CHAPTER 2

Apiculture in Mountain Farming Systems

2.1 INTRODUCTION

Mountain regions all over the world not only represent the most spectacular of the ecosystems on earth but have historically been the habitat of flourishing civilizations. However, the subsistence economy which has long been predominant throughout the mountain areas of developing countries is steadily worsening and reaching a near crisis situation. This is because of the increasing unsustainability of production potentials of the natural resource base as a result of demographic pressure and the emergence of new needs. In these mountain regions, pressure on land, always a precious and scarce source, has been mounting at an unprecedent rate. Consequently, the mountain areas are facing serious environmental problems such as soil erosion, degradation of watersheds and catchments, deforestation and desertification. Mountain development strategies therefore, need reorientation in order to strike a satisfactory balance between population, resource base and environmental health. Such a balance would first and foremost require diversification of income sources of the hill communities (Table 2.1).

2.2 APICULTURE IN THE MOUNTAIN ECOSYSTEM

The practice of modern apiculture occurs in the mountain regions of all continents ranging from zero degrees at the equator to at least 50° North and 30° South (Crane, 1990). Modern hive apiculture with the European species of honeybees, *Apis mellifera*, is practised successfully in the mountains of Switzerland and Austria, Colorado, in the USA, and at higher altitudes in Western Canada. Similarly, mountain apiculture occurs in the South American Andes in Ecuador, Colom-

Table 2.1: Match between mountains specificities and attributes of beekeeping

Attributes of beekeeping	MOUNTAIN SPECIFICITIES					
	Inaccessibility	Diversity	Fragility	Marginality	Niche	Adaptation experience
Product:						
Low weight	*					
High value	*					
Non-perishable	*					
Operation:						
Low investment				*	*	*
Flexible scale				*		*
Non-competing resource user			*	*		*
User of:						
Slack resource;			*		*	
diversity, niche		*				
local skill/ resource						*
Contributor to:						
Diversity, integration, environmental health, addn. income/employment, agriculture, productivity/ as a cottage industry	Can partially salvage the side effects of extractive "dependent patterns", help pollination of wild/diverse flora leading to ecological diversity.					

Source: Jodha, 1990.

bia, and in the temperate Morelos province of Mexico. On the African continent, apiculture is an integral part of the lifestyle of the rural communities living in the western highlands of Ethiopia, the Ruwenzori mountains of Uganda, and the Drakensberg mountains of South Africa (See also Tables 2.2 and 2.3).

The whole Hindu Kush-Himalayan region has a rich tradition of apiculture. In this region, the native domestic hive bee, *Apis cerana*, occurs at an altitude of 3,012 m in Kashmir and 2,970 m in Himachal Pradesh (Mattu and Verma, 1983). It is also believed, that the other wild honeybee species, such as *Apis laboriosa*, occurs at even higher altitudes than these. Apiculture with the native, *Apis cerana*, has been

Table 2.2: Examples of mountain beekeeping and prehistoric honey hunting at different altitudes and latitudes

	Place	Alt. (m)	Lat.	Honeybee	Type of Hive
1.	Andes, nr Quito, Ecuador	2800	0°	temp Am	movable-frame
2.	Andes, nr Bogota, Colombia	2600	5°N	temp Am	movable-frame
3.	Western Highlands, Ethiopia	2400	9°N	trop Am(n)	traditional
4.	Rocky Mts, Wyoming, USA	2140	42°N	temp Am	movable-frame
5.	Rocky Mts, Colorado, USA	2040	39°N	temp Am	movable-frame
6.	Drakensberg Mts, S. Africa	2000	27°S	trop Am(n)	honey hunting*
7.	Swat, NWFP, Pakistan	2000	35°N	trop Ac(n)	traditional
8.	Uludag, Turkey to	1860	40°N	temp Am(n)	movable-frame
9.	Ruwenzori Mts, Uganda	1750	1°S	trop Am(n)	trad, top-bar
10.	Kashmir, India	1700	34°N	temp Ac(n)	trad, mf
11.	Morelos Province, Mexico	1700	28°N	temp Am	movable-frame
12.	White Highlands, Kenya	1630	0°	trop Am(n)	top-bar
13.	Matopo Hills, Zimbabwe	1600	20°S	trop Am(n)	hh*, mf
14.	Concession, Zimbabwe	1500	23°S	trop Am(n)	hh*, mf
15.	Andes, nr Medellin, Colombia	1500	6°N	temp Am	movable-frame
				trop Am	movable-frame
16.	Caucasus Mts, USSR c.	1500	43°N	temp Am(n)	movable-frame
17.	Alps: Switzerland, Austria etc. c.	1500	47°N	temp Am(n)	movable-frame
18.	Western Ghats, India	1300	18°N	trop Ac(n)	movable-frame
19.	Kathmandu, Nepal	1280	28°N	trop Ac(n)	traditional, top-bar, mf
20.	Cascade Range, Oregon, USA	1200	44°N	temp Am	movable-frame
21.	Anatolian Plateau, Turkey	1100	38°N	temp Am(n)	trad, mf
22.	Central India	1000	22°N	Ad	honey hunting*
23.	Swat, NWFP, Pakistan	1000	35°N	trop Ac(n)	movable-frame
24.	Khyber Pass, NWFP, Pakistan	1000	34°N	trop Ac(n)	movable-frame
				temp Am	movable-frame

Am = *Apis mellifera*; Ac = *A. cerana*; Ad = *A. dorsata*; n = native; temp = temperate-zone; trop = tropical; hh = honey hunting; mf = movable frame; nr = near; Mts = mountains; trad = traditional.

*Evidence from prehistoric rock paintings.

Source: Crane, 1990.

practised for at least 2000 years, and this species has been exploited extensively by mountain honey hunters and beekeepers. Indigenous log and pot hives, still in use in the Hindu Kush-Himalayan region, are relics of honey collection techniques used with this native bee species (Verma, 1989b).

In all of the above major mountain regions of the world, modern apiculture evolved in a similar way. Primitive honey hunting has given

Table 2.3: Honeybees used for honey production in mountain regions, with examples from Table 2.2

Honeybees	Altitudes of colonies
In hives	
native tropical *Apis mellifera* 3, (6), 9, 12, (13), (14)	up to 2500 m
tropical (Africanized) *A. mellifera* 1, 2, 15	up to 3000 m
European (temperate-zone) *A. mellifera* native: 8, 16, 17, 21 introduced: 1, 2, 4, 5, 11, 15, 18, 20, 24	up to 3000 m
native tropical *A. cerana* 7, 18, 19, 23, 24	up to 2500 m
native temperate-zone *A. cerana* 10	up to 2000 m
Wild colonies	
native *A. dorsata* (22)	up to 1200 m
native *A. dorsata/laboriosa*	up to 3500 m
native *A. florea*	up to 500 m

Numbers in parentheses refer to prehistoric honey hunting.

Source: Crane, 1990.

way to traditional beekeeping and, in some areas, traditional beekeeping is gradually being replaced by modern movable hive beekeeping.

Mountain apiculture is dependent upon different environmental factors, and amongst these the climate of the region is the most important because of its effect on honey plant resources. Flowering plants, which support honeybee colonies and provide surplus honey to the beekeepers, occur from the equator to a height of 3,000 m above sea level. The final vegetation belt providing bee forage consists of fir and pine forests which extend up to to a latitude of 65° or up to a height of 4,000 m above sea level. From the fir and pine trees, honeybees collect honey dew, as an alternative to nectar, and honey dew is produced by aphids on such trees. On certain mountain slopes of New Zealand and Uludag, a mountain in Turkey, large quantities of honey dew are produced on firs and several species of pine and thousands of tonnes of honey are annually harvested from them. One distinct advantage of apiculture at high altitude is that days are very long in mid-summer with more than 14 hours of daylight. Flowers are stimu-

lated by the long mid-summer days and secrete a lot of nectar (Crane, 1990).

Experiences at higher altitudes in Western Canada have shown that apiculture can be carried out, even if the flowering period (when bees can forage) lasts only four months a year. Although temperatures are too low for bees to fly during the remaining months, enough surplus honey is harvested in these four months to make apiculture a commercially viable industry.

Wilson (1965) studied the effect of high altitude on temperate zone European honeybees (*Apis mellifera*), in Rocky mountains at about 40°N in Colorado, USA. Bee colonies normally kept at 1,585 m were shifted to an altitude between 2,896 and 4,267 m for the period June to August. The results revealed that altitudes had no effect on prolificness of the queen bee, brood development, mortality of brood or adult bees, pollen and nectar collecting efficiency and even swarming despite the fact night temperatures in summer were below freezing point at these altitudes. When the colonies were inoculated with *Mellisococcus pluton*, European foul brood appeared in all colonies but high altitude did not increase the severity of the disease. At such high altitude one would expect bees to show some signs of stress but Wilson observed none.

In the mountainous area, the only noticeable difference was reduction in the foraging range of both *Apis cerana* and *Apis mellifera*. For example, *Apis mellifera* worker bees foraged 4 km from their hives at 1,609 m, and 1.6 km at 4,023 m (Wilson, 1965). Similarly, foraging range of *Apis cerana* was 0.25 to 0.30 m along steep slopes and 0.65 m along gentle slopes. However, this difference was not because of altitude but in relation to the gradient of the land (Dhaliwal and Sharma, 1974).

Honeybees living in cold temperate regions of the world adopt different strategies for winter survival which have been reviewed by several workers (Seeley and Heinrich, 1981; Johansson and Johansson, 1979; Michener, 1974; Ribands, 1953). These include careful selection of suitable protective nest site, storage of honey in the hive as winter food, compact dustering of bees in side colony. Isometric contraction of flight muscles inside the clusters and use of stored honey as winter heat fuel source enables honeybee colonies to survive, when the winter temperatures fall below −30°C or less and their survival is possible even at as far north as 60°N latitude.

The above review suggests that the constraints of severe cold climate and high altitude do not limit apiculture development programmes. They are successfully practised in both developing and developed mountain areas of the world.

2.3 APICULTURE AND MOUNTAIN PERSPECTIVE

The development scenario in the mountain areas of developing countries in general and in the Hindu Kush-Himalayan region in particular reflects a widening gap between effort and achievement. Due to extensive and intensive cultivation to increase agricultural production, per capita availability of land is declining. Agriculture is being extended to submarginal and marginal lands with serious environmental consequences. Likewise, the other development interventions in this region are showing increasing unsustainability. The underlying reasons for this scenario is the disregard of mountain perspective in development activities of mountain areas. According to Jodha (1989a) mountain perspective means "explicit consideration of mountain specificities (characteristics) and their implications, while conceiving and implementing activities in mountain areas. Several such mountain specificities include inaccessibility, fragility, marginality, diversity, niche (or comparative advantage) and people's adaptation experience in mountain areas (Jodha, 1989a). These specificities are not only interrelated due to their common causes as well as shared consequences, but they have intra-mountain variations. Moreover, these characteristics have physical (climate), biological and socio-economic dimensions." Thus for sustainable development of mountain agriculture, efforts should be diverted to activities/options that are in tune with mountain characteristics. Apiculture is one such non-land based activity which fits in very well in relation to sustainable development of mountain agriculture. The relevant attributes of apiculture in relation to mountain characteristics as defined by Jodha (1989a) are as follows (Table 2.1).

Physical dimensions of inaccessibility such as slope, overall terrain conditions and landslides play a less constraining role in apiculture development because hive products are characterized by low weight, high value, non-perishability, high storage capacity and easy transportation. Nevertheless, certain manifestations such as isolation, distance, poor communications and limited mobility create some problems for diffusion of modern bee management technology among the farmers and also in monitoring bee epidemics and other natural catastrophies. These can however largely be overcome through the improvement in traditional beekeeping with native *Apis cerana* instead of introducing the exotic European honeybee (*Apis mellifera*) which requires high cost modern bee management technology.

Exploitation of forest and grassland ecosystems by man has resulted in an overall degradation of environment and is largely responsible for the present ecological crisis. On the other hand, use of botanical resources of these ecosystems by bees for pollen and nectar have proved rewarding because of their activities as pollinators,

thus helping in the conservation of a large number plant species. The natural population of honeybees is, therefore, an integral part of forest and grassland ecosystem. However, any pressure operating upon the mountain resource system, whether natural or man-made, adversely affects the beekeeping potentials of that area. For example, as a result of deforestation, overgrazing, changing agricultural practises and the use of biocides is causing irreversible damage to bee fauna with the result that different honeybee species in the region are facing threatened extinction. Such declining trends in populations of honeybees in nature, not only means a serious negative impact on the income level of the mountain farmers living at, or below subsistence level, but also serious impairment or partial loss of essential ecological services such as cross-pollination and propagation of several cultivated and wild plant species.

Apicultural diversity has different dimensions. It can be physical (climatic), bee species and genetic diversity, honey plant resources (biological) as well as hive products diversity. For example, different agro-climatic regions, i.e., higher hills and their interior valleys, middle hills and sub-tropical areas are ideally suited for beekeeping. In all these ecological zones of the Hindu Kush-Himalayan region, hundreds of flowering plants species (both wild and cultivated) are found which act as excellent nectar and pollen sources out of which honeybees produce diversified hive products such as honey, beeswax, royal jelly, pollen, propolis and venom. These provide both nutritious food and cash income to the mountain farmers. At present, the Hindu Kush-Himalayan region is the richest in the world from the honeybee species and genetic diversity point of view as all the four or more honeybees species are now found in this region. Each of these species can be further divided into several sub-species, and geographic ecotypes and offer excellent opportunities for their genetic improvement by selective breeding.

Apiculture offers options for communities in the economically marginal category because it is generally a low investment activity. In addition, it is flexible enough to match any scale of operation or any category of manpower (children, women, old people, etc.). The mountain region being marginal areas as against prime areas of plains, in terms of physical and economic resources do not in any way affect beekeeping. For example, less fertile and barren land (physical marginality) or socio-politically neglected mountain societies (landless labourers and marginal farmers, etc.) do not come in the way of beekeeping development.

It is interesting to note unlike in the green revolution, modern hive beekeeping first developed in the temperate Hindu Kush-Himalayan region, and it has now spread to the lowland plain areas of the sub-

tropical region. This may have happened because of the following reasons:

— Honey is the only sweetening source in the hills as sugar cane does not grow in temperate climates. Transport from the plains is difficult due to inaccessibility and inadequate transport facilities.
— In the hills, more useful races of the native bee, *Apis cerana*, are found. These are larger in size, more productive, and less prone to negative traits like frequent swarming and absconding found in the plains.
— The wild bee, *Apis dorsata/laboriosa*, builds its nest in difficult and inaccessible sites, such as rock cliffs and this makes honey harvesting a risky exercise in mountain areas. This necessitated the need to introduce modern hive beekeeping in the mountain areas first.
— All the temperate fruits grown in the Hindu Kush-Himalayan region require honeybees for cross-pollination to ensure a good crop.
— During the British rule in the Indian subcontinent, several British officials preferred to settle in the hills. They played an important role in introducing modern apiculture as many of them kept bees as a hobby. Thus owing to ideal climatic conditions, great diversity of bee and floral resources, the mountains provide an excellent niche, for beekeeping development.
— Mountain honey produced from diverse bee flora, is considered better in quality than honey from lowland areas, as a result of which it fetches a higher price and produces effective upland-lowland trade links.
— Honey in the mountain areas is used, even today as a barter commodity in exchange for other life-sustaining essential and precious commodities.

Mountain communities in this region through trial and error over the generations, have evolved traditional methods of beekeeping with the basic concept to build beehives providing maximum natural conditions. For example, beekeepers in the mountain areas have devised fixed wall or log hives generally located in the kitchen room or in front of it to keep the bees warm in the cold climate and also to protect them from predators and other enemies. However, with the introduction of modern bee management technology, such traditional bee hives are now being replaced by modern movable frame hives.