ONE
Introduction

The Hindu Kush-Himalayan region extends from Afghanistan in the west to Myanmar in the east, covering hill and mountain areas of eight countries; viz., Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan. It is not only the world's highest mountain region but also the most populous; the total population of this region is about 120 million. The Himalayan region could be divided into the Outer Himalayas or Siwalik Hills lying in the south, followed in the north by the Lesser Himalayas, Main or Central or Great Himalayas, and Trans-Himalayas in the northern part of this mountain chain. The altitude of the Siwaliks is relatively low, up to 1;000masl, and the climate varies from tropical to subtropical. The annual rainfall in this zone ranges from 1,500-1,800mm. The Lesser Himalayas consist of parallel ranges in the west and scattered mountains in the central region. The altitude ranges from 1,000-1,500masl, and the climate varies from subtropical to sub-temperate. The climate of the Great Himalayas is temperate and the altitude varies from 1,500-3,500masl. The Trans-Himalayan zone consists of the valleys of the rivers rising behind the Great Himalayas. The altitude of this region varies from 3,500-4,500masl and the climate varies from temperate to semi-arctic.

Agriculture is the main occupation of more than 80 per cent of the people, as many as 95 per cent of the farmers have small land holdings of up to 0.5-2.0 ha each (Bhatti et al. 1992; Mulk 1992; Shrestha and Katwal 1992; Yanhua et al. 1992). Due to the small land holdings and other inherent problems of mountain areas, such as undulating physiography, cold and harsh climatic conditions, and limited sunlight, farming alone is not sufficient to make an adequate living. Thus, there has always been a need to explore alternative income-generating opportunities which help to alleviate the pressure on land, on the one hand, and improve the economic conditions of the people on the other.

Beekeeping is one such off-farm based, food and income-generating activity for small farmers in the mountain areas. Beekeeping as a profession means rearing honeybees for the production of honey and other bee products and for crop pollination. Honeybees use the unharnessed ecological niche — nectar and pollen from various plants — that cannot be harnessed for human use without the mediation of honeybees. Beekeeping is a flexible occupation and it creates off-farm employment opportunities for many sectors, including women and the landless. An equally important role of beekeeping is the increase in productivity of agricultural, horticultural, and forage crops. This recognition of honeybees' role in the conservation of natural ecosystems and biodiversity is rather recent but is gaining ground.

Honeybee Species in the Hindu Kush-Himalayan Region

In the context of honeybee species' diversity, the Hindu Kush-Himalayan Region is one of the richest in the world. At least five different species of honeybee are found in this region. Among these, *Apis cerana, Apis dorsata, Apis florea,* and *Apis laboriosa* are native, whereas the European honey bee, *Apis mellifera,* has been introduced. Among the native honeybee species, *Apis dorsata, Apis florea,* and *Apis laboriosa* cannot be kept in hives; these species build their nests in the open air on tall trees, on shrubs, and on vertical cliffs respectively. The other two species, *Apis cerana* and *Apis mellifera,* can be kept in hives, and they play a key role in honey production and crop pollination (Figure 1.1).

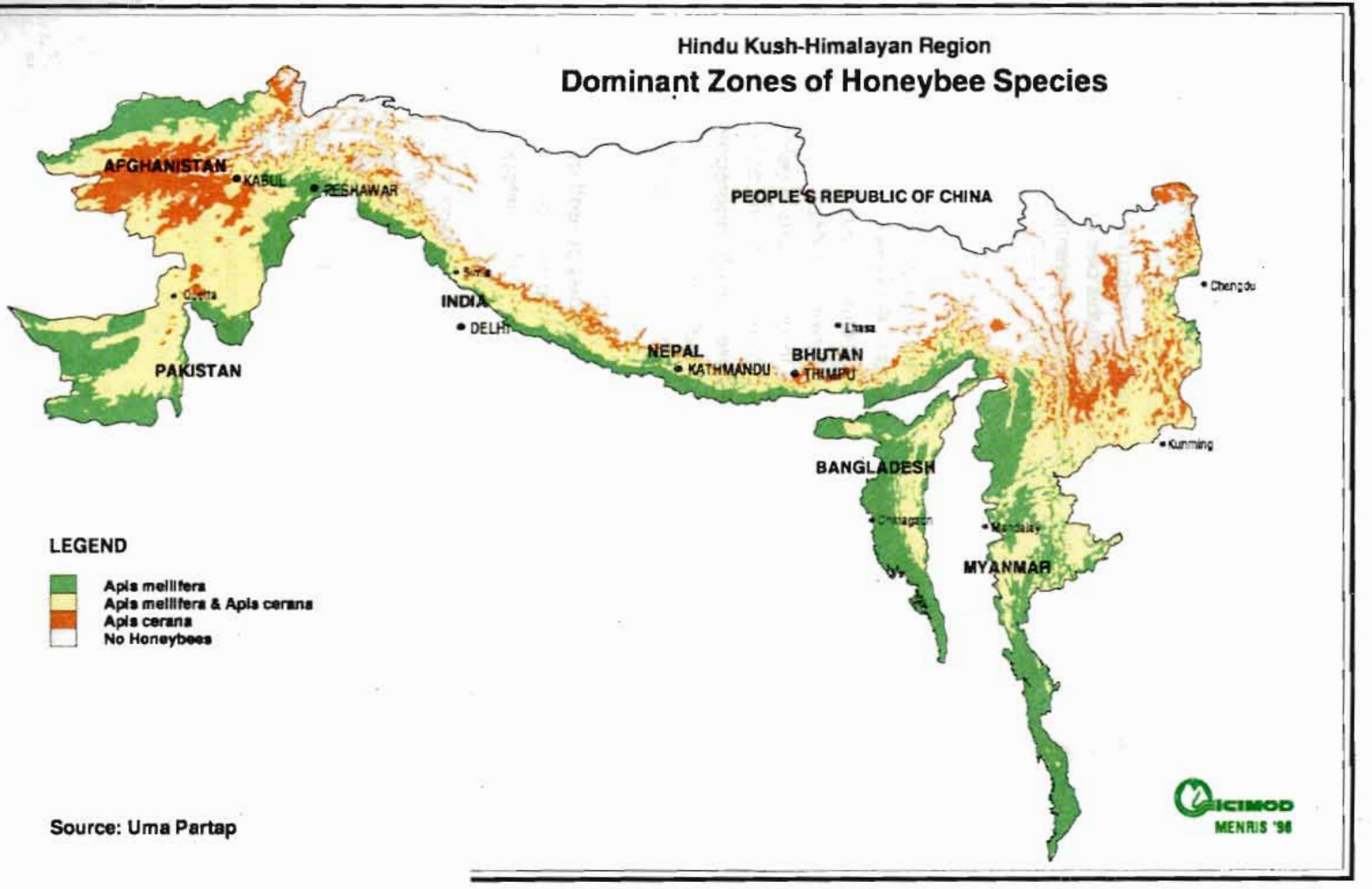
Apis dorsata

Apis dorsata is known as the giant honeybee or rock bee. This species is distributed throughout the Himalayas up to an altitude of even 2,000masl. It builds single comb nests in the open air, mostly on branches of tall trees; in shaded places during summer; and in sunny places during winter. One may find several nests of *Apis dorsata* on a single large tree. This species is generally migratory in nature. *Apis dorsata* produces abundant honey and is an important pollinator of different agricultural and horticultural crops. It, however, is difficult to handle because of its defensive behaviour. Honey-hunting communities collect a lot of honey and beeswax from this species. In a few places, beekeeping with this bee species is carried out in open nest sites.

Apis florea

Apis florea is the smallest amongst the honeybee species and is, therefore, called the little bee. Similar to *Apis dorsata*, this species also builds single

Figure 1.1


Hindu Kush-Himalayan Region
Dominant Zones of Honeybee Species
AFGHANISTAN
KABUL
PESHAWAR
PAKISTAN
INDIA
DELHI
NEPAL
KATHMANDU
BHUTAN
THIMPU
PEOPLE'S REPUBLIC OF CHINA
Lhasa
Chengdu
Kunming
BANGLADESH
MYANMAR
LEGEND
Apis mellifera
Apis mellifera & Apis cerana
Apis cerana
No Honeybees
Source: Uma Partap
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comb nests which are often suspended from the branches of bushes, hedges, trees, caves of buildings, chimneys, and so on. This species is distributed in the plains and hill areas and found at up to 1,500masl. This species is also migratory in nature and a colony seldom remains in one place for more than five months. The annual honey yield from this bee species varies from one to three kg/colony. Farmers believe that the honey produced by *Apis florea* has a special medicinal value. Farmers in a few places also carry out beekeeping with this bee in open nest sites as with *Apis dorsata* *Apis florea* is another potential pollinator of agricultural crops.

Apis laboriosa

This species has only been recently reported and studied. It is found at altitudes ranging from 1,200 to 3,500masl in the remote, mountainous valleys of Bhutan, China, India, and Nepal where it nests beneath the rock overhangs of vertical cliff faces (Underwood 1992; Sakagami *et al.* 1980). This species is also migratory in nature and a colony does not remain in one place all year round. Colonies are found at heights of at least 10 metres above the ground and are typically aggregated, with as many as 76 colonies or more at a single cliff site.

Apis cerana

Apis cerana is one of the native bees and is widely spread all over the Hindu Kush-Himalayan Region at altitudes of up to 3,600m. It has a gentle temperament, is industrious, has qualities of cleanliness, and can be handled easily. Unlike *Apis dorsata* and *Apis florea*, this bee builds parallel combs inside a cavity. Beekeeping with this species is a common tradition among several mountain communities. Farmers keep it in traditional fixed comb hives made from logs, walls, and earthen pitcher frames and in modern, movable frame hives.The honey yield of *Apis cerana* varies between 10-20kg per colony per year, which is much less than that of the European bee, *Apis mellifera*. However, it is an excellent crop pollinator. This species is not popular among commercial beekeepers because of its low honey yield and undesirable behavioural traits such as frequent swarming, absconding, and robbing habits.

Apis mellifera

The European honeybee, *Apis mellifera*, has been imported in recent years to the countries of the Himalayan region for commercial honey production. This species produces more honey and beeswax than the

native bee, *Apis cerana*. This bee also builds parallel combs. The species has become popular with commercial beekeepers because it maintains prolific queens, has less swarming and absconding tendencies, and has good honey-gathering qualities. However, beekeeping with this species requires expensive technology and a substantial amount of chemical treatment to control epidemics, because it is highly susceptible to diseases and parasites. The species has been introduced to almost all the countries of the Hindu Kush-Himalayan Region and is doing well in the plains and sub-mountainous regions of China, India, Nepal, and Pakistan below altitudes of 1,500masl. Above this altitude, only *Apis cerana* is well adapted.

Melipona spp

Melipona spp are stingless honeybees. These are distributed throughout the warmer areas of the region, below 1,000masl. Two species are known to occur in the *Terai* areas of Nepal (personal communication with Beekeeping Development Project (BDP) officials). Like true honeybees, *Melipona* also has a well-developed social system. This species makes its nest within cavities and can also be kept in hives. In the Hindu Kush-Himalayan region, only a few farmers in the Dang, Rolpa, and Surkhet districts of Nepal are keeping *Melipona*. This species stores honey in special honey pots kept separately from the brood cells. It is an important and efficient pollinator of crops, but its uses and management as a crop pollinator are largely unexplored (Crane 1990).

Bee Products

The main purpose of beekeeping in countries of the Hindu Kush-Himalayan Region has been the production of honey and other bee products which are used as food and medicine and sold for cash income. **Honey** is the most important of all the bee products in all countries of the region. It is a nutritive food which is mostly composed of the sugars, fructose and glucose, with very small amounts of amino acids, enzymes, and minerals. The FAO Commission (*Codex Alimentarius*) defines honey as the *"unfermented, sweet substance produced by honeybees from the nectar (secreted by floral and extrafloral nectaries) and honeydew (secretions of or on living parts of plants) which the bees collect, transform, and combine with specific substances and then store in honeycombs."* While codifying the standards, the commission stressed that *"honey shall not have any objectionable flavour, aroma or taint absorbed from foreign matter during its processing and storage, and*

shall not contain natural plant toxins in an amount which may constitute a hazard to health."

In the Hindu Kush-Himalayan Region, honey is harvested both from the wild colonies of *Apis cerana, Apis dorsata,* and *Apis laboriosa* and from the domesticated *Apis cerana* and *Apis mellifera*. China is the biggest producer and exporter of honey among the countries of this region.

Beeswax is another important bee product, and it is widely used for making candles, medicines, and in the cosmetics' industry, especially for skin creams, lipsticks, and various lotions. In countries of the Hindu Kush-Himalayan Region, most of the beeswax is obtained from wild colonies of *Apis dorsata*. As for honey, China is the largest producer of beeswax.

Other bee products include **pollen, royal jelly, and bee venom**. All these products are used for medicinal purposes. So far, China is the only country in the Hindu Kush-Himalayan Region which has developed a technology for the commercial production of these bee products. Such products are mainly exported and they bring in large amounts of foreign exchange.

Pollen, harvested from bee colonies, is used as a protein supplement in human dietary systems. It is also used to feed honeybees during the dearth periods when pollen is not available from flowering plants. Date palm pollen has been used for treating human sterility caused by the presence of gonadotropic hormones. Pollen is also used to facilitate the proper functioning of the human prostrate gland.

Royal jelly is the most expensive of all the hive products (over US$ 100 per kg). It is a milky white substance produced by the hypopharyngeal glands of young worker bees exclusively to feed the queen (throughout her larval and adult life) and the young (up to three days old) worker and drone larvae. Royal jelly is rich in Vitamins B and C and has antibiotic and antitumor properties. It is used in medicines, tonics, beverages, and cosmetics.

Bee venom is a very minor product. It is stored in the poison sac of the sting apparatus. It is acidic in nature and has a complex chemical composition. Bee venom is used to treat rheumatoid arthritis and for desensitising patients who are allergic to bee stings. In recent years, bee acupuncture therapy has been used for the treatment of various diseases.

In India and China, bee venom is collected with the help of an electric venom collector without causing any injury to the bees.

Yet another hive product which is collected by *Apis florea, Apis mellifera,* and *Melipona* spp is **propolis**. This is the resinous substance collected by the foragers of these bee species to seal cracks in the hive and reduce the number of entrances. *Apis dorsata* bees have also been observed to use propolis to strengthen the attachment of their comb to its support, but this does not seem to be very common. Propolis is gathered from the sticky and gummy exudations of some plants such as alders, poplars, and some conifers. Propolis has many antibacterial and antifungal properties and is used for medicinal purposes, e.g., skin ointments. One of the commercial products presently being tried out in China is propolis soap.

Honeybees and Pollination of Mountain Crops

Another very important role of beekeeping is increasing the quality and yield of fruits and seeds of various crops through the pollination services of honeybees. There are good examples in both developed and developing countries where the pollination services of honeybees are used to increase the productivity of various agricultural and horticultural crops (Partap and Partap 1997). Many commercial varieties of crops, for example, apples, almonds, citrus, pears, and various vegetable crops, are self-sterile and require cross-pollination to produce fruits and seeds.

The availability of natural insect pollinators is decreasing rapidly due to the continuous use of pesticides and decline of habitats necessary for nesting and hibernation. This has increased the need for managing hive bees, such as *Apis cerana* and *Apis mellifera,* for the pollination of different crops (Figure 1.2).

Information on the role of honeybees in pollination, which leads to increases in the quality and yield of crops, has been widely documented (McGregor 1976; Crane 1991; Free 1993; Partap and Verma 1994; Verma and Partap 1993 and 1994). Studies have shown that bee pollination increases fruit production in apples, lemons, litchis, peaches, pears, persimmons, and plums by 24, 15, 2, 2, 14, 1.2 and 6 times, respectively (Crane 1991). Improved seed production has also been found in the case of greater cardamon, mustard, sesame, sunflower, and onion by 10, 1.4-1.6, 1.3, 1.5 and 1.7 times, respectively (Table 1.1). Such high increases in the yields of various crops are expected in

Figure 1.2 Colonies of Honeybee (Apis cerana) for pollination of Indian mustard in the Kathmandu Valley, Nepal (L.R. Verma)

crops which are self-sterile and, therefore, produce seeds and fruits only if cross-pollinated.

Table 1.1 ***Examples of Increase in Crop Production due to Honeybee (Apis Cerana) Pollination***

Increase in Fruit Production			Increase in Seed Production		
Apples	x	24	Greater Cardamon	x	10
Lemons	x	15	Mustard	x	1.4-1.6
Litchis	x	2	Sesame	x	1.3
Peaches	x	2	Sunflower	x	1.5
Pears	x	14	Berseem	x	2.7
Persimmons	x	1.2	Onion	x	1.7
Plums	x	6			

Source: Crane 1991

Bee pollination studies carried out in Kathmandu Valley (Table 1.2) proved that there is a significant increase in the fruit setting, seed setting, and seed weight (i.e., seed yield and quality) of vegetable crops such as cabbages, cauliflowers, Indian mustard, lettuce, and radishes (Partap and Verma 1994; Verma and Partap 1993 and 1994).

Among the countries of the Hindu Kush-Himalayan region, India has promoted beekeeping as an essential component for the pollination of fruit crops as well as for vegetable seed production. Considering the importance of bee pollination, government institutions and farmer

Table 1.2 ***Impact of Apis Cerana Pollination on Vegetable Seed Production in Hilly Areas***

Crop	Increase in Pod Setting (%)	Increase in Seed Setting (%)	Increase in Seed Weight (%)
Cabbages	28	35	40
Cauliflowers	24	34	37
Radishes	23	24	34
Indian Mustard	11	14	17
Lettuce	12	21	9

Source: Verma and Partap 1993

entrepreneurs in Himachal Pradesh, a hill province in the Indian Himalayas, rent bee colonies to orchardists for the pollination of temperate fruit crops. This is increasing the awareness of fruit farmers about the application of honeybees for pollination. The State Horticultural Department of Himachal Pradesh gives bee colonies on rent at a rate of Indian rupees (IRs) 50 (US$ 1.5) per colony per season. Some private beekeepers also rent out honeybee colonies for pollination, but at higher rates.

In other countries of the Hindu Kush-Himalayan region, the practice is yet to be adopted as an integral part of mountain crop production technology. The awareness of policy-makers, researchers, and extension workers about promoting bees and beekeeping as an important component in increasing the crop productivity of mountain agriculture is necessary.

Need to Study Bee Flora

In beekeeping, we use honeybees as micro-manipulators of flowers to produce honey and other hive products. Honeybees visit a variety of plants for pollen and nectar (McGregor 1976). However all the plant species are not available in one locality, and a given plant species may also show variations in usefulness for bees when it is in different localities (Latif *et al.* 1958; Singh 1989; Kiew and Muid 1991). The nectar and pollen potentials of a plant are affected by the longitude, latitude, altitude, and soil and climatic conditions. A plant which produces nectar and pollen prolifically in one area may not yield the same amount of nectar and pollen in another area. Moreover, a plant that produces abundant

nectar and pollen may not be of much importance to honeybees and beekeeping in an area, if it is not fairly abundant in that particular area. For example, the Indian butter tree is an extremely prolific secretor of nectar and is a source of pure *chiuri* honey in western Nepal, where it occurs in abundance, but only a few trees of this species are found in other areas of Nepal and therefore it is not important for beekeeping in those areas.

In addition to the abundance of honey plants and their nectar and pollen potentials in an area, the foraging range of honeybees is also important in determining the utility of honey plants for them. Foraging range refers to the distance over which a bee can forage for the collection of pollen and nectar. Only those plants which are present within the foraging range of honeybees are important for beekeeping. To make use of other plants, such as forest and avenue trees, which are outside the foraging range, the honeybee colonies have to be carried (migrated) to these areas. Migratory beekeeping will be discussed in detail in Chapter 4.

Hive bees prefer to forage closer to their hives (normally within a 300-800 metre radius of the apiary), and this preference is further emphasised by the tendency of successful foragers to recruit more bees when foraging nearer rather than when foraging from distant sources. Thus, the honey plants present within this range have the greatest value for beekeeping. However, if necessary, the bees can forage a considerable distance from their hives. The maximum foraging range of the Himalayan honeybee, *Apis cerana*, is within a radius of up to two kilometres from the apiary (Verma 1990). In extreme circumstances, the European honeybee, *Apis mellifera*, foraged on a crop up to a distance of 11.3km away from the apiary (Eckert 1933; Free 1993).

The success of beekeeping essentially depends on the abundance of bee flora in an area. A good crop of honey from bee colonies can be harvested only if bees have an abundance of honey plants to forage. Therefore, the following knowledge about bee flora is very important.

1) The beekeeping potential of an area must be known. This is an essential step in promoting beekeeping in any area.
2) The carrying capacity of an area in terms of the number of bee colonies it can sustain.
3) Slack season needs of good bee-food during winter should be managed.
4) Proper bee management by honeybee entrepreneurs and farmers is essential.