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Beekeeping in Mountain Life-support Systems

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Introduction

Opportunities for beekeeping occur in mountainous regions of all continents, and at latitudes ranging from 0° at the equator to latitudes at least as high as 50°N and 30°S. I have seen productive honey production at the equator up in the Andes at 2800 m, and at 47°N in the European Alps up to 1500 m. Mountain beekeeping is feasible with native or introduced honeybees, and in areas covered by widely different types of vegetation. These include tropical and deciduous forests, coniferous forests where honeydew is produced, steppeland, high pastures, and cultivated land where suitable arable crops or fruits are grown. Beekeeping is currently carried out in mountain regions at all technological levels. In many of the regions, honey hunting has given way to traditional beekeeping with fixed-comb hives, and in some of them traditional beekeeping has been wholly or partly replaced by the use of top-bar hives with movable combs or, more commonly, of movable-frame hives.

Table 1.1 lists 24 examples of mountain beekeeping of which I have personal experience. It shows the altitude and latitude, the bees used, and the type of hive. Four examples of honey hunting recorded in prehistoric rock paintings are added, to show the great antiquity of honey collection from bees in mountain regions.

TABLE 1.1

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°N	temp Am	movable-frame
2. Andes, nr Bogotá, 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 Medellín, 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

*Evidence from prehistoric rock paintings

Am = *Apis mellifera*; Ac = *A. cerana*; Ad = *A. dorsata*; n = native; temp = temperate-zone; trop = tropical

I have seen effective traditional beekeeping with simple and inexpensive home-made hives: at 2400 m in the western highlands of Ethiopia at 9°N (Table 1.1.) (3), at 1750 m in the Ruwenzori mountains of Uganda on the equator (9), and at lower levels—on the Anatolian plateau in Turkey at 38°N (21) and in Europe at 47°N (17). All the above beekeepers had native *Apis mellifera*, tropical bees in Africa, and temperate-zone bees in Turkey and Europe. In Uganda and Kenya, both on the equator, top-bar hives are used which are well suited to tropical African bees. Some top-bar hives are also used outside Africa, but modern movable-frame hives are much more usual as the successor to traditional fixed-comb hives. In the Americas, where the bees kept are introduced *Apis mellifera*, there are modern hives in a number of high regions: in the Andes (1, 2, 15), in the high interior of Mexico (11), and in the Rocky and associated mountains (4, 5, 20) of North America. In Asia, I have seen *Apis cerana* kept in movable-frame hives at fairly high altitudes in India—Kashmir (10) and the Western Ghats (18), in Nepal (19), and in Pakistan: Swat (23) and Khyber Pass (24), NWFP. Modern hives are also used in many other parts of the Hindu Kush-Himalayan region.

In the mountains of northeast Italy, royal jelly as well as honey is produced from both nectar and honeydew (Barbattini 1988).

Climatic and Plant Requirements for Beekeeping

Climate has important effects on the plants from which bees feed, and thus indirectly affects colonies and their honey yields. Direct effects of climate on bees are considered in the next Section.

Table 1.2 shows broadly how the earth's vegetation changes at different latitudes, and different altitudes (heights above sea level). If we start on the equator at sea level, and move north or south to higher latitudes, the vegetation changes roughly in accordance with columns 1 and 2 of the Table. If, instead of moving north or south, we travel to the higher altitudes entered in column 3, the vegetation changes in a rather similar way, as shown in column 4.

TABLE 1.2

Variation of vegetation with latitude at sea level, and with altitude at the equator

Latitude at sea level	Vegetation	Approx. altitude at equator		Vegetation
0°		0 ft	0 m	
10°	wet jungles	2,000 ft	600 m	tropical forests
20°	savannas	4,000 ft	1,200 m	tropical forests
30°	deserts	5,500 ft	1,650 m	subtropical forests
45°	steppes, evergreen woods	7,000 ft	2,100 m	subtropical forests
55°	deciduous forests	10,000 ft	3,000 m	temperate deciduous forests
65°	pine forests	13,000 ft	3,900 m	temperate pine forests
75°	tundras	16,000 ft	4,800 m	mosses and lichens
90°	perpetual snow	—		perpetual snow

(Data from Good, 1974)

Flowering plants that can support honeybee colonies, and provide surplus honey for the beekeeper, are found at sea level from the equator to a latitude of about 55°. At the equator they grow at altitudes up to about 3000 m. At intermediate latitudes the height limit for flowering plants is correspondingly lower. The final vegetation belt providing bee forage consists of pine forests, which may extend to a latitude of 65° at sea level, or at the equator to a height of nearly 4000 m. At one season in the year, some of these forests provide a honeydew flow that can be exploited by migratory beekeeping. Honeydew is produced by aphids on certain trees, and the bees collect it as an alternative to nectar. At about 42°S in New Zealand, certain mountain slopes are covered with beech trees (*Nothofagus solandri* v. *cliffortioides*) on which much honeydew is produced, and thousands of tonnes of honey are harvested annually from it. On Uludag, a mountain in Turkey (entry 8 in Table 1.1), large amounts of honeydew are produced on the fir *Abies bornmülleriana* and several species of pine (*Pinus*).

Bees and flowering plants evolved together: bees obtain their food from flowers, and also pollinate them. So temperatures that are high enough for native plants to flower are likely to be high enough for native bees to forage on them. Experience at high latitudes in western Canada shows that beekeeping can be carried out even if the flowering period (when bees can forage) lasts for less than four months in the year, with eight months at temperatures too low for bees to fly. Colonies of bees can survive over the long winter months because temperatures are so low that they are quiescent in their hives, consuming a minimal amount of food. At lower latitudes winter temperatures are higher, so the bees are more active and their food consumption is greater, thus reducing the beekeeper's harvest.

There is one important effect at high latitudes which is absent near the equator. The days are very long around midsummer—giving 18 hours of daylight in southern Sweden, and 19 hours in Leningrad, USSR, and Finland. Not only do the long days give bees a greatly extended foraging period each day, but flowers are stimulated by the high insolation during midsummer days, and secrete much more nectar. Near the equator, daylight does not last much more than 12 hours at any time of year.

Toxic Honeys

Honeys from a few plant species are poisonous to man, because of a toxic component of the nectar. Some of those listed by Crane (1989a) grow at high or fairly high altitudes, and include the following members of Ericaceae:

Species	*Toxic agent*
Arbutus unedo, strawberry tree	arbutin (a glucoside)
Kalmia latifolia, mountain laurel	acetylandromedol (grayanotoxin I, andromedotoxin, rhodotoxin, asebotoxin)

some *Rhododendron* spp. including:

R. ponticum	andromedotoxin/acetylandromedol
R. anthopogon	

Many *Rhododendron* honeys are not toxic; Kafle (1984) includes *R. campanulatum, R. ferrugineum, R. hirsutum* and *R. thomsonii* among these, and he reports that in Nepal the only toxic one is *R. anthopogon* which grows above 4200 m, so honeys harvested below this altitude should be safe. However, Kerkvliet (1981) studied components of toxic honey from unknown *Rhododendron* species purchased at 1500 m, 40 km east of Lukla in Nepal, and he found grayanotoxin analogues known in some other species, but not grayanotoxin I, II or III.

The Suitability of Different Honeybees for Mountain Beekeeping

As far as my experience goes, many types of honeybees (*Apis* species), except *florea*, live and produce surplus honey in mountain regions (see Table 1.3). The species that nest in cavities (*Apis mellifera* and *Apis cerana*) have both proved suitable for beekeeping in mountainous regions where both the climate and the bee forage are appropriate. In any one area, native honeybees evolved to survive under the conditions prevalent in that area, and altitude is not a direct determining factor, as latitude is. However, a beekeeper needs more than colony survival, which would itself give him good honey harvest. He needs his colonies to store honey surplus to their own requirements, although this characteristic is of no benefit to the bees themselves. Certain mountain races and ecotypes are noted for their ability to survive and to store surplus honey. In Europe, *A. mellifera carnica* (Carniolan) bees from the eastern Alps, are very frugal in their use of food, but start brood rearing early in the spring; they do well also in lowland areas farther north than in their native mountains. In tropical Africa, *A. mellifera monticola* does well at high altitudes on Mount Kenya, and is reputed to be more gentle than lowland bees, but Dietz and Krell (1986) did not find that this was so, at any rate between 1600 and 2500 m.

Apis cerana bees in the temperate Kashmir valley in India are extremely good performers; they are large, and can be kept in Langstroth hives. They behave like temperate-zone bees; colonies have not developed the habit of absconding at the start of a nectar dearth, as tropical *Apis cerana* colonies have. Verma (1989) reports beekeeping in India, with *Apis cerana* at 2077 m in Kashmir, and at 3017 m with the rather similar *Apis cerana* in Himachal Pradesh. I do not know of substantial trials with Kashmir bees at lower altitudes.

Table 1.1 shows that both tropical and temperate-zone *Apis mellifera*, whether native (in the Old World) or introduced (in the New

TABLE 1.3
Honeybees used for honey production in mountain regions, with examples from Table 1.1

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

Numbers in parentheses refer to prehistoric honey hunting

World), are successfully used at high altitudes. The same is true of both tropical and temperate-zone native *Apis cerana*. *Apis cerana* has been introduced into only one or two new areas, but I am not able to report on its performance in new territory.

The conclusion must be that the honeybees themselves do not limit beekeeping at high altitudes, provided the climate and the seasons are suitable, and there are sufficient plants, providing flowers for the bees to forage on, for a long enough period. The situation is in fact the same as in lowland areas.

EFFECTS OF LATITUDE ON PLANTS AND HONEYBEES

It is a general rule that many plants can succeed if moved from a lower to higher latitude, but not if moved to a lower latitude, i.e. nearer the equator. The reason is that one or more stages of the annual growth cycle of these plants occurs at a season of the year when there is a certain change in photoperiod (daylength). The stage of plant development may be triggered by the direction of the change (for instance at midwinter, when daylength ceases to decrease and starts to increase), or by the rate of change, which is higher at higher latitudes, as one goes from the equator to the poles. Secondly, the most rapid rate of increase occurs at the spring equinox, and at this time, many plants grow very rapidly. A plant from a high latitude taken to the equator lacks the stimulus of a rapidly increasing daylength, and may therefore not complete its growth cycle.

Experiments with temperate-zone *Apis mellifera* in controlled-environment chambers (Kefuss 1978) showed that brood can be reared under both long-day and short-day conditions, so there is no critical daylength to be exceeded before brood rearing can start. Brood rearing was stimulated by increasing daylength (as after midwinter) and it was suppressed by decreasing daylength (as at the end of summer). Kefuss also suggested that the rate of change might have an influence: that a rapidly increasing daylength might be a strong stimulus to egg-laying and brood-rearing in honeybees. If so, it could partly explain why colonies of Italian bees taken to higher latitudes continue to rear much brood in spring and summer—a feature welcomed by beekeepers where there are prolific honey flows, but disastrous where spring or summer flows are poor and interspersed with dearth periods. Such latitude effects would be independent of altitude or climate. A different view is taken by Omholt (1987) from theoretical calculations: that brood is reared in the winter cluster to reduce the water content of individual bees when this reaches a specific level.

Effects of High Altitudes on Honeybees

Wilson (1965) carried out experiments on temperate-zone European bees, in the Rocky Mountains at about 40°N in Colorado, U.S.A. During four successive summers, colonies normally kept at 1585 m were placed at altitudes between 2896 and 4267 m for the months of June to August. Virtually no changes were found in the rates of the queens' egg laying, brood development, or mortality of brood or adult bees. Pollen and nectar foraging were also unaffected; bees were seen foraging 4 km from their hives at 1609 m, and 1.6 km from them at 4023 m. Swarming occurred, although night temperatures in summer were often below freezing point at high altitudes; but at the end of the summer, workers did not evict drones from the hives until there was an appropriate reduction in daylength, as at low altitudes.

Colonies were altogether remarkably little affected by the higher altitudes. In a disease study, colonies inoculated with *Melissococcus pluton*, all developed symptoms of European foul brood, as expected. But the high altitude did not in itself increase the occurrence of the disease. Wilson expected to find signs of stress in the bees, due, for instance, to the very cold summer nights, to low oxygen concentration in the air, or to other factors, but he found virtually none.

Working at 1538 m in the Western Himalaya, Dhaliwal and Sharma (1974) found that in mountain areas the foraging range of *Apis cerana* was reduced, not because of the altitude itself, but in relation to the gradient of the land. The first three entries below are their results, and the other entries are quoted by them.

0.25 to 0.30 m	W. Himalaya, along steep slopes
about 0.65 m	W. Himalaya, along gentle slopes
1.4 m	W. Himalaya, maximum for all foragers
0.9 m	Bihar, Central India
1.04 m	maximum in Bihar
0.7 to 0.8 m	maximum in Sri Lanka

In Europe, the flight of *Apis mellifera* drones on and over mountain ridges in the Alps was studied by Ruttner (1976).

The Use of Different Hive Bees

Introduction of New Tropical Honeybees

In both the Americas and Asia, an important and sometimes overriding factor has been the importation of exotic honeybees. In the Americas, tropical African *Apis mellifera* was introduced in the fifties (Crane 1989a), and this has led to the disappearance, from many tropical and subtropical regions, of temperate-zone *Apis mellifera* that originated in Europe, which itself had been introduced before 1900.

The 'Africanized' bees that resulted from hybridization between the two races of *Apis mellifera* have proved unsatisfactory for beekeeping: they are difficult to manage in modern hives, and very readily alerted to sting. However, since they are less able to survive at high altitudes than in lowlands, their effect on beekeeping has been less in mountain areas. **It is most important that tropical African bees are never allowed to reach Asia**.

Introduction of New Temperate-Zone Honeybees

The introduction of European (temperate-zone) *Apis mellifera* has quite different effects. In certain temperate and subtropical countries in the Americas, Australasia and Asia, this bee is now the basis of a flourishing beekeeping industry. European *Apis mellifera* is much more productive than most native *Apis cerana*, and more suited to modern bee management using movable-frame hives. The better strains are nearly as gentle as most *Apis cerana*. In the tropics, European *Apis mellifera* generally does best in hill or mountain areas, especially where nectar-yielding crops are grown.

But many importations of exotic *Apis mellifera* have been disastrous because new diseases or parasitic mites have been introduced with the bees, and have then infected or infested the native honeybees: *Apis cerana* in tropical Asia, or *Apis mellifera* in North Africa and Turkey. All but a few per cent of the native honeybee colonies may then be wiped out, and the existing long-established craft of beekeeping destroyed.

A visit to some mountain areas of the North West Frontier Province of Pakistan in May 1989 led me to the unhappy conclusion that *Apis cerana* populations are likely to decline to a level that is no longer viable. In certain areas, traditional *Apis cerana* beekeeping may be replaced by a more productive type of beekeeping with European *Apis mellifera*, but this requires a higher capital investment and higher technological operation if it is to be effective. If the rural population is rich and educated enough, to satisfy these requirements, much good can arise. If not, the opportunity for a modest improvement in the standard of living of the poorest families will be lost.

Requirements and Motivation of People in Mountain Regions to Keep Bees

When we consider, instead of the bees, the people in mountain regions who might be—or who might become—beekeepers, we find different and even more significant forces at work.

Human Communications and Population Density

All over the world, mountainous regions are commonly characterized by broken terrain, with steep and rocky slopes that cannot easily be cultivated, supporting only a low density of human population. Transport and travel are slow and arduous. So are communications among the scattered inhabitants, and also between them and people at centres from which help and advice might come—in our case, on beekeeping activity. In some mountain regions, the rural people are also extremely poor, and have very few possessions.

Poverty

The 24 mountain locations where I have experience of hive beekeeping (Table 1.1) are distributed in different continents as follows:

Americas: 1, 2, 4, 5, 11, 15, 20
Africa: 3, 9, 12, 14
Europe/Mediterranean: 8, 16, 17, 21
Asia: 7, 10, 18, 19, 23, 24.

Beekeepers in the seven locations in the Americas, and in the four in Europe or the Mediterranean region, had sufficient or ample incomes; they could buy or make movable-frame hives and honey-extracting equipment. If necessary, they could afford to fence their apiaries. Many owned a car or truck; one (20) used a small plane to monitor his apiaries. In some mountain beekeeping locations in Africa, comparatively rich beekeepers were using modern hives. But in Ethiopia (3), Uganda (9) and Kenya (12), for instance, some beekeepers were extremely poor. At most of the seven locations in Asia, I have seen modern beekeeping by some people who get a sufficient income from it. I have also visited beekeepers who were financially very poor indeed, and to them, a simple form of beekeeping with *Apis cerana* could give welcome additional food although it would be unlikely to provide sufficient total income for the family.

In 1973 in Ethiopia, the people were financially extremely poor but they had a very long and rich tradition of beekeeping. Bees were an integral part of their lives, and the beekeepers made hives of local materials to a very high standard of craftsmanship. The same is true to a certain extent in Kashmir in India. Shah (1984) suggests that bees have been kept in hives there since the 1400s, and I believe that the date may well be much earlier.

Special Problems in Tropical Asia

In tropical Asia there is another factor which is common to both mountain and lowland areas: more than one species of honeybees is present and can be exploited. Large honey harvests can be obtained from wild nests of the giant or rock bee *Apis dorsata/laboriosa* which is found up to 3500 m, and in lowland areas small harvests from the gentle dwarf bee *Apis florea*. Intermediate amounts can be harvested from wild nests, and especially from hives, of *Apis cerana*. In regions where *Apis dorsata* was absent, and *Apis cerana* was the most prolific source of honey, traditional hive beekeeping with *Apis cerana* started many centuries ago. But where *Apis dorsata* was present, its much larger honey yields suppressed interest in *Apis cerana*, and the more convenient method of exploitation—by keeping these bees in hives—did not start until quite recently (Crane 1989b). In most mountain regions of tropical Asia except at the head of the Indus valley, *Apis dorsata* is present, and its nests are still a source of much honey. These regions lack any long tradition of beekeeping with *Apis cerana*. Moreover in Bhutan and other Buddhist areas, there is resistance to beekeeping on the grounds that it might involve killing bees.

As I see it, there are special difficulties in promoting and developing beekeeping in many parts of the Hindu Kush-Himalayan region. But these lie less in the high altitude itself, or in the native bees or bee forage, than in diseases and parasitic mites introduced with exotic honeybees, and to deficiencies in human life. These dificiencies may include poverty, inaccessibility due to the broken terrain, lack of education, and in some regions lack of tradition of beekeeping. In our attempts to alleviate poverty by using beekeeping as a life-support system, we should concentrate much attention on aligning our proposals according to the background of the people we are trying to help. In areas where the educational level is higher, and transport is easier, beekeepers can learn to work at a higher technological level, and may obtain a good income from beekeeping. But in poorer areas, we must promote types of beekeeping, and of hives, that conform to the general way of life of the people. There must not be a western intrusion at an entirely different technological level.

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Mountain Perspective and Beekeeping

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Introduction

The dominant scenario characterizing most of the mountain areas clearly indicate the following trends:

1) Widening gap between efforts and achievements in the field of mountain development

2) Emerging indicators of unsustainability of resource base, production streams and resource use/management practices as manifested by persistent negative changes.

The primary reason for the above scenario can be associated with disregard of mountain perspective (to be elaborated), by the development activities in mountain areas. Hence, the search for solution to the above problem should be concentrated on activities/options: (a) which fit well with the mountain specificities, and (b) which have potential to redress or salvage the side effects of processes and factors contributing to the unsustainability scenario in mountains. Beekeeping seems to possess some attributes which can satisfy the above two requirements. In the following discussion, first I elaborate on mountain perspective and then try to look at beekeeping with mountain perspective.

Mountain Perspective[1]

In simple terms mountain perspective means, explicit consideration of mountain specificities (characteristics) and their implication, while conceiving and implementing activities in mountain areas. Disregard of these specificities tend to make most of the development interventions in mountains relevant, ineffective, often counterproductive, and give rise to a scenario reflecting a widening gap between development effort and achievement.

Mountains have several characteristics which differentiate them from most other regions. However, important amongst them are: inaccessibility, fragility, marginality, diversity, niche (or comparative advantage) and people's adaptation mechanisms in mountain areas (Table 2.1 and Annexure 2.1). These specificities are not only interrelated due to their common causes as well as shared consequences, but they have intra-mountain variations. Moreover, they have physical (climatic), biological and socio-economic dimensions. The complexity of these specificities and their interrelationships have important operational consequences.

Operational Implications/Consequences

Firstly, these specificities give rise to certain objective circumstances in the form of constraints or potentialities. Some of them include distance, poor mobility and high transport cost (due to inaccessibility and fragility); seasonability, narrow production base, limited but diverse production options, strict limits to resource use intensity (due to fragility, marginality, diversity, niche etc.), diverse potentialities of specific activities with their spatial and temporal dependencies (due to diversity and a number of physical constraints).

Secondly, the complex of specificities or the objective circumstances give rise to dependent patterns of activities, as reflected through transformation processes of mountain areas in the past. These dependent activities fall under three categories.

1) First, the pattern of activities, including resource use systems which are in keeping with the mountain specificities. They include, diversified and interlinked production activities (e.g. crop, horticulture, livestock), with spatial and temporal linkages, traditional methods of resource management including social sanctions to regulate use of resources.

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[1] For detailed discussion on Mountain Perspective and its implications for integrated mountain development see Jodha (1990).

TABLE 2.1

Match between mountain specificities and attributes of beekeeping

	Mountain Specificities					
Attributes of beekeeping	Inaccessibility	Diversity	Fragility	Marginality	Niche	Adaptation mechanisms
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, agr. productivity cottage industry	Can partially salvage the side effects of extractive "dependent patterns", help pollination of wild/diverse flora leading to ecological diversity.					

2) The second category of dependent patterns includes the same set of activities as mentioned above but have higher intensity of resource use, and some additional activities which are insensitive to mountain specifications. Owing to forces of change like increased pressure on land, market links and public interventions, the emerging pattern of activities in mountain areas (e.g. extension of cropping to submarginal lands, deforestation etc.), violate the imperatives of mountain specificities and generate unsustainability scenario, because they have strong extractive orientation generated by higher local and external demands.

3) The third category of activities, which could be described better by calling them "independent patterns" rather than dependent patterns, cover most of the development interventions, which are conceived and implemented with little concern for mountain perspective. In a way they complement the dependent patterns mentioned under (2) above.

Attributes of Beekeeping

Role and importance of beekeeping in mountains can be discussed with reference to: (1) mountain specificities, and (2) 'extractive' dependent patterns of activities and resource use systems, mentioned above. However, to facilitate this we have to briefly discuss some attributes of beekeeping as an activity by mountain people.

Beekeeping is not a new activity for mountain farmers. Using traditional methods of management, beekeeping has been a sustenance-oriented small-scale cottage industry in many mountain areas. Modern management-based beekeeping offers much higher income potential for these areas. Without going into technical details like type of bee, their behaviour and productivity, as discussed by others (Verma 1990), the following attributes of beekeeping could be noted and related to mountain perspective (Table 2.1):

Products of Honeybee

The products of honeybee such as honey, pollen and wax are characterized by low-weight, high-value, nonperishability, high storability and easy transportation. These attributes match very well with first order requirements of any product which could adapt well to 'inaccessibility' characteristics of mountains.

Beekeeping as a Side Activity: Cost and Scale Factors

In this regard beekeeping has several positive features. Unless picked up on a commercial scale, beekeeping is a low-investment activity with plenty of flexibility to match any scale of operation. This makes it suitable to low-resource farmers (reflecting economic marginality). Furthermore, since beekeeping does not compete for other resources especially land area and labour, it fits well into small farmers' resource situation. It helps in the prevention of further increase in pressure on land, which otherwise leads to higher resource-use intensity, and resource degradation. Moreover, honeybees contribute to income generation at a time when income from other sources might not be available. Thus beekeeping helps in generating (non-covariates) flows of incomes.

User of Slack Resource

Honeybee is a user of a slack resource (a resource otherwise not used) associated with diverse flora of mountains, some of which are best for the honeybee (Verma 1990). In both macro- and micro-context this is an additional income-generating activity, without much involvement of additional input. However, once picked up on commercial scale with mobile hives, etc., investment may be quite high. But that adds to beekeeping's potential to make much higher use of temporal and spatial diversity of mountain resources. This offers an ideal option to match imperatives of mountain specificities like diversity, niche etc.

Indirect Contribution

Besides generating direct income and employment and helping in self-provisioning of nutrients in farm families, beekeeping performs an important function in pollination activity (Verma 1990). The service of honeybees can be utilized more in the macro-level context, but even in the case of orchards, etc., it can be associated at the individual farm level. Through this service, honeybees help in yield, quality and stability of several agricultural products. This is an integrative function of beekeeping, where it effectively contributes to sustainability and diversity of agriculture and botanical resources in general. Thereby, it adds to environmental health, in some measure by pollination of wild plant species. These gains may be higher in mountain areas because of the diversity of flora. In fact, beekeeping is one of the important activities that strengthens nature's regenerative systems despite pressure of market and resource-extractive technologies adopted in mountain agriculture. A detailed enquiry into "service functions" and "direct income-generation functions" of the honeybee can reveal the potential of beekeeping in relieving the stresses caused by "extractive, dependent patterns" of activities in mountain areas. More quantification of the issues raised above can be made to sharpen the role of beekeeping in the mountain context (see Table 2.1).

REFERENCES

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ANNEXURE 2.1

A Note on Mountain Specificities

Mountain Specificities: The important conditions characterizing mountain areas which, for operational purposes, separate mountain habitats from other areas are termed here as 'mountain specificities'. The important six mountain specificities (some of which might be shared by other areas such as deserts in the plains), are as follows:

Inaccessibility. Due to slope, altitude, overall terrain conditions, and periodical seasonal hazards (e.g. landslides, snow storms etc.) inaccessibility is a well known feature of mountain areas. Its concrete manifestations are isolation, distance, poor communication, and limited mobility. Besides the dominant physical dimension, it has socio-cultural and economic dimensions, which are reflected by socioeconomic differentiation and inequity of access to resources, information, and opportunities. Inaccessibility, greatly help reinforce other conditions such as marginality and diversity as mentioned below.

Fragility. Mountain areas, due to altitude and steep slopes, in association with geologic, edaphic, and biotic factors, which limit the former's capacity to withstand even a small degree of disturbance, are known for their fragility. Their vulnerability to irreversible damages due to overuse or rapid changes, extends to physical land surface, vegetative resources, and even delicate economic life support systems of mountain communities. Consequently, when mountain resources and environment start deteriorating due to any disturbance, it happens at a fast rate. In most cases the damage is irreversible or reversible only over a long period. This factor is largely responsible for the vicious circle of 'poverty—resource degradation—poverty', in fragile ecological zones of mountain regions.

Marginality. 'Marginal' (in any context) is one which counts the least with reference to 'mainstream' situation. This may apply to physical and biological resources or conditions as well as to people and their sustenance systems. The basic factors which contribute to such status of any area or a community, are remoteness and physical isolation, fragile and low-productivity resources, and several man-made handicaps, which prevent one's participation in the 'mainstream' patterns of activities. The above basic factors, also lead to secondary patterns of relationship between 'mainstream' and 'marginal entities'. They are reflected through neglect and exploitation of the latter by the former. The mountain regions being marginal areas as against prime areas in most cases, share the above attributes of marginal entities and suffer consequences of such status in different ways.

Diversity or Heterogeneity. In their natural state, some degree of heterogeneity is a characteristic of all types of habitats. Soil type changes every 20 miles as they say. However, in mountain areas, one finds immense variations among and within eco-zones, even at short distances. This extreme degree of heterogeneity in mountains, is a function of interactions of different factors such as elevation, altitude, geologic and edaphic conditions, steepness and orientation of slopes, wind and precipitation, mountain mass, and relief of terrain. The biological adaptations (e.g. naturally suited plant types) and socioeconomic responses (e.g. cultural patterns, structure of economic activities etc.), to the above diversities, also acquire a measure of heterogeneity of their own. The 'diversity or heterogeneity' phenomenon, applies to all mountain characteristics discussed here.

'Niche' or Comparative Advantage. Owing to their specific environmental and resource related features, mountains provide a 'niche' for specific activities or products. At the operational level, mountains may have comparative advantage over the plains in these activities. Examples may include: specific valley serving as habitat for special medicinal and bee plants, mountains acting as source of unique products (e.g. some fruits, flowers,

minerals, etc.), and mountains serving as well known sources of hydro-power production. Thus, 'niche' has both physical and biological dimensions. Though not comparable to biophysical niches, it is not difficult to identify some specific socio-cultural characteristics of mountain communities (e.g. their social organization, attitudes, etc.), which may impart some added advantage to them in activities such as management of collective goods and community resources. In practice, however, niche or comparative advantage may remain dormant unless circumstances are created to harness it. On the other hand, if certain developments lead to elimination of 'exclusiveness' characterizing a situation or resource base, the comparative advantage may cease to exist. Production of special hill crops (e.g. flowers, hive products, mushrooms, medicinal plants, etc.) in the plains by creating artificial environments or by help of research, is one such example, where the comparative advantage of mountain is lost. However, mountains, owing to their heterogeneity, have several, often narrow, but specific niches, which are harnessed by local communities, through their diversified activities. The modern development programmes often lead to their elimination or over-exploitation.

Human Adaptation—Mechanisms. Mountains, through their heterogeneity and diversity even at the very micro-level, offer a complex of constraints and opportunities. Mountain communities through trial and error over the generations, have evolved their own adaptation mechanisms. Accordingly, the mountain characteristics are either modified (e.g. through terracing and irrigation) to suit their needs or activities are designed to adjust to the requirements of mountain conditions (e.g. by zone specific combination of activities, crops, etc.). Adaptation mechanisms or experiences are reflected through formal and informal arrangements for management of resources, diversified and interlinked activities, to harness micro-niches of specific eco-zones, and effective use of upland-lowland links. However, with the changed circumstances such as increased population pressure, increased role of market forces, and side effects of public policies and programmes, a number of adaptation mechanisms are losing their feasibility and efficacy. (Note: Extracted from Jodha [1990]. Refer to the same for references and illustrations).