Chapter 2
Bees As Crop Pollinators

Why are bees important pollinators?

There are about 20,000 species (types) of bees found in the world. Many of these are found in the Hindu Kush-Himalayan region. They include honeybees, bumble bees, stingless bees and solitary bees as described in Chapter 6. All bees depend on food (nectar and pollen) provided by flowers: they cannot survive without it. While visiting flowers for food they also aid pollination by transferring pollen from one flower to another. A close relationship exists between plants that require cross-pollination and bees that use nectar and pollen for food.

Bees are important to farmers because they are better than other insects at pollinating flowers of many agricultural, horticultural, and forage crops, as well as other plants (Figure 2.1). Therefore, a large number of bees on a crop ensures good pollination that results in higher yields and better quality produce. Without bees many crops would produce little or no fruit or seed.

Bees have the following characteristics that make them the most important pollinators.

- Bees are social insects. Other insects collect nectar mostly to satisfy their individual needs whereas bees collect nectar and pollen to feed their young.
- Bees have body hairs. When a bee visits a flower some pollen becomes attached to its body and is transferred to the stigma of another flower that the bee visits. This accomplishes pollination.

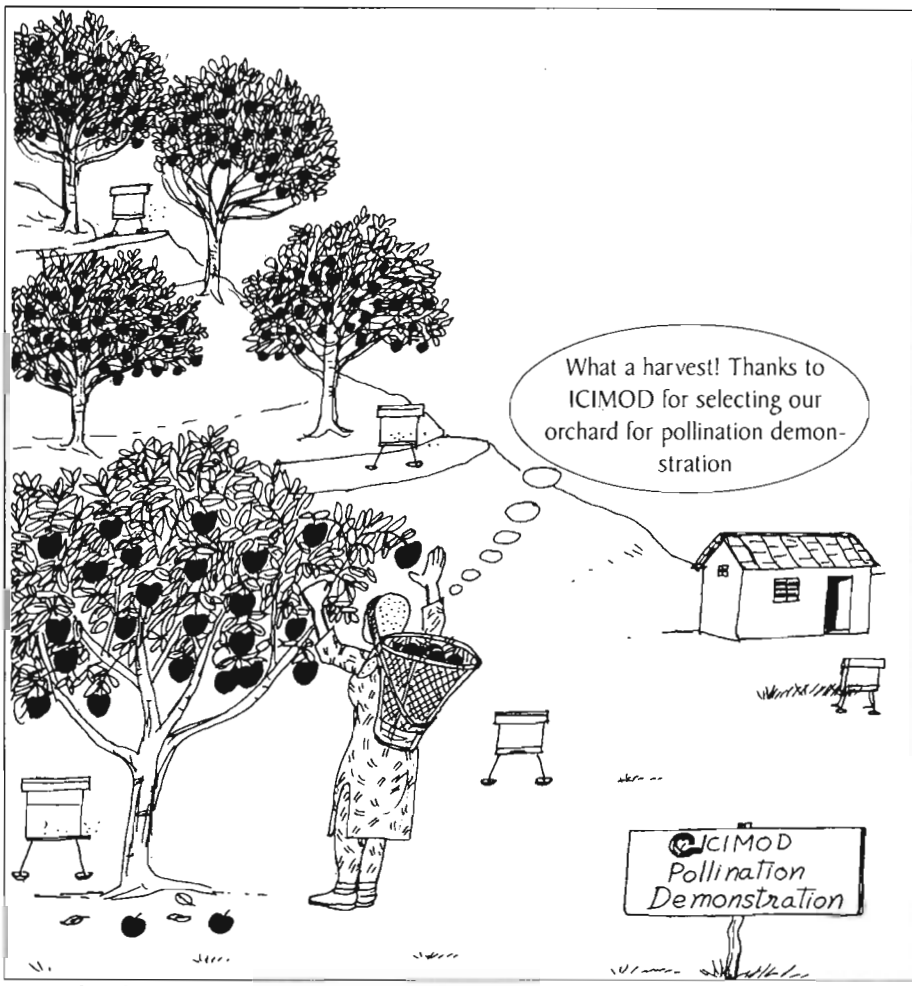

Figure 2.1: Bees are important pollinators of many agricultural and horticultural crops.

- Bees show flower constancy: i.e., a foraging bee usually moves from one flower to another of the same species for as long as nectar and pollen are available. Other insects haphazardly visit flowers of different species. This constancy in foraging is important for effective cross-pollination.
- Many species of bees, e.g., honeybees and stingless bees, are kept in man-made nest sites and are mass-reared for honey production. They are also managed for crop pollination.
- Many species of bees (other than those kept for honey production) can also be managed for crop pollination.

The most important are bumble bees and solitary bees, e.g., alkali bees, horn-faced bees, and leaf-cutter bees.

How do bees pollinate a crop?

A bee visiting the flowers of a crop becomes conditioned to that particular crop. During a single foraging trip, it visits a number of flowers of the same crop. While collecting nectar and pollen, the bee brushes against the anthers of a flower and some pollen grains are picked up by the hairs on its body and head. When the bee visits another flower some of the pollen grains are captured by the sticky surface of a receptive stigma, thus effecting cross-pollination (Figure 2.2).

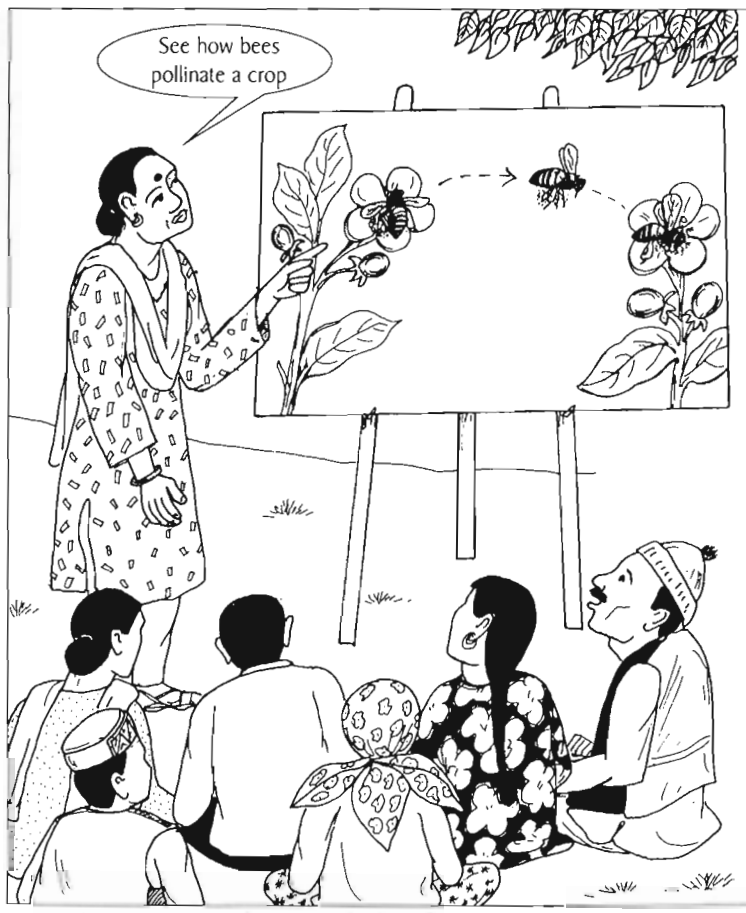

Figure 2.2: A bee pollinates a crop by transferring pollen from one flower to another of the same or different plant of a crop.

Why are honeybees the most important of all bee species in pollination?

Honeybees are the most widely known of all bees because they provide honey, beeswax, and other products such as pollen, propolis, and royal jelly. Beekeeping is a prevailing tradition among mountain farming communities. The Himalayan honeybee, *Apis cerana*, is kept in traditional fixed-comb hives such as log hives, wall hives, and pitcher hives, as well as in modern movable-frame wooden hives. Beekeeping is becoming an entrepreneurial activity in mountain areas. Honeybees have certain characteristics—social and behavioural—that make them the most effective and reliable crop pollinators.

- Honeybees live in colonies where the young are nursed and fed with a mixture of honey and pollen by adults throughout the year. A colony is defined as a group of insects living in a common nest that they have constructed (Figure 2.3). They work together to supply each other's needs and cooperate to raise offspring. Honeybee colonies are large compared to those of other bees consisting of 10,000 to 80,000 individuals depending upon the species.
- They have the potential for working long hours. They start their foraging early in the morning and cease late in the evening, working many hours a day.
- Honeybees have evolved a special communication system by which thousands of foragers can be deployed when a good food source is present.
- Compared to other bee species, they visit many flowers per unit time.
- They are adapted to different climates.
- They are micro-manipulators of flowers.
- Some species can be managed in large numbers and moved to crops where and when necessary.
- Most importantly, honeybees provide honey, beeswax, and other hive products for man.

What are the members of a honeybee colony?

Honeybees live in colonies. A honeybee colony can contain up to 80,000 bees, depending on the species. A colony of

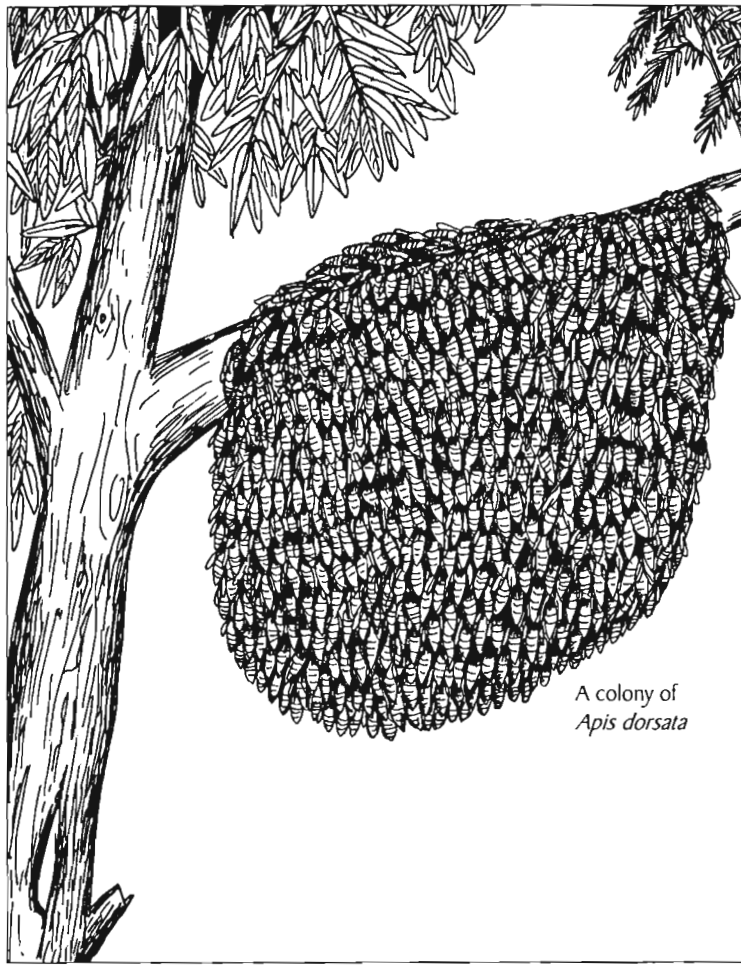

Figure 2.3 A colony of honeybees: honeybees live in colonies (10,000 - 80,000 bees) in which food (honey and pollen) is stored and the young are nursed.

honeybee consists of one queen, a few drones, and thousands of workers (Figure 2.4). The queen is the only fertile female in the colony. She is much longer and darker than drones and worker bees. However, it is difficult to find her in the colony because she is usually covered by many worker bees.

The queen is the mother of all other bees in the colony. The most important function of the queen is to lay eggs to produce offspring. Immature stages (eggs, larvae, and pupae) are collectively called the brood. The majority of fertilized eggs laid by the queen develop into worker bees

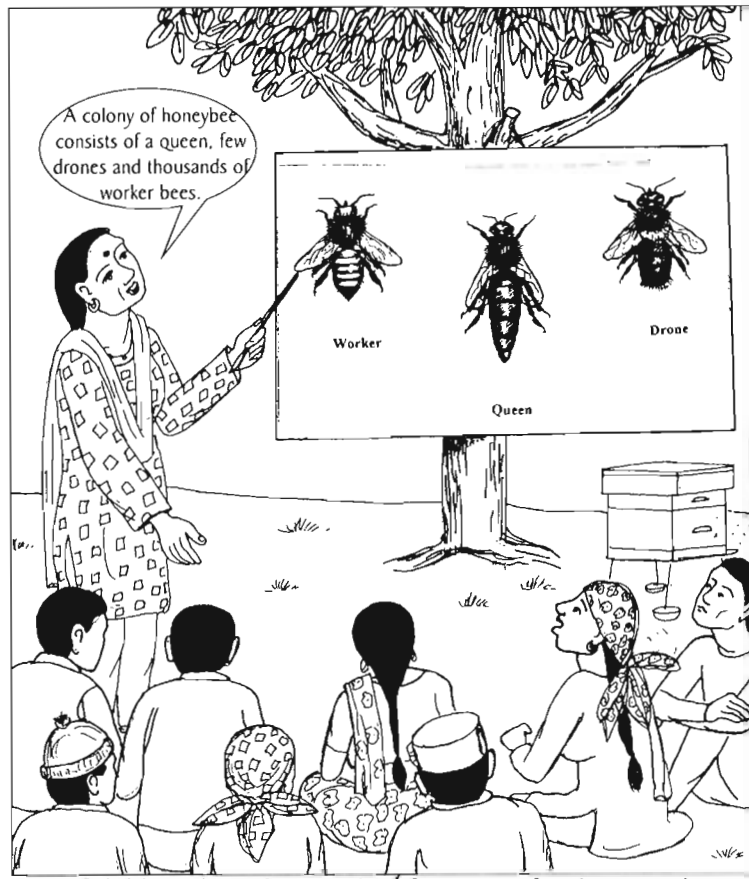

Figure 2.4: A honeybee colony consists of a queen, a few drones, and thousands of worker bees.

or daughters. She also lays a few unfertilized eggs during the swarming or reproduction season that develop into drones (male bees).

Workers are sterile females and are produced in thousands. They are the smallest members of the colony. They do all the work required for its survival. They feed the brood, take care of the young, build the nest, clean the hive, defend the colony from pests and predators, and regulate colony temperature. They store both nectar and pollen in the hive to provide food for the colony. Workers also collect nectar and convert it into honey. Although worker bees are sterile, in the absence of a queen over a long period of time, they develop functional ovaries and lay unfertilized eggs that develop into drones.

Drones are generally produced when a colony is preparing for swarming. In this situation, the colony will also construct queen cells. Thus both drones and queens are reared together. The drones fly from the colony to mate with a queen. Drones are bigger than workers and smaller than the queen and have large eyes.

The honeybee colony lives in and between combs called a nest. The nest consists of wax combs made by the bees in which the young are reared, and the adults live with their food stores (Figure 2.5). Worker bees construct the combs from wax produced by wax glands in their bodies. Honeybee

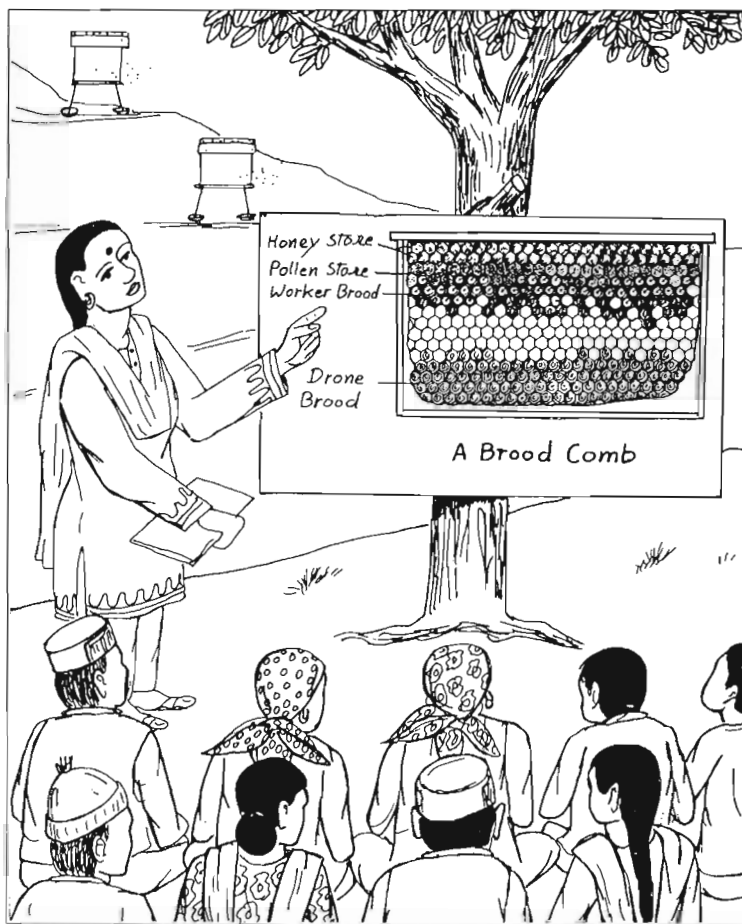

Figure 2.5: A honeybee nest consists of wax combs in which honey and pollen are stored and the brood is reared.

nests are located in protected places. While some species prefer dark places, such as hollow tree trunks, others live in the open, in bushes, tall trees, etc. The combs are two sided and are composed of hexagonal cells. The combs contain stored honey at the top, followed by a layer of stored pollen, and below are the brood of all stages (eggs, larvae, and pupae).

What is swarming?

Swarming

Swarming is defined as the departure from its nest of a portion of the adult worker bees of a colony, with a queen and a few drones (Figure 2.6). Swarming is the natural way

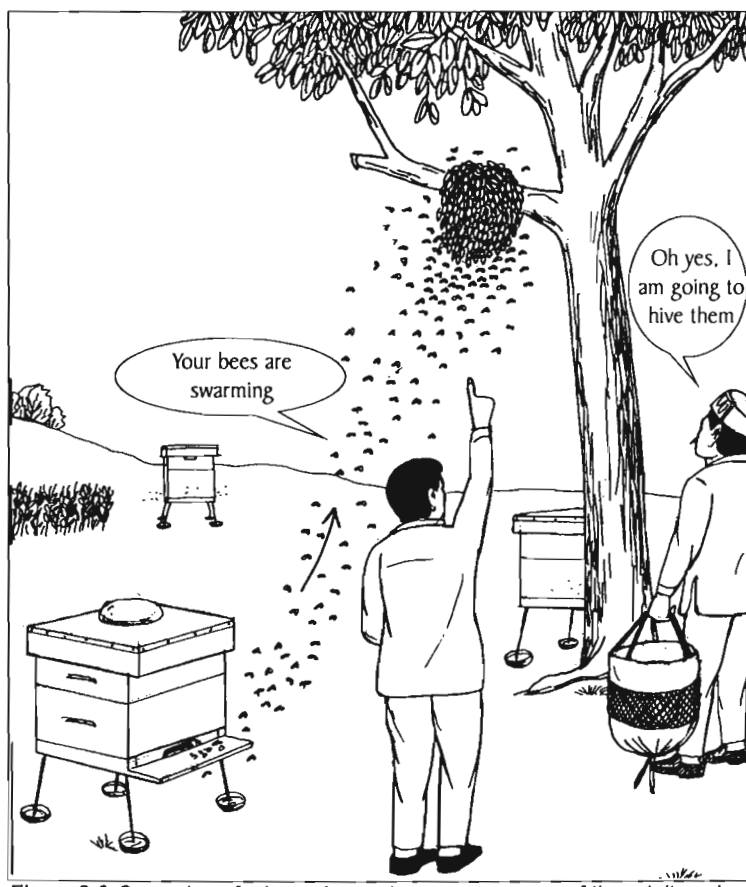

Figure 2.6: Swarming of a honeybee colony means some of the adult worker bees and few drones led by the old queen leave the old nest site and form a new colony.

for colonies to multiply. A part of the colony with the old queen leaves the hive or old nest site to search for a new site. The remaining members continue living at the original site with a newly emerged queen. This queen becomes fertile, mates with drones, and lays eggs.

Swarming generally occurs during the active brood-rearing season, usually between February and June, depending on climatic conditions. In low hill areas it occurs during February to March, and in high mountain areas it takes place during May-June.

Predicting swarming

Colonies generally prepare for swarming when food is plentiful, i.e., when there are plenty of suitable flowering plants. The main symptom of a colony preparing for swarming is the construction of drone cells and the appearance of a drone brood (Figure 2.5). This is followed by the construction of queen cells. In *Apis cerana,* queen cells are generally constructed on the bottom margins of the brood combs (Figure 2.7). In *Apis mellifera,* queen cells are also constructed on the face of brood combs. It may not always be necessary to examine the combs for the presence of a drone brood. Swarming can also be predicted by the presence of adult drones in the colony. They can be seen at the hive entrance when they leave during the afternoon (15.00-17.00 h).

Need to prevent swarming and how it is done

Swarming of bee colonies may be beneficial for reproduction, but, for a beekeeper, swarming means the loss of half of his bees (especially if he is unable to catch and hive the swarm). Frequent swarming (especially outside the active brood-rearing season)—as is common with the Himalayan honeybee, *Apis cerana*—is not beneficial for the beekeeper. For example, swarming four or five times will result in small, weak swarms that may not be able to establish healthy colonies and will probably die sooner or later. Swarming has a negative impact on honey production and crop pollination because weak colonies are not effective, either

Figure 2.7: Presence of queen cells and a drone brood is an important symptom of a colony preparing for swarming.

at the production of honey or at pollination, since they have a small percentage of foragers. Therefore, it is necessary to control frequent swarming in order to maintain strong, healthy colonies. This can be achieved in the following ways.

- Inspect the colony regularly and check whether it is preparing for swarming. This means checking whether queen cells or a drone brood are present as these are the main indicators.
- If queen cells or a drone brood are present, assess the strength of the colony. Judge whether it can be divided

into two without having a negative impact on honey production, crop pollination and survival. If it is strong enough, destroy all queen cells except for one and divide the colony; i.e., put half of the bees with one queen cell into another hive. The other bees with the old queen will remain in the same/parent hive.

- If the colony is not strong but is still preparing for swarming, destroy all the drone brood and the queen cells. This will help control swarming.
- If the colony is strong but the bees are congested, provide more space by placing a super over the brood chamber (Figure 2.8).

Figure 2.8: Swarming is often due to congestion in the colony and can be prevented by providing bees with more space.

- Try to keep the colony free from disease and enemies.
- If the colony has decided to swarm, it is important to break its swarming impulse by pseudo-swarming (false swarming). This can be done by allowing the bees to fly away without a queen. This is affected by putting a queen gate at the hive entrance (Figure 2.9) or by caging the queen (Figure 2.10). The bees will come back because the queen remains in the hive.

Figure 2.9: Providing the queen gate at the hive entrance can help prevent swarming and absconding. Since the queen can not leave the hive, the bees also come back.

Figure 2.10:Caging the queen is another way to control swarming and absconding. Even if the bees fly away, they will come back because the queen is in the hive itself.

What is absconding?

Absconding and migration

Absconding is the departure of all adult bees of a colony from their nest leaving behind whatever brood and food stores are in it. Absconding may be due to a shortage of food, disturbance to the bees, excessive heat and cold, poor ventilation, presence of old and defective combs, and attack by enemies and disease.

Figure 2.11:The main symptom of a colony preparing for absconding is that it has very little or no food (honey or pollen stores) and has no brood.

Migration is the periodic movement of a colony. The term is restricted to the regular seasonal movements of the honeybee colonies that result from an inherited response to geographic cues and not from a direct response to a lack of food.

Predicting absconding

Shortage of food and excessive disturbance of the nest are common causes of colonies preparing for absconding. When a colony is in this state it can show the following peculiar behaviour.

- It does not defend itself against enemies.
- It ceases brood-rearing although the queen continues to lay eggs.
- It has a small, scattered brood or no brood (Figure 2.11).
- There is very little or no food stored (Figure 2.11).
- Bees stop cleaning the hive.
- Cannibalism is observed: adult bees first devour young larvae, then older larvae, and finally pupae.
- There is a progressive reduction in the relative number of pollen carriers entering the hive. This is an external but important symptom of a colony preparing to abscond.

Prevention of absconding

Absconding has an adverse effect on farmers/beekeepers as bees are lost. It also has a serious negative impact on honey production and crop pollination. Therefore, it is necessary to control absconding. Listed below are some of the ways it can be done.

- Lack of suitable pollen and nectar sources is the most important reason for absconding. So provide sugar syrup (prepared by dissolving two parts of sugar in one part of water [2:1 weight to volume ratio]) and feed this to the colony every evening (Figure 2.12). This will meet the bees' requirement for nectar and help to control absconding.
- When preparation for absconding has reached an advanced stage—pollen collection is zero, there is no response to sugar feeding, and there is no brood—it is important to break the so-called absconding impulse by pseudo-absconding (false absconding). This can be done by allowing the bees to fly away without the queen, either by using a queen gate at the hive entrance (Figure 2.9) or by caging her (Figure 2.10). Open the hive and allow the bees to leave; they will come back because the queen cannot escape. Remove all empty combs. When the bees return to the hive, feed them with sugar syrup. In this way, they will establish themselves in the hive as a new swarm. Give them combs or comb foundation sheets to build new combs.

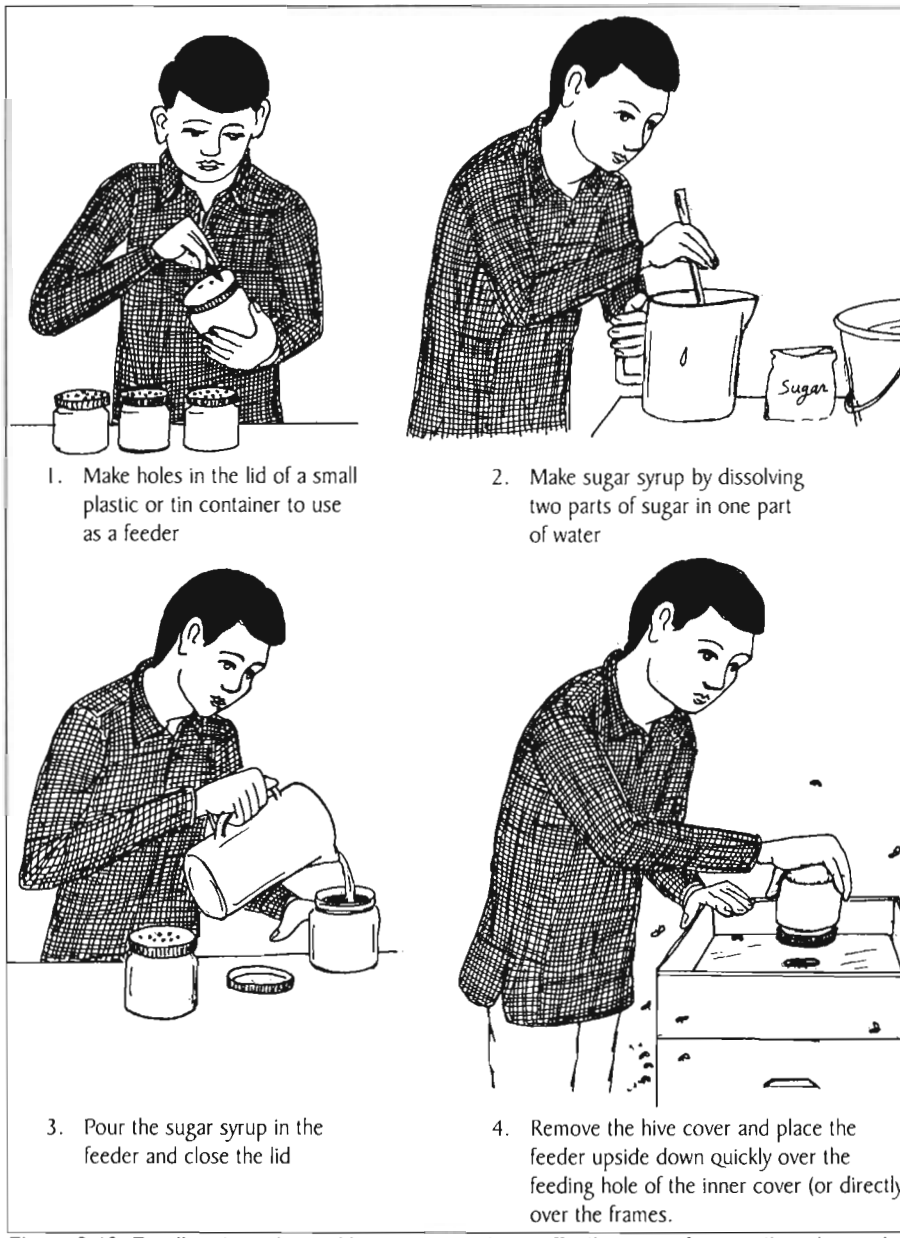

Figure 2.12: Feeding the colony with sugar syrup is an effective way of preventing absconding, especially if absconding is due to the dearth of bee floral resources.

- The provision of shade during summer and warmth during winter will help to control absconding.
- Provide adequate ventilation to the hive as poor ventilation can lead to absconding.

- Remove old and defective combs from the hive.
- Keep the bottom board clean.
- Take measures to control diseases and enemies as these can also make a colony abscond.

What are the principal honeybee species in the Hindu Kush-Himalayan region?

Five species of true honeybees (*Apis* spp) and a few species of stingless honeybees are found in the Hindu Kush-Himalayan region. True honeybees include the giant honeybees or rock bees (*Apis dorsata*) and *Apis laboriosa,* the little honeybee (*Apis florea*), the Asian honeybee (*Apis cerana*), and the European honeybee (*Apis mellifera*). Several types of stingless honeybees, including species of *Melipona* and *Trigona,* are also found in the region. As described below, some species can be kept in hives and others cannot.

Honeybees that cannot be kept in hives

The giant honeybees or rock bees (*Apis dorsata* and *Apis laboriosa*) and the little honeybee (*Apis florea*) cannot be kept in hives. They make their nests in the open on vertical cliffs, on branches of tall trees, and on bushes. They cannot be managed for honey production and crop pollination. Honey from these bees is harvested by traditional honey-hunting methods.

Apis dorsata, also known as the giant honeybee or rock bee, is found throughout the Himalayas up to 1,000m. It builds single comb nests in the open on branches of tall trees and on tall buildings and chimneys, in shady places during summer, and in sunny places during winter. As many as 70 or more colonies can be found on a single tree (Figure 2.13). This species is migratory in nature; a colony never stays in the same place for more than six months. *Apis dorsata* is an abundant producer of honey and an important pollinator of many agricultural and horticultural crops. It nests in low hill areas during winter and migrates to the high hills in summer.

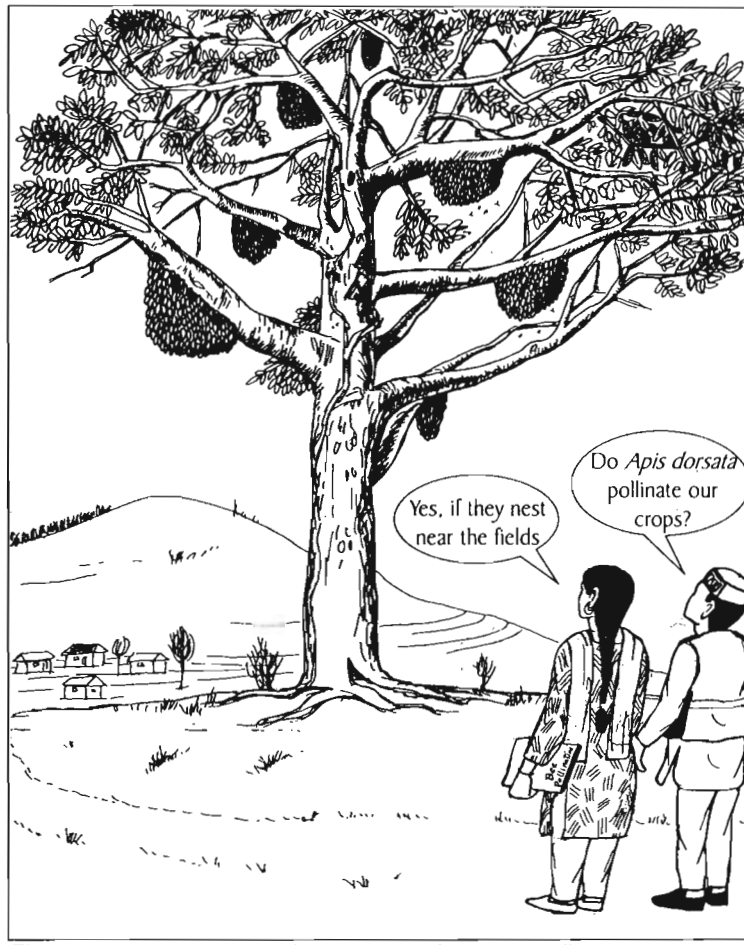

Figure 2.13: Apis dorsata makes single comb nests on tall trees; many nests can be found on a single tree.

Apis laboriosa is found from 1,200 to 3,500m in remote mountainous areas of Bhutan, China, India, and Nepal. It nests beneath rock overhangs on vertical cliff faces (Figure 2.14). It is also migratory in nature and a colony does not remain in one place the year round. Colonies are found at a height of at least 10m above the ground and occur in groups. Like *Apis dorsata,* 70 or more colonies can be found at a single cliff site. It is also an important crop pollinator.

*Apis florea** is the smallest honeybee species and is called the little bee. It also builds single comb nests on the branches

* *Recently more species of* Apis *have been identified in Asia and firm confirmation of this species of little bee as* Apis florea *is yet to be completed.*

Figure 2.14: Apis laboriosa nests on cliffs. There can be many colonies on a single cliff site.

of bushes, hedges, small trees, and chimneys (Figure 2.15). This species is found in the plains and in hilly areas up to 500m. It is also migratory in nature and a colony seldom stays in one place for more than six months. *Apis florea* is another pollinator of agricultural crops.

Honeybees that can be kept in hives

Two of the species of honeybee present in the Hindu Kush-Himalayan region can be kept in hives and managed for honey production and crop pollination. These include the Asian honeybee, *Apis cerana,* and the European honeybee,

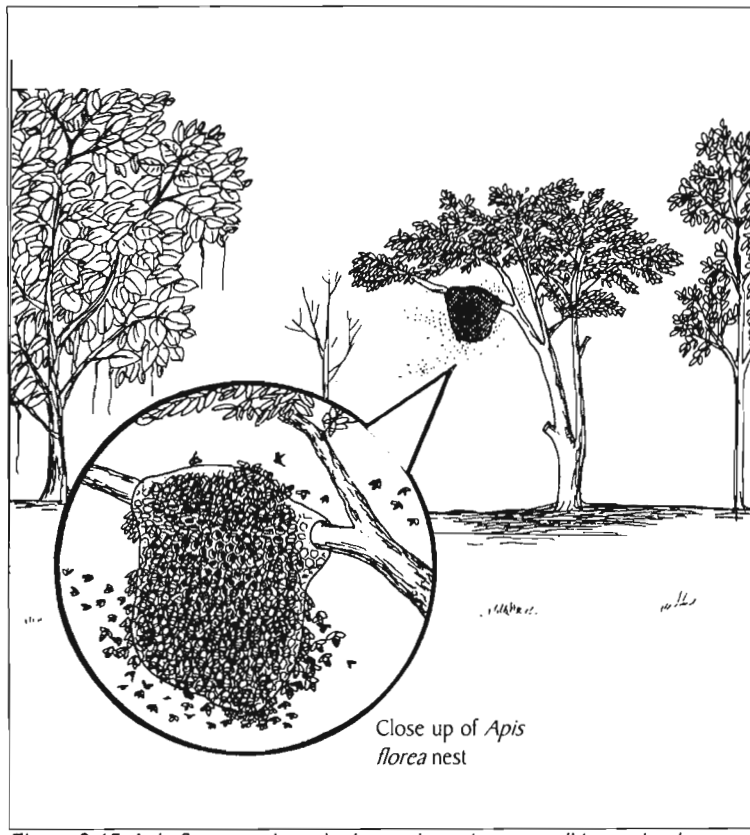

Figure 2.15: Apis florea *makes single comb nests on small trees, bushes, hedges, chimneys etc.*

Apis mellifera. These are cavity-nesting bees and are also called hive bees.

Apis cerana, the Asian hive bee or Himalayan hive bee, is widespread up to 3,000m throughout the Hindu Kush-Himalayan region. It has a gentle temperament, an industrious nature, and good cleanliness qualities. Unlike *Apis dorsata, Apis laboriosa,* and *Apis florea* that build single comb nests in the open, *Apis cerana* makes multiple parallel combs inside a cavity. Beekeeping with this bee is a common tradition among several mountain communities. Farmers keep it in traditional fixed-comb hives such as log, wall, and earthen-pitcher hives and in movable-frame wooden hives (Figure 2.16). A colony of *Apis cerana* produces 5-20 kg of honey per year and is an excellent crop pollinator. This

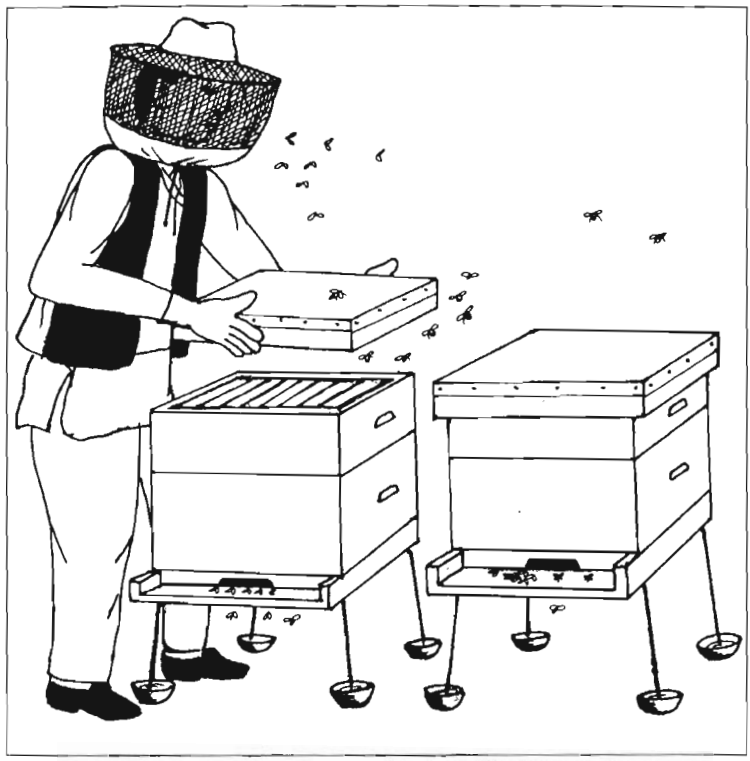

Figure 2.16:Hive bees, Apis cerana and Apis mellifera can be kept in the hives and managed for honey production and crop pollination.

species has not become popular among commercial beekeepers because of its low honey production and undesirable behavioural traits such as frequent swarming, absconding, and robbing habits.

European races of *Apis mellifera* have been imported to the Himalayan region for commercial honey production. This species is kept in hives and makes parallel combs. It is popular among commercial beekeepers because it produces more honey than *Apis cerana*, maintains a prolific queen, has low swarming and absconding tendencies, and has good honey-gathering qualities. However, beekeeping with this species requires expensive technology and a high degree of chemical treatment to control diseases and parasites to which it is more susceptible.

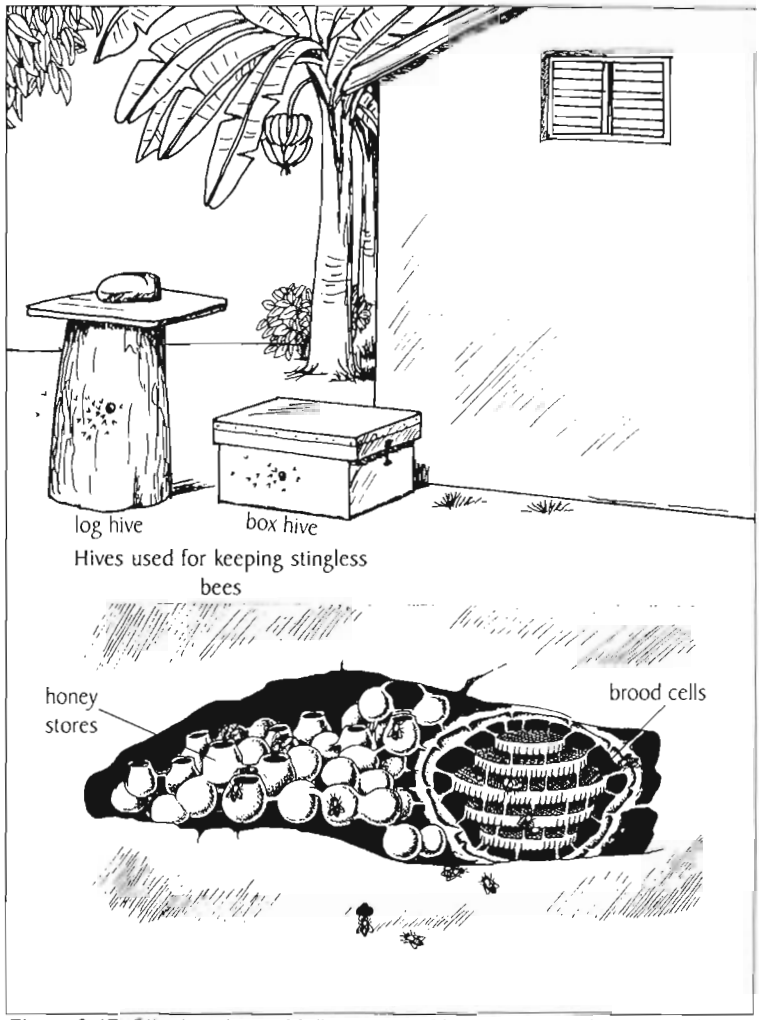

Figure 2.17: Stingless bees, Melipona and Trigona can also be kept in the hives

Like true honeybees, the stingless honeybees, *Melipona* spp and *Trigona* spp, can also be kept in hives and managed for honey production and crop pollination. They are called dammar bees. Several wild species of *Melipona* and *Trigona* are found in parts of India, Nepal, Pakistan, and Bangladesh. They are the smallest honey-yielding bee. They do not sting but bite. They build their nests in hollows of trees and rocks or walls. They store honey in special pots separate from the brood cells (Figure 2.17). A substance called bee dammar

can also be obtained from their colonies. Beekeeping with these bees is a prevalent tradition among the Maya people of the Yucatan peninsula on the east coast of Mexico, Brazil, Colombia, and adjacent areas. In the Hindu Kush-Himalayan region, a few farmers in Dang, Rolpa, and Surkhet districts in Nepal practise beekeeping with *Melipona* spp.