Four

Bee Forage Management

Bee forage management can be important for increasing the beekeeping potential of an area. Without proper bee forage management, it is difficult to maintain an apiary of strong and healthy bee colonies. Poor management of bee forage, especially during dearth periods (the dearth period in the low hill areas is generally during the summer and, in the high hill/mountain areas, during winter), results in weak colonies which are susceptible to various diseases and infections. Such colonies generally abscond and the beekeepers have to suffer the loss of their bees. This has an adverse affect on both honey production and crop pollination. Thus, it is necessary to ensure year-round availability of bee forage.

This chapter deals with the tools for bee forage management. Bee forage management is carried out in two steps: the first step is to assess the bee forage potential of an area and the second is to improve upon it. These are described in detail in the following text.

Assessing the Bee Forage Potential

Before starting beekeeping in any area, it is helpful to know the availability of bee forage or the bee forage potential. This helps in assessing as well as improving the beekeeping carrying capacity of a particular area. The beekeeping carrying capacity of an area is the number of bee colonies it can support. It depends upon the density, distribution, nectar and pollen potentiality, and blossoming of the bee plants existing in an area. In order to assess the bee forage potential, bee forage calendars of the nectar and pollen yielding plants of an area are prepared. A **floral calendar or bee forage calendar** for beekeeping is a time-table that indicates the approximate date and the duration of the blossoming period of the existing honey or pollen plants in an area. In addition to the time

and duration of blossoms of honey plants, it also involves the mapping of density, distribution, and honey potential of the regional bee flora. Such floral calendars should be prepared for each ecological region where beekeeping is practised.

Value of Bee Forage Calendars

The bee forage calendar is one of the most useful tools of the apicultural extension worker. It enables her/him to inform beekeepers what to expect and when in terms of bee forage availability so that they can manage their colonies in the most rational manner. Beekeeping in an area cannot develop without an understanding of the calendar; and for migratory beekeeping, floral calendars for different foraging zones along the migration route are required. Thus, the bee forage calendars are very valuable for the development of beekeeping in the temperate Hindu Kush-Himalayan region where mixed types of bee flora exist. These are of great help in selecting the most suitable places for the bees to be moved during winter when the temperature in the Hindu Kush-Himalayan region is very low.

Preparation of a Bee Forage Calendar

Assembling a floral calendar for any specific area is simple though time-consuming. It requires complete observation of the seasonal changes in the vegetational patterns or agro-ecosystems of an area, the foraging behaviour of the bees, and the manner in which the honeybee colonies interact with their floral environment. The accuracy of a bee forage calendar, and hence its practical value, depends solely on the careful recording of the beginning and end of the flowering seasons of the plants, how these vary from year to year, and how they affect the bees. Preparing a bee forage calendar normally requires the following steps (Akratanakul 1986).

1. Make a general survey of the area and list the flowering plants paying special attention to the plants with a high floral density per unit area per tree.
2. Place strong honeybee colonies in the area, inspect the hives regularly, and observe changes in the amount of stores within the hive by weighing them **(but remember that newly-collected nectar contains more water)**.
3. When monitoring the hives' food stores, survey the area in the vicinity of the apiary and within the flight range of the bees to record the species of plants that the bees visit.

4. Record whether each plant is visited for nectar or pollen or both.
5. Study the frequency with which the bees visit each flower species in relation to changes in the level of colonies' food stores. If there is a continuous increase in food stores in direct response to the availability of the plants visited, the plants are good forage sources. If the food stores remain stable, the plants can meet the daily food requirements of the colonies but cannot be classified as major sources of food **(but remember that food is used up more rapidly when more brood is present)**.
6. Carefully record the changes in the blossoming of all the plants visited. When the colonies begin to lose weight, the flowering season should be considered finished for all practical purposes.

Once all data on forage species have been assembled for the whole year and repeatedly verified, they should be judged as they relate to the actual performance of the honeybee colonies. The calendar can then be drawn in the form of circular or linear charts, showing the weekly or monthly availability of plants and their flowering sequence. As an example, the floral calendar of Kathmandu Valley prepared by the author is presented in Table 4.1.

Improving the Bee Forage Potential

After the assessment of bee forage potential, the next step is to improve upon its potential. This, in turn, helps to improve upon the beekeeping potential or the beekeeping carrying capacity of an area. This can be achieved either through beekeeping-oriented plantations or by moving the bee colonies to other areas where bee forage is available (migratory beekeeping). The first option involves the management of bee forage, whereas the second option involves the management of bees.

Beekeeping-oriented Plantations

Bee forage potential and, therefore, beekeeping carrying capacity can be increased by establishing beekeeping-oriented plantations. Managing honey plant resources is necessary for the following reasons.

Improving the Beekeeping Potential of an Area

Subsistence farmers generally keep only a few bee colonies. Since the floral needs for small-scale beekeeping are few, the existing honey plants in an area can support these colonies. However, to promote beekeeping as an income-generating activity or for crop pollination, more bee colonies

Table 4.1: **Bee Forage Calendar for the Kathmandu Valley**
(Only important bee plants are included)

Plant species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Abelmoschus esculentus						○	●	●	●	○		
Ageratum conyzoides			⊙	⊙	○	○	○	○	●	⊙	⊙	
Albizia spp				●	⊙	○						
Allium cepa				●								
Amaranthus spp							⊙	●	⊙			
Bauhinia purpurea									●	○		
Bauhinia variegata			○	●								
Berberis asiatica			○	●								
Borago officinalis		⊙	⊙	●	●	⊙		⊙	⊙	⊙	⊙	⊙
Brassica campestris	●										●	●
Brassica juncea		●	⊙									
Brassica oleracea botrytis		●	●									
Buddleia asiatica		⊙	●									
Calendula officinalis		⊙	●	⊙								
Callistemon citrinus			⊙	●	⊙					●	●	
Campsis grandiflora					⊙	⊙	●					
Capsicum annum						⊙	●	⊙	○			

Plant species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Centauria cyanus		●	●	●								
Choerospondias axillaris				●	⊙							
Cirsium spp				●	⊙	⊙						
Citrus grandis		⊙	●									
Citrus sinensis			●	⊙								
Coriandrum sativum			●	⊙								
Cucumis sativus						●	●					
Cucurbita spp					⊙	●	●	⊙	⊙			
Diospyros kaki			●	●								
Eupatorium glandulosum				●								
Eucaplyptus spp				⊙	⊙	●						
Fagopyrum esculentum									●	⊙		
Grevillea robusta				●	⊙							
Helianthus annuus							●	⊙	⊙			
Lagerstroemia indica						⊙	●					
Leucosceptrum canum		●	●									
Mahonia nepaulensis	●											⊙
Prunus cerasoides											●	
Prunus domestica		●	⊙									

Plant species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prunus persica		●	⊙									
Pyrus communis		●	⊙									
Pyrus pashia		⊙	●									
Psidium guajava					⊙	●						
Raphanus sativus		⊙	●									
Rhus spp									●	⊙		
Rubus ellipticus			⊙	●								
Sechium edule					⊙	⊙	●	●	⊙	⊙		
Schima wallichii					⊙	●						
Trifolium repens		●	●	●	⊙	⊙	○					
Vicia faba		●	⊙									
Zea mays						●	●	⊙	⊙			

○ Only a few plants are in bloom;
⊙ 50 per cent of the plants are in bloom;
● All the plants are in bloom

Source: Author's observations

are needed. Therefore, to support a large number of bee colonies, large amounts of bee forage are needed. In this case, the plants that provide surplus nectar and pollen, as well as those which support bee colonies during a dearth period, should be planted.

Improving Quality of Honey

The need to manage bee flora also arises when a beekeeper wants to produce high quality honey for marketing purposes. Some unifloral honeys sold by plant names fetch a premium price, e.g., citrus honey from northeastern India, clover honey from the USA, eucalyptus honey from Australia, and chiuri (Indian butter tree) from Nepal. These are some examples of good quality unifloral honey. In this case, managing multipurpose plant species which provide forage sources for making honey of excellent quality is essential. The established plantations of the Indian butter tree, a multipurpose plant species found in the Jajarkot district of the midwestern region of Nepal, are an example of such management.

Managing Crop Pollination and Bee Forage

When bee colonies are kept for the sole purpose of crop pollination, sufficient bee forage is required around the apiaries throughout the year, particularly for the slack winter period when the crops are not flowering, so that colony strength can be sufficiently built up by the time pollination services are required. This can be achieved by:i) planting such bee plants on wastelands and hedges which provide other benefits; ii) cultivation of crops with optimal agronomic conditions; iii) proper cropping patterns and rotation of useful crops; and iv) planned and judicial application of pesticides.

Meeting Needs in Slack Periods

An ideal location for beekeeping is one in which there are at least three plant species that yield surplus honey in considerable quantities and bloom during different months. In addition, there should be a great variety of minor plants yielding both nectar and pollen to support bee colonies between main flows. Such locations are not common in the Hindu Kush-Himalayan region; in many areas honey plants are available for a certain period of the year and then there is a dearth period for about two months during summer in the low hills and during winter in the high hill areas. Thus, there is a need to manage honey plants in order to support bee

colonies during this dearth period by providing enough nectar and pollen for their sustenance; this means growing cultivated crops, ornamental plants, weeds, or small shrubs.

There are other options to support bee colonies during the slack months, for instance, feeding the bees with sugar or migrating them to other areas (to the high hill areas during summer and the low hill areas during winter) where flowering plants are available. However, for a small-scale beekeeper from the mountains, both these options are impractical. Farmers may find feeding sugar syrup to bees an expensive option. Also, migration of bee colonies is profitable only for commercial beekeepers and not practical for small-scale beekeepers. Moreover, the migration of bee colonies is possible only in areas accessible by road.

The Bee Forage Plantation Approach

Several plant species have been named after the beekeepers who championed them. **Chapman honey plant** (*Echinops sphaerocephalus*), **Simpson honey plant** (*Scrophularia marilandica*), and **Pellett clover** (*Trifolium ambiguum*) are a few examples from the early 1900s. While these attempts at planting for bees met with varying degrees of success, none are being pursued today by large segments of the beekeeping community. So far, large-scale planting, solely from an apicultural viewpoint, is not considered profitable in terms of net economic returns (Akratanakul 1986; Partap 1992; Verma 1992). Moreover, land is a scarcity in mountain areas, therefore using large areas for the plantation for bees is not possible. Thus, unconventional land-use practices are much favoured for this purpose and the motive is always linked to other development programmes. Plantations on common property lands and roadsides and community forestry are examples. Past efforts in this direction have yielded satisfactory results. For example, roadside plantations in China and Pakistan, social forestry programmes in northwestern India, and community forestry plantations in Nepal included several multipurpose plant species which were also good bee forage plantations. As a result, apiculture has flourished in these areas. A list of such multipurpose plant species which are important honey plants for plantations on common property land, government land, and private land in different agro-ecological zones, besides other uses, is given in the Annex to Chapter 4.

However, according to Ayers and Harman (1992) under the following three situations, a beekeeper can profitably plant bee forage only for

beekeeping. The first is when a beekeeper owns land and wishes to plant something on it but does not intend to manage the land for conventional agricultural production. The second is when land adjacent to an apiary is not owned by the beekeeper but the owner is willing to have it planted for bee forage. The third situation occurs when bees from a particular apiary are routinely poisoned by agricultural pesticides but the beekeeper for some reason is compelled to maintain the apiary in that particular location. Under such conditions, if the land on which the apiary is located belongs to the beekeeper, he can plant it with bee forage. Here bee forage planting could help divert bees from pesticide-laden agricultural areas during risk periods. This helps to reduce the loss of bees and to provide quality bee forage at the same time.

Desirable Properties of Bee Forage Plantations

Bee forage plantations, whether carried out with the sole purpose of beekeeping or linked to other development purposes, should have the following characteristics (Ayers and Harman 1992).

High Quality Honey

The first important property of bee forage plants is that they should produce honey of good quality. For this reason, beekeepers need to consider producing speciality honey. Many common plants are the best source of quality honey in different agroclimatic zones. For example, *Citrus* spp and clovers for low hill areas; Indian butter tree and *Eurya* spp for the middle hills; and apple and *Plectranthus* spp for the high hills.

High Productivity

Bee forage plantations should also be highly productive. Highly productive bee plants are characterised by relatively long blossoming periods, generally in terms of several weeks or months; a high density of nectar-secreting flowers per plant or unit area; good nectar quality with high sugar concentration; and accessibility of the nectaries to the bees. Examples include *Calliandra calothyrsus* and *Callistemon* spp in the low and middle hills and *Plectranthus* spp for the high hill areas.

In an area where the existing forage supplies adequate nectar and pollen throughout most of the season, except for one or more periods when the nectar and/or pollen flows dwindle, plant species that bloom when nectar and/or pollen flows are very low should be considered for planting.

Whereas, in areas where, during most of the period, little nectar or pollen is produced, plantations should be more productive for as much of the season as possible. The most obvious solution is to plant long-blooming and highly-productive plant species.

A second and more interesting solution could be to plant the land in a multi-layered design, as for example, a herbaceous layer with a partial tree layer. In this system, even though the different layers might not be made up of long-blooming species, the unit of land they occupy could remain productive over prolonged periods if the species are chosen correctly. Therefore, careful attention should be given to the blossoming dates of the various components of the plantations. If plants, such as shrubs and vines, that occupy ecological niches different from those of herbaceous plants and trees, are added to multi-layered systems they can become very productive.

It is essential when planning a bee forage system to ensure that the different components of the system are productive in the environment in which they will be planted.

Low Maintenance

The third important property for a bee forage plantation is that it should require minimum maintenance. The first rule for producing a low maintenance system is that the plants should be adapted to the niche in which they are to be planted. While non-agricultural plants can often be grown in inappropriate habitats, the extra maintenance needed to keep them there almost outweighs the benefits.

Perennial plant species with very long life cycles should be preferred for planting so as to avoid frequent replantations. The species should be aggressive enough to quickly occupy the initial interplanting spacing. Finally, the plant species that will compete well with weeds should be chosen. Trees and shrubs possess many of the low maintenance characteristics desired in a bee forage system, since, once established, they often remain in the system for many years. However, they have two main drawbacks. The time interval between establishment and first bloom can be quite long, often many years. In addition, in temperate zones they remain in bloom each year only for short periods of time.

Should Not Become a Weed

Another desirable characteristic of a good forage system is that the species chosen should not become invasive or obnoxious weeds for the

neighbouring plant species. Careful consideration should, therefore, be given to native plant species or, at least, to the species that are already established in the area.

Meet the Farming Needs of the Community

The final desirable property of bee forage planting is that instead of acting only as a quality bee forage, it should also meet the needs of the community, i.e., it should be multipurpose. Therefore, plant species that are used as fuel, fodder, and fencing, or that have some other commercial value, should be considered for planting as bee forage.

The selection of plant species in mountain areas is highly location-specific. Therefore, it is not easy to prescribe a general combination. The best way is to work out a list of honey sources from an agro-ecological zone or on an agro-ecosystemic basis and then make further choices considering other uses of plant species and farmers' needs.

***Bee Management Using Bee Forage from Other Areas* (Migratory Beekeeping)**

Another way to overcome the beekeeping carrying capacity limits of an area is to use the bee flora of other areas through migratory beekeeping. **Migratory beekeeping** is actually management of bees to use forage in other areas by the migration of bee colonies. This provides the bees with better forage and the beekeeper with surplus honey. (In commercial-scale beekeeping, a large number of honeybee colonies are owned by an individual beekeeper for production of honey and other hive products.) This practice is also becoming popular in the countries of the Hindu Kush-Himalayan region.

China leads the other countries of the region in commercial beekeeping. It produces over 200,000 tons of honey; 800 tons of royal jelly, and 1,000 tons of bee pollen every year. China is also the largest exporter of honey in the world, contributing to 16 per cent of world exports (ITC-UNCTAD-GATT 1986).

Likewise, in the mountain areas of other countries of the Hindu Kush-Himalayan region, i.e., Pakistan, India, Nepal, and Bhutan, there is tremendous potential for migratory beekeeping. In some areas, such as the North West Frontier Province of Pakistan, beekeeping is already a large-scale venture. In Himachal Pradesh, a province in the Indian Himalayas, the government, some cooperatives, and individual farmers

maintain large numbers of colonies, loaning them to apple growers for use in pollination.

Maintaining such a large number of colonies would need good beekeeping areas with several honey plants blossoming during different months of the year to provide surplus honey to support bee colonies during dearth periods. However, such areas are not always available or easy to find, especially during winter months, in mountain areas where bee flora are not available for most of the year. Many other areas also do not provide enough bee flora throughout the year. Under these circumstances, the beekeepers have three choices, i.e., either feed the colonies with sugar syrup or move them to other areas where bee flora are available or harvest less honey. It depends upon the economics involved. Commercial beekeepers prefer the second choice and move their colonies to other places in order to provide the bees with a good, productive foraging environment. This system of migrating bee colonies to a particular locality to provide the bees with a better source of forage is helpful for commercial honey production.

Mountain areas, how-ever, provide a comparative advantage in this respect. The beehives can be moved up and down the agro-ecological zones to take advantage of the natural vegetation. Spending winter in the foothills, where winter crops and other plants bloom will help. And colonies can be moved into the middle hills and valleys when the weather gets warmer. By April, the temperate fruit zone provides a most suitable niche, and honeybees could also be needed for the pollination of fruit crops. Plenty of flora are available in this zone during this period. Summer provides scope, with bee flora available in high mountain areas, and this continues until the end of the rainy season. Autumn is the lean period but by that time some of the rosaceous plants start flowering in the foothills. Colonies are then moved down into these areas.

The system of migratory beekeeping is in practice in parts of China, e.g., Yunnan, Himalayas, Himachal Pradesh and Jammu and Kashmir, the Myomyo area of Myanmar, the North West Frontier Province of Pakistan, and, to some extent, in the middle hills of Nepal. Afghan refugees in the North West Frontier Province of Pakistan and beekeepers from high mountain areas in Himachal Pradesh can be seen moving their colonies up and down along the highways, staying for a few weeks in one place and then moving on. Large numbers of bee colonies can be seen in deep forests, near the wastelands, and along the sides of crop fields (Figure 4.1).

Figure 4.1 Migratory beekeeping in the North West Frontier Province of Pakistan (Photo: L.R. Verma)

The practice of migratory beekeeping is advantageous in more ways than one. It helps to harness the honey sources in their natural state, avoiding the need for concentrated bee forage plantations. It also increases the honey yield to three times that of stationary beekeeping. In addition, honeybees provide the benefits of pollination to several plant species, both wild and cultivated. In Himachal Pradesh, for example, migratory beekeeping has been successfully used in apple pollination. The transportation costs involved in the practice of migratory beekeeping is duly compensated through benefits from pollination services and surplus honey yields.

Guidelines for Migratory Beekeeping

i Potential sites for the migration of bee colonies should be validated. In selecting sites, one should not set up hives in the vicinity of local beekeepers' apiaries.

ii Sites should be easily accessible by vehicle and close to the honey crop. It is best to have sites at the edge of woodlands, even when using flowering crops.

iii Entrances of the hives should be properly blocked with perforated netting so that bees do not get out but still have plenty of air. Hives with supers should be secured with the belt or copper staples hammered in obliquely. Any cracks in the hives should be sealed with a strong, wide sticky tape.

iv Only strong colonies with sufficient food supplies for at least a week should be moved. If the food supplies are not sufficient, the colonies should be fed for three to four days before setting off.

v It is vital to ensure that the colonies have sufficient ventilation for the journey, otherwise the strongest and the best colonies might suffocate. If the bees are being moved a long distance, place some moss (or cloth) soaked in water near them to keep them cool.

vi Use a suitable vehicle for transporting bee colonies. Load and unload bees as gently and steadily as possible.

vii Colonies should be transported during the night and reach the selected places early in the morning. The journey should be as smooth as possible. Avoid making any stops. If it is necessary to stop, keep the engine running to keep the bees quiet. If long breaks are needed, particularly in hot weather, the bees must be unloaded and allowed to fly. The journey should then be continued in the evening.

viii When you reach your destination, do not open the hive entrances until all the colonies are on their stands. In fact, it is better to wait even longer, but be careful that the colonies do not overheat.