.6.2

Determination of hydroxymethylfurfural (HMF) content
AOAC 980.23
or
Determination of hydroxymethylfurfural by HPLC - Harmonised Methods of the European Honey Commission, Apidologie – Special Issue **28**, 1997, Chapter 1.5.1

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Harmonised methods of the European Honey Commission, Apidologie - special issue, **28**, 1997.

NOTE: CCS asked CCMAS to consider retaining only those essential references.
CODEX STAN 12-1981, Page 7 of 7.

Appendix C
Organic honey standards for European Union

Council Regulation (EC) No 1804/1999 of 19 July 1999 supplementing Regulation (EEC) No 2092/91 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs to include livestock production
Official Journal L 222, 24/08/1999 P. 0001 – 0028

BEEKEEPING AND BEEKEEPING PRODUCTS

1. GENERAL PRINCIPLES

1.1 Beekeeping is an important activity that contributes to the protection of the environment and agricultural and forestry production through the pollination action of bees.

1.2 The qualification of beekeeping products as being from organic production is closely bound up both with the characteristic of the hives' treatments and the quality of the environment. This qualification also depends on the conditions for extraction, processing and storage of beekeeping products.

1.3 When an operator runs several beekeeping units in the same area all the units must comply with the requirements of this Regulation. By derogation from this principle, an operator can run units not complying with this Regulation provided that all the requirements of this Regulation are fulfilled with the exception of the provisions laid down in paragraph 4.2 for the siting of the apiaries. In that case, the product cannot be sold with references to organic production methods.

2. CONVERSION PERIOD

2.1 Beekeeping products can be sold with references to the organic production method only when the provisions laid down in this Regulation have been complied with for at least one year. During the conversion period the wax has to be replaced according to the requirements laid down in paragraph 8.3.

3. ORIGIN OF THE BEES

3.1 In the choice of breeds, account must be taken of the capacity of animals to adapt to local conditions, their vitality and their resistance to disease. Preference shall be given to the use of European breeds of Apis mellifera and their local ecotypes.

3.2 Apiaries must be constituted by means of the division of colonies or the acquisition of swarms or hives from units complying with the provisions laid down in this Regulation.

3.3 By way of a first derogation, subject to the prior approval by the inspection authority or body, apiaries existing in the production unit not complying with the rules of this Regulation can be converted.

3.4 By way of a second derogation, swarms on their own may be acquired from beekeepers not producing in accordance with this Regulation during a transitional period expiring on 24 August 2002 subject to the conversion period.

3.5 By way of a third derogation, the reconstitution of the apiaries shall be authorised by the control authority or body, when apiaries complying with this Regulation are not available, in case of high mortality of animals caused by health or catastrophic circumstances, subject to the conversion period.

3.6 By way of a fourth derogation, for the renovation of the apiaries 10 percent per year of the queen bees and swarms not complying with this Regulation can be incorporated into the organic production unit provided that the queen bees and swarms are placed in hives with combs or comb foundations coming from organic-production units. In the case, the conversion period does not apply.

4. SITING OF THE APIARIES

4.1 The Member States may designate regions or areas where beekeeping complying with this Regulation is not practicable. A map on an appropriate scale listing the location of hives as provided for in Annex Ill, Part AI, section 2, first indent shall be provided to the inspection authority or body by the beekeeper. Where no such areas are identified, the beekeeper must provide the inspection authority or body with appropriate documentation and evidence, including suitable analyses if necessary, that the areas accessible to his colonies meet the conditions required in this Regulation.

4.2 The siting of the apiaries must:

(a) ensure enough natural nectar, honeydew and pollen sources for bees and access to water;

(b) be such that, within a radius of 3 km from the apiary site, nectar and pollen sources consist essentially of organically produced crops and/or spontaneous vegetation, according to the requirements of Article 6 and Annex I of this Regulation, and crops not subject to the provisions of this Regulation but treated with low environmental impact methods such as, for example, those described in programmes developed under Regulation (EEC) No 2078/92 which cannot significantly affect the qualification of beekeeping production as being organic;

(c) maintain enough distance from any non-agricultural production sources possibly leading to contamination, for example: urban centres, motorways, industrial areas, waste dumps, waste incinerators, etc. The inspection authorities or bodies shall establish measures to ensure this requirement.

The above requirements do not apply to areas where flowering is not taking place, or when the hives are dormant.

5. FEED

5.1. At the end of the production season hives must be left with reserves of honey and pollen sufficiently abundant to survive the winter.

5.2 The artificial feeding of colonies is authorised where the survival of the hives is endangered due to extreme climatic conditions. Artificial feeding shall be made with organically produced honey, preferably from the same organic production unit.

5.3 By way of a first derogation from paragraph 5.2, the competent authorities of the Member States can authorise the use of organically produced sugar syrup, or organic sugar molasses instead of organically produced honey in artificial feeding, in particular, when it is required by climatic conditions that provoke crystallisation of honey.

5.4 By way of a second derogation, sugar syrup, sugar molasses and honey not covered by this Regulation may be authorised by the inspection authority or body for artificial feeding during a transitional period expiring on 24 August 2002.

5.5 The following information shall be entered in the register of the apiaries with regard to the use of artificial feeding: type of product, dates, quantities and hives where it is used.

5.6 Other products different from those indicated in paragraphs 5.1 to 5.4 cannot be used in beekeeping which complies with this Regulation.

5.7 Artificial feeding may be carried out only between the last honey harvest and 15 days before the start of the next nectar or honeydew flow period.

6. DISEASE PREVENTION AND VETERINARY TREATMENTS

6.1 Disease prevention in beekeeping shall be based on the following principles:

(a) the selection of appropriate hardy breeds;

(b) the application of certain practices encouraging strong resistance to disease and the prevention of infections, such as: regular renewal of queen bees, systematic inspection of hives to detect any health anomalies, control of male broods in the hives, disinfecting of materials and equipment at regular intervals, destruction of contaminated material or sources, regular renewal of beeswax and sufficient reserves of pollen and honey in hives.

6.2 If despite all the above preventive measures, the colonies become sick or infested, they must be treated immediately and, if necessary, the colonies can be placed in isolation apiaries.

6.3 The use of veterinary medicinal products in beekeeping which complies with this Regulation shall respect the following principles:

(a) they can be used in so far as the corresponding use is authorised in the Member State in accordance with the relevant Community provisions or national provisions in conformity with Community law;

(b) phytotherapeutic and homeopathic products shall be used in preference to allopathic products chemically synthesised, provided that their therapeutic effect is effective for the condition for which the treatment is intended;

(c) if the use of the above mentioned products should prove or is unlikely to be effective to eradicate a disease or infestation which risks destroying colonies, allopathic chemically synthesised medicinal products may be used under the responsibility of a veterinarian, or other persons authorised by the Member State, without prejudice to the principles laid down in paragraphs (a) and (b) above;

(d) the use of allopathic chemically synthesised medicinal products for preventive treatments is prohibited;

(e) without prejudice to the principle in (a) above formic acid, lactic acid, acetic acid and oxalic acid and the following substances: menthol, thymol, eucalyptol or camphor can be used in cases of infestation with Varroa jacobsoni.

6.4 In addition to the above principles, veterinary treatments or treatments to hives, combs etc., which are compulsory under national or Community legislation shall be authorised.

6.5 If a treatment is applied with chemically synthesised allopathic products, during such a period, the colonies treated must be placed in isolation apiaries and all the wax must be replaced with wax complying with the conditions laid down in this Regulation. Subsequently, the conversion period of one year will apply to those colonies.

6.6 The requirements laid down in the previous paragraph do not apply to products mentioned in paragraph 6.3 (e).

6.7 Whenever veterinary medicinal products are to be used, the type of product (including the indication of the active pharmacological substance) together with details of the diagnosis, the posology, the method of administration, the duration of the treatment and the legal withdrawal period must be recorded clearly and declared to the inspection body or authority before the products are marketed as organically produced.

7. HUSBANDRY MANAGEMENT PRACTICES AND IDENTIFICATION

7.1 The destruction of bees in the combs as a method associated with the harvesting of beekeeping products is prohibited.

7.2 Mutilation such as clipping the wings of queen bees is prohibited.

7.3 The replacement of the queen bees involving the killing of the old queen is permitted.

7.4 The practice of destroying the male brood is permitted only to contain the infestation with Varroa jacobsoni.

7.5 The use of chemical synthetic repellents is prohibited during honey extractions operations.

7.6 The zone where the apiary is situated must be registered together with the identification of the hives. The inspection body or authority must be informed of the moving of apiaries with a deadline agreed on with the inspection authority or body.

7.7 Particular care shall be taken to ensure adequate extraction, processing and storage of beekeeping products. All the measures to comply with these requirements shall be recorded.

7.8 The removals of the supers and the honey extraction operations must be entered in the register of the apiary.

8. CHARACTERISTICS OF HIVES AND MATERIALS USED IN BEEKEEPING

8.1 The hives must be made basically of natural materials presenting no risk of contamination to the environment or the apiculture products.

8.2 With the exception of products mentioned in paragraph 6.3(e) in the hives can be used only natural products such as propolis, wax and plant oils.

8.3 The beeswax for new foundations must come from organic production units. By way of derogation, in particular in the case of new installations or during the conversion period, bees wax not coming from such units may be authorised by the inspection authority or body in exceptional circumstances where organically produced beeswax is not available on the market and provided that it comes from the cap.

8.4 The use of combs, which contain brood, is prohibited for honey extraction.

8.5 For the purposes of protecting materials (frames, hives and combs), in particular from pests, only appropriate products listed in Part B, Section 2, of Annex 11 are permitted.

8.6 Physical treatments such as steam or direct flame are permitted.

8.7 For cleaning and disinfecting materials, buildings, equipment, utensils or products used in beekeeping only the appropriate substances listed in Annex 11 Part E are permitted.