

# Beekeeping Training for Farmers in the Himalayas

Resource Manual for Trainers

FOR MOUNTAINS AND PEOPLE



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The International Centre for Integrated Mountain Development, ICIMOD, is a regional knowledge development and learning centre serving the eight regional member countries of the Hindu Kush Himalayas – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan – and based in Kathmandu, Nepal. Globalisation and climate change have an increasing influence on the stability of fragile mountain ecosystems and the livelihoods of mountain people. ICIMOD aims to assist mountain people to understand these changes, adapt to them, and make the most of new opportunities, while addressing upstream-downstream issues. We support regional transboundary programmes through partnership with regional partner institutions, facilitate the exchange of experience, and serve as a regional knowledge hub. We strengthen networking among regional and global centres of excellence. Overall, we are working to develop an economically and environmentally sound mountain ecosystem to improve the living standards of mountain populations and to sustain vital ecosystem services for the billions of people living downstream – now, and for the future.



# Beekeeping Training for Farmers in the Himalayas

## Resource Manual for Trainers

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# Foreword

Honeybees are an integral part of the human food chain as pollinators of crops. As pollinators they also have an essential role in maintaining mountain biodiversity and the mountain environment. Beekeeping has contributed to rural development through the centuries by supporting agricultural production and providing honey, wax, and other products for home use and sale. Beekeeping has a special significance for farmers in the Hindu Kush Himalayas. It offers a way for those with few resources – especially poor and landless farmers and women – to obtain income, as it requires only a small start-up investment, can be carried out in a small space close to the home, and generally yields profits within a year of operation. Mountain farmers have kept bees in hives for centuries for personal use, but beekeeping is now becoming more popular as an income generating activity. To take full advantage of bees, farmers need to take a modern approach to bee management using frame hives and focusing on production of quality colonies and quality honey. For this they need up-to-date training. Currently, many organizations are training farmers in beekeeping. However, the content and delivery of training courses vary considerably across the region – and almost all are using curricula developed during the 1980s which do not include newly emerging issues and innovations regarding such subjects as indigenous honeybees, value chains, gender and equity, integrated pest management, and policy-related issues.

Supported by the Austrian Government, ICIMOD has been working for more than two decades in collaboration with regional partners on issues related to indigenous Himalayan bees and beekeeping for biodiversity conservation and poverty alleviation. Among other activities, training on modern beekeeping has been provided to many local trainers and beekeepers.

Working with partner organizations in Bangladesh, Bhutan, India, and Nepal, and supported by the Austrian Development Agency, ICIMOD's beekeeping project embarked on a process to develop an integrated and inclusive curriculum and course on basic beekeeping training for Hindu Kush Himalayan farmers. The extended participatory process was led by the Bangladesh Institute of Apiculture; the Renewable Natural Resource – Research and Development Centre in Jakar, Bhutan; the Dr YS Parmar Horticulture and Forestry University in Solan, India; and the Beekeeping Development Section of Nepal's Department of Agriculture. These organizations engaged a wide range of stakeholders – trainers, trainees, government and non-governmental organizations (NGOs), associations and federations, and private entrepreneurs – in the identification of curriculum needs, and curriculum and training development and testing. This manual is the result.

The manual provides a basic resource for trainers and field extension workers in government and NGOs, universities, vocational training institutes, and private sector organizations, and for local trainers in beekeeping groups, beekeeping resource centres, cooperatives, and associations, for use in training farmers in the Himalayan region in basic beekeeping. The manual was prepared to meet formal training needs in Bangladesh, Bhutan, India, and Nepal, but it is suitable for use in ICIMOD's other member countries as well – Afghanistan, China, Myanmar, and Pakistan. Individual countries will be preparing editions in local languages adapted for the specific conditions in each country.

The manual covers the full range of basic topics related to beekeeping development, including the importance of beekeeping in modern agriculture and the use of bees for crop pollination; production of honey, wax and other hive products; honey quality standards; and using value chain and market management to increase the benefits accruing to beekeepers. The focus is on participatory hands-on training, with issues explained in simple language with many illustrations. We are confident that this manual, and the country-specific versions based on it, will be a source of support for beekeeping training across the region, and will help marginalized mountain farmers, women and men, to develop a sustainable livelihood from bees and beekeeping, while contributing to maintenance of a healthy environment.



**David Molden**  
Director General, ICIMOD

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The manual could not have been prepared without the involvement of beekeepers and trainers in the participating countries who shared their very enriching and practical experiences and we would like to thank them all for their valuable suggestions. Many individuals and organizations were involved in the process of developing and obtaining approval for curricula in Bangladesh, Bhutan, India, and Nepal and then preparing this manual – women and men practitioners, trainers, beekeepers, resource persons, and others – and we thank them all for their invaluable contributions. We would like to offer particular thanks to Ameerul Islam, Chairperson of the Executive Board of the Bangladesh Institute of Apiculture; Dasho Sherub Gyaltzen, Secretary at the Ministry of Agriculture, Royal Government of Bhutan; Vijaya Mallik, Director General of the Department of Agriculture, Ministry of Agriculture and Cooperatives, Government of Nepal; Krishan Ram Dhiman, Vice Chancellor of Dr YS Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh; and Banwari Lal Saraswat, Director of the National Bee Board, India, for approving and accepting the curriculum for implementation in regional and national level training courses; and to all the resource persons from Bangladesh, Bhutan, India, and Nepal for their significant contribution in making the manual simpler, more visual, and more relevant in the context of HKH region.

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Finally, to all readers and users, we welcome your feedback on all aspects of the manual for the improvement of future editions and the editions in regional languages.

## The Country Resource Teams

The four countries involved in the project set up individual country resource teams to work on the curriculum development and the resource manual; the team members are listed below.

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# Introduction to the Manual

## Background

### The role of bees and beekeeping

Honeybees play an essential role for rural mountain communities and the environment. Honeybee products, especially honey and beeswax, are an important source of income, nutrition, and medicine, while the bees themselves play an equally or even more important role as pollinators for agriculture and natural ecosystems. As pollinators, they support agricultural production, forestry, and the maintenance of biodiversity. They also help to combat soil degradation by enhancing the replenishment cycle: more pollination, more seed set, more plants, more biomass returned to the soil, leading to less soil erosion, less flooding, and a more conducive environment for sustainable living. All four groups of bees play a role in pollination – bumble bees, stingless bees, solitary bees, and honeybees – but the honeybee is the most important. It is estimated that one third of the human diet comes from insect-pollinated plants, and that honeybees provide 80% of that pollination. Honeybees are the only bee that can be managed by farmers and are the focus of this manual.

Traditionally, poor and landless farmers in remote mountain areas of the Hindu Kush Himalayan region have found bee colonies in the forest, protected them, and harvested small amounts of honey from them. Local tradition allows farmers to claim ‘ownership’ of such colonies whilst leaving them at their original nesting site, thus acting as ‘guardians of biodiversity’. Farmers with more space and resources kept the indigenous Himalayan hive bee in simple homemade log or wall hives close to the house.

In more recent times, beekeeping has become a more professional activity. The advent of frame hives made it possible for bees to be managed, hives to be moved around to appropriate places, and honey production to be increased to commercial levels. At the same time, a reduction in natural pollinators as a result of loss of natural habitats and increased use of insecticides has made it essential in many parts of the world to keep bees for the pollination of agricultural crops.

### The importance of beekeeping for Himalayan farmers

Beekeeping has a special significance for farmers in the Hindu Kush Himalayas. It offers a way for those with few resources – especially poor and landless farmers and women – to gain income, as it requires only a small start up investment, can be carried out in a small space close to the house, and generally yields profits within the first year of operation. Bees provide honey, beeswax, propolis, royal jelly, and bee venom for home use and sale. In addition to the direct income from bee products, beekeeping also generates off-farm employment opportunities in many fields including hive carpentry, production and sale of honeybee colonies, honey trading, renting and hiring of bees for pollination, and bee-based micro enterprises.

Beekeeping has become increasingly important with the decrease in populations of indigenous bees and other pollinators as a result of loss of forage and nesting places and expansion of monoculture agriculture. Beekeeping is needed to support pollination of the newly introduced cash crops, as well as the more traditional subsistence crops and natural vegetation on which farmers depend.

### The need for training

Many factors need to be addressed so that farmers can make the most of the potential of beekeeping to provide income for families and communities and to contribute to rural development in general. The foremost among these challenges is to build the capacity of farmers and other related individuals and

organizations in managing bee colonies to enhance honey production and pollination services. The areas that need to be addressed include colony management, harvesting and processing of honey and other bee products, using value chain approaches to make the most of market opportunities, and honey trade and policy related issues. It is also important to improve the knowledge of development workers in topics related to the potentials of beekeeping, including promoting awareness of the role of bees as pollinators in agricultural productivity and biodiversity, and to facilitate an enabling environment for trade in terms of national and other policies.

## The Resource Manual

This resource manual has been developed to address the gaps in existing curricula with a focus on training content and delivery methods. The manual provides guidance to trainers for effective delivery of sessions using more visual presentations, as well as guidance on practical exercises.

The manual has been prepared as a basic resource for those intending to train farmers in the Himalayan region in basic beekeeping. The manual was prepared specifically to meet the formal training needs in Bangladesh, Bhutan, India, and Nepal. However, most of the benefits and challenges of beekeeping are common across the Himalayan region and the manual is suitable for use as a basis in all eight Himalayan countries, although the contents should be customized to meet the needs of individual countries. Customizing can be done at national level or by individual trainers drawing on their own resources. The manual is intended mainly as a resource for trainers and field extension workers in government and non-government organizations, universities, vocational training institutes, and private sector organizations, and for local trainers in beekeeping groups, beekeeping resource centres, cooperatives, and associations. Trainees and other farmers can also use the resources in this manual directly.

## Developing the manual

The International Centre for Integrated Mountain Development (ICIMOD) developed this manual as part of a project on 'Improving livelihoods through knowledge partnerships and value chains of bee products and services in the Himalayas' supported by the Austrian Development Agency (ADA), focusing in the first instance on Bangladesh, Bhutan, India, and Nepal. The process of developing the manual started with a review of existing curricula, led in Bangladesh by the Bangladesh Institute of Apiculture (BIA); in Bhutan by the Renewable Natural Resource – Research and Development Centre (RNR – RDC), Jakar; in India by the Dr YS Parmar University of Horticulture and Forestry (YSPUHF), Solan, Himachal Pradesh; and in Nepal by the Beekeeping Development Section (BDS), Department of Agriculture. Participants from related government organizations, non-government organizations, universities, vocational training institutes, beekeepers' associations, networks, and cooperatives contributed to the process of curriculum development through a series of workshops in all four countries.

A committee representing key stakeholders was formed in each country that had finalized a country level curriculum before the curriculum was submitted for approval to the authority concerned. All the participating countries now have a national level curriculum approved by the appropriate authority: the Bangladesh Institute of Apiculture Executive Board in Bangladesh; the Ministry of Agriculture in Bhutan; the National Bee Board in India; and the Department of Agriculture, Ministry of Agriculture and Cooperatives in Nepal. The approved curricula in all four countries are broadly similar, with the main difference that Bangladesh approved a training period of 10 days and the other three countries a training period of 7 days.

The resource manual, drafted jointly by resource persons from the countries, is designed to cover all the topics included in the country level curricula. The draft training materials were tested at a field level training organized by Nepal's Beekeeping Development Section (BDS) in Kushadevi village near Godavari, Nepal, in April 2011, and at training courses organized by the partner organizations in Bangladesh and Bhutan. The manual was revised to take the inputs and suggestions provided by the training participants into account.

The lead partner organizations in Bangladesh, Bhutan, India, and Nepal are publishing country-specific versions of this resource manual in Bengali (Bangla), Dzongkha, Hindi, and Nepali with appropriate modifications for the context and local needs.

### Maximizing the Impact of Training: Selection of Training Participants

The number of participants that can be accommodated in a single training event can range from 20–30, but with more participants the degree of interaction and level of participation will be reduced, which may have a negative impact on training effectiveness. Government and development organizations that provide training generally intend to benefit poor and marginalized farmers, including women and those from disadvantaged groups. In order to ensure that the intended target groups do actually benefit, it is important to follow certain criteria when selecting participants. The following selection criteria are suggested as a guide.

- Focus on the most disadvantaged farmers and those who are most likely to benefit from the training.
- Beekeepers experienced in traditional beekeeping and wishing to modernize or extend their approach should be given priority. This means that farmers who already have bees should get first priority, and those who are planning to start beekeeping as a new enterprise should come second.
- Beekeepers with small landholdings who are not food sufficient throughout the year should be given priority.
- Trainees should be active beekeepers and small farmers who will directly apply the learning themselves, rather than people in leadership positions in the local community.
- Participants should preferably be nominated by their own group or village organization.
- The trainee group should include a mixture of participants, both men and women and people from different socioeconomic groups, with a similar level of knowledge about beekeeping.
- Special consideration should be given to women because they generally have fewer opportunities to participate in training events as a result of institutional and social barriers. Simple affirmative action, for example selecting two women participants from a village, may have a positive impact in increasing women's participation in the community.

# Using the Manual

## Content and Structure

This manual is a resource for trainers. It provides a course for trainers to use that has up-to-date technical content covering all the basic topics relevant for farmer's level training in beekeeping. The training approach uses participatory principles to enhance the trainees' motivation, commitment, and ownership of the process. The participatory learning methods, practical hands-on approach, and use of simple statements and visual presentations are intended to maximize the effectiveness of the sessions.

The basic training techniques include short presentations, practical exercises, sharing of case studies, group discussions, field observations, and discussion and question and answer sessions. The resource manual encourages the use of hands on training for all technical sessions. Farmer-to-farmer learning is encouraged through the extensive discussion sessions.

The topics presented are outlines. The trainers should have an in-depth knowledge of the subject and be able to elaborate the training material and answer any questions that might arise. The trainer should also be experienced in training at the farmer level using participatory techniques. Some practical tips are provided at the end of this section for those with less experience of this type of training. The development and management of the training programme should include not only training implementation, but the full cycle starting from training needs assessment, design, delivery, implementation of training outcomes, and monitoring and evaluation of the training.

The resource manual covers the material in thirty sessions designed to be delivered over 7 days (10 in Bangladesh); most include practical exercises as a key method of delivery. The suggested length of each session varies from 45 minutes to 2 hours, with time allowed for participants to interact and discuss in each session. A short review session is included at the start of each day. The training organizers can adjust the sessions in consultation with trainers and participants depending upon the context and participants' expectations and existing skills and knowledge. A. The resource manual also suggests the training process for each session, lists the necessary resource materials, and includes a brief description of steps for practical exercises to help the trainer organise the training effectively. The basic structure of the sessions is as follows:

<b>Session title:</b>	Indicates the main content of the session
<b>Sub-topics:</b>	Indicates the detailed content of the main session
<b>Time:</b>	Approximate time required for theory and practical exercises
<b>Objectives:</b>	Areas to be covered and skills to be imparted
<b>Training methods:</b>	Suggested methods for teaching/training on the session topic
<b>Materials:</b>	The equipment and materials needed for the session
<b>Activities and exercises:</b>	Suggested activities and exercises including the objectives and detailed steps
<b>Resource materials:</b>	Resource materials such as handouts, case study reports, posters, photos, and figures

A list of references, suggestions for further reading, and web sites is provided at the end of the manual.

## Materials

The materials required are listed for each session. The organizer of the training has the main responsibility for ensuring that the materials are available but the trainer holding the particular session should always check that the materials are ready before the start.

The following materials are common to all sessions and essential for the training overall.

- An apiary, or at least five movable frame hives with honeybee colonies, and one or two log hives, all with bees; species can be *Apis mellifera*, *Apis cerana*, or a few of each, depending on which the focus of the training
- A set of colony inspection and beekeeping equipment (an extra set is useful but not essential)
- A folder for each participant containing a pen, writing pad, and resource materials; this should be distributed during registration or at the start of Session 1
- A computer and LCD projector, where possible, otherwise the appropriate equipment for displaying visual material such as posters depending upon the training venue. Ensure that all equipment is set up and tested before the training session starts.
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards (coloured card rectangles measuring around 8 x 6 cm), marker pens of different colours, masking tape, soft pin board with pins, or hard board with blue tack or sellotape
- Wall clock that all can see
- Enough seats in the training room for all participants. The training room can be set up each day according to that day's requirements. The seating arrangement must enable face-to-face interactions among the participants.

## Training Tips and Methods

The trainer is expected to have experience of farmer level training and training using participatory techniques. The suggested methods are outlines that the trainer can adapt and customize to the needs of the specific group of trainees and the training situation. Some general guidelines and reminders are provided below for those with less experience of this type of training. Further ideas can be found in a number of publications, for example Kane et al. (2003).

Trainees are expected to participate actively and may well have more comments and questions than can be discussed in the formal sessions. The trainer and trainees should be prepared to use break times (tea/lunch/evenings) to discuss with individuals or groups any additional questions that couldn't be answered in the sessions. It may be necessary to schedule short additional sessions in the evening (for residential courses) or before the regular training time in order to deal with all topics.

### Tips for the trainer

- The individual trainers should be responsible for ensuring that the required materials are ready before the start of the session.
- Make sure that all required materials and equipment are in good condition and in the correct place before the session starts.
- Familiarize yourself with the training methodology before the start of the course.
- Avoid long lectures and give short presentations with as much visual material as possible.
- Prepare practical exercises prior to the session.
- Encourage ownership by working jointly with participants to set a 'code of conduct' or rules and norms for the training that will ensure a good atmosphere and make the training more productive and interesting (for example, personal responsibility for learning, respect for others, punctuality, mobiles off). Encourage participation and interaction for learning among participants, and make sure the interaction is balanced (not dominated by a few individuals).

Most sessions have a 'question and answer' and 'discussion' component. In general the 'question and answer' component will come first (see below) followed by discussion. But for some topics, the order will be reversed. The trainer should arrange each session as s/he feels to be most appropriate.

## Guidelines for the question and answer session

The question and answer session is used mainly to clarify the content. Ask questions along the following lines to make sure that all participants have understood the topic well.

- What did you learn from this session?
- 'Why, what, where, which, who, when' questions relating to the session topic.
- Is anything not clear?

## Guidelines for group discussions

The session can be facilitated by the trainer or by the participants themselves.

- First briefly explain your approach to the group – how the discussion will be conducted and for how long. If the group is very large, split them into smaller groups.
- Explain which topic the groups will be discussing, and the objectives (expected outcomes) of the discussion.
- Remember that your role is to encourage full participation and support mutual learning among the group members.
- Facilitate and structure the flow of the discussion and help individuals to make their points using supportive statements along the lines of 'Would you like to add something?'; 'What do you think of this?', and so on.
- Make sure the discussion is balanced (not dominated by a few individuals).
- Use a clock to limit time given to those who have made many contributions and give a chance to those individuals who have not yet contributed.
- Keep track of the discussion to make sure that all discussion points are captured or understood by the members.
- If you have more than one group, ask representatives to share some of the main points in a plenary.
- Use metacards at the end of the discussion to enable individuals to add further points not yet raised or note points that are still unclear. Look at the metacards after the session and consider whether any of the points raised should be discussed further in the group or with individuals.

## Reviewing the previous day's work

Starting from the second day, the beginning of each day should begin with a review of the previous day's work, to identify, review, and reflect on the key lessons learned. The review session provides an opportunity:

- for participants to ask for more clarification from the trainers/facilitators;
- for the trainers to obtain feedback on the training content, training process, methodology, and materials;
- to discover any issues or problems emerging from the first day's sessions.

The review should consist of a discussion and question and answer session focusing on the following questions:

- What did you learn from yesterday's sessions?
- Is any clarification needed?
- Was there anything missing in terms of subject matter or content?
- Did the methodology used help you participate in the session?
- Do you have any suggestions for future sessions?

You don't have to limit the discussion to these questions. Participants should be able to ask any questions, but whether they can be answered will depend on the availability of time and the relevance of the question. Use the flipchart to capture answers to the above questions and metacards to structure the session (for example, ask participants to write down their questions and then group them for combined answers). Don't spend too much time on individual questions. Use metacards at the end of the session to capture any points that could not be covered and explain to participants that the feedback will be given in future sessions. Review the cards after the session and consider whether the points raised should be discussed further in the group or with individuals.

# Day 1

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**Session 1:** Opening – Introduction, Expectations, and Objectives

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**Session 2:** Introduction to Beekeeping – Importance, Status, and Challenges

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**Session 3:** Bee Species in the Himalayas – Characteristics and Conservation

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**Session 4:** The Honeybee Life Cycle

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**Session 5:** Morphology and Work Division of Adult Honeybees

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# Session 1 Opening – Introduction, Expectations, and Objectives

**Time: 1 hour 30 minutes**

## Objectives

- Introduce participants and resource persons
- Discover participants' expectations for the training
- Share training objectives and discuss them in relation to participants' expectations
- Discuss any issues related to the training raised by participants

## Training Methods

- Presentation and discussion

## Materials

- One folder per participant containing a pen, writing pad, the training schedule, a copy of the manual (if resources are sufficient), and copies of any articles that the trainer considers relevant
- Metacards and marker pens, soft board and pins
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Wall clock

## Activities and Exercises

### Activity 1: Introduction of participants and resource persons

The introduction session should be used to create an environment for learning in which participants feel at ease and are keen to participate in and contribute to the training. The training organizer should facilitate the session in such a way that the participants and resource persons are introduced and can get to know each other. Make the introductions fun with techniques such as peer introduction (pairs of participants introduce each other) or an icebreaker exercise. Participants could mention their reasons for wanting to do the training or one or two of the things they want to learn.

### Activity 2: Discovering trainees' expectations

The overall training schedule has been developed based on the training needs identified from consultation and feedback from previous training events. However, it is still important to know the expectations of this particular group of trainees and to ensure that the trainees are aware of the scope and limitations of the course. Wherever possible, the training should be made more trainee centred and needs based. By involving the trainees actively at the start, the planned training sessions can be tailored to meet their specific needs. Distribute metacards and ask each participant to write down at least three expectations that s/he has of the training on separate cards. Pin the metacards to a soft board or stick them on the flip chart or black or white board in groups of similar types. Discuss and clarify the expectations with the participants. The cards will be kept and reviewed on the last day of the training or discussed during individual sessions where appropriate.

### Activity 3: Training objectives

It is important to explain the overall training objectives to the participants so that they have a clear idea of what topics will and will not be covered, and an opportunity to modify their own expectations. The main objective of the training is to provide the basic knowledge and skills that are needed for beekeeping in the Himalayan region. These include the following:

- Traditional and movable frame hive beekeeping
- Bee species and their characteristics
- Beehives and beekeeping equipment
- Colony management
- Bee diseases and their control
- Bee pests and their control
- Pollination and bee forage
- Bee colony migration
- Honey harvesting, processing, and marketing a
- Other hive products
- Bee enterprises and value chains
- Group mobilization and networking
- Policies related to beekeeping

### Activity 4: Adjust the training objectives and sessions in response to the expectations

The course organizer and participants should discuss possible modifications of the planned training objectives and sessions based on the results of the discussion of expectations and objectives. Any adjustments or revisions should be based on the common concerns of all participants and ensure that all individuals will have an opportunity to leave with the knowledge and skills outlined in the objectives. The length of time taken for different sessions can be modified, but imparting basic skills should take priority over teaching additional topics.

# Session 2 Introduction to Beekeeping – Importance, Status, and Challenges

## Sub-topics

- ▶ Introduction (traditional and movable frame hive beekeeping)
- ▶ Status, potential, and challenges

## Time: 1 hour

Theory: 45 minutes

Discussion: 15 minutes

## Objectives

Trainees will

- understand the importance of beekeeping and be able to give a basic introduction,
- have a knowledge of the status, advantages, and potential of beekeeping, and
- know about the main challenges to beekeeping in the Hindu Kush Himalayan region.

## Training Methods

- Lecture
- Discussion
- Question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and marker pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture

Present an outline of the importance, status, and challenges of beekeeping as outlined in the resource materials (below). Use slides and photos to illustrate the talk, or large blown up photos and drawings in areas where there is no electricity.

### Activity 2: Discussion and question and answer

It is important to help trainees understand the importance of beekeeping, and the advantages and challenges, by discussing in depth and encouraging questions.

## Take home message

Beekeeping has a unique position and significance in the hills and mountains of the Hindu Kush Himalayan region. The bees help support a rich biodiversity and ensure crop pollination, and beekeeping provides opportunities for employment and income generation across a wide range of people, including the poorest of the poor, women, and people from disadvantaged groups.

# Session 2 Resource Materials

## Introduction to Beekeeping – Importance, Status, and Challenges

### Introduction

Beekeeping is the activity of people managing honeybees in hives in order to collect honey and other products, pollinate crops, and/or raise bees for sale. The hives provide a favourable environment for the bees as a base for foraging and gathering pollen and nectar; this helps maximize the production of hive products and the effectiveness of pollination services. Beekeeping has the technical name 'apiculture', and the place where the hives are kept is an apiary.

Agriculture is the main source of livelihoods for more than 80% of the rural population in the Hindu Kush Himalayan region. Up to 90% of the farmers in the region are small or marginal farmers – cultivating less than one hectare of land each. Honeybees are important crop pollinators and beekeeping can help these farmers maximize pollination and increase crop production, while providing honey and other products for consumption and sale. Few resources are needed to start beekeeping, and basic skills can be easily learned, at the same time, the demand for bee products and services is high, thus beekeeping has a great potential in the region.

### Beekeeping today

Beekeeping has a long tradition in the Hindu Kush Himalayas and is an important source of income, nutrition, and medicine for mountain communities. Farmers manage the indigenous honeybee *Apis cerana* in log and wall hives close to the homestead, while some, especially in remote areas, protect bees in the forest and harvest honey from their nests. These traditional practices are still followed in many places in the region.

Commercial beekeeping started in the region in the 1970s with the introduction of the exotic honeybee *Apis mellifera*. Formal courses on beekeeping for farmers using *Apis mellifera* bees and movable frame hives were started in the early 1980s in Bangladesh, India, and Nepal. They were not based on traditional practices, or the indigenous bee species. Similar courses started in Bhutan in 2006. Beekeeping has generated employment for beekeepers; promoted cross-pollination services, which have enhanced the quality and productivity of crops; and helped in biodiversity conservation.

ICIMOD has worked for two decades with partners in different countries in support of beekeepers and focusing especially on the indigenous hive honeybee. Activities include genetic improvement of the indigenous bee, clarifying the role of the bee in crop pollination, bee conservation, and capacity building in beekeeping, including organizing training events and publishing books and articles. Many other national and international non-government organizations (NGOs) in the region have also been involved for many years in beekeeping and pollination management activities, although mostly with *Apis mellifera*.

The geophysical conditions of the Hindu Kush Himalayan region are very conducive to beekeeping. The diversified natural forests across the region are rich in bee flora, and many of the crops grown in different places are a good source of pollen and nectar. Both of these resources are vital components for beekeeping. The rich tradition of beekeeping in rural areas of the region, and the traditional skills and knowledge of mountain beekeepers, can help in the promotion of commercial beekeeping.

### Benefits of Beekeeping

Beekeeping has both direct and indirect benefits. The direct benefits are the hive products: honey, beeswax, pollen, royal jelly, bee venom, propolis, and bee colonies (Figure 1). These can be consumed to improve

Figure 1: **Direct benefits from beekeeping**Figure 2: **Indirect benefits from beekeeping**

a family's nutrition, sold for cash income, or used as a basis for enterprise development, for example cosmetics based on beeswax.

The indirect benefits include pollination, which leads both to increased crop productivity and maintenance of natural biodiversity, including sustaining the natural products used by farmers (Figure 2). Beekeeping also generates off-farm employment opportunities in different fields including hive carpentry, production and sale of honeybee colonies, honey trading, renting of bees for pollination, and bee-based micro enterprises.

Beekeeping is ideally suited as a means of income generation for a wide range of people with otherwise limited opportunities, including the poorest of the poor, women, and people from disadvantaged groups. It usually needs only a very small start up investment, can be carried out in a small space close to the house, and yields profits within the first year of operation.

### Major Challenges

Many factors can pose a challenge to beekeepers and hinder the promotion of beekeeping in the Hindu Kush Himalayan region. They can be broadly grouped under threats to bee survival, barriers to honey trade, lack of knowledge, and non-conducive policies. The main factors are summarized below.

#### Threats to survival

- Reduction in bee foraging areas as a result of deforestation and forest fires
- Poor accessibility to forage areas (forest and farming) as a result of the limited road network
- Use of poisonous pesticides
- Limited use of biological measures for protection of crops against pests and diseases

#### Barriers to honey trade

- Lack of a pesticide residue monitoring programme; lack of accredited laboratories and equipment; lack of a certification system in the Hindu Kush Himalayan countries, except in China and India
- Poor quality honey due to lack of processing and packaging services at different levels

**Lack of knowledge, skills, and awareness**

- Lack of awareness at the farmer's level about the role of honeybees in pollination and biodiversity conservation
- Lack of knowledge sharing among key stakeholders both within countries and especially at the regional level
- Lack of skilled labour and effective mobilization of existing labour
- Lack of technology development and research on beekeeping

**Non-conducive policy environment**

- Inadequate policies on beekeeping

# Session 3 Bee Species in the Himalayas – Characteristics and Conservation

## Sub-topics

- ▶ Bee species in the Himalayas and their characteristics
- ▶ Promotion and conservation of bees

## Time: 1 hour

Theory: 30 minutes

Practical: 30 minutes

## Objectives

Trainees will

- be able to identify the different honeybee species and their characteristics,
- know the climatic requirements of the different honeybee species, and
- be aware of promotion and conservation techniques for honeybees.

## Training Methods

- Lecture and demonstration
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos, of the different honey bee species
- Bee specimens – living or dead
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture and demonstration

Describe the different types of honeybees found in the Himalayan region and summarize their morphological characteristics, geographical location, and nesting habits, as outlined in the resource materials (below).

Describe different approaches to, and the importance of promoting, conservation. Use PowerPoint slides and photos to illustrate the talk, or large blown up photos and drawings in areas where there is no electricity. Let the participants look at specimens of different bee species.

### Activity 2: Discussion and question and answer

Use in depth discussion and question and answer approaches to discover whether the trainees can recognize and differentiate the different species, understand the different characteristics and the implications (for example, which species are useful for pollination of crops grown at high altitude), and understand the importance of conservation. Encourage trainees to talk about conservation and suggest their own approaches, as well as those mentioned in the lecture. Ask them to imagine what would happen if there were no bees, or no bees of a particular species. Talk about the importance of creating awareness of the need

for conservation. Support the discussion by writing major points or questions on a white or blackboard or on sheets of brown paper that can be taped to the walls.

**Take home  
message**

The Hindu Kush-Himalayan region is home to unique species of indigenous honeybees which are themselves part of, and also help to maintain, the rich biological resources of the region. These bees provide people and the environment with enormous benefits. It is our collective responsibility to conserve them in their native habitat.

# Session 3 Resource Materials

## Bee Species in the Himalayas – Characteristics and Conservation

### Introduction

Honeybees are social insects and live in colonies. Their main source of nutrition is flower nectar and pollen. Five honeybee species are found in the Himalayas of which four are indigenous to the region (*Apis florea*, *Apis dorsata*, *Apis laboriosa*, and *Apis cerana*) and one has been introduced (*Apis mellifera*). Their major characteristics and differences are summarized below.

Figure 3: Little honeybee (*Apis florea*) colony



### Little honeybee (*Apis florea*)

- The smallest of the *Apis* species
- Found in hills and plains at altitudes up to 1,200 masl
- Open nesting honeybee; builds single small comb nests under small tree branches or bushes (Figure 3)
- Colonies migrate frequently if the nesting site and forage area is inappropriate
- Average honey yield is 1 kg per colony per year
- Honey regarded as having high medicinal value
- Efficient pollinator of crops and natural flora in the Himalayan foothills

Figure 4: Giant honeybee (*Apis dorsata*) colony on a tree branch



### Giant honeybee (*Apis dorsata*)

- Found in hills and plains at altitudes up to 1,000 masl
- Open nesting honeybee, prefers undisturbed nesting sites, usually on the top of tall trees, tall buildings, or water towers
- Builds single large comb nests, usually with several nests at one site (Figure 4)
- Migrates to the hills in summer and to plains areas in winter
- Highly defensive and performs mass attacks
- Honey production can be as high as 30–50 kg per colony per year
- Excellent pollinators of field crops, fruit, and natural flora

Figure 5: Himalayan cliff bee (*Apis laboriosa*) colonies on a rocky cliff face



### Himalayan cliff bee (*Apis laboriosa*)

- Found in hill areas from 1,200 to 3,000 masl
- Similar to *Apis dorsata* but darker and more defensive
- Prefers nesting in the open, mainly on large steep rocky cliff faces (Figure 5)
- Builds single large comb nests, bigger than the *Apis dorsata* combs, with many colonies nesting close together at one site

- Migrate from place to place depending on the season and availability of bee flora
- Average honey production is 60 kg per colony per year
- Excellent pollinators of crops and wild flora

### Asian or indigenous hive bee (*Apis cerana*)

- The only wild bee that can be kept in hives; traditionally managed by farmers in the region
- Found in all eight countries of the Hindu Kush Himalayan region, in plains and hills from below 300 masl up to 3,400 masl,
- The local race found in plains areas is smaller than the race found in hill areas
- A cavity nesting honeybee, which nests in hollow tree trunks, rock voids, and walls
- Builds multiple parallel combs; the number of combs depends on the colony size (Figure 6)
- Can be kept in log, wall, or movable frame hives and managed for commercial beekeeping
- A healthy colony has 25,000 to 30,000 bees
- Can produce up to 20 kg honey per hive per year, more in China
- Bees can fly up to 2 km from the hive to collect nectar, pollen, and water
- Has frequent swarming, absconding, and robbing tendencies that complicate managed beekeeping; characteristics can be improved through continuous selection of the best colonies
- Resistant to diseases and mites (especially European foulbrood and *Varroa* spp.)
- Excellent pollinators of fruit trees, field crops, oil seeds, and wild plants; colonies can be transported to fields for crop pollination; particularly useful for pollination of high mountain crops and plants.

Figure 6: Log hive containing *Apis cerana* comb



Min Bdr Gurung

### European honeybee (*Apis mellifera*)

- The only honeybee used for commercial beekeeping in most parts of the world (Figure 7)
- Originated in Africa and spread to Europe and Asia, introduced from Europe to the Americas and other countries throughout the world
- Can be kept up to around 1,500 masl, but needs to be moved to plains areas during winter and mountain areas in summer to exploit floral resources
- All eight countries in the Hindu Kush Himalayan region have started commercial beekeeping with this bee
- Builds multiple parallel combs
- A healthy colony contains 60,000 to 70,000 bees
- Average recorded honey yield per colony per year: 40 kg in Nepal, 35 kg in India, 20 kg in Bangladesh and Bhutan
- Bees can travel up to 5 km from the hive in a single foraging trip to collect nectar, pollen, water, and propolis
- Swarming and absconding tendencies quite low
- Susceptible to diseases and parasites (such as brood and mites); needs special management in terms of technology, knowledge, and skills
- Migration of bee colonies can increase honey productivity
- Excellent pollinator of fruit trees, field crops, oil seeds, and other crops

Figure 7: European hive bee (*Apis mellifera*)



Nabin Baral

## Differences between *Apis cerana* and *Apis mellifera*

Differences between these two species are summarized in Table 1.

Table 1: Comparison of *Apis cerana* and *Apis mellifera*

<i>Apis cerana</i>	<i>Apis mellifera</i>
Indigenous bee in the Himalayas (Asian honeybee)	Exotic bee in the Himalayas (European bee)
Can be kept at higher altitudes and in remote areas	Successful in plains areas
Can be kept from 300 masl to around 3,400 masl	Can be kept up to around 1,500 masl, but needs to be moved to plains areas in winter
A healthy colony has 25,000 to 30,000 bees.	A healthy colony has 60,000 to 70,000 bees.
Can fly up to 2 km from the hive in a single foraging trip	Can fly up to 5 km from the hive in a single foraging trip.
Frequent swarming, absconding, and robbing tendencies	Swarming and absconding tendencies quite low
Resistant to European foulbrood and <i>Varroa</i> mites (although susceptible to Thai sac brood virus)	Susceptible to brood diseases and mites; needs special management in terms of technology, knowledge, and skills
Can produce up to 20 kg honey per hive per year, more in frame hives in China.	Can produce up to 100 kg honey per hive per year in the Himalayan region
Colonies can be caught in the wild and maintained in simple log or wall hives with a minimum of inputs, although for commercial beekeeping, it is also necessary to use a frame hive.	Colonies must be purchased from bee apiaries or a bee breeder and can only be managed in a frame hive, which requires management skills
Can survive under harsh climate conditions such as low winter temperatures, extreme fluctuations of temperature, and long periods of rainfall; continues to fly on dull cloudy days; suitable for small scale stationary beekeeping	Requires migration to warmer areas in winter, intensive management practices, standardized equipment, and larger foraging grounds
Efficient pollinator throughout its entire range	In plains and lower altitude hill areas, efficient pollinator; available in the crop flowering season; easy to migrate where needed
Ideal characteristics for pollinating mountain crops; can work under cool and cloudy conditions; ideally suited as a pollinator of early flowering crops such as almonds, peaches, and plums	Cannot ensure pollination at higher altitudes; not available when needed by early flowering species in mountain areas
No capital outlay unless the first swarms are purchased; all the materials necessary can be collected locally; only minimal labour required for maintenance; bees in frame hives need only a small amount of feeding in the dearth period, doesn't need to be fumigated.	Migratory beekeeping expensive, vulnerable, and high risk in poorly accessible high mountain areas, with a lack of transport and communication facilities; training expensive, and does not make use of local knowledge, must be fed in the dearth season.
Honey has a comparative advantage in terms of quality and the selling points of being generally 'organic' and 'natural'	Requires chemicals to treat diseases and parasites and these may contaminate the honey

## Conservation of Honeybees

Bees are under threat the world over. Loss of bee forage areas, loss of floral diversity, loss of natural forests, the move to monoculture cropping, the wide use of pesticides, and more recently the transfer of pests and diseases are all contributing to a marked reduction in bee numbers.

The indigenous honeybees of the Hindu Kush Himalayas play a pivotal role in the maintenance of the region's biodiversity, as well as in pollination of mountain crops, especially at higher altitudes. Beekeeping with the Himalayan hive bee also offers a way for poor mountain farmers, and especially women and landless farmers, to earn some cash income without much investment. It can be used to support pollination in crops such as fruit, for example almonds, apples, apricots, and plums, and vegetable and vegetable seed crops at altitudes and in seasons where the European bee isn't active. At lower altitudes, beekeeping with the European bee can provide a massive boost to crop productivity through improved pollination, providing the basis for a small industry that generates considerable employment.

But the honeybees in the Himalayas are also threatened. Improved understanding of the benefits derived from bees, and the potential impact of their loss, will help people realize the need for conservation, and motivate governments and farmers alike to take action. Some of the actions needed are listed in the following.

- Expansion of bee forage areas
- Plantation of bee flora in forests and on degraded waste lands
- Reduction of deforestation, control of forest fires
- Adoption of organic farming or integrated pest management systems for crop protection
- Ensure traditional honey hunting practices are kept at a low and sustainable level to prevent brood destruction
- Enforce policies for the promotion and conservation of honeybees
- Raise awareness about the role of beekeeping in conserving the environment and biodiversity

Beekeeping can be a profitable enterprise and at the same time can help conserve the indigenous bee species if public awareness can be raised and the issues addressed at government and community level.

# Session 4 The Honeybee Life Cycle

## Sub-topics

- ▶ The life cycle of the honeybee
- ▶ The three kinds of adult bee

## Time: 1 hour

Theory: 30 minutes

Practical: 30 minutes

## Objectives

Trainees will

- know about the life cycle of the honeybee, and
- know about the three kinds of adult bee in a colony and their specific tasks.

## Training Methods

- Lecture
- Direct observation
- Discussion; question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- Movable frame hive with bee colony with brood (eggs, larvae, pupae) and all three kinds of adult
- Hive inspection materials and tools
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities and Exercises

### Activity 1: Presentation

Give a short presentation on the life cycle of the honeybee and the three kinds of adult bee in a colony as outlined in the resource materials (below). Use posters, photos, or PowerPoint slides to illustrate the talk.

### Activity 2: Observation in the apiary

- Step 1:** Inform the trainees about the precautionary measures to be taken before opening the hive for inspection
- Step 2:** Open the beehive and show the eggs, larvae, and pupae to the trainees so that they can clearly identify and understand the different stages in development of the bee brood (the stages in the life cycle). Ask trainees to identify the different stages on their own.
- Step 3:** Show the three kinds of adult honeybee (queen, workers, drones), and ask trainees to identify them on their own.

### Activity 3: Discussion and question and answer

Use in depth discussion and question and answer to discover whether the trainees can recognize and differentiate the different stages in the life cycle, and can identify the three types of adult bee and understand the way in which tasks and activities are divided among them.

#### Take home message

- It is important to understand the honeybee life cycle as it is the basis for activities such as queen rearing, colony multiplication, colony division, disease and pest management, and general apiary management.
- To be successful, a beekeeper must know about the different kinds of adult honeybee, their division of work, and their behaviour.

# Session 4 Resource Materials

## The Honeybee Life Cycle

### Introduction

Honeybees live together in a highly organized group called a colony. When bees are managed in hives, each hive houses a single colony. It is the colony that matters and tasks are accomplished through division of labour. Every member of the colony works not for itself, but for the benefit of the colony.

### Honeybee Life Cycle and the Different Types of Adult

#### The honeybee life cycle

A honeybee colony has three kinds of adult: queen, worker, and drone. Each goes through the same four developmental stages, but the time needed to complete each stage differs. The honeybee life cycle has four stages: egg, larva, pupa, and adult. The stages are further subdivided in terms of development (Figure 8).

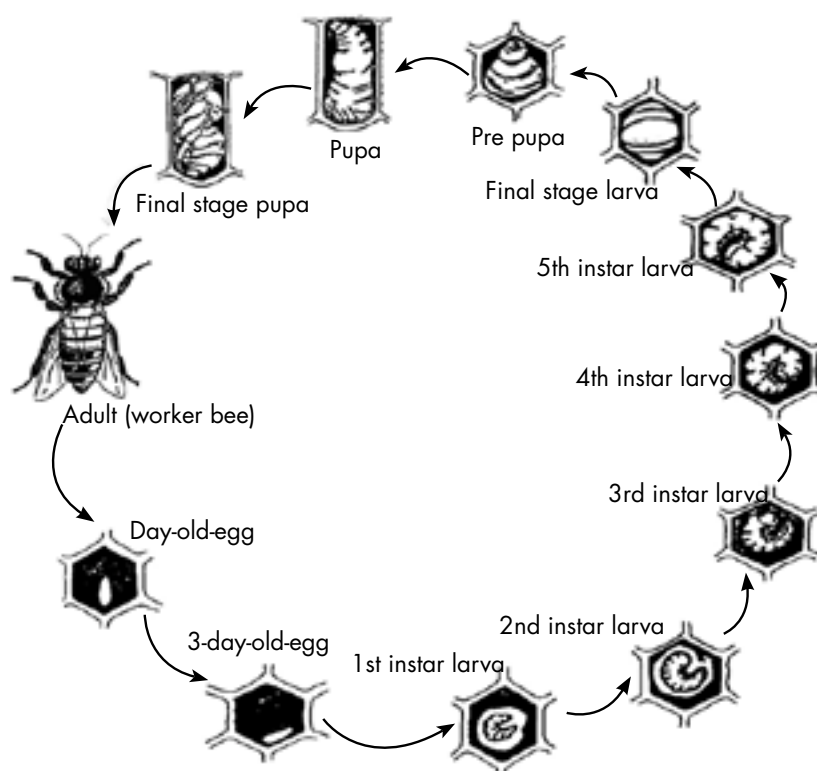
The average time taken for the different kinds of bee to complete each stage is summarized in Table 2 and explained in more detail below.

Table 2: Life cycle of different types of adult honeybee

	Egg stage	Larval stage	Pupal stage	Total time to adult emergence	Lifespan
Queen	3 days	5 days	7–8 days	15–16 days	2–5 years
Worker*	3 days	6 days	11–12 days	20–21 days	6 weeks to 6 months*
Drone	3 days	7 days	14 days	24 days	about 2 months

\* The age a worker bee reaches is determined by the distance it flies; the longer the flight time the shorter the lifespan.

Figure 8: The honeybee life cycle – egg to adult ('instar' refers to the stage between each moult)



## The life cycle stages

### Egg

- The queen inserts her head into a cell to see if it is clean and then lays a single egg. The eggs look like small white cylinders (Figure 9).
- The queen lays eggs for workers, drones, and queen production in specific worker, drone, and queen cells in a brood comb. The bees make the cells a different size for each type of adult.
- Queen eggs and worker eggs are fertilized, drone eggs are unfertilized.
- The egg stage lasts 3 days. At the start, the egg stands vertically on the base of the cell, then slants, and finally lies flat on the base before hatching.

Figure 9: Honeybee eggs inside cells



### Larva

- Small larvae hatch from the egg after 3 days. They are shiny white and curved, with no eyes (Figure 10).
- Queen and drone larvae grow to be larger than worker larvae.
- The larval period is 5 days for a queen, 6 for a worker, and 7 for a drone.
- The food given to the larvae differs. Queen larvae are fed royal jelly throughout the larval period; drone and worker larvae are fed royal jelly for 3 days and bee bread (a mixture of honey and pollen) for the remaining 3 or 4 days.
- The internal organs start to develop as the larvae grow. They moult several times and after the last moult they enter the pupal stage. The larval stage last 5 to 7 days depending upon the kind of adult they will become.

Figure 10: Honeybee larvae inside cells



Figure 11: Honeybee pupae inside cells



### Pupa

- The pupal stage is also called the dormant stage.
- Worker bees seal the cells with a porous beeswax cap and the larva spins a cocoon around itself (Figure 11). The developing bee remains inside the cocoon without eating or moving. The pupal stage lasts for 7–8 days for a queen, 11–12 days for a worker, and 14 days for a drone
- During this stage, the internal organs and body appendages develop. Finally the adult bees emerge.

### Adult

- The adults emerge from the cocoon and bite a hole in the top of the sealed cell to come out.
- Immediately after emergence, the adult workers are a light colour, and then become darker.
- The total time taken to develop from egg to adult is 15–16 days for a queen, 20–21 days for a worker, and 24 days for a drone (Figure 12).

Figure 12: *Apis cerana* queen and worker bees



- The life span of the different types of adult bee is different. A queen lives for 2–5 years, a worker for 6 weeks to 6 months, and a drone for an average of 2 months.

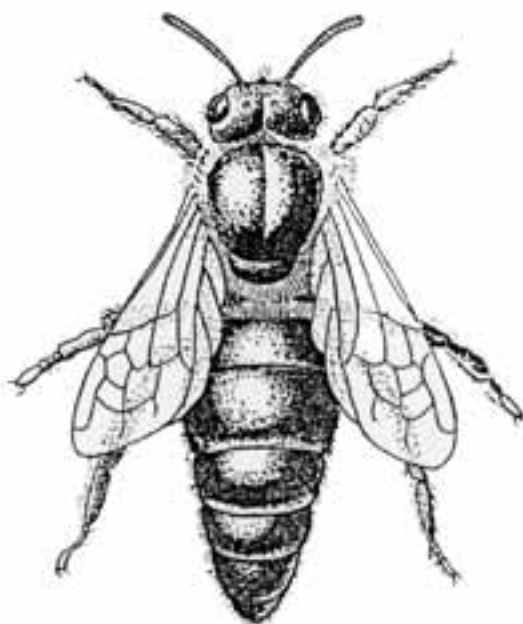
### The three kinds of adult honeybee

A healthy colony has three distinct types of individuals – queens, workers, and drones – each with a specific role.

#### Queen bee

- Each colony has a single queen bee irrespective of the colony size.
- The queen is the only egg laying bee and thus the mother of all the bees in the colony.
- The queen bee is larger than the worker and drone bees, has a black and shiny cylindrical and longer body, and a round and comparatively small head (Figure 13).
- The queen has a small sting at the end of the abdomen which is used for fighting with other queens if any are produced by the colony.
- At emergence, the virgin queen is comparatively smaller and moves fast on the comb, whereas the mated and egg-laying queen has a bulging abdomen and moves slowly.

Figure 13: **Queen bee**



#### Drone bees

- Drones are males produced from unfertilized eggs.
- A drone bee is larger than the worker bee, blackish and hairy (Figure 14).
- The drone population in a colony increases at the time of swarming and during the honey flow period; during spring and autumn in the plains and mid hill areas, and during summer in the high hills and mountains.
- Drones are fed by the workers.
- A colony will usually have a few hundred drones.

Figure 14: **Drone**



Figure 15: **Worker**



### Worker bees

- Workers are sterile females and develop from fertilized eggs.
- Workers are smaller than the drones and have yellowish-and dark brown abdominal stripes (Figure 15).
- The workers are the main group in a colony, with 60–70,000 in an *Apis cerana* colony and 25–30,000 in an *Apis cerana* colony.

# Session 5 Morphology and Work Division of Adult Honeybees

## Sub-topics

- ▶ Identification of body organs in the different kinds of adult
- ▶ Work division according to the kind of bee, age, and colony needs

## Time: 1 hour

Theory: 30 minutes

Practical: 30 minutes

## Objectives

Trainees will

- know the morphology of worker, queen, and drone bees; and
- know about the work division in a colony according to the type and age of bees, and colony needs.

## Training Methods

- Lecture and demonstration
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos, and anatomical drawings of the different kinds of adult honeybee
- Movable frame hive with bee colony
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture and demonstration

Give a short presentation on the morphology of queen, worker, and drone bees, and the work division in a colony as outlined in the resource materials (below). Use slides and photos to illustrate the talk, or large blown up photos and drawings in areas where there is no electricity.

### Activity 2: Discussion and question and answer

Use discussion and question and answer approaches to discover whether the trainees are clear about the morphology of honeybees and understand the work division according to adult type and age and colony needs.

### Take home message

- A colony has three kinds of adult bee, each with a specific morphology and anatomy suited to their function.
- Work is divided according to the type and age of the bees; all three kinds of adult bee are essential for the colony.

# Session 5 Resource Materials

## Morphology and Work Division of Adult Honeybees

### Morphology and Anatomy of the Honeybee

The honeybee is an insect and has a body divided into three parts: head, thorax, and abdomen (Figure 16).

#### Head

The head contains the eyes, mouth parts, antennae, hypopharyngeal gland, and salivary gland.

#### Eye

The honeybee has two flat oval compound eyes at the side of head and three simple eyes located in a triangular pattern between the compound eyes (Figure 17).

The compound eyes can detect the shape and colour of objects, but not light intensity, and are used for distant sight. The simple eyes detect light intensity and are used for near sight.

#### Mouth

The mouth is composed of the proboscis, mandibles, labrum, and labium (Figure 16).

Figure 16: **Morphology of a worker honeybee**

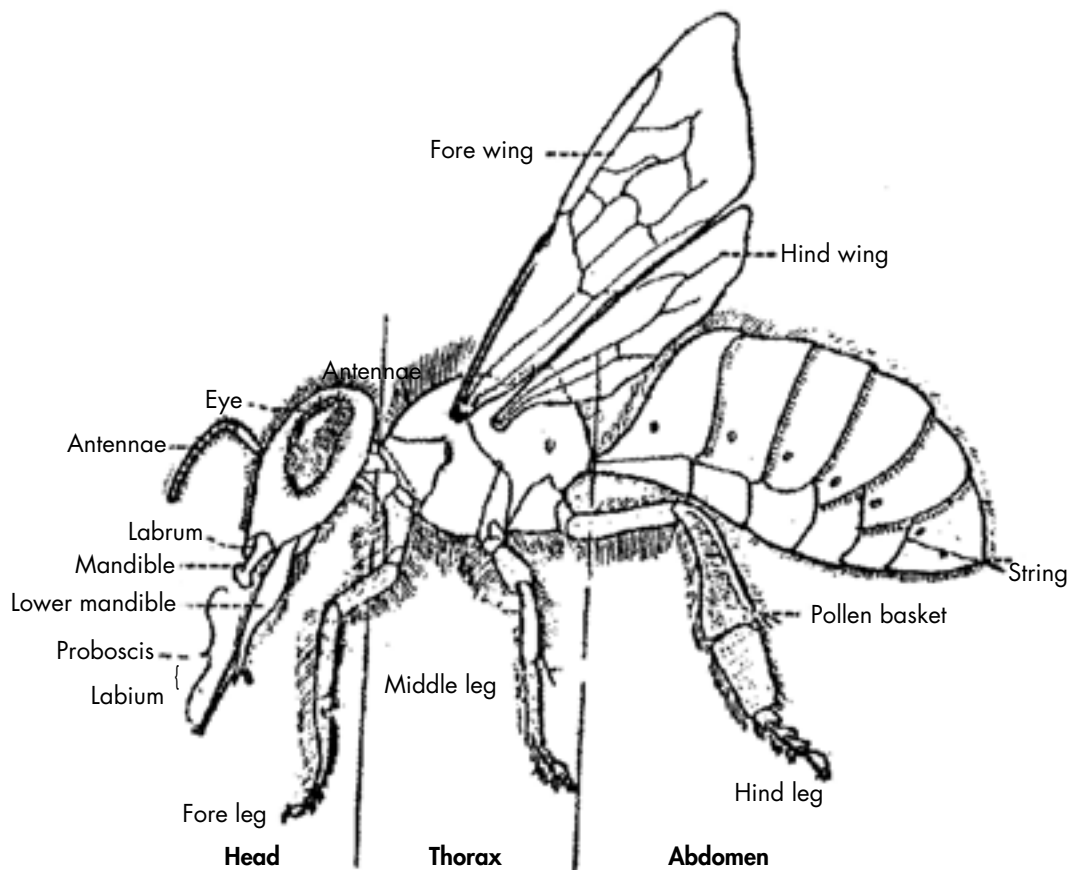
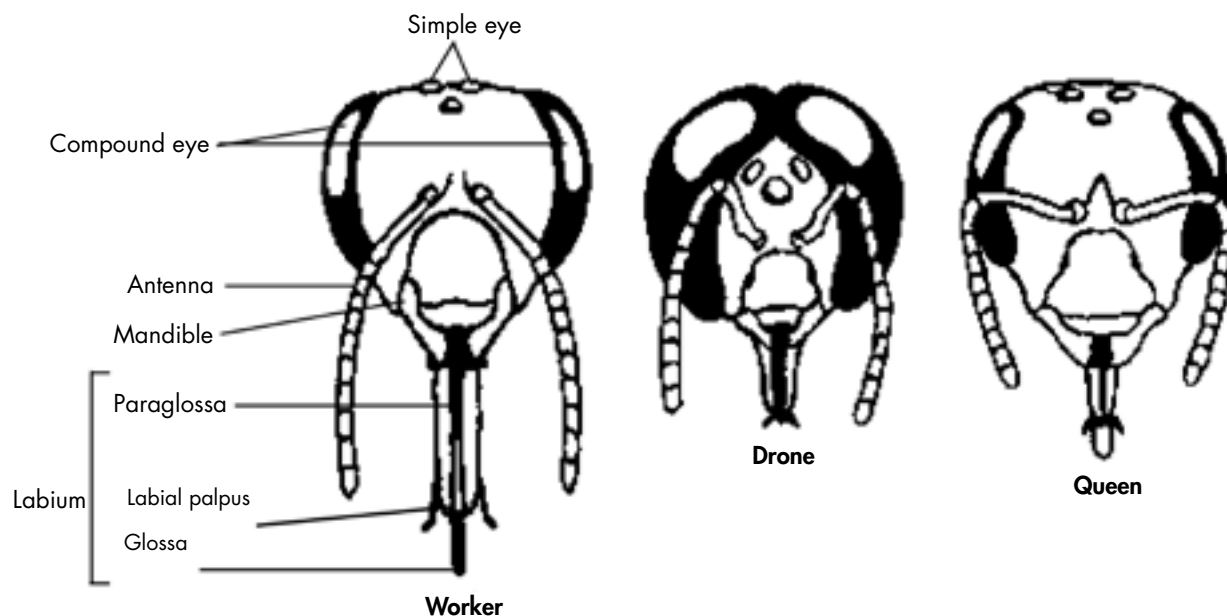


Figure 17: Head and mouth parts of the three types of honey bee



The proboscis is a flexible tube used to suck up liquids (nectar, water, honey) into the mouth. It is a temporary structure formed from the glossa, paraglossa, and galea and is folded behind the head when not in use.

The glossa is composed of an array of hairs that form a tube at the centre and a sponge-like structure at the end. The spongy hairs absorb the liquid which is sucked upward through the tube. The glossa functions as a tongue and can 'taste'. The sucking capacity of a honeybee depends upon the length of its proboscis. *Apis cerana* has a shorter proboscis (3.5–4 mm) and smaller nectar collection capacity; *Apis mellifera* has a longer proboscis (6.5 mm) and greater collection capacity.

The sickle-shaped mandibles are like paired 'teeth', one on each side of the mouth. They are used to collect pollen and propolis, to soften and manipulate wax by chewing, to clean other bees, and to bite workers from other colonies or pests.

The labium is formed from two fused secondary maxillae and is equivalent to the floor of the mouth; it assists in chewing.

The labrum is equivalent to the upper lip and supports the sucking process.

### Antenna

The head contains a pair of antennae which are used to detect smells, for touching, and to help balance the body during walking and fighting.

### Hypopharyngeal glands

Worker bees have a pair of hypopharyngeal glands on the head which secrete the food called royal jelly. Hypopharyngeal glands are large and active during the period in the worker bee's life when they are feeding royal jelly (see below), and then dry and inactive.

### Salivary glands

Worker bees have salivary glands in their mouth connected with the glossa ('tongue'). They produce saliva containing enzymes which is mixed with the food called 'bee bread' that worker bees prepare by grinding honey and pollen in the mouth. The enzymes help in food digestion.

## Thorax

The thorax is divided into three parts. It has three pairs of segmented legs and two pairs of wings (Figure 16).

## Legs

The three pairs of legs have different functions. The forelegs hold an antennae cleaner or pollen comb, the middle legs are used to clean the thorax, and the hind legs have a pollen basket for collection and carrying of pollen (Figure 18).

## Wings

The two pairs of wings are mounted on the dorsal (rear) segments of the thorax. The front (fore) wings are larger than the back (hind) wings. The pairs are connected by hamuli (hooked structures) which enables flight.

## Abdomen

The abdomen is divided into nine segments, which contain three major glands: the wax glands, scent gland, and poison gland.

## Wax gland

The fourth to seventh segments of the abdomen have white shiny wax mirrors located on their lower parts connected to four pairs of wax glands, which secrete liquid wax onto the mirrors to form wax plates. The pollen combs on the forelegs are used to scrape the wax off and move it to the mandibles where it is ground and mixed with the secretion from the salivary gland (saliva) before being used to build combs.

## Scent gland

The seventh abdominal segment contains a wide pale-yellow stripe connected to a scent-producing gland inside. The scent is used for the identification of friends and foes.

## Poison gland and sting

The seventh abdominal segment contains a pair of poison glands (made from merging the eighth and ninth segments) connected to a sting. The sting has curved barbs which stick in the bodies of mammals. When the bee flies off after stinging, the sting usually separates from the brackets, pulling out part of the bee's abdomen, and the bee dies.

Bee venom (apitoxin) is a complex mixture of proteins (enzymes), peptides, amines, and other compounds.

Figure 18: **Pollen basket: a) hind leg showing position of pollen basket; b) worker bee with filled pollen basket**

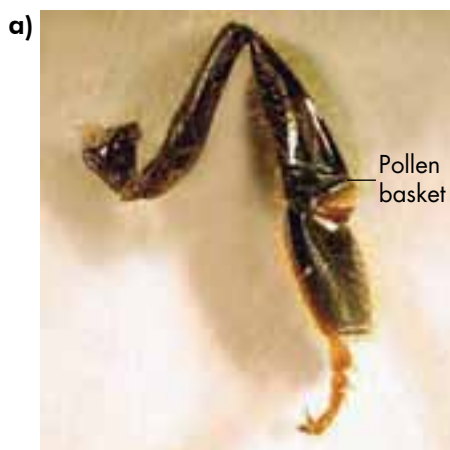
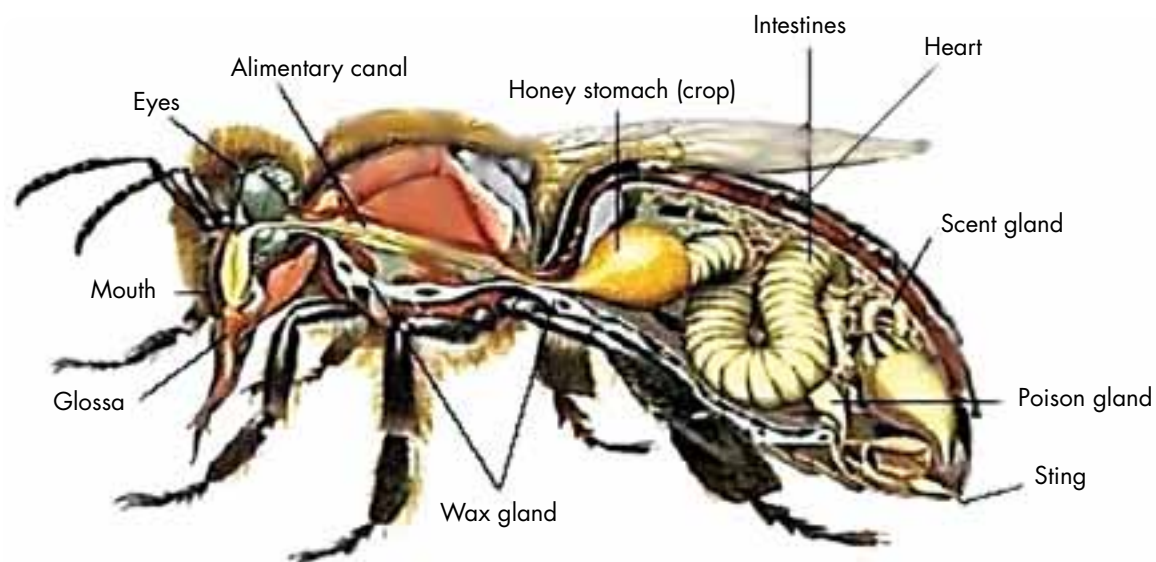


Figure 19: **Internal anatomy of the honeybee**

Bee venom is commonly used in traditional medicine, but high doses can be lethal. The lethal dose for a human is equivalent to about 600 stings for an adult, or 90 stings for a small child. However, most human deaths result from just one or a few bee stings as a result of allergic reactions, heart failure, or suffocation from swelling around the neck or the mouth.

### **Internal Anatomy of the Honeybee**

Figure 19 shows the main features of the internal anatomy of the honeybee.

#### **Honey stomach or crop**

The honeybee alimentary canal passes from the mouth through the thorax to the fourth segment of the abdomen where it connects to an enlarged sac called the honey stomach or crop. Nectar is stored in the crop temporarily after collection and regurgitated after the bee returns to the hive, where it is passed to a house bee who stores it in a honey cell. A thick membrane inside the crop prevents the nectar from passing into the intestine.

#### **Respiration**

The honeybee abdomen has ten pairs of small breathing pores called spiracles: three on the thorax and seven on the abdomen (to the right and left of the body). They are connected to the tracheal trunk via air sacs for respiration.

#### **Circulatory system**

The heart is a long slender tube extending from the thorax and connected to the aorta which runs forward to the head. The ventral (lower) part of the abdomen does not have any blood vessels.

#### **Nervous system**

The brain is a very small organ located in the upper portion of the head and joined by sensory nerves to the eyes, antennae, and frontal mouth parts. The brain coordinates and regulates the functions of all the bodily systems.

#### **Reproductive organs**

The reproductive organs of the drone comprise a pair of small flattened testes at the side of the abdomen. The testes produce spermatozoa which are ejaculated via an ejaculatory duct.

The reproductive system of the queen consists of a cylindrical ovary composed of narrow tubes. The ovary produces eggs, which pass out through an oviduct. The semen received during mating with drones is stored in an organ called the spermatheca, which is connected with the oviduct.

Workers are sterile females and have poorly developed reproductive organs. Egg laying workers can develop reproductive organs in the absence of a queen, but can only lay unfertilized eggs.

## Work Division of the Different Kinds of Honeybee

### Queen bee

- The primary task of a queen bee is to lay eggs.
- The virgin queen flies out on a warm, sunny day around 3–8 days after emergence to a 'drone congregation area', where she mates in flight with a number of drones from her own or other colonies (10 to 20 or so). She may return to the area for several days until she is fully mated. She stores the sperm in a structure called the spermatheca from where it is selectively released over her lifetime.
- The queen starts laying eggs 3–7 days after mating.
- The queen can lay fertilized and unfertilized eggs. Eggs are fertilized just before laying using the stored sperm. Fertilized eggs become female workers or queens; unfertilized eggs become male drones.
- A healthy *Apis cerana* queen can lay around 800 eggs per day; an *Apis mellifera* queen can lay up to 2000 eggs per day.
- The queen bee is also responsible for colony mobilization. She releases a pheromone which determines all the functions of the colony, including identification, foraging, swarming, and absconding.

### Drone

- The only task for a drone is to mate with a virgin queen.
- After mating, the workers stop feeding the drones and they die.

### Worker bee

- All the work in a honeybee colony is performed by the worker bees, including honey and pollen collection, brood rearing, building combs, feeding the drones and queen, cleaning the hive, and defending the colony.
- The specific activities are defined by the age of the bee (Table 3), with tasks inside the hive for the first 3 weeks after emergence (comb building, brood care, hive cleaning, thermoregulation, queen care, honey ripening) and then outside (foragers and scouts). Under special circumstances, workers can perform any kind of task irrespective of age as per the need of the colony.
- Normally workers do not lay eggs. However, in the absence of a queen, queen cells, or eggs for 2 weeks (*Apis cerana*) or 3 weeks (*Apis mellifera*), they start laying eggs. These workers are called laying workers. They lay unfertilized eggs which develop into drones, and the colony may slowly collapse.

Table 3: Age-related activities of worker bees

Age	Tasks
1–3 days	Walk; cluster and warm brood; eat any scattered food; clean cells
3–6 days	Nurse maturing larvae; feed larvae with honey and pollen (bee bread)
6–12 days	Produce royal jelly from the hypopharyngeal gland which develops in the head; feed royal jelly to worker and drone larvae until they are 3 days old, and to the queen bee throughout her life.
12–18 days	After the hypopharyngeal gland dries up, produce wax for building combs from the four pairs of wax glands that develop at the ventral edge of the abdomen; build combs
18–20 days	After the wax glands stop secreting, guard and defend the hive entrance using the newly developed venom gland and sting
More than 21 days	For the remainder of their life, act as foragers and collect nectar, pollen, propolis, and water from the surrounding area



# Day 2

## Review of Day 1

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**Session 6:** Beehives and Beekeeping Equipment

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**Session 7:** Colony Inspection

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**Session 8:** Annual Colony Cycle and Seasonal Management

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**Session 9:** Swarming

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**Session 10:** Absconding

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# Session 6 Beehives and Beekeeping Equipment

## Sub-topics

- ▶ Types of bee hive, identification and use
- ▶ Identification and use of modern beekeeping equipment

## Time: 1 hour

Theory: 15 minutes

Practical: 45 minutes

## Objectives

Trainees will

- be able to identify and use beehives and other beekeeping equipment.

## Training Methods

- Lecture
- Demonstration and discussion

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- Movable frame beehive (empty)
- Other beekeeping equipment

## Activities and Exercises

### Activity 1: Lecture

Give a short presentation on the design of movable frame hives, and the various pieces of equipment and accessories used in modern beekeeping as outlined in the resource materials (below). Discuss the basic use of beehives and methods for identification. Use slides, photos, and drawings to illustrate the talk.

### Activity 2: Demonstration of equipment and discussion

Show the trainees the hive(s) and equipment. Let them handle and try out the hive and different pieces of equipment while discussing among themselves. Answer, or allow other trainees to answer, any questions they may have on the equipment.

## Take home message

- Beekeeping equipment is very important for apiary management in modern beekeeping.
- The quality of honey production is determined in part by the standard and cleanliness of the beekeeping equipment used by the beekeepers.

# Session 6 Resource Materials

## Beehives and Beekeeping Equipment

### Introduction

Colony inspection and management, and harvesting of honey are quick and easy with a movable frame hive and the appropriate beekeeping equipment. The main pieces of equipment and accessories are described in the following.

### Hives

#### Movable frame hive

A movable frame hive has two types of chamber: the super chamber for honey production and the brood chamber. The super chamber is only added during the honey flow season. (Where productivity is very high, more than one super can be added, but this is very uncommon in the Hindu Kush-Himalayan region.) The standard design used for *Apis mellifera* is a Langstroth hive, first patented in 1852 and still used throughout the world. The advantage of this hive is that the bees build honeycomb into frames – wooden rectangles designed to hold a comb, which are slotted downward into grooves from the top of the hive and can be easily lifted out. The frames are set at a fixed distance from each other, which is calculated to prevent bees from attaching honeycombs where they would connect adjacent frames or connect the frames to the walls of the hive.

The queen can be excluded from the super chamber, which allows combs to be built that contain only honey with no brood. Both the brood chamber and the super are designed to take ten frames, but in general the super is not as tall as the brood chamber and the super frames are not as long as the brood chamber frames. When colonies are small or weak and cannot build combs on all frames, individual frames can be replaced with a dummy board, which is solid and can't be used to build a comb. The dummy board fills the empty space and helps the colony to keep warm.

A smaller beehive called a Newton hive is used for *Apis cerana*. It is constructed in the same way with ten frames in each chamber, but the dimensions of both hive and frames are smaller than those of the Langstroth hive, as is appropriate for the smaller bees.

The main parts of a hive are shown in Figure 20. They include a bottom board, entrance, brood chamber, brood frames, super (honey chamber), super frames, inner cover and outer cover, with a ventilation hole covered with wire netting.

#### Nucleus beehive

A nucleus hive is a small beehive with only four or five frames which is used for colony division or to maintain bees (Figure 21).

#### Mating hive

A mating hive is a small hive filled with nursing bees and brood frames without a queen (Figure 22). A matured queen cell at a stage 1 or 2 days before emergence is put into the mating hive. After emergence, the virgin queen is nourished by the nurse bees. She mates with drones within a few days and starts laying eggs. If the egg laying pattern is good, she can be sold or used to replace a queen in a colony (requeening).

#### Hive stand with bowl

A four-legged stand is used to raise the hive and help protect it from ants. Each leg should stand in a bowl filled with water (Figure 23) to prevent ants entering.

## Hive Accessories

### Queen excluder

A queen excluder (Figure 24) can be placed between the brood chamber and the honey chamber to prevent the queen entering and laying in the honey chamber. The size of holes in the excluder is designed so that the queen bee cannot pass through but workers can.

Figure 20: **Parts of a movable frame hive**

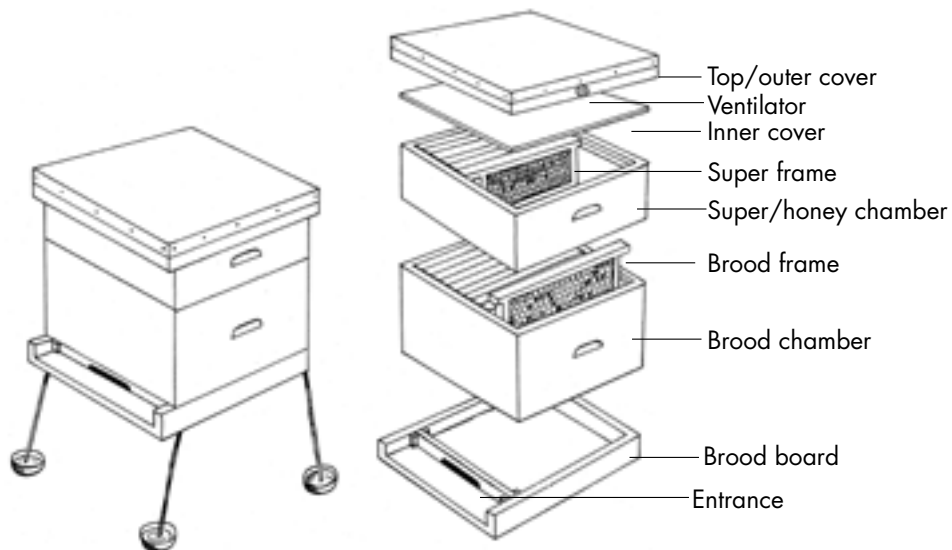


Figure 21: **Nucleus beehive**



Figure 22: **Mating hive**



Figure 23: **Hive stand with bowls**



Figure 24: **Queen excluder**



### Queen gate

A queen gate made of aluminium (Figure 25) can be placed at the entrance of the beehive to prevent the queen flying out under certain conditions:

- until a queen bee has become accustomed to a new hive,
- during swarming and absconding, and
- after transferring a colony to a movable frame hive following swarming.

Do not use a queen gate if there is a virgin queen in the colony as it will prevent her from going out on a mating flight.

Queen gates are generally used in *Apis cerana* beekeeping, there is rarely any need for them with *Apis mellifera*.

### Pollen trap

A pollen trap is a piece of equipment for collecting the pollen pellets from worker bees returning to the hive (Figure 26). There are many different designs and ways of positioning a trap, but the principle is always the same. A screen or grid is placed at the entrance of the hive so that the bees must pass through it to enter. As the bees go through the grid, the pollen pellets are dislodged from the hind legs and fall into a collecting box or tray below. The size of the hole in the grid is the crucial factor, the pellets must be dislodged without hindering the bees' flight. A typical screen would be 5-mesh hardware cloth or 3/16 inch (5 mm) diameter perforated sheet. The collecting tray is covered with a finer mesh screen so that bees can't enter it.

### Feeder

A jar or frame feeder can be used to feed the bees during periods when wild food is unavailable, insufficient, or inaccessible, for example, in winter and the rainy season. A jar feeder is made by making small holes in the lid of a plastic jar with a heated needle (Figure 27). The jar is filled with sugar syrup and inverted over the central hole of the inner cover of the brood chamber to feed the colony. A frame feeder is made out of two parallel pieces of wood or plywood with a gap between and is the same size as a brood frame (Figure 28). The frame feeder is filled with sugar syrup and placed upside down in the brood chamber. The bees feed on the solution coming out through holes made in the lid.

Figure 25: **Queen gate**



Figure 26: **Pollen trap**



Figure 27: **Jar feeder**



Figure 28: **Frame feeder**



Figure 29: **Comb foundation**Figure 30: **Comb foundation press**Figure 31: **Smoker**Figure 32: **Bee veil**

## Comb foundation

Prepared comb foundation sheets made of beeswax with a raised pattern of cell outlines are used to maximize the profit in modern beekeeping (Figure 29). Comb foundation for *Apis mellifera* is designed to fit the Langstroth hive brood frames and can be cut to fit the super frame. Comb foundation for *Apis cerana* is designed to fit the Newton hive; it is smaller and has a smaller cell size. Bees build cells on both sides of the foundation for laying eggs or storing honey. Comb foundation saves the bees time and energy in building new combs, which increases the honey yield. Because the bees follow a preset pattern for building, the combs are straight and regular and easier to handle. It is only possible to use a honey extractor if the comb is built on comb foundation.

## Comb foundation press

A comb foundation press is made of sand and cement, cemented into a wooden frame (Figure 30). The upper and lower surfaces are imprinted deeply with a comb cell pattern. Melted wax is poured onto one side and the frame closed. The solidified sheet can be pulled off the cement base and has a raised pattern of cells on both sides. Comb foundation can also be made using iron rollers with an imprinted cell base pattern. Plain wax sheet is rolled between the rollers which print a cell base pattern on both the sides of the sheet.

## Colony Inspection and Maintenance Equipment

### Smoker

A smoker is used to smoke the honeybees and subdue them when opening a beehive for inspection or honey harvesting (Figure 31). When worker bees smell smoke they fill themselves with honey and are less able to sting, and the smoke encourages the bees to leave the combs. Any slow burning material can be used in the smoker such as old dry sacking, rotten wood, rags, or dried leaves. The smoker shown in Figure 31 has a bellows attached. A few puffs of smoke at the entrance and the central hole of the inner cover at the top of the opened hive are usually enough to calm the bees.

### Bee veil

A bee veil is used to protect the face and head from bee stings while handling bees (Figure 32). The bee veil must be fixed tightly to the shoulder at the base to prevent the bees entering inside. It can be made from any wide-brimmed hat using black net and cloth. The black net provides good visibility for inspecting the colony. A bee veil is important for good colony management.

## Gloves

Gloves are used to protect the hands from bee stings and to keep bees from crawling up inside the sleeves (Figure 33). They should be thick enough to prevent the sting reaching the skin but thin enough for the beekeeper to feel through. They are usually made of soft leather, and may have canvas or cotton forearm coverings and ventilation on the forearm. Sometimes, the entire glove is made of canvas and cotton, but leather is more sting-resistant. Gloves are useful for beginners to help them develop confidence in handling bees. But handling frames with gloves is cumbersome and experienced beekeepers rarely use them.

Figure 33: Gloves



## Hive tool

A hive tool (Figure 34) is used to pry apart the frames from the brood or super chamber and/or to separate frames glued to each other with propolis or wax. Using the tool to pull out the frames while inspecting the colony or during honey harvesting doesn't disturb the bees. A hive tool is especially important for hives with *Apis mellifera* as they collect propolis and use it to seal hive cracks and gaps between the frames and the hive body.

Figure 34: Hive tool



## Bee brushes

Two types of brushes are used in beekeeping. A soft brush is used to remove honeybees from the frame, and a rough brush is needed for cleaning the bottom board and inner cover (Figure 35).

Figure 35: Bee brushes (soft and rough)



## Wooden or bamboo swat

A fly swat (Figure 36) is used to kill bee predators such as wasps and hornets that are trying to catch bees by flying near the hive entrance or around the beehive.

Figure 36: Fly swat



## Honey and Wax Processing Equipment

### Honey extractor

A honey extractor is essential in modern beekeeping (Figure 37); it is used to extract honey without destroying the combs. This helps to increase the honey yield as the empty combs can be reused in the super and bees do not have to spend time building new combs. The honey quality is also better than that of honey extracted by manual squeezing. The honey frame is taken out of the super, the wax is uncapped using a warm knife, and the frame is put in the extractor. Usually the extractor is designed to take two or four frames. In a tangential extractor, honey is extracted from one side of the frame, and the frame

Figure 37: **Reversible type stainless steel honey extractor**



is then taken out, turned, and replaced to extract the honey from the other side. In a reversible extractor, both sides can be extracted without removing the frame. Stainless steel extractors give the best quality honey.

### Knife

A sharp long knife is needed to uncap the sealed honey combs and to cut up old combs (Figure 38).

### Honey strainer

The harvested honey may contain all sorts of impurities such as bee's wings, legs, combs, and wax. The honey is poured through a stainless steel strainer (Figure 39) or cloth to remove the contaminants.

### Wax melter

A melter is needed for melting the beeswax; it can be electrical or solar powered (Figure 40). This is a cheap and easy way of melting wax which does not affect the wax quality or smell. Hot water can also be used for melting and processing wax.

## Swarming, Migration, and Bee Management Accessories

### Queen cage

A queen cage is a small netted box used to caging a queen under certain conditions. The box looks like a matchbox made with wood and iron net (Figure 41). It is used during requeening, transferring bees from one hive to another, and capturing and/or hiving a swarm. It helps the beekeeper to find the queen and hive her easily.

### Carrying cage

A carrying cage is used for transporting a bee colony from one place to another. It is similar to a beehive but much smaller and can hold only 3 or 4 frames (Figure 42). The top cover has a handle for carrying and is well ventilated.

### Swarm bag

A swarm bag can be used to capture a swarm during swarming or absconding, and to transport a colony from one area to another. The bag is made of thin cloth or nylon net (Figure 43).

Figure 38: **Knife**



Figure 39: **Honey strainer**



Figure 40: **Solar wax melter**



### Queen cell protector

A queen cell protector is made of plastic or thin wire netting and shaped like a queen cell but larger (Figure 44). It is used to protect a new queen from an older queen or another emerging queen during swarming and other situations.

Figure 41: **Queen cage**



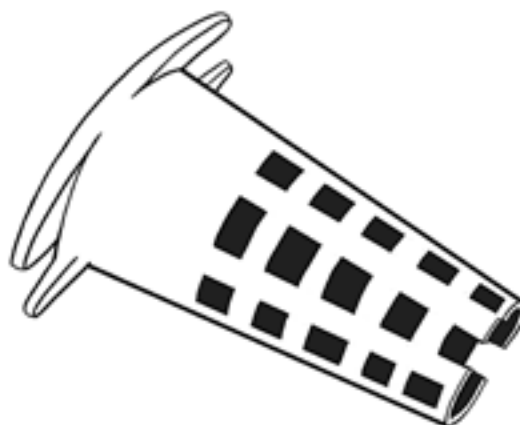
Figure 42: **Carrying cage**



Figure 43: **Swarm bag**



Figure 44: **Queen cell protector**



# Session 7 Colony Inspection

## Sub-topics

- ▶ Preparation for colony inspection
- ▶ Suitable weather and time
- ▶ Colony inspection (from outside and inside)
- ▶ Record keeping

## Time: 1 hour

Theory: 15 minutes

Practical: 45 minutes

## Objectives

Trainees will

- know why, when, and how to inspect a colony,
- be able to inspect the colony from outside and from inside after opening the hive, and
- be able to keep an apiary record.

## Training Methods

- Lecture
- Practical exercise with colony observation
- Question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos of colony inspection
- Movable frame hive with honeybees
- Colony inspection materials (bee veil, hive tool, smoker, globes, brush, knife, bee gloves, colony inspection forms, pen)
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture

Describe the reasons for colony inspection and the way it is carried out as outlined in the resource materials (below). Discuss the appropriate timing, the precautionary measures to be used, and the steps to follow. Use PowerPoint slides and photos to illustrate the talk, or large blown up photos and drawings in areas where there is no electricity.

### Activity 2: Practical exercise

- Step 1:** Demonstrate the observations to be taken and activities to be carried out during a colony inspection.
- Step 2:** Divide the trainees into four or five groups and ask each group to carry out a colony inspection by opening the hive following the steps described in the resource material.
- Step 3:** Ensure that each group fills out a record of the inspection on a colony inspection form.

### Activity 3: Discussion and question and answer

Use in depth discussion and question and answer approaches to discover whether trainees are fully clear about the importance of colony inspection, the best time to do it, and the actual techniques of inspecting and recording, including safety precautions.

#### Take home message

- Beekeepers should consider the weather and time when planning an inspection.
- They should undertake the inspection as quickly as possible, while taking due care.
- Diseased and angry colonies should be inspected last; hands and equipment should be washed thoroughly with soap after an inspection.

# Session 7 Resource Materials

## Colony Inspection

### Introduction

Bee colonies must be inspected in order to know the status of colony development, whether any diseases are present, whether there is a queen, the amount of brood (eggs, larvae, and pupae), and of food (pollen and nectar stores). This information helps in determining and planning seasonal management practices. Colony inspection is performed from outside and inside (by opening the hive).

### Appropriate Weather and Time

The best time to inspect a colony depends on the weather and also the bees' daytime routine.

- Inspection should be carried out during clear and calm weather.
- Inspection should not be carried out when it is hot and bright, cold, cloudy, or threatening storms or rain.
- Colony inspection is easier when a large number of bees are out foraging and fewer are in the hive.

The appropriate times and recommended inspection frequency at different locations are summarized in Table 4.

**Table 4: Appropriate time for colony inspection**

Area	Season	Time of day	Inspection frequency*
Hills and mountains	Winter	11:00 to 14:00	Every 3 to 4 weeks
	Summer	08:00 to 10:00 and 16:00 to 18:00	Every 10 to 15 days
Foothills and plains	Winter	10:00 to 14:00	Every 3 weeks
	Summer	07:00 to 10:00 and 16:00 to 18:00	Every 10 days

\*Colony inspection should be carried out at 2 to 7 day intervals if the colony has shown a swarming impulse or signs of disease or pests, and after introducing a new queen or queen cell.

### Colony Inspection from Outside

Colony inspection from outside provides an idea of the colony status without opening the hive. It can provide the following information about a bee colony:

#### Health

- A larger number of incoming and outgoing bees and pollen carrying foragers at the hive entrance indicates that the colony is strong and healthy.

#### Potential problems

- Larvae, pupae, and newly-emerged bees scattered at or in front of the entrance indicates that the colony is diseased.
- Bee excreta and black patches seen around the entrance indicates that the colony is abnormal or diseased.
- Many dead bees with an extended proboscis scattered at or in front of the entrance indicates that the colony has been poisoned.
- Bees crawling and unable to fly indicates bee disease.
- A large number of bees on flight, fighting with each other, and fighting to the death indicates robbing.

- Clustering of bees at the hive entrance with only a few flying to forage may indicate absconding or swarming.
- A large number of drones and erratic bee movement may indicate worker laying or a queenless colony.

If any signs are seen indicating possible problems, then the colony should be inspected from inside by opening the hive and the problem solved as soon as possible.

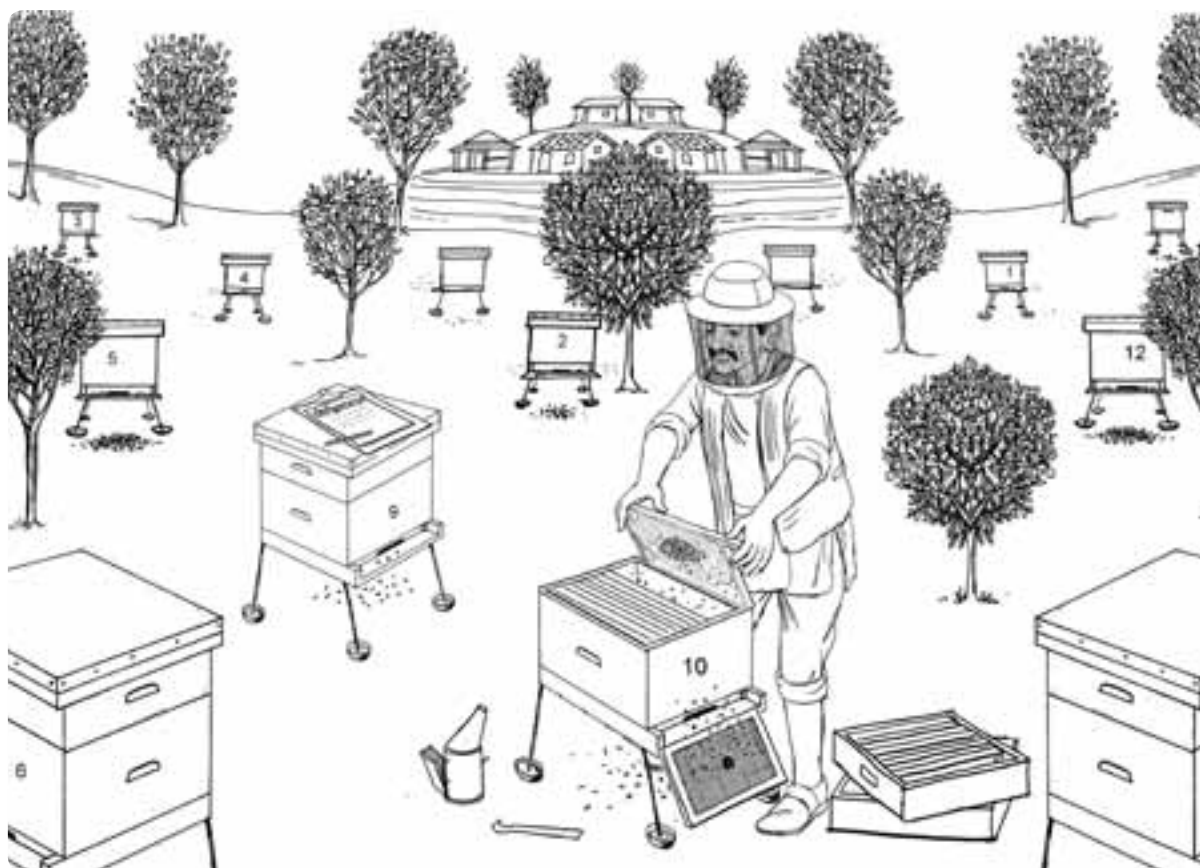
## Colony Inspection from Inside

Inner inspection is carried out after the outer inspection to confirm the colony status, strengths, and any abnormalities, and to perform any necessary management practices (Figure 45). The inner inspection of a colony should be carried out with a clear set of objectives. The necessary equipment should be gathered together before inspection starts. Observations should include the following:

- Condition of the queen
- Colony strength – number of adult bees and amount of brood (eggs, larvae, and pupae)
- Food stores (honey and pollen)
- Presence of pests and disease
- Symptoms of swarming and absconding
- Need to provide more frames with comb foundation or combs
- Cleanliness and hygiene
- Need to remove unnecessary, deformed, or additional combs built by the bees

A commercial beekeeper with many hives may inspect a sample to gain an idea of the general condition of the apiary.

Figure 45: **Bee colony inspection**



## Preparation

The following equipment and accessories should be collected together before the inspection:

- Bee veil
- Hive tool
- Knife
- Smoker or cotton cloth roll
- Gloves if wanted
- Observation form
- Pen

## Steps in inspection

- Stand beside the hive (standing in front of the hive disturbs incoming and outgoing bees).
- Give 2–4 puffs of light smoke from a smoker or roll of smouldering cotton cloth at the hive entrance.
- Lift off the outer cover and lay it upside down in front of the hive. Smoke the hive lightly through the hole of the inner cover. Remove the inner cover and place in a slanting position next to the hive stand. If the queen is seen while taking out the inner cover, she should be kept safely inside the hive.
- If there is a super, take it off and stand it safely on the outer cover.
- Remove any dummy boards or frame feeders from the brood chamber and put them down outside.
- Inspect the brood frames carefully on both sides one after the other by holding and rotating; make sure that the pollen, nectar, and queen and nurse bees don't fall outside the hive.
- Replace the brood frames carefully after each has been inspected.
- Replace any dummy boards or frame feeders, and/or replace with frames with empty combs or comb foundation.
- Replace the super, refit the inner cover, and cover the hive with the outer cover.
- Record the observations in the observation sheet while inspecting the colony. A sample observation sheet is shown in Table 5.

**Table 5: Colony inspection record sheet**

Apiary site			Colony number				Age of queen			Remarks
Date	Total number of combs		Bee status				Food storage		Presence of disease	
	Total brood	Honey	Adults	Eggs	Larvae	Pupae	Nectar	Pollen		

Excellent = + + +      Medium = + +      Poor = +      Nil = –

## Note the following

- The inspector should wear unscented, clean, and colourless clothes.
- The inspection should be carried out quickly and gently.
- Continue the inspection even if the bees sting, without becoming over-excited. Stings should be removed gently.
- If the bees are angry and defensive, immediately close the hive by replacing the cover.
- Strong and healthy colonies should be inspected first followed by weak or diseased and angry colonies.
- If the queen is seen in a brood frame while inspecting, take extra care and replace in the brood chamber immediately.
- After inspecting diseased colonies, wash hands and any equipment and accessories thoroughly with soap and water before inspecting another (healthy) colony. Otherwise wash hands and equipment with soap and water at the end of the inspection.

# Session 8 Annual Colony Cycle and Seasonal Management

## Sub-topics

- ▶ Location and seasonal factors affecting the colony cycle
- ▶ Colony management during the honey flow season
- ▶ Colony management in the off season

## Time: 1 hour 30 minutes

Theory: 45 minutes

Practical: 45 minutes

## Objectives

Trainees will

- understand the annual cycle of the honeybee colony, and
- be able to plan and carry out year round management of bee colonies including seasonal honey harvesting and periodic colony and brood management.

## Training Methods

- Lecture
- Practical exercise
- Discussion and question and answer

## Materials

- LCD projector, PowerPoint slides, diagrams, photos
- Movable frame hive with bees
- Beekeeping equipment
- Materials for colony inspection (see Session 7)
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture

Give a presentation on the annual colony cycle and seasonal management activities as outlined in the resource materials (below). Explain the differences between the honey flow and dearth periods and discuss seasonal honey harvesting and the periodic colony and brood management activities. Use PowerPoint slides and photos to illustrate the talk, or large blown up photos and drawings in areas where there is no electricity.

### Activity 2: Practical exercise

- Step 1:** List and describe the various seasonal and periodic activities.
- Step 2:** Ask one trainee to open a hive
- Step 3:** Inspect the colony, pointing out the findings to the trainees, and discuss the activities that need to be carried out based on the results of the inspection. For example, some colonies may need supplementary feeding or more comb foundation may be needed.
- Step 4:** Show the trainees how artificial feeding is done and add comb foundation

### Activity 3: Discussion and question and answer

Use discussion and question and answer approaches to discover whether the trainees understand the need for regular and seasonal colony management and know when and under what circumstances the specific activities are needed.

#### Take home message

- Beekeepers should be able to develop strong colonies by using appropriate colony management practices 2 months before the honey flow season and developing at least a 10 frame colony during the onset of honey flow.
- They should know how to prepare the hives, and should collect together the necessary equipment and accessories in time for the honey flow period.
- Dearth is an emergency period for honeybees. Beekeepers should provide sufficient supplemental food to maintain colonies and should take measures to protect them from pests.
- Beekeepers need to be aware of ways in which they can save a colony from destruction and prevent absconding.

# Session 8 Resource Materials

## Annual Colony Cycle and Seasonal Management

### Annual Cycle of a Colony

The annual cycle or pattern of a honeybee colony reflects the process of sustaining the colony around the year based on the climatic conditions and weather, and the availability of forage. The annual cycle is affected by seasonal change. The morphology, anatomy, and genetic character of honeybees is adapted to allow continued development and maintenance of a colony even under unfavourable climatic conditions.

### Seasonal Colony Management

Seasonal colony management is the set of management practices designed to meet the different needs of a colony over the year. Colony management is an integral part of modern beekeeping and is essential to maximize honey production, for colony division, for the production of other bee products, and for providing pollination services. The honey flow period is the time when the most flowering plants are available for forage. The off season or dearth period is the time when little forage is available and the climatic conditions are unfavourable for foraging. The timing of these periods differs in different locations. The approximate timings at different altitudes of the Himalayan region are provided as a guide in Table 6.

**Table 6: Honey flow and dearth periods at different altitudes in the Himalayas**

	Honey flow season	Off season (dearth)*
High hills	April, May, June, July, August	September, October, November, December, January, February, March
Mid hills	April, May, September, October, November, February, March	June, July, August, December, January
Foothills and plains areas	April, October, November, December, January, February, March	May, June, July, August, September

\* The honey flow and off (dearth) seasons vary according to forage source and exact location

### Flow Season Management

The honey flow season is very important for both bees and beekeepers. This is the time for increasing colony strength, honey production, colony multiplication, queen production, swarming control, brood disease control, and migration.

### Activities before and during the honey flow season

Before the season

- Establish a healthy colony prior to the honey flow season.
- During the season
- Clean hives.
- Observe the presence and performance of the queen.
- Check the status of the brood and adult bees.
- Widen the entrance of strong colonies.
- Provide a honey super once all the brood frames are full and the colony active to create a good working environment for the bees. Fill all ten slots with frames with previously harvested combs that have been cleaned, or with comb foundation if no used combs are available.
- Add additional frames to the super as needed.

- Wait until 70% of honey cells in the super are capped and then harvest honey.
- Check the combs in the brood chamber and remove any that have been abandoned or that look very old (blackened).
- Control and manage swarming.
- Avoid using drugs to treat a colony during the honey flow season. If disease and pest attacks occur, apply suitable control measures but don't harvest the honey.
- Feed colonies and keep them warm if there is a cold wave during the honey flow season, especially during winter in foothill and plains areas.
- Keep bee colonies in the shade if it is dry and hot.

## Off-Season (Dearth) Management

The dearth period is very risky for both bees and beekeepers. Colonies may become weak due to scarcity of food, pest and disease attacks, and robbing and absconding. The following management practices should be adopted in the off season (dearth) period.

### Winter off season

- Ensure the bee colonies have enough food through feeding management.
- Keep bee colonies warm by narrowing the entrance and ventilator.
- Remove empty combs and use a dummy board(s). Unite weak and queenless colonies.
- Don't harvest honey during a cold period.
- Place the colonies in a sunny location with the entrance facing south to east.
- Migrate colonies to warmer areas if possible.
- Avoid colony division and queen rearing.

### Dry and summer off season

- Ensure the hives have sufficient food and water.
- Keep the bee colony strong by feeding them sugar, and if necessary by uniting weak colonies.
- Take appropriate measures to control pests and disease.
- Take appropriate measures to prevent and control absconding.
- Unite weak and queenless colonies.
- Take appropriate measures to prevent colonies from robbing.
- Keep the bee colonies under a roof or shade during the rainy season.
- Remove empty combs and store in a safe place.
- Avoid colony division and queen rearing.
- Widen the ventilation and entrance to enable better air circulation.

# Session 9 Swarming

## Sub-topics

- ▶ Introduction
- ▶ Causes of swarming
- ▶ Time and season
- ▶ Control and management
- ▶ Method for capturing a swarm
- ▶ Management of a swarming colony and new swarm

## Time: 1 hour

Theory: 30 minutes

Practical: 30 minutes

## Objectives

Trainees will

- understand swarming, its causes, time and symptoms; and
- know how to control and manage swarming.

## Training Methods

- Lecture
- Practical exercise
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- Movable frame hive with bee colony
- Empty movable frame hive
- Colony inspection equipment
- Swarm bag or basket
- Queen gate and queen cage
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture

Give a presentation on swarming and how to control it, including causes, timing, and symptoms, as outlined in the resource materials (below). Use slides and photos to illustrate the talk, or large blown up photos and diagrams in areas where there is no electricity.

### Activity 2: Practical exercise

**Step 1:** Ask trainees to inspect the brood comb in a colony preparing for swarming.

**Step 2:** Ask them to identify the queen cells, drone cells, and worker cells in the brood comb.

**Step 3:** Describe the steps for preparing a new colony with a quality queen cell.

**Step 4:** Show them how to destroy unwanted queen and drone cells.

**Step 5:** Capture and relocate the swarm as described in the resource materials.

If no colony is available that is preparing to swarm, demonstrate as well as possible using a normal colony and diagrams and photos showing a colony preparing to swarm, queen cells, and other symptoms of swarming.

### Activity 3: Discussion and question and answer

Use discussion and question and answer approaches to discover whether the trainees understand swarming, can recognize the symptoms, and know how to control it.

#### Take home message

- Honeybee population growth and honey collection take place during the same season.
- Swarming can significantly hamper honey production. Swarming control and regular requeening of colonies with quality queens is very important to avoid loss of honey production.

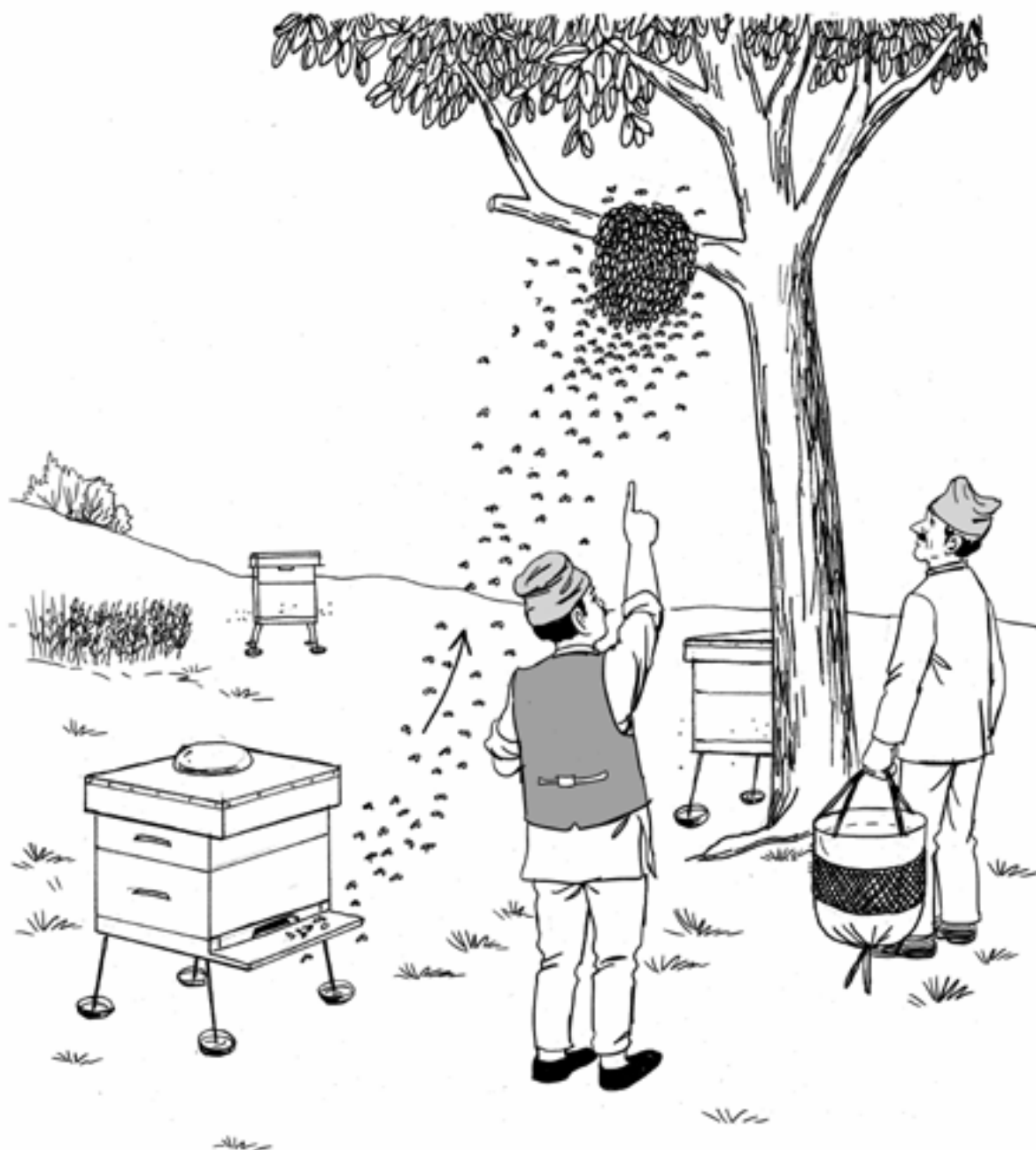
# Session 9 Resource Materials

## Swarming

### Introduction

Swarming is the natural process used for colony reproduction. In swarming, the old queen flies away from the hive with thousands of worker bees to form a new colony (Figure 46). In the first swarming, the mother queen leaves with 50–70% of the workers. There may be further swarming with a virgin queen. Repeated swarming reduces the number of workers each time, which may leave the colony and late swarms too weak to survive.

Figure 46: **Honeybee swarming**



## Symptoms of Swarming

- The number of drone cells and drones in the colony increases
- Queen cells are seen at the edges of combs
- Bees cluster at the hive entrance
- Bees hover around the hive making a piping sound
- There are many bees flying a short distance from the existing hive and clustering on a nearby tree branch or similar place.

## Causes

- Genetic trait
- Congestion in the colony
- Lack of space for egg laying
- Lack of space for hive food storage
- Increase in temperature
- Delay in requeening

## Season and Time

Swarming takes place when there is a sufficient flow of pollen and nectar. The most favourable time is spring and autumn at lower altitudes, and, May, June, and July in the high hills.

Swarming usually takes place on a sunny day from around 9 to 10 in the morning to 3 in the afternoon. In hot areas swarming may start earlier at around from 7 or 8 am. Swarming does not occur when it is rainy or stormy.

## Control and Management

A strong colony can be weakened by swarming, which reduces honey yield. Management practices should aim to control swarming using the following approaches.

### Prevention

- Inspect the colony at regular intervals.
- Allow sufficient space in the brood and super for brood rearing and honey storage.
- Add new comb foundation so that the bees can make more comb cells for eggs and collection of nectar and pollen.
- Destroy unnecessary queen cells.
- Remove any combs with unnecessary drone cells.
- Enable good ventilation with full air circulation in the hive.
- Requeen the colony with a quality queen each year.
- Place a queen gate at the hive entrance if there are signals indicating the start of swarming.
- Divide the colony.

### Swarm capture

If a colony does swarm, it should be captured and rehoused as follows (Figure 47).

- Try to settle the flying bees by spraying dust and water.
- Allow the bees to cluster for a while at one place.
- Capture the swarm with the help of a swarm bag or basket (Figure 47a,b).
- Hang the bag with the swarm near the desired area for the new hive (Figure 47c).
- Put the swarm in a new beehive (Figure 47d).
- Transfer combs with nectar, pollen, and brood from the existing hive to the new hive.
- Provide supplementary feeding if there is a food deficit.
- Use a queen gate for 3 days to keep the queen in the new hive (Figure 47e).

Figure 47: Capturing and hiving a swarm



a) capturing a swarm with a swarm bag



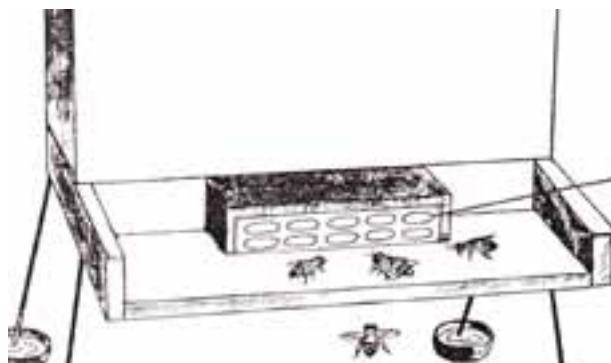
b) capturing a swarm with a basket



c) hanging the swarm bag with the captured swarm



d) hiving the swarm into a new hive



e) new hive with queen gate fitted

# Session 10 Absconding

## Sub-topics

- ▶ Introduction to absconding, symptoms and identification
- ▶ Causes of absconding
- ▶ Types of absconding (planned and emergency)
- ▶ Control and management of absconding
- ▶ Differences between swarming and absconding

## Time: 1 hour

Theory: 45 minutes

Practical: 15 minutes

## Objectives

Trainees will

- understand the absconding process and when it is likely to occur,
- be able to control and manage absconding, and
- know the difference between swarming and absconding.

## Training Methods

- Lecture
- Observation
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- Movable frame hive(s) with a weak colony
- Colony inspection equipment
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards, pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture

Give a presentation on absconding and how to control it, including causes, timing and symptoms, as outlined in the resource materials (below). Explain the difference between swarming and absconding. Use slides and photos to illustrate the talk, or large blown up photos and diagrams in areas where there is no electricity.

### Activity 2: Observation

**Step 1:** Ask trainees to inspect the weak colony.

**Step 2:** Ask them to gather information on the status of egg laying and honey storage in the brood combs in the colony.

**Step 3:** Ask them to gather information about disease and natural pests in the colony.

**Step 4:** If symptoms of absconding are observed, start the control measures against absconding described in the resource materials as a practical exercise.

### Activity 3: Discussion and question and answer

Use discussion and question and answer approaches to discover whether the trainees understand absconding, can recognize the symptoms, and know how to control it. Make sure they recognize the difference between swarming and absconding.

#### Take home message

- Transfer of a colony from a traditional to an improved hive at an unfavourable time of year, without appropriate technology, or by an unskilled person may induce absconding and result in a negative attitude towards modern beekeeping.
- Absconding of honeybees is always harmful to beekeepers, thus it is important to keep colonies strong during the dearth period, to continue feeding, and to protect the bees from diseases and pests.

# Session 10 Resource Materials

## Absconding

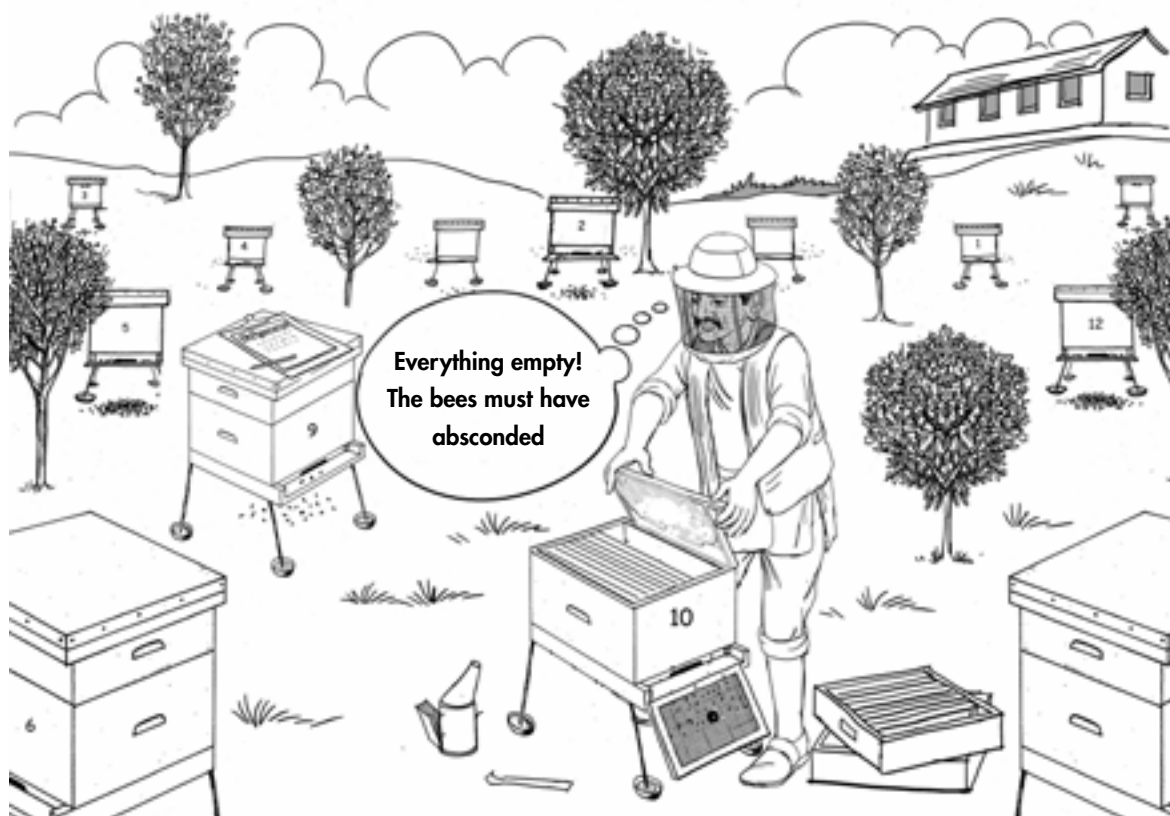
### Introduction

Absconding is the process in which a honeybee colony completely abandons a hive as a result of problems. Absconding can result from unfavourable conditions, especially during the dry season or dearth period and in hot and rainy weather. Absconding usually takes place during the day between 10 am and 3 pm. Two types of absconding can occur: planned and emergency.

### Symptoms of Absconding

- Workers create a non-laying environment for the queen 15 days before absconding.
- The number of eggs, larvae, and pupae in the colony is reduced.
- Stores of nectar and pollen are depleted.
- Fewer bee flights (incoming and outgoing) are seen at the entrance.
- Many workers fly around the hive making piping sounds. Bees take off fast and fly higher.
- After planned absconding, combs are left empty (Figure 48). Some brood and honey may be left after emergency absconding.

Figure 48: An empty hive with no brood, bees, or food – the bees have absconded



## Causes

- Lack of food during the dearth period due to harvesting all the honey at the end of the honey flow season
- Endemic disease and attack by pests
- Too high a dose of medicine given to a diseased colony
- Inadequate and inappropriate seasonal management of the colony
- Transfer of a colony from a traditional to an improved hive at an unfavourable time of year
- Poor transfer of a colony from a traditional to an improved hive as a result of having inadequate technical skills
- Use of a sub-standard improved hive and technology
- Disturbance to bees as a result of poor methods of colony inspection
- In the case of *Apis cerana*, robbing as a result of insufficient space between hives
- Lack of an appropriate and safe site and obstacles in the path of bees flying to and from the entrance
- Genetic trait

## Differentiating Abscending from Swarming

Swarming and absconding are similar in the following ways.

- Worker bees crop the honey and exit from the hive at a specific time.
- The worker bees fly away after the queen bee exits.

Differences between swarming and absconding are shown in Table 7.

**Table 7: Differences between swarming and absconding**

Swarming	Abscending
Swarming occurs during the honey and pollen flow season because of population growth and lack of space (congestion) in the hive.	Abscending occurs during the dearth period and/or because of adverse conditions resulting in weakening of the colony, including climate, lack of food, and occurrence of pests and disease.
Bees continue foraging.	Bees stop foraging.
Only a portion of the colony leaves the hive.	All bees abscond.
Brood, pollen, and honey stores remain in the comb after swarming.	Combs are generally empty after absconding, although some workers, brood and honey may be left.
The swarmed bees settle temporarily nearby at a lower height while deciding on their destination.	The destination has been decided, so absconded bees fly at greater height and settle permanently away from the apiary.
Bees fly at a lower height.	The bees fly higher and fast.
The swarm settles easily into a new hive and starts foraging immediately after hiving.	An absconded colony that is captured and placed in a hive does not settle easily and tries to abscond again.
A new colony develops after swarming. This is a colony multiplication procedure and can be beneficial for a beekeeper	Abscending is migration and no new colony develops. It is harmful for beekeepers.

## Control and Management of Abscending

- Leave some honey when harvesting at the end of the honey flow period.
- Feed with sugar syrup continuously for 3 days if the brood combs don't have any food stores.
- Ensure timely investigation and treatment of diseases.
- Protect colonies from pests.

- Do not disturb the colonies with over frequent colony inspection.
- Undertake seasonal management practices to protect bee colonies from cold, hot, and moist conditions.
- Place additional brood combs from a strong colony into a weak colony and protect the colony against robbing.
- Place beehives at an appropriate site that protects them from heat, cold, and other disturbances such as smoke, vehicle noise, and animal transit.
- Requeen the colony every year.
- Provide additional brood combs from a strong colony to a colony suspected of planning to abscond during hive inspection.
- Make the bee entrance small using a queen gate.
- Try to settle the colony nearby through dusting or sprinkling water.
- Hive an absconded colony into a new hive after capture and placing the hive in a separate place to try and prevent further absconding.
- Have a skilled technician transfer a colony from a traditional to an improved hive during a favourable season and using appropriate technology.
- A colony in an apiary showing signs of absconding should be transferred to another hive and placed separately in a different place, otherwise other colonies may also develop an absconding impulse.

# Day 3

## **Review of Day 2**

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**Session 11:** Dividing a Colony

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**Session 12:** Uniting Colonies

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**Session 13:** Transferring Bees from a Traditional Hive to a Movable Frame Hive

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**Session 14:** Artificial Diet and Comb Foundation and Management

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# Session 11 Dividing a Colony

## Sub-topics

- ▶ Introduction
- ▶ Points to consider (colony status, bee population, queen, feed, season, time)
- ▶ Colony selection
- ▶ Preparation
- ▶ Methods for dividing
- ▶ Management of divided colonies

## Time: 1 hour

Theory: 15 minutes

Practical: 45 minutes

## Objectives

Trainees will be able

- to divide a colony and manage the divided colonies.

## Training Methods

- Lecture
- Practical exercise
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- Movable frame hive with a strong colony of bees
- Empty hive
- Colony inspection equipment
- Queen/queen cell
- Feeder and sugar solution
- Comb foundation
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape

## Activities and Exercises

### Activity 1: Lecture

Give a presentation on the aim of colony division, and appropriate conditions and time for dividing a colony. Use slides and photos to illustrate the talk, or large blown up photos and diagrams in areas where there is no electricity.

### Activity 2: Practical exercise

**Step 1:** Decide which method to use for colony division

**Step 2:** Explain the method step-by-step

**Step 3:** Ask two or three trainees to divide the colony step-by-step under your guidance as described in the resource material.

### Activity 3: Discussion and question and answer

Use discussion and question and answer approaches to discover whether the trainees have clearly understood all the dimensions of colony division.

#### Take home message

- For commercialization of beekeeping, it is necessary to carry out colony division using queens or queen cells from selected colonies. This results in colony multiplication and genetic improvement.
- Colony division using emergency queens or queen cells leads to genetic erosion and reduces the honey productivity of the colony.

# Session 11 Resource Materials

## Dividing a Colony

### Introduction

Colony division is a method of multiplying bee colonies, i.e., producing two or more colonies from a mother colony. Colony division is used to control swarming, as well as in commercial beekeeping to increase the number of colonies. The colonies can be used to increase the number of colonies in the apiary for honey production or sold for income. Colony division during the honey flow season can reduce honey production and it is necessary to decide whether division or honey production should have priority.

### Points to Consider

#### Time/Season

Usually the best time for colony division is during the honey flow season. According to geographical location, colony division can be performed twice a year. For example, in foothill and plains areas, first between mid February and mid April and again between early October and early November. In the high hills of Nepal, it can be performed once between April and August. Commercial beekeepers can carry out artificial queen rearing and use the queens for colony division as needed.

#### Weather

- Colony division should not be performed in rainy or cold periods.
- The best days are reasonably sunny and warm.

#### Colony status

- The mother colony selected for division should be strong and healthy. A strong colony means 10 frames covered with bees of which 6 contain brood, and sufficient stored food (honey and pollen).
- The colony should have drones and queen cells.

#### Colony characteristics

Only the best colonies should be selected for multiplying. Selection should be based on the following characteristics:

- Egg laying capacity of the queen
- Honey and pollen collection capacity of the colony
- Good defensive behaviour and resistance to pests and disease
- Low tendency to swarm or abscond
- Capacity for rapid recovery of the population during the onset of honey flow, and able to maintain the population during the off season

### Planning for Colony Division

Before dividing a colony, the mother colony should be selected, a decision taken on the time and season of division, and all the required materials collected together and prepared.

### Equipment and Materials

- Empty hive including a dummy board
- A strong mother colony
- A frame fitted with comb foundation and empty comb
- Feeder/sugar
- Colony inspection equipment

## Methods for Colony Division

### Natural division using queen cells developed during swarming

The presence of multiple queen cells in a colony during the swarming season indicates a need for division. Dividing such colonies and using the queen cells in new daughter colonies can help control swarming. However, although it solves the immediate problem of swarming it does not help improve the genetic traits.

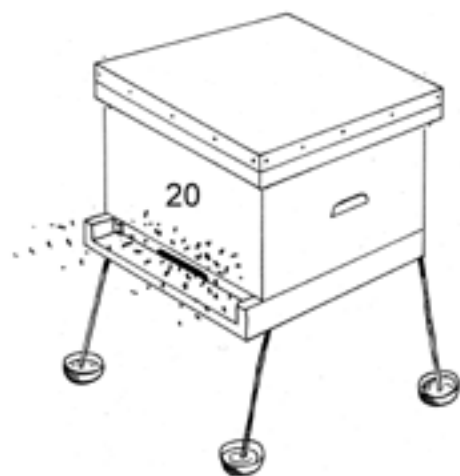
### Colony division from queen production

Select the best colony based on the selection criteria given above. Produce queens from this colony before the onset of honey flow. These queens can be used to replace the old queen and to start new daughter colonies. The mother colony can be multiplied into several nucleus colonies (Figure 21) but each should have at least 2 brood combs and 3–4 combs with food (nectar and pollen). The prepared colonies can then be sold or migrated according to need.

The steps are as follows (Figure 49):

- Select the most appropriate mother colony.
- Move the hive about 1 foot (30 cm) to the left of the existing location.
- Place an empty hive about 1 foot (30 cm) to the right of the previous location, leaving the old location empty.
- Take 3 to 4 brood combs from the mother colony together with the existing queen and place in the empty hive.
- Keep 1 mature queen cell with 3 to 4 brood combs in the mother colony.
- Divide the combs with food stores equally between the hives. Remove any remaining queen cells.
- Divide the adult bees equally between the hives.
- Check whether the incoming foragers are entering both hives equally.
- If more foragers are entering one of the hives, move it further from the previous location and move the other hive closer to the previous location. Continue to adjust until equal numbers of foragers are entering both hives. Add frames with empty combs or comb foundation to the colony with the queen after colony division.
- Close and cover the hives.
- Divided colonies can be moved to the desired position by increasing the distance from the old position at a rate of 1 to 1.5 feet (30 to 45 cm) per day in the evening after the bees have stopped foraging.
- Divided colonies should be fed with sugar syrup in the evening for 3 days after division and comb foundation added as necessary.

Figure 49: Steps in colony division



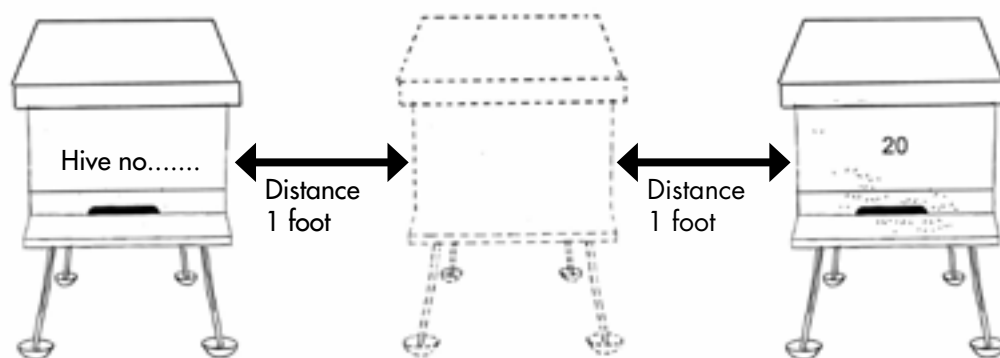
Step 1: Inspect the colonies



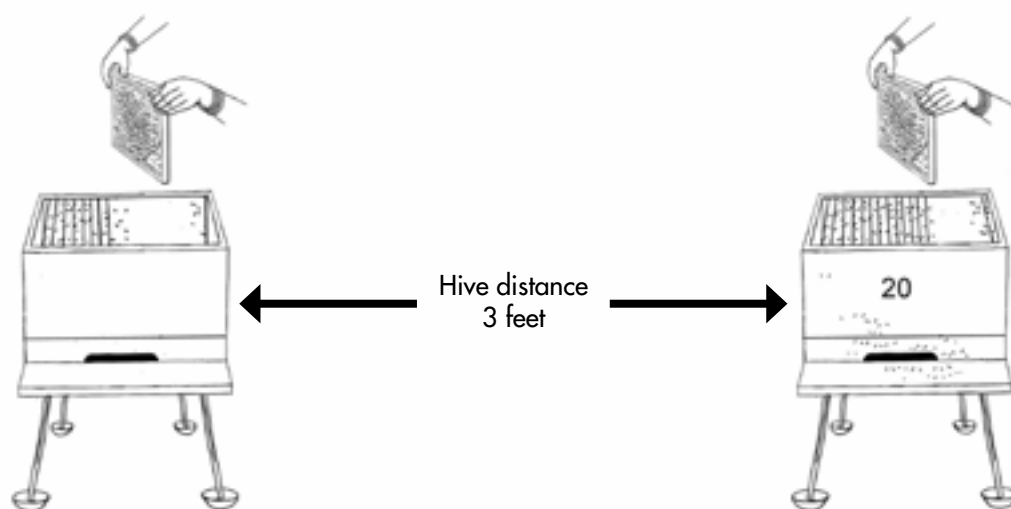
Step 2: Select the best mother colony

(Figure 49 continues)

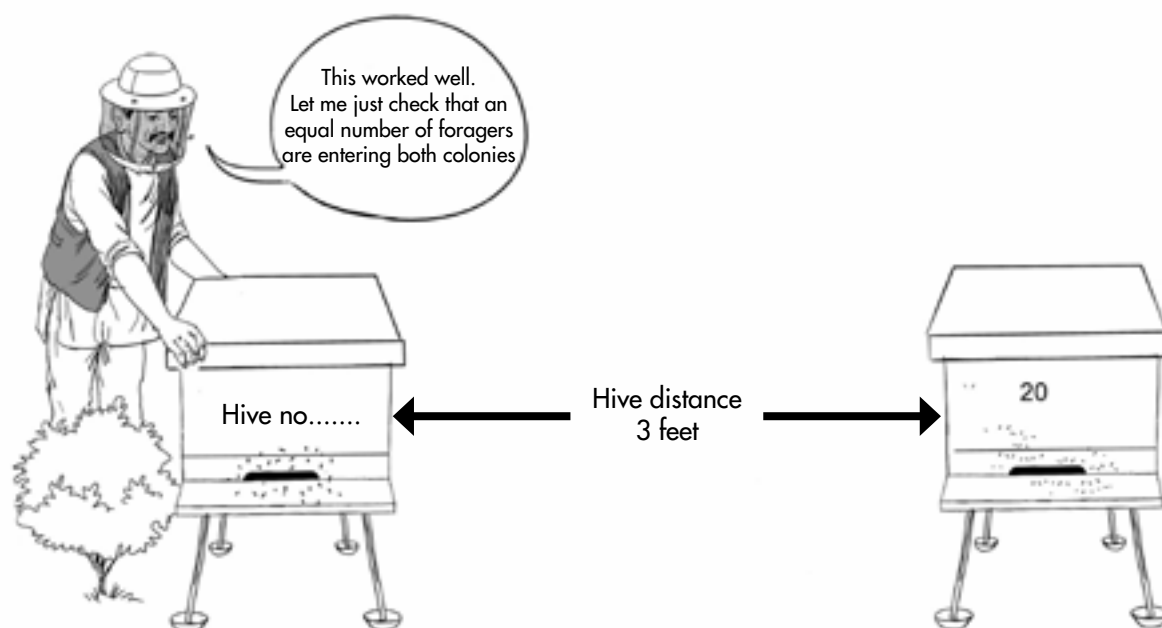
(Figure 49 continued)



Step 3: Move the mother colony 1 ft (30 cm) to the left and place an empty hive 1 ft (30 cm) to the right of the previous mother colony position. The hives are a hive width plus 2 feet apart



Step 4: Put 4 to 5 brood frames with the queen in the new hive



Step 5: Check the colony division is balanced and close the hives with the covers

# Session 12 Uniting Colonies

## Sub-topics

- ▶ Introduction
- ▶ Considerations (situation, time, and season)
- ▶ Preparation
- ▶ Method for uniting colonies
- ▶ Management of the united colony

## Time: 1 hour

Theory: 15 minutes

Practical: 45 minutes

## Objectives

Trainees will

- learn to unite honeybee colonies and manage the colony after uniting.

## Training Methods

- Lecture
- Practical exercise
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- Two movable frame hives with weak bee colonies
- Honey and sugar syrup
- Colony inspection equipment
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture

Give a presentation on uniting colonies as outlined in the resource materials (below). Use slides and photos to illustrate the talk, or large blown up photos and diagrams in areas where there is no electricity.

### Activity 2: Practical exercise

If the training is residential, do this in the evening.

**Step 1:** Ask trainees to select two weak colonies and inspect them.

**Step 2:** Explain the practical steps in uniting the colonies as described in the resource materials.

**Step 3:** Ask trainees to carry out the steps on their own, but under your guidance.

**Activity 3: Discussion and question and answer**

Use discussion and question and answer approaches to discover whether the trainees clearly understand how to unite colonies.

**Take home message**

- Uniting colonies results in a smaller number of strong colonies, which are more manageable, productive, and profitable than a large number of weak colonies.
- It is always better to maintain strong and healthy colonies for successful beekeeping.

# Session 12 Resource Materials

## Uniting Colonies

### Introduction

Colonies are united to make a strong healthy colony from two (or more) weak colonies, or one weak and one strong colony, according to the needs of the beekeeper. Uniting the pheromones of two weak colonies results in the development over time of a new and single pheromone for the united, strong, and healthy colony.

The reasons for uniting colonies include the following:

- Weaker colonies: uniting weak colonies results in a single strong colony.
- Queenless colony or weak queen: If the colony doesn't have a queen, and no possibility of producing a new queen (no fertilized eggs or queen cells in the colony), the queenless colony should be united with a colony with a good queen (a 'queen-right colony').
- Worker laying: Sometimes worker bees may lay eggs if the time without fertilized eggs or a queen is too long. The laying workers should be removed as soon as they start egg laying and the remainder of the bees united with a queen-right colony.
- Inability of the queen to lay fertilized eggs: Occasionally a queen may not lay, or may lay only unfertilized eggs which become drones. This can happen under unfavourable weather conditions or when the colony has an emergency queen. Under such circumstances, the non-performing queen can be removed and the colony united with a queen-right colony.
- Increasing honey production: Two or more colonies can be united at the onset of the honey flow season to increase colony strength and maximize honey production.

### Points to Consider

- All the foragers should have returned to the hive before colonies are united, thus it is best to unite them in the evening.
- One of the colonies selected for uniting should be made queenless before uniting it with a queen-right colony.
- Be careful not to lose bees from the queenless weaker colony while placing the hive on the paper barrier on top of the brood chamber of the strong queen containing colony (see method).
- Remove any laying workers from the queenless or weak colony.
- The paper placed between the two colonies should be perforated but able to prevent bees from passing through.
- A diseased colony should not be united with a healthy colony unless fully treated and recovered.

## Uniting Colonies

### Preparation

- Identify the colonies to be united.
- Bring distantly placed colonies closer before uniting. A weak colony can be brought close to the stronger, queen-right colony by moving at a rate of about 2 feet (60 cm) per day.
- Feed the colonies continuously with sugar syrup for 3 days before uniting if food stores are insufficient.
- Remove the queen of the weaker colony 24 to 48 hours prior to uniting.
- Remove all the empty combs and super/s from the colonies to be united during daytime.
- If laying workers need to be removed, the colony should be taken about 200 m away from its existing location and all the bees shaken off the comb before the hive is replaced in its original location. Only the bees that return to the original location should be united.
- Remove combs with worker eggs from worker laying colonies before uniting.

## Method

The paper barrier method is the safest way of uniting colonies (Figure 50). A perforated paper is placed between the two hives (colonies) to be united. This allows mixing of the pheromones of the two colonies, resulting in a single united colony. Always unite the weak colony with the strong colony, not the strong with the weak.

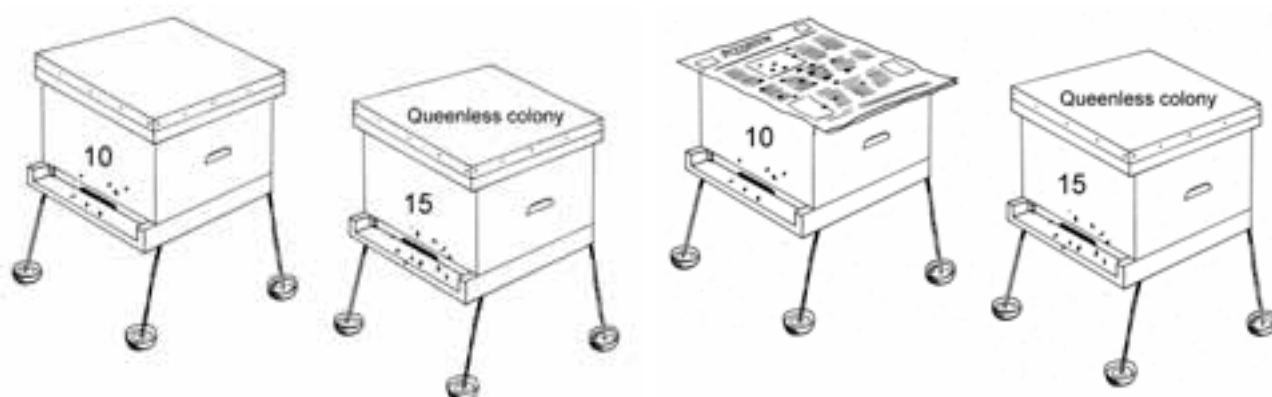
The steps are as follows:

- The colonies to be united should already have been moved close to each other (see above).
- Give a light puff of smoke at the entrances of the colonies.
- Remove the (outer and inner covers) of the queen-right (strong) colony and place a perforated paper over the frames to fully cover the brood chamber.
- Spread honey or 2:1 sugar syrup lightly on the paper
- Remove the bottom board of the queenless colony and place the hive on the perforated paper on top of the brood chamber of the queen-right colony. (The smoke will have encouraged the bees to withdraw to the combs so that there are no bees left on the bottom board.)

## Management

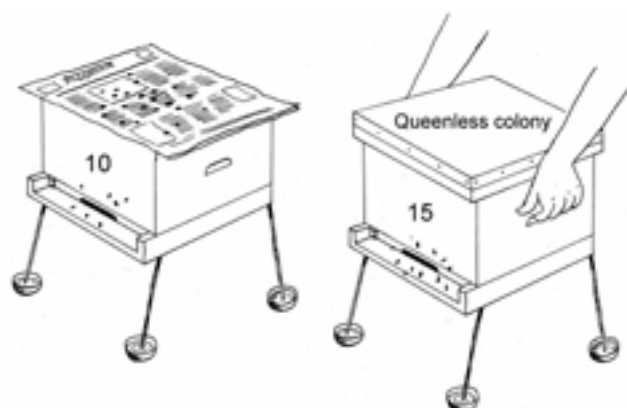
Honeybees from the colonies are united when the pheromones of the two colonies are thoroughly mixed by diffusion through the perforated paper. The bees will chew the paper from both sides; it will disintegrate within 48 hours and the bees will mix. The hive should then be opened and the bees and frames from the upper chamber transferred to the lower chamber so that all the bees are in one chamber. The united colony should be fed with artificial food for 3 days after removing the paper. If required, a super can be added after some days once the brood chamber is full and the united colony fully active, particularly during the honey flow season

Figure 50: The paper barrier method for uniting colonies



Step 1: Queen-right and queenless colonies moved close together

Step 2: Covers of queen-right colony removed and replaced with a sheet of perforated paper smeared with syrup or honey



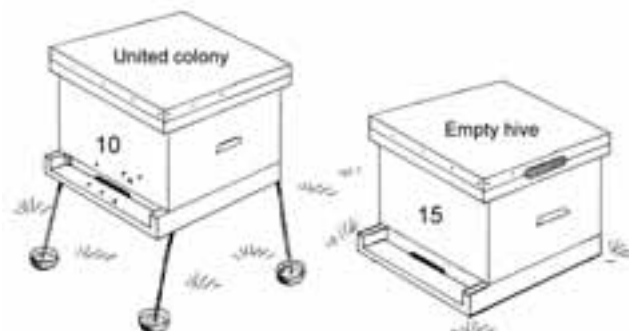
Step 3: Queenless colony lifted from bottom board



Step 4: Queenless colony placed on sheet of paper above queen-right colony



Step 5: Pheromones of colonies allowed to unite while bees chew the paper



Step 6: After 2 days bees and frames from upper chamber transferred to lower chamber and covers replaced on the united colony

# Session 13 Transferring Bees from a Traditional Hive to a Movable Frame Hive

## Sub-topics

- ▶ Introduction
- ▶ Time and season
- ▶ Preparation
- ▶ Quality of the colony (status inside the hive, queen, drone, food, brood)
- ▶ Method of transfer
- ▶ Precautions
- ▶ Management of the transferred colony

## Time: 2 hours

Theory: 15 minutes

Practical: 1 hour 45 minutes

## Objectives

Trainees will

- be able to transfer a colony from a wall or log hive to a movable frame or modern hive, and
- be motivated to undertake modern beekeeping through management of transferred colonies.

## Training Methods

- Lecture
- Practical exercise
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- Documentary film and poster
- Log or wall hive with bees
- Movable frame or modern hive
- Smoker
- Sharp knife, strong thread,
- Queen cage, queen gate
- Colony inspection equipment
- Mat or newspaper
- Flip chart or board
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture

Give a presentation on the method of transferring a colony from a traditional to an improved beehive and why it is important, and briefly describe the management practices for the transferred colony as outlined in

the resource materials (below). Use slides and photos to illustrate the talk, or large blown up photos and diagrams in areas where there is no electricity. You can show the 30 minute documentary film in the evening, before the session, or during the lunch break.

### Activity 2: Practical exercise

- Step 1:** Explain the method of transferring a colony step-by-step from a log or wall hive to a modern hive as shown in the resource materials.
- Step 2:** Ask two or three trainees to try it themselves under the guidance of the trainer.

### Activity 3: Discussion and question and answer

Use discussion and question and answer approaches to confirm that all trainees clearly understand the method of transferring a colony from a traditional to an improved hive, and the reasons why it is advisable.

#### Take home message

- Beekeepers can be motivated to undertake improved beekeeping with *Apis cerana* bees for income generation and employment by transferring the colonies from traditional to improved hives.
- The colony may abscond if transferred without proper technical skills or during the wrong season, and ignoring the basic requirements of the bees.

# Session 13 Resource Materials

## Transferring Bees from a Traditional Hive to a Movable Frame Hive

### Introduction

In order to undertake commercial beekeeping and maximize profit, colonies must be transferred from traditional to modern hives to enable improved colony management practices to be applied. It is difficult to increase income from traditional beekeeping in log or wall hives because the amount of honey produced by bee colonies in traditional hives is very low and proper colony management is not possible. The main differences between the traditional and modern methods are summarized in Table 8.

Table 8: Differences between traditional and movable frame hives

Traditional hive	Movable frame hive
Less honey production	More honey production
Brood, combs, and adult bees are destroyed during honey harvesting; parts of these remain in the honey and reduce its quality.	Pure honey can be extracted using a honey extractor. The combs can be reused.
Not possible to use comb foundation or a honey extractor.	Comb foundation can be added to the hive.
Not possible to divide or unite colonies.	Colony division and uniting is possible.
Artificial feeding not possible.	Artificial diet can be given.
Colony migration is difficult.	Colony migration is easier.
Disease and pest control is difficult.	Disease and pest control is relatively easy.
Queen rearing and colony production is not possible.	Queen rearing and colony production is possible.

### Transferring a Colony

#### Preparation

Collect together and prepare all the necessary materials before transferring the colony from a traditional hive to an improved hive. Materials include the wall or log hive with bees, an empty movable frame hive, colony inspection equipment, sharp knife, thread, and a queen cage. It is important to have a helper. The colony should be transferred during the day in the warm honey flow season.

#### Colony quality

The colony to be transferred should have the following qualities:

- Strong queen-right colony
- Sufficient drones
- Sufficient stores of nectar and pollen
- Sufficient brood in the comb
- Healthy
- Active (favourable) beekeeping season

#### Precautions

The following precautions should be taken:

- Use smoke.
- Use a bee veil.
- Use a sharp comb-cutting knife.

- Use strong string to bind the comb.
- Combs should be adjusted within the frame and not attached to each other, and frames should fit tightly in the hive.
- The brood or honey comb should be fitted tightly onto the top bar.
- Be sure to hive the queen and all the bees.
- If the queen is found during colony transfer she should be caged and kept in the modern hive, and released after transferring the colony; the cage should then be removed.
- Hide the old hive and keep the modern hive in the place where the traditional hive was previously; use a queen gate to prevent the queen leaving.

### Steps in colony transfer

Colony transfer should be completed as quickly as possible. It should be carried out during the day when bees are out foraging. The steps are listed below and illustrated in Figure 51.

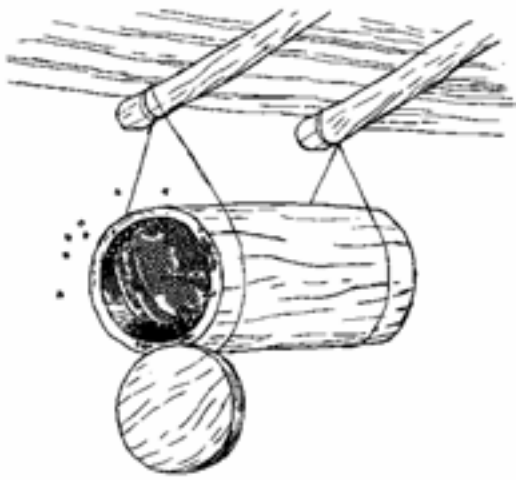
- Collect up the materials needed and place close to the traditional hive.
- Blow a light puff of smoke into the hive entrance.
- Slowly open one of the lids to the right or left of the hive entrance.
- Blow more smoke into the entrance to encourage the bees to leave the combs and cluster elsewhere in the hive.
- Cut a comb from the traditional hive holding it in one hand; do not let it fall or break. Brush off any bees remaining on the comb onto paper or into the new hive.
- Cut the comb to fit in the frame removing the honey storage portion. Take care not to damage the brood while cutting and framing the comb.
- While fitting the comb in the frame, place both the wires of the frame into the comb by making a shallow furrow with a knife on the face of the comb.
- Tie the comb to the frame at both sides so that it will not swing, and place the frame in the hive.
- Repeat the procedure with each comb one-by-one until all the combs are fitted into frames and placed in the modern hive.
- Transfer the clustered bees (colony) gently by hand from the traditional to the modern hive. Ensure that the queen is transferred to the new hive.
- Place the inner and outer covers on the hive.
- Place the modern hive with the bees in the place where the traditional hive was before. Face the entrance in the direction that the traditional hive entrance was facing.
- Brush any remaining bees from the log hive onto a mat or newspaper spread on the ground together with any bees brushed off the old combs.
- Look carefully for the queen, if she has been dropped on the mat, capture her safely and put her in the hive.
- Place the mat or paper with brushed off bees next to the new hive entrance so that the bees can enter. Hide the log some distance away.
- Again look carefully for the queen, if she has been dropped on the ground, capture her safely and put her in the hive.
- If the traditional hive was a wall hive, blow smoke into it and seal the hive and entrance completely after all the bees have flown out.
- Once you are sure that the queen is in the modern hive, install a queen gate so that she cannot leave.

### Management of the transferred colony

After the colony has been transferred from a traditional to a modern hive do the following:

- Use a queen gate.
- Use a dummy board if there are less than 8 combs.
- Continue feeding sugar syrup in the evening for 3 days.
- Clean the hive after 3 days, and cut and remove the strings from around the combs.
- Remove any empty combs and replace the frames with frames containing foundation.
- Check whether the queen is laying.
- Do not disturb or handle the bees unnecessarily.

Figure 51: Transferring a bee colony from a traditional log hive to a movable frame hive



a) opening one of the lids



b) puffing smoke into the hive



c) removing a comb after cutting it inside the hive



d) cutting away the honey storage area and framing the brood bearing part of the comb



e) making shallow grooves on the face of the comb with a knife to fit the wires of the frame



f) tying the combs on both sides with string to prevent swinging



g) fitting the frames with tied comb into the modern hive



h) transferring the clustered bees from the log hive to the frame hive



i) filled hive ready to close



j) placing the modern hive where the traditional hive was before and facing in the same direction



k) brushing any remaining bees from the empty log hive onto a mat or paper on the ground



l) inspecting the area to see if the queen is on the mat or floor



m) placing the bees from the mat or paper next to the hive

# Session 14 Artificial Diet and Comb Foundation and Management

## Sub-topics

- ▶ Introduction
- ▶ Types of artificial diet and method of preparation
- ▶ Feeding honeybee colonies
- ▶ Storage of comb foundation and method of use

## Time: 1 hour 30 minutes

Theory: 30 minutes (two presentations of 15 minutes each)

Practical: 1 hour

## Objectives

Trainees will

- understand the importance of and need for an artificial diet,
- know about different types of artificial diet,
- be able to prepare an artificial diet and feed it to a colony,
- understand the importance of comb foundation and how it is used in modern beekeeping, and
- know how to fit and manage comb foundation.

## Training Methods

- Lecture
- Practical exercise
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- Movable frame hive with bees
- Colony inspection equipment
- Sugar
- Water
- Soya flour
- Honey
- Plate or cooking bowl
- Pot for preparing syrup (jug, bowl)
- Plastic or frame feeder
- Empty frame
- Comb foundation
- Knife
- Small wooden tool
- Match box
- Candle or melted wax
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture

Give a presentation on the importance and need for an artificial diet, different types of diet, preparing syrup, candy, and pollen substitute, and feeding methods as outlined in the resource materials (below). Use slides and photos to illustrate the talk, or large blown up photos and diagrams in areas where there is no electricity.

### Activity 2: Practical exercise

Trainees learn how to make three different types of artificial food.

#### Preparation of syrup

- Step 1:** Collect together the materials for preparing syrup (sugar, water, jug).
- Step 2:** Mix 1.5 kg sugar and 1.5 litres warm water in a jug and stir thoroughly to dissolve. Cool before using.
- Step 3:** Pour the prepared syrup into a frame feeder or plastic jar feeder.
- Step 4:** Discuss and share information on any issues not covered in the practical exercise.

#### Preparation of candy

- Step 1:** Collect together the materials for preparing candy (honey, powdered sugar, water, container for mixing). Grind the sugar if powdered sugar is not available.
- Step 2:** Mix 0.5 kg powdered sugar and 100 gm honey thoroughly in a cooking bowl or bucket. (You can use water if no honey is available, but it is not as nutritious.)
- Step 3:** Wrap the candy in wax paper or a plastic sheet keeping both ends open and place it on the top of the frame or on the bottom board in the hive, taking care not to squash any bees.
- Step 4:** Discuss and share information on any issues not covered during the practical exercise.

#### Pollen substitute

- Step 1:** Collect together the materials for preparing pollen substitute (soya flour, honey or powdered sugar, water)
- Step 2:** Mix 100 gm soya flour with honey, or powdered sugar and a little water, until it has a candy-like consistency.
- Step 3:** Place the substitute on top of the frame bar in the brood chamber taking care not to squash any bees.
- Step 4:** Discuss and share information on any issues not covered during the practical exercise.

### Activity 3: Lecture

Give a presentation on the importance of comb foundation, how to prepare it, and how to use it, as outlined in the resource materials (below). Use slides and photos to illustrate the talk, or large blown up photos and diagrams in areas where there is no electricity.

### Activity 4: Practical exercise

Trainees learn to use comb foundation and how to store comb foundation and old combs.

#### Using comb foundation

- Step 1:** Collect together the materials and equipment.
- Step 2:** Demonstrate how to put comb foundation in a frame by fitting the foundation in the groove.
- Step 3:** Fix the foundation in the frame with melted wax from a pot or burning candle
- Step 4:** Attach the wires of the frame to the face of the comb foundation with drops of melted wax or by pressing the wire into the comb foundation with a sharp heated knife or hive tool.
- Step 5:** Make sure that the comb foundation is properly fixed in the frame.
- Step 6:** Place the frame with comb foundation in the hive.

### Storing comb foundation

- Step 1:** Place the sheets of comb foundation in a pile with a piece of paper the same size as the foundation between each sheet.
- Step 2:** Wrap the pile of comb foundation sheets with a larger piece of paper in a flat bundle and tie securely so it is fully closed and not open to the air.
- Step 3:** Store the packed comb foundation sheets in a safe dry place.

Methods for storing old combs are given in the resource materials.

### Activity 5: Discussion and question and answer

#### Take home message

- An artificial diet is mainly provided in emergencies. When fed continuously, it should be fed for 3 days followed by a 3-day non-feeding interval.
- A colony may be destroyed as a result of robbing and natural pests such as ants if the artificial diet is provided without proper care.
- Beekeepers need to remove old combs every 2 years and should use comb foundation made of pure beeswax to ensure good quality honey production.
- Beekeepers need to use the appropriate size of comb foundation for the frame to reduce production of drones and minimize the chances of comb destruction during migration and honey extraction.

# Session 14 Resource Materials

## Artificial Diet and Comb Foundation and Management

### Artificial Diet and Feeding Management

Nectar and pollen may not be available in sufficient quantities throughout the year in the bee pasture. Artificial food is needed to supplementing the colony's diet during times of food deficiency.

- Artificial feeding is needed to meet the daily energy requirements of a colony if the hive food store is exhausted.
- An artificial diet also activates bees to work.

Different types of artificial food can be used for feeding in different seasons and circumstances. An artificial diet is mainly provided in emergencies. When fed continuously, it should be fed for 3 days followed by a 3-day non-feeding interval. It is important to avoid spillage outside the hive as spilled food can attract pests such as ants that may destroy the colony. The three common types of food are sugar syrup, candy, and pollen substitute.

### Sugar syrup

#### Preparation and use

Syrup is used in different concentrations. The amount and strength of syrup is selected according to the specific situation and season.

- 1:1 syrup (1 part sugar, 1 part water)  
This is normally given as a supplement when there is a food deficiency in a normal colony or during the dearth season in order to activate the colony to work.
- 2:1 syrup (2 parts sugar, 1 part water)  
This syrup is used to feed medicine and in the cold season.
- 1:2 syrup (1 part sugar, 2 parts water)  
This syrup is used for feeding in the hot dry season.

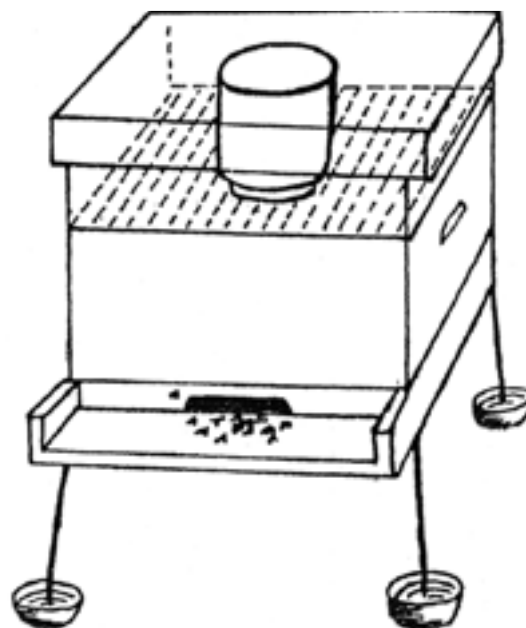
#### Feeding using a frame feeder

- Pour the syrup into a frame feeder, put 5–7 pieces of straw into the feeder extending to the upper edges to prevent the bees from sinking, and place the feeder in the hive
- The feeder can also be loosely covered with clean muslin before placing in the hive to facilitate feeding.

#### Feeding using a plastic jar

- Perforate the lid of a plastic jar with a series of holes.
- Pour the syrup into the jar, tightly close the perforated lid, and invert the jar on the lid of the inner cover or on top of the frame bar so that bees can feed from it (Figure 52).

Figure 52: Artificial feeding with an inverted plastic jar containing sugar solution



### Precautions for feeding

- Always feed in the evening, except in special situations such as feeding a new swarm.
- Place the syrup inside the hive not outside.
- Remove the feeder with any remaining syrup in the morning.
- Do not spill the syrup when preparing it or feeding the colony.
- Wipe up any spilled syrup immediately with a wet cloth.
- Do not provide more syrup than needed.
- Feed the syrup on the same day it is prepared.

### Candy

Candy is a semi-solid material prepared with finely ground sugar mixed with honey or water. It is used as a supplement during the dearth period. In general, candy prepared from 0.5–1 kg of sugar is enough to feed a colony for 1 day during the dearth. Honey or water can be mixed with the powdered sugar to produce candy, but candy prepared with honey will keep better and is more nutritious.

#### Preparation

- Grind the sugar to a fine powder on a clean slate or in a mill.
- Mix 200–300 g honey thoroughly with 1 kg powdered sugar. The amount of honey should be just sufficient to give a semi-solid 'candy' consistency. Water can be used instead of honey, but is not as good. Wrap candy in a plastic sheet with closely positioned holes punched in it, or a solid plastic sheet or wax paper with both ends open.

#### Feeding

- Place the candy on the top bars, in an open space in the brood chamber, or in a frame feeder placed in the middle of the brood chamber.

### Pollen substitute

Pollen is a basic food for the overall development of honeybees. It is rich in protein which is needed for the physiological development of adults and brood. Ideally bees should be fed in the hive with stored pollen; if this isn't available, an artificial pollen substitute can be prepared.

#### Preparation

- Make flour from soya or gram by roasting, de-husking, and grinding.
- If used, grind sugar to a fine powder on a clean slate or in a mill.
- Mix 100 g of soya flour with enough honey, or powdered sugar and a little water, to make a candy like consistency. This amount is usually enough for 1 week for one colony.

#### Feeding

- Wrap in a clean perforated plastic bag and place on the top bar, being careful not to squash any bees. Leave in place until fully consumed. If made with sugar and water, check occasionally for signs of fungus growth and remove if necessary.

### Comb Foundation and Management

Comb foundation is a sheet made of beeswax with an embossed comb pattern, which is used in modern beekeeping to help bees build regularly-shaped combs fast (see Figure 29 in Session 6). Worker bees consume a large amount of honey and nectar when producing wax to build combs (estimates suggest 10 g of honey to make 1 g of beeswax), and it takes a considerable amount of time. Thus comb building reduces the productivity of the colony. Comb foundation speeds up the process by providing a wax base and a pattern that bees can use to start from when building a new comb. It must be used in the brood chamber frames, and can also be used in frames for the super chamber if no old combs are available for

reuse. Different comb foundation is used for *Apis mellifera* and *Apis cerana* bees; foundation for the Newton hive (*Apis cerana*) has a smaller cell size and smaller sheets. Using comb foundation has a number of advantages.

- It helps production of straight regular combs.
- It is easier for beekeepers to inspect and replace combs.
- Honey can be harvested with a honey extractor (which requires straight combs) to give uncontaminated high quality honey; harvesting with an extractor is faster and doesn't break the combs so that they can be reused.
- Collection and storage of hive product is faster as the bees use the small volume of wax they excrete more efficiently.
- Combs are stronger and will not be damaged during migration.
- Drone production in a hive can be minimized as the foundation does not have the larger cells needed for drone rearing. When the bees want to rear drones, they adapt the foundation and make larger cells.

### Installing comb foundation

- The foundation sheet should be placed in the groove of an empty frame, fixed with melted wax from a pot or burning candle, and the wires of the frame attached to the face of the comb with drops of melted wax or by pressing the wire into the comb foundation with a sharp heated knife or hive tool.
- Foundation is mainly used in the brood chamber and in or just before the honey flow season. If combs are needed in the super of a bee colony, it is best to use stored old combs, or to move honeycombs from the brood chamber to the super and place new comb foundation in the brood chamber.
- The frame with foundation can be placed at the centre or side of the hive according to the colony status and season. It should be placed at the side in a strong colony and at the centre in a weak colony. It is better not to provide foundation during the dearth season, but if needed, it should be placed at the side. In a strong colony, old combs or foundation should be added to the super shortly before the honey flow season. Two or more comb foundations can be supplied at the same time to a colony in the honey flow season.
- Comb foundation can be cut to fit the super chamber if needed.
- The colony size and external temperature should be taken into consideration when adding comb foundation.
- During the cold season, the comb foundation or stored old combs should be dipped in warm water before placing in the hive.

### Storing comb foundation

#### New foundation

- Prepared comb foundation sheets should be wrapped in clean newspaper, with individual sheets separated by a piece of paper, and stored safely in a cool dry place for later use.

#### Old combs

- Wrap old drained combs still in the frame in newspaper. Store safely in a cool, dry place protected from fungi and insects. Make sure they are free from wax moth or other pests before reusing.
- After opening a packet of old combs, select ones that are reusable and air them in the open for 24 hours in a safe place.
- Immerse the combs in clean water for a short time, drain the water from the cells on both sides, dry in the shade, and then use.



# Day 4

## **Review of Day 3**

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**Session 15:** Queen Production Methods

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**Session 16:** Control of Robbing in a Honeybee Colony

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**Session 17:** Control and Management of Laying Workers

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**Session 18:** Bee Pasture

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# Session 15 Queen Production Methods

## Sub-topics

- ▶ Introduction, natural and artificial production
- ▶ Progeny selection, time management
- ▶ Identification of queen cells (emergency, swarming, supersedure)
- ▶ Selection of queen cells
- ▶ Requeening and management

## Time: 2 hours

Theory: 45 minutes

Practical: 1 hour 15 minutes

## Objectives

Trainees will

- know about natural and artificial queen rearing,
- know about the types of queen cells (emergency, swarming, and supersedure),
- understand requeening,
- be able to carry out and manage requeening by grafting, and
- be able to select the best mother colonies for queen rearing.

## Training Methods

- Lecture
- Practical exercise
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- Movable frame hives with queen-right colonies and queenless colonies
- Nucleus hive
- Queen and queen cells
- Queen cage
- Knife
- Bamboo needle
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture

Give a presentation on natural and artificial queen rearing, types of queen cells (emergency, swarming, and supersedure), how to select the best quality mother colonies for queen rearing, and how to carry out and manage requeening and grafting, as outlined in the resource materials (below). Use slides and photos to illustrate the talk, or large blown up photos and diagrams in areas where there is no electricity.

## Activity 2: Practical exercise

Trainees will inspect queen cell right colonies and undertake requeening or queen cell grafting as described in the resource materials.

- Step 1:** Prepare a nucleus hive containing 3–4 brood frames.
- Step 2:** Identify the queen cells in the queen right colony and select the best one
- Step 3:** Explain and demonstrate how to separate the queen cell
- Step 4:** Demonstrate how to graft a separated queen cell onto the brood comb in a nucleus hive.
- Step 5:** Ask trainees to cage the queen together with a few worker bees and a cotton ball soaked with honey.
- Step 6:** Place the queen in the brood area of the nucleus colony.

## Activity 3: Discussion and question and answer

Use discussion and question and answer approaches to discover whether the trainees understand queen rearing, queen cell grafting, and requeening.

### Take home message

- Queen rearing should be carried out in a colony that produces more honey, is resistant to diseases and pests, and has a lower tendency to swarm and abscond, so that positive genetic traits are selected.
- Colony multiplication using an emergency queen or emergency queen cell is a poor practice which gives weak colonies with low productivity.

# Session 15 Resource Materials

## Queen Production Methods

### Introduction

The quality of a queen is very important for successful beekeeping. Continuous selection and multiplication of the best colonies is vital for genetic improvement. Colony characteristics such as population growth, pollen and nectar collection, storage capacity, disease resistance, and gentleness are all determined by the genetic quality of the queen. All the bees in the colony, including the male drones, are offspring of the queen; thus she is the only member of the colony to pass on genetic traits. Requeening colonies annually helps to keep them strong and healthy.

Queen production is carried out for the following reasons:

- Requeening of a queen-right colony or queening of a queenless colony
- Requeening to replace the queen in a non-productive colony
- Sale of queens to others
- Sale of colonies through colony multiplication

A queen cell is specifically developed by the bees in a colony to produce a queen. It is larger and longer than the worker and drone cells. A structure on the comb resembling a cow teat is a queen cell.

Two methods can be used for queen production: natural and artificial.

### Natural Queen Production

Honeybees produce queens naturally for three different reasons:

- Swarming
- Supersedure
- Emergency

Beekeepers can encourage natural production of queens by creating a queen-producing environment in a colony at a favourable time of year.

Figure 53: **Swarming queen cells**



### Swarming queen cell

Honeybees have an impulse to swarm during the favourable honey flow season to multiply the colony. Queen cells developed at the edge of the brood comb with the acceptance of the queen and workers are swarming cells (Figure 53). Preparation for swarming begins with the development of many swarming cells. These cells produce good quality queens and can be used in requeening and when dividing colonies.

### Supersedure queen cell

Supersedure is the intentional replacement of a queen in a queen-right colony through the preparation of one or more queen cells by worker bees (Figure 54). Usually one or more queen cells are prepared in the centre

Figure 54: **Supersedure queen cells**Figure 55: **Emergency queen cells**

or at the side of the face of the brood comb to replace an old queen because she is underperforming (old, injured, diseased, laying unfertilized eggs, has diminished pheromone production), and the queen is forced to lay eggs in these cells. After the new queen emerges, she mates with drones and starts laying eggs. The workers usually kill the old queen. In general, a colony practising supersedure does not swarm. Older queens are superseded more frequently than younger ones because of the diminished performance and pheromone production. These queen cells can also be used for requeening other colonies or for colony division.

### Emergency queen cell

If the colony accidentally becomes queenless, the worker bees start developing many queen cells 1 day later from fertilized eggs or from young larvae. These are called emergency queen cells (Figure 55). They may be scattered in any part of the brood comb. Queen cells developed in an emergency are smaller and not all are of good quality. Swarming may also take place from emergency queen cells.

### Artificial Queen Production

Queens can be produced artificially from a selected colony at a favourable time. The beekeeper prepares queen cells using beeswax and grafts 1–2 day-old larvae from the worker cells into the queen cells with the help of a grafting needle. The nurse bees feed royal jelly to the grafted larvae, take care of the cells, and prepare mature queen cells, which can then be separated and transplanted to a queenless colony or nucleus colony (Figure 21).

The ideal time for queen rearing is different in different parts of the Hindu Kush-Himalayan region depending on the specific geography and climatic situation. Ideally it should be carried out during the honey flow period and under favourable weather conditions (warm and dry). This means March to April and September to October in plains, hills, and mid-hills areas, and around June in mountain areas.

### Colony selection for queen production

Each colony in an apiary should be numbered for easy record keeping. Records should be maintained of different functions so that the genetic characteristics can be evaluated. Selection of colonies to produce queens and drones should be based on the following qualities.

- Strong and healthy
- Gentle
- Low tendency to swarm and abscond
- Population grows even in the dearth period
- Good nesting behaviour, cover brood combs even in unfavourable seasons
- Resistant against pests and diseases
- High capacity for honey and pollen collection and storage

## Selection of a queen cell

The colony may have several queen cells of different quality. The following should be considered when selecting a queen cell:

- Choose a queen cell that is being attended and protected by a large number of workers.
- Choose a cell that is long and cylindrical (bigger cells generally have better quality queens).
- Retain two queen cells of different maturity.
- Remove any other queen cells to control swarming.

## Requeening, queen release and replacement

If a new queen is placed directly in a colony she may be attacked and killed by the workers. The following methods can be used to avoid this.

### Queening using a queen cage

- Remove all the queen cells from all the combs in a queenless colony.
- Make a queen-right colony queenless 24 hours before requeening.
- A queen that is going to be used for requeening should be kept in a queen cage with 5–6 attendant nurse bees and a cotton ball or pieces of cotton cloth soaked in honey (Figure 56).
- Place the queen cage with queen between brood frames in the colony (Figure 57).
- After 24 hours in the colony, give a few puffs of smoke and then release the queen from the queen cage. If the released queen is covered by worker bees or they start climbing on the queen or teasing the queen wings, then re-cage the queen for a further 24 hours.

Figure 56: Handling and caging a queen

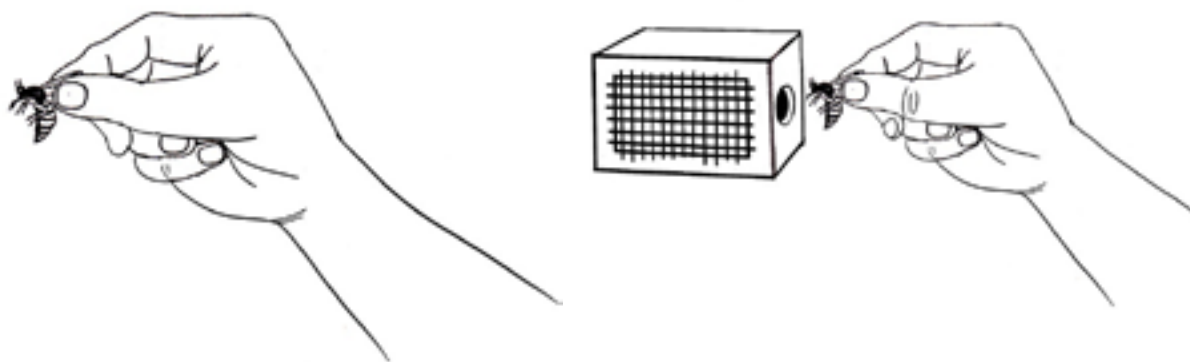
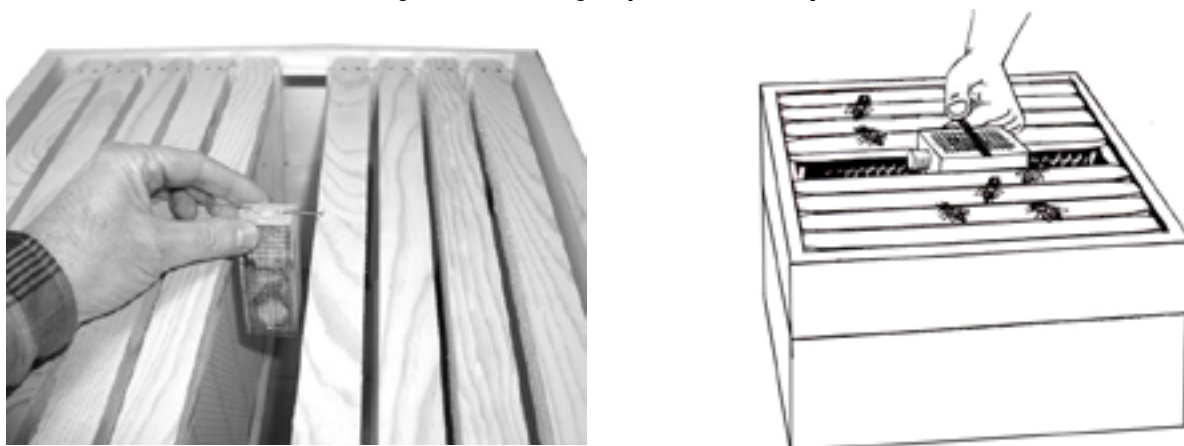


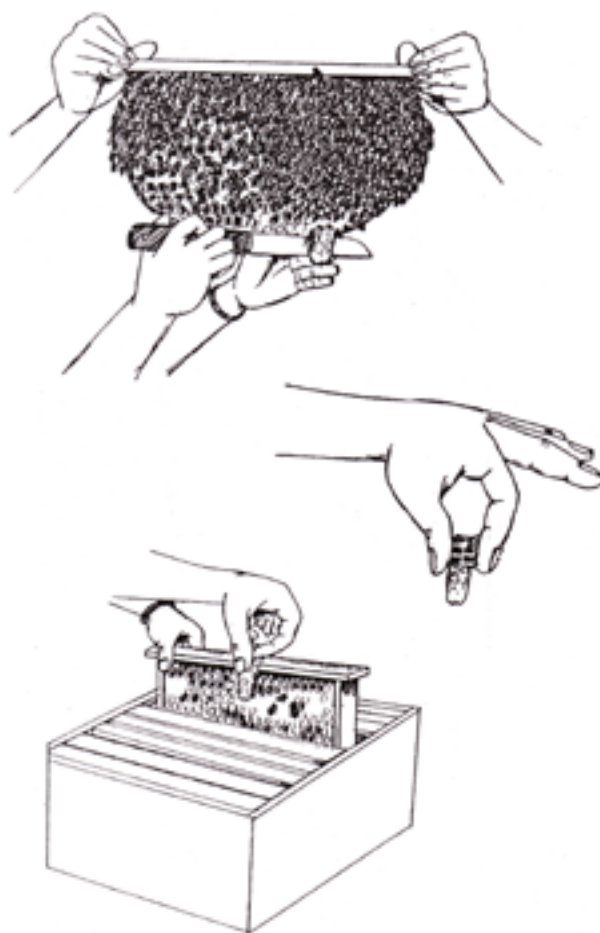
Figure 57: Placing a queen in a colony



### Grafting a queen cell

- Use a knife to carefully cut out a selected queen cell together with a small piece of comb (Figure 58). Remove a brood comb from the centre of the brood chamber of the queenless colony and cut a space the size of the cell and comb piece at the edge of the comb. Place the queen cell and comb in the space and fix in place with a bamboo needle.
- Inspect the colony every 2–3 days to confirm queen emergence and queen laying. If egg laying does not start within 15 days, remove the queen and either introduce a new queen, graft a new queen cell, or unite the colony with a queen-right colony.
- Sometimes, the new queen may lay unfertilized eggs as a result of the absence of drones during her mating flight and/or an unfavourable environment for mating, and drones start developing in the worker cells. If this happens, the queen should be removed and another queen or queen cell introduced, or the colony should be united with a queen-right colony.

Figure 58: Queen cell grafting



# Session 16 Control of Robbing in a Honeybee Colony

## Sub-topics

- ▶ Introduction
- ▶ Management
- ▶ Causes of robbing
- ▶ Problems of robbing

## Time: 45 minutes

Theory: 15 minutes

Practical: 30 minutes

## Objectives

Trainees will

- know about robbing and how to identify it, and
- know about the causes, prevention, and control measures.

## Training Methods

- Lecture
- Practical exercise
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- Apiary
- Colony inspection equipment
- Empty movable frame hive
- Knife
- Flour or yellow kesari powder
- Kerosene
- Small sprayer with water
- *Artemisia* or *Parthenium* leaves
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture

Give a short presentation on robbing, when it takes place, how to recognize it, and causes and management, as outlined in the resource materials (below). Use slides and photos to illustrate the talk, or large blown up photos and diagrams in areas where there is no electricity.

### Activity 2: Practical exercise

Trainees observe and learn how to manage robbing.

Ask trainees to do the following:

- Step 1:** Inspect the activities of a colony being robbed from outside the hive.
- Step 2:** Dust flour or yellow kesari powder over the bees flying near the hive entrance of the colony being robbed.
- Step 3:** Inspect the entrance of all the colonies in the apiary
- Step 4:** Mark the colonies where they see flour or yellow kesari powder at the entrance. These are the robbing colonies.
- Step 5:** Puff smoke or spray water on the robbing bees at the entrance of the hive being robbed
- Step 6:** Place *Artemisia* or *Parthenium* weeds at the entrance of the colony being robbed.
- Step 7:** Examine the effectiveness of the control measures
- Step 8:** Close the entrance and widen the ventilation of the colony being robbed and keep the colony at a separate place, or temporarily in a room.
- Step 9:** Place an empty hive with combs that have some honey in them at the original position of the hive being robbed. The robbing bees will finish the honey and realize that the hive is now empty and there are no bees to fight with, and will not return.

### Activity 3: Discussion and question and answer

Use discussion and question and answer approaches to discover whether the trainees understand robbing, its causes, and management practices.

#### Take home message

- Beekeepers need to ensure that colonies in an apiary are equally strong by feeding an artificial diet during the dearth period.
- Beekeepers should pay proper attention to colony management, otherwise they can face considerable losses through robbing, absconding, and colony destruction.

# Session 16 Resource Materials

## Control of Robbing in a Honeybee Colony

### Introduction

Robbing is a sign of bee colonies fighting in an apiary. It can have different causes but is usually the result of lack of food in a hive during the dearth period resulting in a stronger colony robbing a weaker one (Figure 59).

### Causes

- Lack of food stores in a hive resulting from complete honey extraction at the end of the honey flow season
- Bees attracted by honey spilled during honey harvesting in an open yard, which stimulates the robbing tendency
- Feeding sugar during the day or spilling sugar syrup
- Syrup left in a feeder during the day
- Differences in colony strength in an apiary
- Inadequate food stores in a strong colony and sufficient honey in a weak colony
- Honey smell emanating during the dearth period as a result of taking too long for hive inspection
- Cracks and crevices in a hive and emanating honey smell
- Feeding syrup only to a few weak colonies
- Wider ventilation leading to emanation of a smell of honey during the dearth period
- Keeping two or more different honeybee species together in an apiary

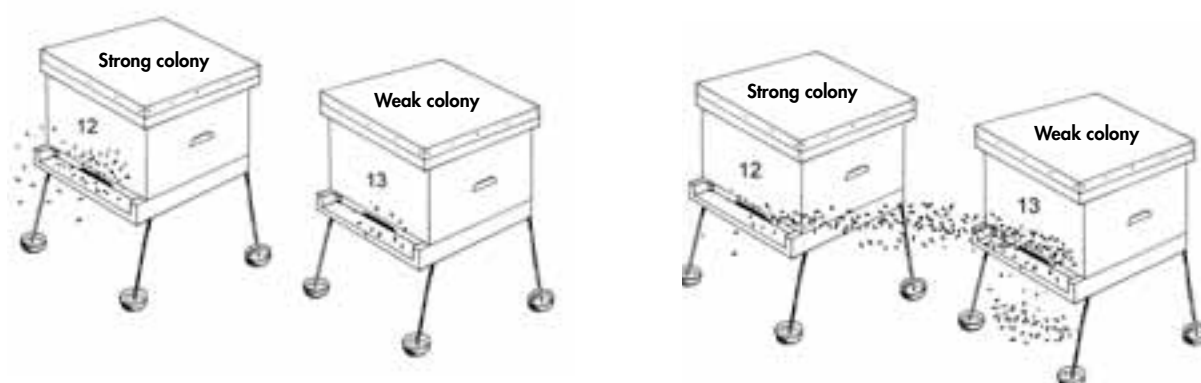
### Symptoms

- Robber bees trying to enter a colony with many workers flying around the hive
- Increased number of guard bees at the hive entrance and fighting between robber and guard bees
- Dead bees seen on the ground near the entrance while flying bees make a strong piping sound
- Robber bees entering hive with an empty stomach and leave with a swollen stomach

### Characteristics

- At the start, guard bees can control the robbers at the hive entrance, but then the robber bees start freely robbing honey.
- Robbing continues until the honey store in the colony being robbed is exhausted. Many bees die in the robbed colony, which can push them towards absconding.

Figure 59: **Normal colonies without robbing (left) and robbing colonies (right)**



- Usually robbing is between strong and weak colonies, but sometimes two robber colonies fight each other which kills a large number of bees in both and can lead to absconding or colony destruction.
- Robbing may also be a species-specific genetic behaviour. *Apis cerana* bees have a tendency towards robbing at any time during both the honey flow and dearth periods, whereas in *Apis mellifera*, robbing is only common in the dearth season.

## Prevention

- Just after robbing starts, water or kerosene mixed with water should be sprayed over the bees, which will encourage the robbers to return to their colony as if it were raining. As an alternative, *Artemisia* or *Parthenium* leaves can be kept in front of the entrance of the colony being robbed to prevent robbing.
- The robber bees cannot enter into a colony if longer weeds or tree branches are kept in front of the entrance.
- Smoke the hive being robbed every 5–10 minutes while robbing is ongoing to calm the bees.
- Narrow the entrance of the hive being robbed so that only one bee at a time can pass through.
- If robbing continues, dust flour or yellow kesari powder over the flying bees and observe where incoming bees are coated with flour or colour to identify the robber colony/ies.
- If robber bees are attempting robbing over a longer period, take the robber colony 1–2 km away from the apiary for at least a week.
- If only one colony is susceptible to robbing, then move the colony being robbed to another site or inside, and place an empty hive with combs that have some honey in them at its original position. The robber bees will finish the honey and then learn that the hive has nothing more to offer and there is no one to fight with and will not return.

## Management

- Ensure that all colonies in the apiary are strong.
- Make sure each colony has an emergency honey stock by leaving some honey at the end of the honey flow period; stop harvesting when 20–25% of the honey remains.
- Harvest the honey in a closed yard or use a net if harvesting has to be carried out in an open yard (see Session 25, Figure 85).
- Do not drop honey or syrup around the colonies; if any is spilled, clean it up immediately with a wet cloth.
- Only feed syrup in the evening; remove any remaining syrup early the next day and keep it in a closed room.
- Keep harvested comb in a closed space. Freshly harvested comb can be reused or stored in a box. Older combs can be used to extract wax.
- *Apis mellifera* and *Apis cerana* colonies should be kept in different apiaries to minimize robbing between them.
- Seal any cracks and crevices in the hives.
- Narrow the entrances if robbing starts. Regularly inspect colonies to determine their status.
- Supplement the food for a weak colony with honey from a strong colony as necessary.
- Colonies susceptible to robbing can be placed in a location with long grass in front of the entrance.

# Session 17 Control and Management of Laying Workers

## Sub-topics

- ▶ Introduction
- ▶ Control and management of laying workers

## Time: 45 minutes

Theory: 15 minutes

Practical: 30 minutes

## Objectives

Trainees will

- be able to identify laying workers, and
- know about their management and control.

## Training Methods

- Lecture
- Practical exercise
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- Empty movable frame hive
- Colony with laying workers
- Colony inspection equipment
- White cloth or newspaper
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture

Give a presentation on queenless colonies, causes of laying workers, and how to identify and control them, as outlined in the resource materials (below). Use slides and photos to illustrate the talk, or large blown up photos and diagrams in areas where there is no electricity.

### Activity 2: Practical exercise

Trainees learn how to identify, control, and manage laying workers. Trainees should ask questions and discuss queries during the exercise.

**Step 1:** Show participants how to identify the laying worker colony.

**Step 2:** Move the laying worker colony at least 20 m (65 feet) away from its original position and place an empty hive in its place.

- Step 3:** Shake off all the bees from the combs of the laying worker colony onto a cloth or newspaper spread on the ground. The laying workers (with functional ovaries) will be unable to fly back to the hive and will die. Any normal workers will fly back to the hive.
- Step 4:** Shake out the eggs laid by the workers from all the combs after shaking off the worker bees.
- Step 5:** Put the combs from which the laying worker eggs have been shaken off in the empty hive placed at the previous location of the laying worker hive.
- Step 6:** Place frames with combs containing honey and pollen in the hive.
- Step 7:** Allow the foraging bees to return to the new hive.
- Step 8:** Note that the hive should now be requeened as described in the previous section.
- Step 9:** Discuss any outstanding points.

**Take home  
message**

- Do not leave a colony queenless for any length of time; immediately introduce a new queen or queen cell.
- Regular inspection and good management of bee colonies is necessary to prevent destruction by worker laying.

# Session 17 Resource Materials

## Control and Management of Laying Workers

### Introduction

In the absence of a queen, queen cell, or young worker larvae (less than 3 days old), and when any fertilized eggs fail to produce a new queen, some workers feed on the royal jelly themselves and start laying eggs (Figure 60). These are called laying workers (LWs).

In *Apis cerana*, workers start laying eggs 7 days after the start of a queenless situation without a queen cell, egg, or young larvae; in *Apis mellifera*, workers start laying eggs after 10 days.

### Causes

- Accidental death of the queen
- Failure of a new queen to lay eggs upon her return to the hive after mating
- Installation of a queen gate for a long period at the hive entrance of a colony with a virgin queen, or clipping the wings of a virgin queen in a colony or swarm
- Colony division with an emergency queen at an unfavourable time

### Identification

- Shiny, bulging, black abdomen of worker bees
- Workers seen with their abdomens in a laying position in the cells
- Workers furious, walking with K-shaped wings
- More than 1 egg per cell
- Eggs not centrally positioned in the cell and attached towards the wall
- Smaller eggs than laid by a queen
- Drone brood in worker cells
- Smaller than normal drones emerging from worker cells
- Excess number of drones
- Smaller queen cells built on the faces of the comb, and bees clustering at the entrance to the hive

### Control

- Pay attention to the safety of the queen during colony management, hive inspection, and honey harvesting.
- Graft a queen cell or perform requeening immediately in a queenless colony.
- In the absence of a queen cell, place a brood comb with eggs and larvae into the hive.
- Check the status of the queen by colony inspection every 4–5 days after queen cell grafting or the emergence of a virgin queen

Figure 60: Eggs from laying workers



## Management

- If a colony starts worker laying, remove the laying workers before introducing a queen cell or queen.
- Move the worker laying colony 20 m (65 feet) away and place an empty hive at the previous position.
- Shake off all the bees from the combs in the laying colony onto the ground over a sheet of cloth or newspaper. Shake off the workers' eggs from all the combs after shaking the bees onto the ground
- Place good combs with the eggs removed into the empty hive at the old position.
- Add brood frames from other hives with eggs, larvae, pupae, and honey stores to the empty hive.
- The bees on the sheet that are not able to return to the new hive are laying workers and should be left to die. The normal workers will fly back to the cleaned hive.
- The new hive should be requeened, or the colony united with a queen-right colony.

# Session 18 Bee Pasture

## Sub-topics

- ▶ Introduction
- ▶ Preparation and use of a floral calendar
- ▶ Short term and long term pasture management
- ▶ Wild and agro-pasture
- ▶ Pasture mapping and pasture carrying capacity

## Time: 1 hour 30 minutes

Theory: 45 minutes

Practical: 45 minutes

## Objectives

Trainees will

- know about the importance and need for honeybee pasture,
- be able to identify and differentiate sources of pollen and nectar,
- know about pasture improvement and management,
- know how to prepare and use a floral calendar, and
- be able to estimate the carrying capacity of a pasture through pasture mapping.

## Training Methods

- Lecture
- Observation and group exercise
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- Flowering plants
- Example of a floral calendar
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture

Give a presentation on all aspects of bee pasture as outlined in the resource materials (below). Use slides and photos to illustrate the talk, or large blown up photos and diagrams in areas where there is no electricity.

Activity 2: Observation and group exercise

Trainees will identify bee forage through pasture observation, and learn how to prepare a floral calendar and carry out pasture mapping.

**Step 1:** Look at plants in the bee pasture and help participants identify sources of bee pollen and nectar.

**Step 2:** Show different plant specimens as described in the resource materials.

**Step 3:** Ask groups of trainees to prepare a floral calendar, and perform pasture mapping with analysis of the carrying capacity.

### Activity 3: Discussion and question and answer

Use discussion and question and answer approaches to discover whether the trainees understand the importance of bee pasture and how to assess it.

#### Take home message

- Beekeepers need to manage their bee colonies in accordance with the available pasture to maximize the income from honey and colony production.
- The maximum apiary size can be estimated from the availability of pasture. Management of pasture requires conservation and encouragement of perennial bee flora.

# Session 18 Resource Materials

## Bee Pasture

### Introduction and Importance

Bee pasture, or forage area, is the area containing the wild and cultivated plants, bushes, and trees that are the source of the nectar, pollen, propolis, and water needed to fulfil the daily needs of honeybees. Pasture is a primary requisite for beekeeping. Beekeeping can only be successful where there is abundant forage as both brood rearing and honey production require food in the form of honey and pollen. Honeybee colonies will abscond during times of dearth if they don't have food. The honey production potential of a colony is effectively a measure of the food storage capacity, which depends on the availability of nectar and pollen. Colony development is directly dependent on the year round availability of forage. When forage isn't available, the colony won't increase or produce honey, and supplementary feeding must be provided simply to maintain numbers.

### Identification of Bee Flora

Beekeepers need to be able to identify what bee flora are available (both wild and agricultural) before establishing an apiary. A beekeeper has various possibilities for learning to identify which plants can serve as bee flora in general, and which are available close to the (planned) apiary, including

- training and experience,
- study of books, statistics, articles, published by botanists,
- study of a herbarium or plant collection and preserved plants,
- collection and identification of flowers in a lab by technicians,
- observation of flowers being visited by bees,
- study of foraging potential of the area, and
- laboratory analysis of the pollen contained in honey to identify the floral source (mellisopalynology).

### Preparation and Use of a Floral Calendar

A floral calendar should be prepared to record the availability of bee flora around the year in a specific area. The calendar describes the sources of nectar and pollen, the strength of the sources, the flowering time, and the duration of nectar and pollen availability. It shows the availability of bee flora as well as the dearth period, when pasture and feeding management can be carried out. Table 9 shows an example of a simple calendar. When using the calendar to assess resources for a colony, note that *Apis cerana* bees can fly up to 2 km from the hive to forage, and *Apis mellifera* bees up to 5 km.

### Bee Pasture Management

Pasture management is an important aspect of beekeeping because it can significantly increase honey and colony production. The pasture should be developed to provide appropriate forage in line with the number of colonies available at that location. The maximum profit can be obtained from honey production if pasture is available for at least 8–9 months of the year. Short-term pasture management is carried out by planting bee flora that start flowering within a short time (1 month to 1 year) such as mustard, buckwheat, yellow mustard, sunflower, and barseem. Long-term pasture management means systematic planting of perennial flowering plants that start flowering after 1 to 2 years, for example Indian butter tree, bottle brush, citrus fruit, litchi, jamun (*Eugenia* spp.), and sissoo.

Table 9: Sample floral calendar

Month*	April	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
<b>Bee flora</b>												
Indian butter tree**						1	2	4				
Wild cherry												
Crab apple												
Citrus spp.												
Mustard												
Sunflower												
Maize												
<i>Schima wallichii</i>												
Jujube	2	5										

\* The exact flowering time depends on the geographical and climatic conditions.

\*\* Flowering can be rated from 1–5 with 1 indicating only a few plants flowering and 5 all plants in full bloom

## Pasture Mapping and Carrying Capacity

A pasture map shows the availability of bee flora in a given area and time, as well as the amount available and blooming period of particular species. A pasture map indicates the carrying capacity of the pasture, or how many colonies can be supplied with nectar and pollen for how long. In general 15–55 kg pollen, and 60–80 kg nectar are needed per year to sustain a colony. Honey production is affected by both the colony number and the pasture carrying capacity. Pasture mapping is very important for colony migration, and to know the carrying capacity of an area for establishing a new apiary. Commercial beekeepers need to know about the availability of bee flora across the country. Figure 61 shows an example of a bee pasture map for Nepal showing areas that are more and less favourable for commercial beekeeping. Table 10 shows the flowering time and type of product (nectar, pollen) of some of the bee flora available in Nepal.

Figure 61: Bee pasture map for Nepal showing districts where forage is more or less favourable for commercial beekeeping

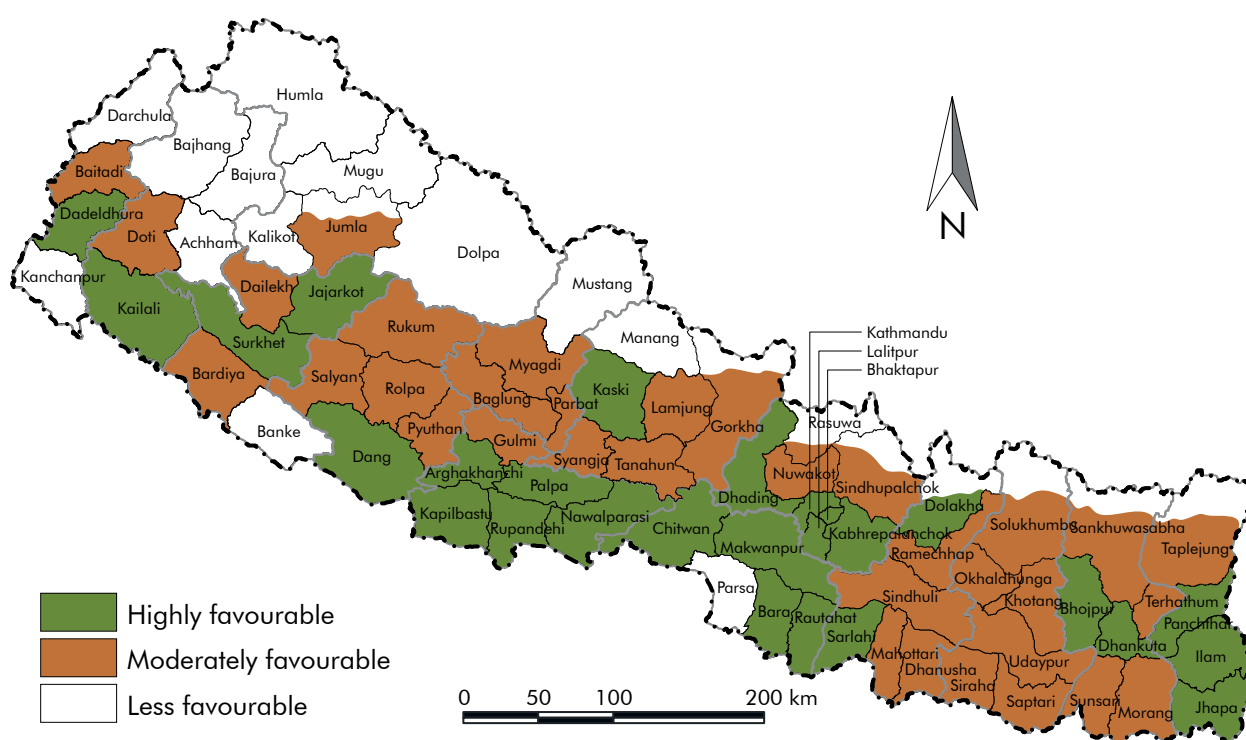


Table 10: The flowering time and products of some of the bee flora available in Nepal

	Flowering month	Product	Strength
<b>Fruit</b>			
Apple	Feb–March	nectar and pollen	medium
Banana	Year round	nectar and pollen	medium
Blackberry	May–Sept	nectar and pollen	strong
Citrus	Feb–March	nectar and pollen	strong
Crab apple	Feb–March	nectar and pollen	strong
Guava	March–May	nectar and pollen	medium
Indian butter tree	Feb–March	nectar	strong
Jujube	Sep–Jan	nectar and pollen	medium
Litchi	Feb–March	nectar and pollen	strong
Papaya	May–Aug	nectar and pollen	medium
Peach	Feb–March	nectar and pollen	medium
Pear	Feb–March	nectar and pollen	medium
Plum	Feb–March	nectar and pollen	medium
Pomegranate	March–April	pollen	medium
Walnut	Feb–April	nectar and pollen	strong
<b>Vegetables</b>			
Broad leaf mustard	Feb–March	nectar and pollen	strong
Cabbage	April–May	nectar and pollen	medium
Cauliflower	April–May	nectar and pollen	medium
Coriander	Feb–May	nectar and pollen	strong
Cucurbits	June–Aug	pollen	strong
Radish	Jan–March	nectar and pollen	medium
<b>Ornamental flowers</b>			
April flower	Feb–March	nectar and pollen	medium
Borage	Year round	nectar	medium
California poppy	Feb–April	pollen	medium
Cotton	August–Sept	nectar	strong
Cuphea	Year round	nectar	low
Echium sp.	Year round	nectar	low
Poppy	Feb–March	pollen	medium
Portulaca sp.	May–Sept	pollen	medium
Wild rose	March–August	pollen	strong
<b>Field crops</b>			
Buckwheat	Aug–Sept	nectar and pollen	strong
Jwar/sorghum	May–July	pollen	strong
Maize	Feb–June (Terai, inner Terai) May–June (hills)	pollen	strong
Rice	Aug–Sep	pollen	medium
<b>Oil seed</b>			
Mustard	Sept–Nov	nectar and pollen	strong
Niger, yellow mustard	Feb–March	nectar and pollen	strong
Sunflower	March–June	nectar and pollen	strong

<b>Forest flora</b>			
<i>Albizia</i> sp.	March–April	nectar	low
<i>Bauhinia</i> sp.	March–April	nectar and pollen	low
Blackberry	March–April	Nectar and pollen	strong
Bottle brush	Feb–May	nectar	strong
<i>Cassia</i> sp.	April–May	Nectar and pollen	medium
Crab apple	Feb–March	Nectar and pollen	strong
<i>Crateva</i> sp.	March–April	nectar	strong
<i>Eucalyptus</i> sp.	Feb–March	Nectar and pollen	strong
Jamunebhandro	Dec–Feb	Nectar and pollen	medium
Kadipatta	Feb–March	Nectar and pollen	strong
<i>Myrica</i> sp.	Jan–Feb	Both	low
<i>Pogostemon</i> sp.	Dec–Feb	nectar	strong
<i>Rhus</i> sp.	April–May	nectar	medium
<i>Rubus</i> and <i>Mahonia</i> spp.	Feb–March	Nectar and pollen	medium
<i>Shorea</i> sp.	April–May	Nectar	low
Sissoo	Feb–March	Nectar	strong
<i>Toona</i> sp.	Feb–March	Nectar	medium
Wild cherry	Oct–Nov	nectar and pollen	strong
Wild jujube	March–April	Nectar	strong
<i>Woodfordia</i> sp.	March–April	Nectar and pollen	strong
<i>Yucca</i> sp	Aug–Sep	Nectar and pollen	strong
<b>Forage</b>			
Berseem	July–Sep	Nectar	strong
<i>Cynodon</i> sp.	Aug–Sep	Pollen	strong
Kapu	March–June	Pollen	strong
Pyauli		Nectar and pollen	strong



# Day 5

## **Review of Day 4**

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**Session 19:** Honeybee Diseases, Malnutrition and Mortality

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**Session 20:** Observation Tour

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# Session 19 Honeybee Diseases, Malnutrition, and Mortality

## Sub-topics

- ▶ Brood diseases (European Foul Brood, Thai Sac Brood, Chalk Brood, and American Foul Brood)
- ▶ Adult bee diseases (nosema, amoeba, paralysis)
- ▶ Malnutrition

## Time: 2 hours

Theory: 1 hour

Practical: 1 hour

## Objectives

Trainees will

- be able to identify the major honeybee diseases, and know about their causes, prevention and control,
- know about the causes, symptoms, and management of honeybee malnutrition.

## Training Methods

- Lecture
- Practical exercise
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- Colony inspection equipment
- Diseased bee colony if available
- Samples of diseased bees
- Sugar, feeder
- Medicines
- Pins or bamboo needle
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture

Give a presentation on the causes, prevention, and control of honeybee diseases (in adults and brood), and of malnutrition, as outlined in the resource materials (below). Use slides and photos to illustrate the talk, or large blown up photos and diagrams in areas where there is no electricity.

### Activity 2: Practical exercise

Participants will learn about the symptoms, control, prevention, and management of major diseases and malnutrition in honeybees.

**Step 1:** Show the diseased bees to the trainees and let them observe the symptoms as described in the resource materials. If no diseased bees are available, show them sample specimens.

- Step 2:** Demonstrate the disease identification process to the trainees.  
**Step 3:** Ask trainees to differentiate between disease and malnutrition.  
**Step 4:** Demonstrate the control measures.

### Activity 3: Discussion and question and answer

Use discussion and question and answer approaches to discover whether all the trainees understand the various aspects of honeybee diseases and malnutrition management.

#### Take home message

- Prevention of disease through better management of colonies is better than cure.
- Use of chemicals and drugs may be harmful to both beekeepers and bees.
- Production of quality hive products can be ensured using biological and physical methods of disease management.

# Session 19 Resource Materials

## Honeybee Diseases, Malnutrition, and Mortality

### Introduction

Honeybees can be infected by a number of diseases, some of them severe enough to destroy a colony, or the whole apiary. The best way to avoid disease is to keep the colonies strong and healthy and carry out colony maintenance activities regularly. Bees can also die from lack of food, and malnutrition can make a colony weak and unable to perform properly, as well as increasing the susceptibility to disease. It is important to be able to recognize symptoms of disease so that action can be taken promptly and the outbreak prevented from spreading. It is also important to understand the nutrition requirements of the bees and ensure these are fulfilled so that the colony can stay strong and healthy.

The honeybee life cycle has four stages; of these, the larvae and adults are the stages most susceptible to disease.

### Brood Diseases

The major brood (larval) diseases are described below.

#### European foulbrood (EFB)

European foulbrood (EFB) is caused by the bacterium *Melissococcus plutonius*. This bacterium infects the mid gut of new larvae and multiplies rapidly. Bacteria come out through the excreta and the disease is transferred to other larvae by the adult bees nursing and cleaning the cells. Infected larvae full of bacteria in the abdomen die and decay. Colonies become weaker and can sometimes be destroyed by an outbreak of European foulbrood. This disease is more common in *Apis mellifera* colonies, but it can also attack and damage *Apis cerana* bees.

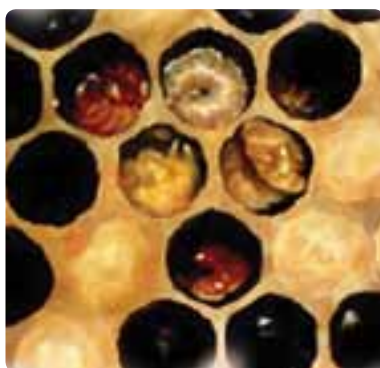
#### Symptoms (Figure 62)

- Weakening of colonies and decreasing population during the honey flow season
- Slow bees
- Dead larvae seen in front of the hive entrance
- Colour of larvae changed to yellowish brown
- Transparent larval tracheae

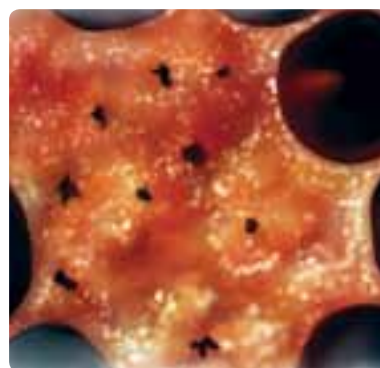
Figure 62: Symptoms of EFB



a) first stage of infection, colour of larvae changed to yellowish brown



b) second stage, larvae extended not coiled



c) final stage showing holes in sealed cells

- Abnormal larval position (extended, not coiled)
- Dead larvae in open cells
- Foul smell comes from infected and decayed larvae
- No uniform brood pattern
- Dead and decayed larvae are sticky and later scaly and attached to the cell wall and cannot be removed by the worker bees.

### Control and management

Alternative types of disease management, including making the colony more resistant so the disease can be avoided, are better than chemical control. Antibiotics have a negative impact on honey quality. The following management practices can help to prevent infection:

- Keep the colony strong. A colony should have at least six brood combs. Any empty brood combs abandoned by the bees, and any very old combs, should be removed from the hives.
- Ensure that there is sufficient food.
- Requeen the colony every year.
- Inspect the colony at regular intervals.
- If a colony shows signs of disease, cage the queen for 11–14 days to make the colony broodless, and then transfer the bees to a new hive with new combs and a new queen.
- Burn the entire infested hive and combs from a diseased colony
- Be aware of the causes of disease transmission

### Thai sacbrood virus (TSBV)

Thai sacbrood disease (TSB) is caused by a virus which infects the abdomen of young larvae and is then excreted. It is a major brood disease in *Apis cerana* bees. The disease is transferred to other young larvae by workers during nursing and cleaning of the hive. The disease was first identified in *Apis cerana* bees in Thailand; it reached Nepal in the 1990s and destroyed more than 90% of managed *Apis cerana* colonies. Disease resistance has increased in the remaining colonies. Infected colonies become weak and abscond as a result of disease pressure.

### Symptoms and identification (Figure 63)

- The brood pattern is abnormal.
- The infected larva is positioned abnormally in the cell, usually at the wall.
- The cap of the diseased pre pupa is sunk at the centre and sometimes perforated. It may appear black at the centre.
- Workers make holes at the centre of the caps to remove diseased larva.
- The skin of the infected larva becomes soft and swells becoming a sac containing a light yellow to brown liquid inside. If the infected larva is picked out using a forceps it looks like a sac filled with liquid.
- The larva dies in the pre-pupal condition just after capping.
- Under the cap, the colour of the dead larva changes slowly from light yellow to brown and finally black, starting with the head and followed by the thorax and abdomen.

Figure 63: Thai sac brood disease



a) larvae and pre pupae

b) larvae with sack-like appearance

### Control measures

- Always keep the colony strong and make sure it has sufficient food.
- Select for disease resistant colonies.
- Identify any diseased colony and isolate from the apiary.
- Transfer the bees to a new hive and provide new comb foundation and feeding syrup.
- Cage the queen to create a broodless condition or make the colony queenless.
- Requeen with a newly-mated queen if available.
- Destroy and burn diseased combs and frames.

### Chalk Brood

Chalk brood is a larval disease caused by the fungus *Ascosphaera apis*. The fungus produces spores which enter into the stomachs of young larvae with food, where they establish and multiply. The infected larva become hard, white, and dry as chalk (Figure 64).

Figure 64: Chalk brood disease



### Symptoms

- An infected larva does not show any symptoms at first but dies inside the capped cell two days after capping.
- The larva then softens and swells slightly.
- Later it shrinks and becomes a hard white chalk-like structure. The bees usually uncap the cells and remove the dead larvae.

### Control

- Disease outbreaks mainly occur in the cold season; try to avoid dampness and maintain strong colonies.
- Remove old and abandoned combs and replace with dummy boards.
- Ensure the colony has sufficient food.
- Chalk brood is not economically important so it is not necessary to treat it with any pharmaceuticals.
- As yet, no losses of colonies or honey production due to this disease have been recorded in the Hindu Kush-Himalayan region.

### American foulbrood (AFB)

American foulbrood is a disease in *Apis mellifera* caused by the bacterium *Paenibacillus larvae*. Larvae up to 3 days old ingest the bacterial spores with food. The spores can survive high temperatures, excess cold, and treatment with various chemicals. In several places across the world, colonies have been lost to this disease resulting in big losses. It has not yet been observed in the Hindu Kush-Himalayan countries or elsewhere in Asia, but the description is included because it is highly destructive. Care should be taken to prevent import of this disease when importing honeybees from outside the region for any purpose.

### Symptoms

- The infected larva changes colour.
- The larva dies after the cell is capped.
- The cap appears sunken, perforated, moist, and dark.
- A sticky, thread-like, brownish, semi-liquid material is seen when trying to pull diseased or recently dead larvae or pupae out with the help of a match-stick or forceps. This is the Rapines test and is the characteristic symptom of the disease (Figure 65).
- Finally, the dead brood turns into a scale-like structure attached to the cell.

### Control

The most common control measure in America and Europe is the complete destruction of the colony by burning.

## Diseases of Adult Bees

### Nosema

Nosema is caused by a protozoan, *Nosema apis*. It affects the digestive system in adult honeybees and causes diarrhoea, which spreads the disease to healthy bees. Usually, the disease breaks out at the end of winter or beginning of spring. It affects all types of adult bee: workers, drones, and queen.

### Symptoms

- Thin faeces is seen inside and outside the hive.
- Diseased bees have a swollen stomach.
- Storage of honey and pollen is low.
- The brown intestine of a healthy bee becomes white and swollen in an infected bee.
- The excreta of infected bees has a foul odour.
- Colony strength and life expectancy are reduced.

### Control

- A strong colony usually recovers naturally from infection, otherwise technical consultation is necessary.

Figure 65: **American foulbrood**



a) healthy brood comb



b) infected brood comb



c) infected larva



d) Rapin's test

## Amoeba

The cyst forming amoeba *Malpighamoeba mellificae* can infect adult bees. It grows and reproduces in the Malpighian tubules of the honeybees and is released in the excreta, from where it can infect other bees. Infected bees do not show any special symptoms, but it can be identified through laboratory examination. As yet, it hasn't been reported in *Apis mellifera* or *Apis cerana* bees in Nepal, but it has been found in India and possibly in other Hindu Kush-Himalayan countries.

## Paralysis

Paralysis, chronic paralysis, or virus disease, is caused by a virus in adult bees. Two types of symptoms are observed.

### Type 1

Beekeepers in England named the disease paralysis because infected bees move their wings and bodies abnormally. They are unable to fly, and crawl on the ground. They develop swollen stomachs, and detached 'K' shaped wings, and die within a few days. If many bees become infected, a colony can be destroyed in a week. It is especially common when a single queen remains with a handful of workers at the end of the rainy season. The symptoms are similar to those of acarine disease (see Section 22).

### Type 2

Type 2 paralysis is sometimes called black robbers or little blacks. In this type, the bees are initially able to fly but are almost hairless and have a dark colour. The abdomen becomes slightly distended and slimy. Infected bees are frequently attacked by the healthy bees and if they fly out are prevented from returning to the hive by the guard bees. Ultimately they become unable to fly and then die within a few days.

Several other viruses can cause paralysis including cloudy wing virus, acute paralysis virus, Arkansas virus, black queen cell virus, deformed wing virus, Egypt virus, Kashmir virus (Indian strain), Kashmir virus (Australian strain), iridescent *Apis cerana* virus, and filamentous virus.

## Control

As in other animals and plants, bee viruses cannot be controlled with pharmaceuticals. Good colony management practices should be adopted as a preventive measure.

## Preventive Measures to Avoid Bee Disease

Many bee diseases can be avoided through proper colony management and preventive measures such as the following:

- Maintain colony strength.
- Ensure sufficient food.
- Replace old combs every 2 years.
- Requeen the colony every year.
- Clean hives regularly.
- Use the queenless or broodless technique against brood diseases, but take care when making a colony queenless or broodless.
- Isolate a diseased colony from the apiary to prevent disease transmission to healthy colonies.
- Only use chemicals or drugs to treat suspected disease following technical consultation.

## Malnutrition

Both brood and adult bees need nutrients for their physical development, and to maintain the proper conditions in the hive (warming and cooling). Undernourished or malnourished bees can become deformed, weak, and diseased or disabled, and unable to carry out their work. Finally, they may die from lack of food. Larvae are voracious eaters and need to be properly fed with nutritious food so that they develop into healthy,

physically fit, adult bees. Death of brood and adult bees, and bad brood cycles, are not always a sign of disease, they may also be due to malnutrition. Bad brood patterns can also result from egg laying by a non perfectly mated queen, and lack of pollen stores during the brood period.

### Necessary nutrients

A worker larva needs 142 mg honey and 134 mg pollen to become a pupa. An adult worker needs 0.7mg of sugar per hour while resting and 11.5 mg during flight to fulfil its physiological needs. Thus, a normal colony needs 60–80 kg honey and 15–55 kg pollen per year. The hypo-pharyngeal gland or fat body of a worker bee does not develop if there is protein deficiency within 8–10 days of their emergence as adults, and protein deficiency may also shorten life expectancy.

### Causes of Mortality

Death of brood and adult bees can have various causes in addition to disease and malnutrition:

- Chilling – If the colony is unable to maintain a brood temperature of 32–35°C (thermo-regulation) because it is too small.
- Excessive heat – During the hot summer in foothill and plains areas, colonies sometimes fail to regulate the colony temperature and combs melt. Sunken caps on sealed brood, holes in the caps, pressing of larvae, and blackening or browning dead brood, can all be caused by excess temperature.
- Food deficiency – If colonies are not properly fed during the dearth period the larvae may become protein deficient. When these larvae emerge as adults, they are deformed and cannot fly, and fall down to the bottom board. Sometimes when there is food deficiency, dead workers are found with their heads in empty cells.
- Pesticide poisoning – Bees can die if pesticides are sprayed to protect crops during blooming. Pesticide poisoning of brood can take place when worker bees bring poisoned nectar and pollen to the nest.

# Session 20 Observation Tour

## Sub-topics

- ▶ Successful beekeepers, apiaries and beekeeping resource centres
- ▶ Government and private farms

## Time: 5 hours

Theory: 30 minutes

Tour: 4 hours 30 minutes

## Objectives

Trainees will

- receive primary information about successful and unsuccessful beekeeping activities from different organizations and individual beekeepers;
- learn about hive products and colony management; and
- learn about the importance of beekeeping; options, challenges, and opportunities in beekeeping; and ways of becoming a successful beekeeping entrepreneur.

## Training Methods

- Lecture
- Direct observation and discussion in the field
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- An apiary and model farm, pictures, records
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture

Tell trainees about the objectives of the observation tour, the places that will be visited, and particular points to which they should pay attention. Use slides and photos to illustrate the talk, or diagrams and posters in areas where there is no electricity. Hand out copies of the observation sheet and explain how it should be filled in.

### Activity 2: Observation tour

- Step 1:** The trainer/facilitator should contact successful beekeepers, entrepreneurs, and other relevant organizations or officials in the vicinity of the training event to make arrangements for an observation tour. The tour may cover one or a number of different sites.
- Step 2:** The trainer/facilitator should visit the field sites and discuss with owners the information to be covered.

- Step 3:** Arrange a vehicle if required.
- Step 4:** Orient the trainees on the where, why, and how of the visit(s) and the code of behaviour. Remind trainees that they should take care not to disturb the bees as directed by the entrepreneurs they visit. Remind them to keep a record of their observations by filling out the observation sheets.
- Step 5:** Introduce the trainees to the cooperating entrepreneur(s) and ask the entrepreneurs to introduce themselves (their village, organization, apiary training, objectives, and any other information). Ask the cooperating entrepreneurs to explain or show equipment, different stages of honeybees, and any relevant information about their farm/ organization/ enterprise as discussed previously with the trainer. Take care to build on, but not to repeat, information that the trainees have already received in the training.
- Step 6:** Trainees should note down any queries.
- Step 7:** After completion of the presentation, they should ask their questions one-by-one, taking care to show respect and consideration.
- Step 8:** The facilitator should stay in the background and focus on facilitating the discussion between entrepreneurs and trainees.
- Step 9:** At the end, the facilitator should thank the entrepreneur and ask for continued cooperation. Remember to pay, if there is any cost for the tour.
- Step 10:** The trainees should hand in their observation sheets to the trainer.

### Activity 3: Discussion and question and answer

The timing of this session is dependent on the tour. If the visit is close by, it can take place immediately trainees return to the meeting venue. In a residential training it can take place in the evening after the tour. Otherwise it can be held before the start of the next day's sessions.

After the tour is over, use discussion and question and answer approaches to discover what trainees have learned during the tour and to answer their queries and discuss the observations. Look at the observation sheets to identify points of agreement and disagreement, and points that trainees have missed. Provide feedback on the sheets to the trainees.

#### Take home message

- During the course of the training, trainees should always ask for clarification if anything is not clear.
- Collect information on becoming a successful beekeeper or entrepreneur by talking directly to entrepreneurs and beekeepers.

# Session 20 Resource Materials

## Observation Tour

### SESSION 20

An observation sheet will help trainees structure and record their observations. The trainees should use the sheet to record their perceptions of the strengths and weaknesses of the beekeeper, entrepreneur, or organization visited, and any other observations and suggestions. A sample format is shown in Table 11.

Table 11: Sample format for recording observations related to the tour

Strengths		Weaknesses		Remarks
1.		1.		
2.		2.		
3.		3.		
4.		4.		
5.		5.		
6.		6.		
7.		7.		
8.		8.		
9.		9.		
10.		10.		

Suggestions if any

- 1.
- 2.
- 3.
- 4.

# Day 6

## Review of Day 5

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**Session 21:** Bee Parasite Management

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**Session 22:** Honeybee Pests

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**Session 23:** Honeybees and Pollination

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**Session 24:** Colony Migration

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**Session 25:** Honey Production, Harvesting, Processing, Storage, and Use

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# Session 21 Bee Parasite Management

## Sub-topics

- ▶ Introduction (Acarines, *Varroa*, *Tropilaelaps*)
- ▶ Type of losses
- ▶ Symptoms and identification
- ▶ Control
- ▶ Points to note
- ▶ Biological control

## Time: 1 hour 30 minutes

Theory: 45 minutes

Practical: 45 minutes

## Objectives

Trainees will

- be able to identify the bee parasites in a colony, and
- know how to control and manage them.

## Training Methods

- Lecture
- Practical exercise
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- Movable frame hive with bee colony infected with brood mites
- Colony inspection equipment
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins.

## Activities and Exercises

### Activity 1: Lecture

Give a presentation on bee parasites, their identification, and methods for control and management, as outlined in the resource materials (below). Use slides and photos to illustrate the talk, or large blown up photos and diagrams in areas where there is no electricity.

### Activity 2: Practical exercise

- Step 1:** Identify a parasite-infected hive and open it.
- Step 2:** Let the trainees see the effect of the parasites on the bees.
- Step 3:** Demonstrate, and let the trainees practise, different ways to manage parasites as described in the resource materials.

### Activity 3: Discussion and question and answer

Use discussion and question and answer approaches to discover whether the trainees understand the problems of parasites, can recognize the symptoms, and know about methods of control and management.

#### Take home message

- Mites can cause great losses in beekeeping and it is important to use integrated management measures – biological, physical, and chemical – for sustainable management and control.
- Management practices can be effective and should be carried out in consultation with a skilled technician.

# Session 21 Resource Materials

## Bee Parasite Management

### Introduction

Mites affect honeybees by sucking their body fluid. Some are internal and others are external. They can directly affect larvae, pupae, and adult bees. Some cannot be seen with the naked eye while others are clearly visible. The three major mites that affect honeybees are described below.

### Acarine Mites (*Acarapis woodi*)

*Acarapis woodi* is a small mite that infests the airways of adult bees causing acarine disease or acariosis. The mites enter through the spiracles and live in the trachea, where they lay eggs and grow their young. They suck bee fluid in the trachea and weaken the bees. The mites are tiny ( $<100\ \mu\text{m}$ , or 1/10th mm) and can only be seen at high magnification (e.g., under a scanning electron microscope) (Figure 66). Acarine is common in Nepal.

### Symptoms

These mites only attack adult bees. Initially, they infect young adults; later, when their population has built up, they attack other bees in the colony, including the queen bee. The signs of infestation are

- bees crawling in front of the hive and unable to fly,
- bees with a shiny abdomen and 'K' shaped wings (Figure 66), and
- reduced honey and pollen storage.

### Treatment

Two simple methods are available for treating mite infested colonies.

1. Soak a cotton ball with 5–15 drops of liquid menthol and place in a matchbox or small perforated plastic bag on the bottom board inside the hive. Leave to evaporate slowly. Repeat weekly for 6–7 weeks. Liquid Vicks (sancho) can be used if menthol is not available.
2. Mix vegetable ghee or oil with powdered sugar to make a paste and place 50–100 gm of the mixture (amount depending on colony size and bee species) on a piece of paper on the top bars where the bees can feed from it. Inspect the hive regularly to make sure that none has been dropped outside the hive and the mixture has not attracted ants.

Figure 66: Acarine mite



a) redrawn scanning electron microscope image



b) infected bee

### Varroa Mites (*Varroa destructor*)

Varroa mites are reddish or brownish oval-shaped mites with a flat button-shaped body and eight legs. They are around 1–1.8 mm long and 1.5–2 mm wide and can be seen with the naked eye (Figure 67). The mites attach to the body of bees and suck the haemolymph, weakening the bee. The female mites enter into an open brood cell with a coiled larva, especially drone brood, and lay eggs before the cell is sealed by the bees. The mites then grow inside the cell. It is a more serious problem in *Apis mellifera* than in *Apis cerana*.

#### Symptoms

The major signs of infestation are

- sunken and perforated pupa cells,
- dead pupae on the bottom board and/or outside the hive entrance,
- smaller bees with deformed wings emerging from cells,
- brood pattern not uniform,
- deformed appendages (legs, wings, and antennae),
- bees unable to fly and walk,
- decreased disease resistance in the colony,
- drones unable to mate with the queen,
- decreasing or exhausted hive food store and low collection of nectar and pollen, and
- low comb building rate.

### Tropilaelaps Mites (*Tropilaelaps clareae*)

*Tropilaelaps* mites are half the size of *Varroa* mites. The reddish-brown mites are about 1 mm long and 0.6 mm wide and visible to the naked eye (Figure 68). They are very mobile moving about easily and quickly in the hive. All stages of the mite feed on the haemolymph of the honeybee larva causing serious damage during development. The mites are attracted to the brood of *Apis mellifera* bees, but cannot survive if they do not find 1–2 day old larvae in the nest. Females enter into the brood cells while they are open and start laying after capping. If sealed brood is taken out with forceps or a pin, the mites can be seen on the pupal body. Sometimes these mites can be seen moving on the brood comb.

#### Symptoms

- *Tropilaelaps* infestation causes damage to the brood resulting in an irregular brood pattern and stunted and deformed adults.

Figure 67: *Varroa* mite (left) and infected honeybee pupa (right)



## Treatment of *Varroa* and *Tropilaelaps* Mites

### Biological methods

Biological methods take longer and are more laborious but are safer than chemical methods.

#### Drone trap

*Varroa* develops mostly in drone brood and can be controlled to some extent by trapping in drone brood cells. At the beginning of the honey flow, identify and destroy all drone brood (after the drones have pupated, remove the part of the comb containing drones after uncapping in an extractor) and destroy the mites together with the drone pupae by burning.

#### Alteration of brood cycle

Egg laying in a colony can be prevented by using a queen excluder during the winter season, and the queen not released for laying until early spring. This creates a broodless condition which reduces the mite population.

#### Cyclical destruction of worker brood

Mites can be controlled by destroying three cycles of worker brood. This method is effective during the brood production period; it increases honey yield and also controls swarming.

- Day 1: A 'caged comb' is prepared by placing a queen excluder jacket around an empty comb and placing the queen on the comb inside the cage.
- Day 9: The empty comb, caged with the queen, should be named 'a' and placed at the centre of the brood chamber.
- Day 18: A second empty comb 'b' is prepared with a caged frame and queen excluder jacket. The queen from frame 'a' should be transferred to frame 'b', and frame 'a' replaced with 'b' at the centre of the brood chamber. The pupae and mites in frame 'a' should be destroyed.
- Day 27: Repeat with a new frame 'c' and destroy the pupae and mites in frame 'b'.
- Day 34: Remove frame 'c', destroy the pupae and mites, and release the queen in the colony.

### Physical methods

#### Brood destruction

If the mite population is excessive, all the bees should be transferred to an empty hive and the old hive containing brood with mites killed by burning.

#### Physical removal

Dusting of glucose powder, milk powder, or wheat flour on the bees in the hives encourages mites to slide and drop off the bees. The dropped mites can be collected and destroyed. The process should be repeated every four days.

### Chemical methods

Bee colonies can be affected by all three types of mites. Infection can lead to colony destruction and great losses to the beekeeper. If the mites cannot be controlled by biological or physical methods, chemical methods can be tried in consultation with a technician.

Figure 68: *Tropilaelaps* mite



# Session 22 Honeybee Pests

## Sub-topics

- ▶ External pests (birds, pine martens, ants, wasps, hornets)
- ▶ Pests in the hive (wax moth, wax beetle)

## Time: 1 hour

Theory: 30 minutes

Practical: 30 minutes

## Objectives

Trainees will

- be able to identify honeybee pests inside and outside of the hive and adopt control measures against them.

## Training Methods

- Lecture
- Practical exercise
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- Apiary
- Small bowls
- Colony inspection equipment
- Swat
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture

Give a presentation on honeybee pests and methods for controlling them as outlined in the resource materials (below). Use slides and photos to illustrate the talk, or large blown up photos and diagrams in areas where there is no electricity.

### Activity 2: Practical exercise

- Step 1:** Show the trainees different honeybee pests from outside the hive and inside the hive using figures, photographs, and samples.
- Step 2:** Show the effects of pests on honeybee colonies.
- Step 3:** Demonstrate different control measures for pests.
- Step 4:** Ask the trainees to carry out different control measures.

### Activity 3: Discussion and question and answer

Use discussion and question and answer approaches to discover whether the trainees know about the major pests and how to control them.

# Session 22 Resource Materials

## Honeybee Pests

### Introduction

Pests are any unwanted and destructive insects or other animals that attack bees and disturb colony development. Some feed on bees or bee brood, some raid honey and pollen stores destroying brood and combs, some suck body fluid from living bees, and some simply knock over bee hives.

### Outside the Hive

#### Wasps and hornets

##### Damage

Wasps and hornets look similar to bees but are larger (Figure 69). As well as eating dead bees, wasps may capture flying bees and bees from the hive to feed to their larvae. They may also rob honey in the autumn. Hornets enter the hive and capture and eat adults.

##### Control

Individual wasps and hornets can be killed with a fly swat (flapper). In general, however, it is better to locate and destroy nests by fire or other means. Reducing the hive entrance size will also help guard bees to defend better against intruding wasps.

#### Pine marten

##### Damage

The pine marten is a cat-sized animal with black or brown fur and a bushy tail (Figure 70). They open hives and feed on honey-filled combs and adult bees. They attack bee colonies at night to avoid people and dogs.

##### Control

Since pine martens are afraid of people and dogs, keeping a dog around an apiary is an effective way of scaring them away. Ensure hive safety by putting a heavy stone on the top of the hive or tie the hive with a hive belt. Placing a scarecrow in the apiary can also be effective.

Figure 69: Wasp (left) and hornet (right)



## Ants

### Damage

Ants are normally wingless, six-legged, predatory insects (Figure 71). They generally nest in the ground although some nest above ground. They enter hives and feed on honey and brood; some species catch adult bees and feed on them.

### Control

Mount the hive on a hive stand, grease the legs of the stand and place them in bowls filled with water. Remove any weeds from around the hives so that ants can't use them to climb up to the hive, and narrow the hive entrance.

## Wall lizards, garden lizards and frogs

### Damage

Wall and garden lizards are small reptiles with a long tail, flat head, scaly body, and four sticky feet for climbing (Figure 72). They are small predators found abundantly in summer. Frogs are tailless amphibians somewhat similar to lizards in appearance. Frogs and lizards feed on a wide range of insects, worms, snails, and similar; if other food is in short supply, they will capture bees from around hives and feed on them.

### Control

Frogs and lizards cannot enter into an improved hive. For other hives, keep the area around the hive clean and scare away any frogs and lizards that are seen hunting or catching bees.

Figure 70: **Pine marten**



Figure 71: **Ant**



Figure 72: **Frog (left) and lizard (right)**



Figure 73: **Spider**

### Spiders

#### Damage

Spiders are eight-legged creatures that spin webs to catch insects for food (Figure 73). They build webs to trap bees inside hives, outside hives on tall trees, and in front of or near hives.

#### Control

Remove any spider webs inside or outside the hive. Use a long stick with a brush on the end to remove webs from tall trees. Prevent spiders from entering the hive by narrowing the hive entrance. Kill, or capture and release a long way away, any spiders which have entered the hive.

### Birds

#### Damage

Crows and bee-eaters (Figure 74) are particularly likely to catch and eat flying bees. When there are few insects around, and especially on cold and cloudy days, they prey on adult bees around the hive.

#### Control

From an environmental point of view, it is better to scare birds away than to kill them. Use a scarecrow in the apiary or a noise maker. Destroy nests of bee eating birds if found near the apiary.

Figure 74: **Bee eater birds**Figure 75: **Bear**

### Bears

Bears (Figure 75) push over beehives and feed on combs and bees.

#### Control

Bears can be scared away by a watchman or dog; a scarecrow in the apiary can also help. The hives can be protected to some extent by placing a heavy stone or wooden plank over the top cover of hive or tying the hive with a hive belt. It is better not to establish an apiary in an area where the bear population is high.

### Inside the Hive

#### Hawk moth

#### Damage

The hawk moth is a large moth with a wing span of 5–6 cm that makes a sound like a hawk. It enters the hive at night and sucks honey from the combs. A single moth can suck 8–10 g of honey at a time.

### Control

The best prevention is to impede entry to the hive by narrowing the entrance and sealing all other holes and cracks with a strip of wood or damp mud. Moths found inside the hive should be killed or scared away.

### Wax moths

Wax moths feed on beeswax. There are two types – the greater wax moth and the lesser wax moth.

### Damage

The greater wax moth is pale brown and rather larger than a grain moth (2.5–3 cm) (Figure 76a); the lesser wax moth is also cream-coloured, has a yellow head, and is the same size as a grain moth (Figure 76b). The female wax moth lays several hundred eggs in corners and crevices in the hive. The hatched larvae move fast (Figure 76c); they feed on the wax in the combs and make holes or webbing tunnels which contain faecal pellets. The whole comb may be converted into a mass of webbing (Figure 76d). Wax moths particularly infect the old drained combs in a weak colony. The greater wax moth is common in hot areas in the summer and rainy season, whereas the lesser wax moth is common in hill areas at most times of year.

### Control

Preventive measures include maintaining strong colonies and uniting weak colonies; regular inspection and cleaning of hives; narrowing the entrance and sealing cracks and crevices; and removing and storing safely any old drained combs.

Figure 76: **Wax moths**



a) greater wax moth



b) lesser wax moth



c) greater wax moth larvae



d) damage to a honeycomb caused by wax moth

## Wax beetle

### Damage

The wax beetle is a small beetle about half the size of a worker bee with hard forewings and membranous hind wings (Figure 77). The beetles hide in corners and crevices in the hive; both adults and larvae feed on stored honey, pollen, and brood (eggs and larvae) causing heavy damage to colonies.

### Control

Preventive measures include maintaining strong colonies; regular inspection and cleaning of hives but not opening the hive unnecessarily, and sealing cracks and crevices with clay. Keep the apiary on hard dry ground as beetles cannot pupate in such places. Trap the beetles already in the hive in a pipe about 8–10 cm (3–4 inches) long and 1 cm (½ inch) in diameter and closed at one end containing artificial pollen substitute pushed down to the closed end. Remove the pipe at intervals and kill any beetles found inside.

## Phorid fly

Phorid flies are a family of small hump-backed flies between 2 and 6 mm long and resembling fruit flies (Figure 78). They tend to run rather than fly. They mostly live around the homestead and feed on kitchen waste and rotting organic matter. Some types are parasites of honeybees. The female fly lays eggs on the abdomen of the adult bees which hatch into larvae within 24 hours. The larvae feed on bee larvae, and can be seen looking like small white maggots in the comb cells.

### Control

An infested hive should be thoroughly cleaned inside and out; in severe cases, the flies can be repelled with smoke from smouldering cotton cloth or paper.

## General Methods for Pest Prevention

Various standard procedures can be used to help protect hives from a range of pests. They include the following.

- Use modern hives as it is much easier to keep them free of pests and to clean them if they do become infested. Keep the colony strong with a young and properly mated queen and sufficient stores of pollen and honey.
- Select a site for the apiary which is less susceptible to pests (e.g., clean dry hard ground, no bears in the vicinity, no bee eater birds nesting close by, no long weeds touching the hives, and so on).
- Fence the apiary and use hive stands with the legs standing in bowls filled with water.
- Avoid pesticide poisoning.
- Use clean equipment in good condition.

Figure 77: Cluster of wax beetles (top) and damage caused by wax beetle larvae (bottom)



Figure 78: Phorid fly



# Session 23 Honeybees and Pollination

## Sub-topics

- ▶ Introduction
- ▶ Role of honeybees in pollination
- ▶ Pollination needs of different crops

## Time: 1 hour

Theory: 30 minutes

Practical: 30 minutes

## Objectives

Trainees will

- understand the relationship between honeybees and pollination services, crop productivity, and biodiversity maintenance, and
- be able to use honeybee colonies for crop pollination.

## Training Methods

- Lecture
- Practical exercise
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides
- Diagrams, photos, and flex prints including a diagram of the parts of a flower and an anatomical drawing of a bee
- Some living or recently caught bees
- Flowers
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture

Give a presentation on the role of bees in pollination and the different benefits, as outlined in the resource materials (below). Include a discussion of the differences between, and advantages and disadvantages of, self and cross pollination Use slides and photos to illustrate the talk, or large blown up photos and diagrams in areas where there is no electricity.

### Activity 2: Practical exercise

Participants should understand the details of pollination and observe bees as they pollinate flowers.

**Step 1:** Describe the details of a flower and floral parts using a large blown up diagram.

**Step 2:** Show the floral parts of self-pollinating and cross-pollinating fresh flowers, including the stamen, stigma, and pollen grains.

- Step 3:** Show, using a diagram and a live (or freshly caught dead) bee, which parts of the bee's body are involved in pollen collection and how pollen is transferred from one flower to another.
- Step 4:** Observe bees collecting nectar and pollinating in the wild.

### Activity 3: Discussion and question and answer

Use discussion and question and answer approaches to discover whether the trainees understand the role of honeybees in pollination.

#### Take home message

- Honeybees provide pollination services that ensure reproduction and genetic continuity of plants, and are rewarded with pollen and nectar. Insect-based pollination is essential for many crops, and a great many wild plants. Thus conservation, promotion, and development of bees benefits mankind in general as well as beekeepers.

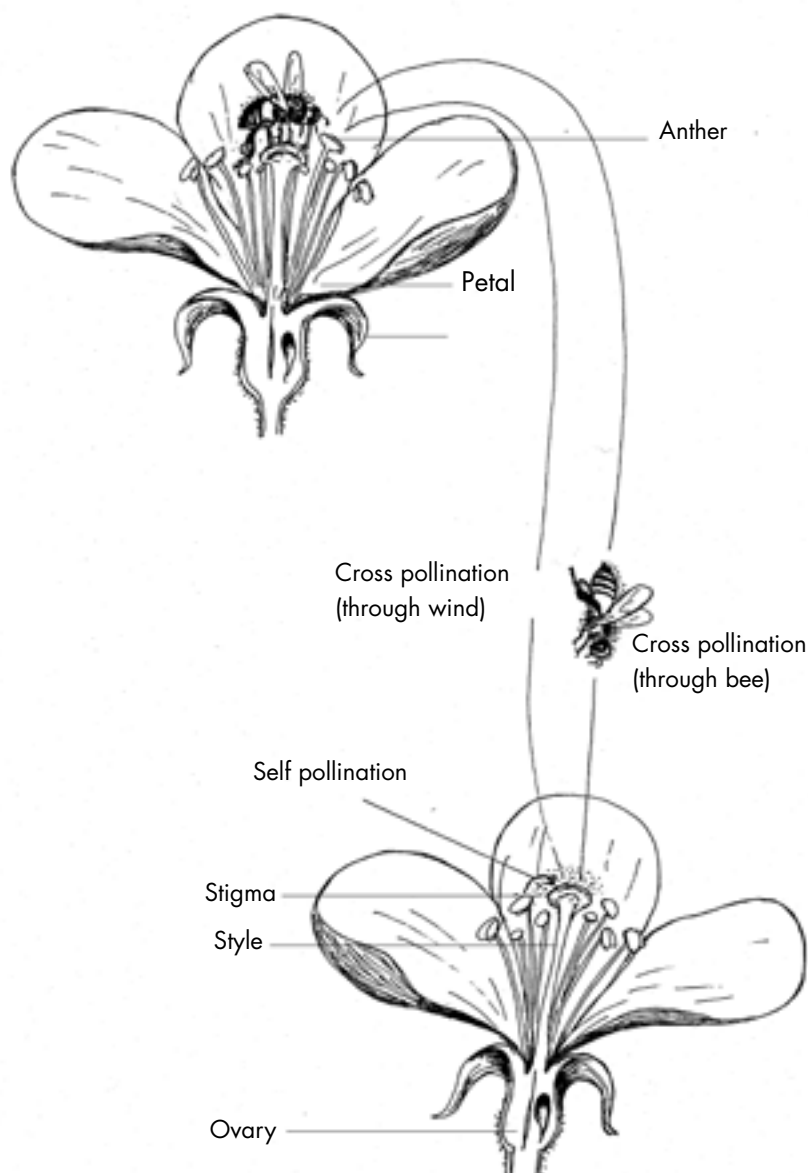
# Session 23 Resource Materials

## Honeybees and Pollination

### Introduction

Pollination is a process by which pollen is transferred in plants from an anther to a stigma enabling fertilization. Pollination is a necessary step in the reproduction of flowering plants and the development of fruit and seeds; without pollination, flowering plants would not produce seeds and could die out. Transfer of pollen grains from the anther to the stigma of the same flower or another flower in the same plant is called self-pollination; transfer of pollen from a flower on one plant to a flower on a different plant is called cross pollination (Figure 79). Self-fertile or self compatible plants can be fertilized by pollen from anthers of a plant of the same variety; self incompatible crops require compatible pollen from a different variety of the same crop. Cross pollination increases genetic diversity.

Figure 79: **The process of cross pollination**



In some cases, pollination is by wind (especially grasses and conifers) or water (aquatic plants), but more commonly, pollination requires pollinators, such as bees, butterflies, moths, flies, beetles, hummingbirds, and bats to carry pollen from one flower to another (Figure 80). Most pollinators are insects. Usually they are trying to get food, the sticky pollen or sweet nectar at the base of petals, and accidentally rub against the stamens and get pollen stuck on themselves (Figure 81). When they move to another flower to feed, some of the pollen can rub off onto this new plant's stigma.

Pollination is a prime factor in crop productivity. Perfect pollination leads to higher crop production with the formation of more large and perfectly formed seeds and fruits (Figure 82). It increases seed viability, rates of germination, and resistance of seeds against disease and pests. Better pollination management can increase crop yields by 35–50% or more (Figure 83).

Figure 80: **Pollination by different bees**



A stingless bee on a mustard flower



A bumble bee on an apple flower



A leaf cutter bee on a mustard flower



An alkali bee on an alfalfa flower



A horn-faced bee on an apple flower



An anthophorid bee on a mustard flower

Figure 81: Pollen grains on the head of a bee



Nabin Baral

Figure 82: Benefits of bee pollination

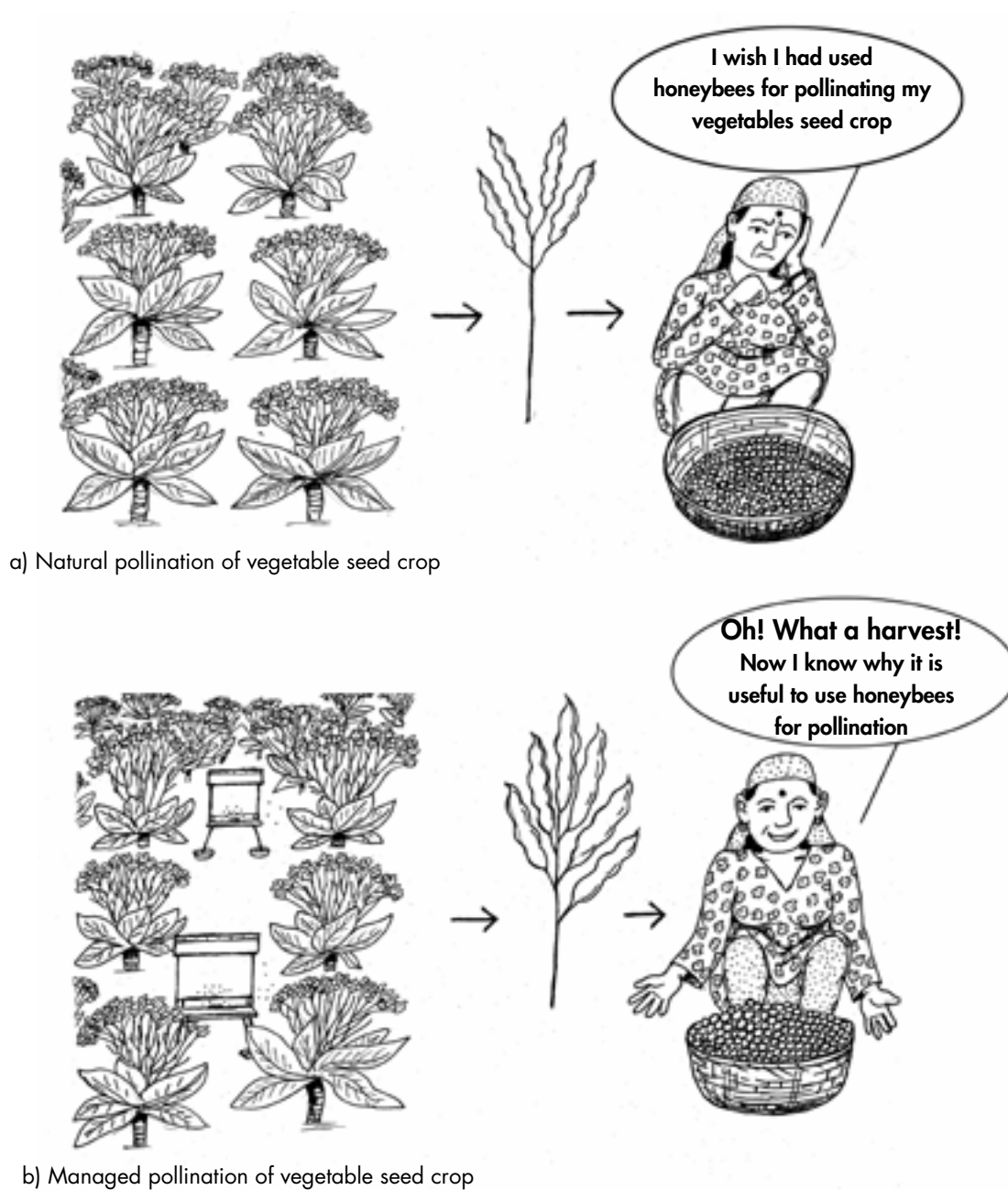


Figure 83: Bee hives placed to pollinate a mustard crop



Nabin CTD Shrestha

### Bees are the Best Pollinators

Honeybees are the most efficient plant pollinators among the insects. It is estimated that one third of the human diet comes from insect-pollinated plants, and that honeybees provide 80% of that pollination. The main reasons for the efficiency of bees are as follows:

- Their hairy bodies pick up a large amount of pollen.
- Their morphological characteristics enable bees to work fast and visit a large number of flowers in a short time.
- The honeybee population multiplies fast during the flowering period of crops and other plants and accelerates foraging work during nectar and pollen flow so that the greatest activity is at the time that the most pollination is needed.
- Honeybees remember particular flowering plants for 4–5 days and keep foraging until the end of the blooming period, which means that pollination services are provided until the end of flowering.
- Honeybees can communicate the position of plants in flower to the whole colony so that large numbers of bees visit the plants.
- Honeybees forage a single species of flower at one time, which means that they are effective in transferring pollen to other plants of the same species rather than to random flowers.
- Domesticated bees can be kept in hives, multiplied according to need, and migrated to a pasture area at the time when a particular crop is ready for pollination.
- Bees provide pollination services in different geographical areas (plains to mountains) and in different seasons (hot summer to cool winter).

The effectiveness of honeybee pollination in particular crops is related to

- the number of bee colonies in the crop area,
- the distance of bee colonies from the targeted crop,
- timing and method of placing honeybee colonies,
- forage preferences of the honeybees,
- queen quality for egg laying in a colony,
- whether the season is favourable for bee forage,
- the level of stores of honey and pollen in the colony, and
- pesticide poisoning.

# Session 24 Colony Migration

## Sub-topics

- ▶ Introduction
- ▶ Advantages
- ▶ Method for migrating and precautions
- ▶ Preparation

## Time: 1 hour

Theory: 30 minutes

Practical: 30 minutes

## Objectives

Trainees will

- know how to increase honey productivity by identifying good pasture and migrating colonies to take advantage of the resources,
- understand how migration supports both increased production of honey and increased agricultural productivity, and
- be able to migrate colonies.

## Training Methods

- Lecture
- Practical exercise
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- Colony inspection equipment
- Marker pen
- Movable frame hive with bees
- Wire netting and nails
- Hammer
- Hive tool
- Hive belt/rope, strips
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture

Give a presentation on the uses of migration, how to migrate colonies, and the precautions to be taken, as outlined in the resource materials (below). Use slides and photos to illustrate the talk, or large blown up photos and diagrams in areas where there is no electricity.

## Activity 2: Practical exercise

Trainees will practise the basic techniques for migration.

- Step 1:** Explain the methods used to migrate colonies.
- Step 2:** Select the colonies to prepare for migration.
- Step 3:** Add additional empty frames or dummy boards if needed and nail the frames to fix them so that they do not move.
- Step 4:** Ask the trainees to practice the method of packing a hive, first positioning the bottom board, then the brood chamber, and fixing these parts with the help of wooden strips and nails.
- Step 5:** Ask them to close the entrance.
- Step 6:** First demonstrate, and then ask the trainees to load the packed hive onto a vehicle.
- Step 7:** Explain to trainees how to place a hive in an apiary according to season and pasture.
- Step 8:** Demonstrate how to open a hive entrance after placing the colonies in an apiary, and ask trainees to open the entrances on the remaining hives.

## Activity 3: Discussion and question and answer

Use discussion and question and answer approaches to discover whether the trainees understand the advantages of colony migration, how to migrate a colony, and the precautions to be taken.

### Take home message

- Colony migration is an important process which can significantly increase honey production. Colony migration is necessary to make beekeeping a competitive and sustainable beekeeping enterprise.
- Beekeepers need to have sufficient information on bee pasture and to carry out an economic analysis as part of the preparation for colony migration.

# Session 24 Resource Materials

## Colony Migration

### Introduction

In general, no one area will contain flowering plants all year round. However, honeybees need to collect nectar and pollen to meet their daily needs and to produce honey, and need supplementary feeding if no pollen and nectar are available. Thus it is useful to move colonies to different areas according to the flowering calendar. This is called migration, and when practised on a large scale is called migratory beekeeping. Migration can also be carried out primarily for pollination of fruit trees or other agricultural crops with honey production a secondary consideration.

Colony migration is usually an essential part of commercial beekeeping. The main objectives are to

- increase honey production,
- strengthen and divide colonies,
- reduce the cost of supplementary feeding,
- increase crop productivity through bee pollination, and
- help conserve biodiversity (agricultural and wild plants) through pollination.

### Points to Consider

The main objective of beekeeping is to maximize honey production and minimize production costs. Thus beekeepers should first identify suitable bee pasture, know the costs of migrating, and migrate colonies with the proper technical knowledge and skills. The following points should be considered when planning migration.

### Migration site selection

- Identify the type of floral sources, season and duration of blooming, and area of pasture and carrying capacity at the home site and possible migration sites.
- Collect information about the local environment and possible use of pesticides for crop protection in the bee pasture area.
- Investigate the likelihood of attack by natural enemies; only migrate colonies to places where the chance of attack is low.
- Estimate the distance of bee pasture from the apiary where the colonies will be located. Find out about the availability of transport to the possible sites for the apiary.
- Analyse the total costs and benefits of migration.

### Selection and preparation of colonies

- Select only strong, healthy, and productive colonies for migration.
- Strengthen the bee colonies for at least two months before migration.
- Collect together all necessary materials, for example supers, frames, comb foundation, honey extractor, and vessels for collecting honey.

### Timing of migration

- Migrate the colonies when flowering of major bee plants has started and at least 5% are in bloom.

### Method of Migration

The main steps are shown in Figure 84.

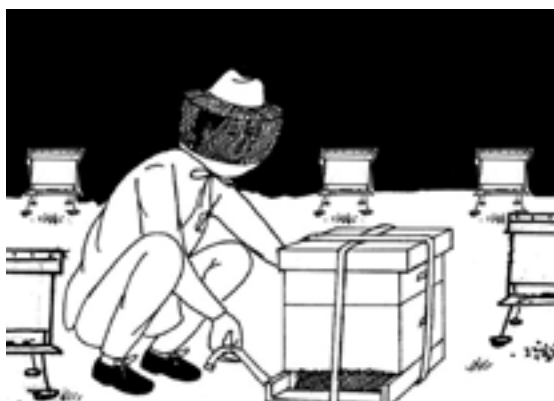
Figure 84: **Migrating an apiary**



a) Sealing the hive entrances after nightfall



b) Don't close the entrance during the day



c) Colonies prepared for migration



d) Loading colonies on a vehicle



e) Migrating colonies at night



f) Waiting for nightfall after temporarily unloading migrated colonies when stopped during the day along the way



g) Removing the belts around the hives at the destination



h) Inspect the hive to see if bees are flying in and out normally



i) Two days later, open the hive to inspect the colonies

## Preparation

Honeybee colonies should be prepared carefully for migration. If the preparation is not done properly, some bees may be left behind or may die during migration. Preparation includes the following:

- Clean the hives.
- Harvest excess honey and remove the super. Bees can die if migrated with honey stored in the hive. Fix frames tightly in the hive.
- Arrange supplementary feeding if migration is over a long distance.
- Seal all cracks and crevices to prevent the bees escaping.
- Fix the bottom board to the brood chamber, and the brood chamber to the super by nailing strips of wood from top to bottom. Use a wire netting inner cover nailed to the brood chamber to give more air if there is danger of overheating, especially during summer; remove the outer cover for long distance migration in the hot season.
- Hives can be tied with a hive belt, wire, or rope without removing the outer cover for short distance migration of a few colonies.
- Narrow the ventilation to prevent excess cold air entering the hive when migration is in the cold season.
- Close the hive entrance after all the bees have entered the hive in the evening using a cloth plug or nailed down wire netting. If bees are clustering at the entrance, they can be encouraged to enter by spraying water or giving a puff of smoke.

## Migration

- Colonies can be migrated by truck, tractor, rickshaw, manually by porters, or a combination of these, depending on the location of the original and new pasture areas and the weather.
- Colony migration should be carried out at night if possible (in winter between 5 pm and 10 am and in summer between 7 pm and 7 am).
- Ensure that air can circulate between hives.
- Carefully load and secure the hives. A vehicle should go slowly and as smoothly as possible.
- Vehicles should not stop for long periods. If they have to stop for a whole day or more, unload the colonies, open the entrances to allow bees to go out to forage, and repack and reload after nightfall.
- Carefully unload the colonies one by one at the destination.
- Place the colonies in a group (the apiary) with at least 5 feet (1.5 m) between hives.
- In general, place so that the entrances face southeast, unless the direction of the forage area, or weather and wind direction, make a different orientation preferable.
- After setting up the hives, open the colony entrances one by one by removing the cloth plug or the nailed hive net, starting at one end of the apiary and moving to the other.
- Thirty minutes after the entrances are open, or as soon as it is day, inspect the flight condition of the colonies from outside. Inspect inside after 2 days unless there is no flight, low flight, workers wet with honey, dead bees, or bees crawling on the ground, in which case the colony should be inspected immediately and the appropriate action taken.
- Inspect the hives every few days. Replace the super on the hive once the brood chamber is full, using old combs or comb foundation in the frames.

# Session 25 Honey Production, Harvesting, Processing, Storage, and Use

## Sub-topics

- ▶ Introduction
- ▶ Methods of harvesting, processing, and storage
- ▶ Quality standards
- ▶ Types of honey and honey nutrients
- ▶ Uses of honey

## Time: 1 hour 30 minutes

Theory: 45 minutes

Practical: 45 minutes

## Objectives

Trainees will

- be able to store honey safely,
- know about honey quality and types, and
- know the uses of honey.

## Training Methods

- Lecture
- Practical exercise
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- Movable frame hive with bee colony
- Colony inspection equipment
- Honey extractor, honey, honey pots and jars
- Comb
- Knife
- Tray
- Wire netting
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape

## Activities and Exercises

### Activity 1: Lecture

Give a short presentation on methods of harvesting, processing, and storing honey; honey quality; the nutrients honey contains; and uses; as outlined in the resource materials (below). Use slides and photos to illustrate the talk, or large blown up photos and diagrams in areas where there is no electricity.

## Activity 2: Practical exercise

Trainees learn about and practise methods of honey harvesting, processing, and storage.

- Step 1:** Open a hive, inspect the colony, and locate and show a comb full of honey and ready to harvest.
- Step 2:** Show the trainees how to remove bees by brushing them off the comb.
- Step 3:** Show how to prepare a comb for extraction by uncapping the cells.
- Step 4:** Show how to extract honey using the extractor.
- Step 5:** Show how to replace the combs after honey harvesting.
- Step 6:** Demonstrate the method that can be used at household level for honey filtration and sedimentation, discuss the types of pots used for storage.
- Step 7:** Demonstrate the precautions to be taken at each stage of the exercise as described in the resource materials.
- Step 8:** Ask groups of students to try extracting honey themselves.

## Activity 3: Discussion and question and answer

Use discussion and question and answer approaches to discover whether the trainees understand the methods for honey harvesting, processing, and storage, quality standards, and uses of honey.

### Take home message

- Solidification of honey is a natural phenomenon, although the speed and extent depend on the source, season, and location of the honey store. Solid honey can be liquefied by standing the honey jar in hot water. Solid honey can be eaten without liquefying.
- Daily consumption of honey contributes to a healthy and longer life.

# Session 25 Resource Materials

## Honey Production, Harvesting, Processing, Storage, and Use

### Introduction

Honey is a sticky, semi-liquid, scented product made by honeybees from the natural nectar or honeydew of flowers and plants, which is collected, processed, concentrated, and stored by the bees in combs. Honey has been used as a food and medicine from time immemorial.

Honey production involves the complete process of beekeeping management, as described in the preceding sessions, harvesting combs from a bee colony, extracting the honey from the combs, and processing ready for sale or use.

### Harvesting

Harvesting is the process of extracting honey from honeycombs taken from honeybee colonies. Honey can be harvested from wild bee colonies ('honey hunting') or from domesticated bees. Although a large amount of honey is still harvested from wild bees in the Hindu Kush-Himalayan region, the majority is now harvested from domesticated *Apis cerana* and *Apis mellifera* bees. To maximize income from commercial beekeeping, it is important to produce a large volume of good quality honey. At the same time, it is important to remember that bees store honey to use as food. The harvested honey should be in excess of the needs of the colony, and harvested at a time when the colony can still replenish its stores. Proper colony management is necessary to maintain honey quality and increase the amount of honey produced.

### Method (Figure 85)

- Only harvest during the honey flow period.
- Set up the extractor in a closed room or in a tent made of fine mesh netting away from the apiary. Use a big dish or tray to collect drips.
- Lift each frame from the super and identify combs ready to harvest. Lift out frames containing combs in which more than 70% of cells are capped. Brush the bees off the comb back into the hive. Take as many frames as will fit in the extractor (2,4, or 8). If all frames are filled they can all be harvested.
- Replace the frames taken for harvesting with old frames with cleaned comb if available.
- The frames in the brood chamber with honey should be left to fulfil the colony's needs. Although it is possible to harvest frames from the brood chamber, this is not good practice and will weaken the colony.
- Take the frames to the honey extractor in a bowl or other container to prevent dripping.
- Remove the caps from the cells on both sides of the comb with a sharp knife; collect the caps in a dish.
- Place frames in the extractor and rotate it to force the honey out of the combs. Pour the honey collected at the base of the extractor into a stainless steel container or glass jar.
- Put the frames with empty combs back into the hive if no extras were available, or store for later use.

### Processing

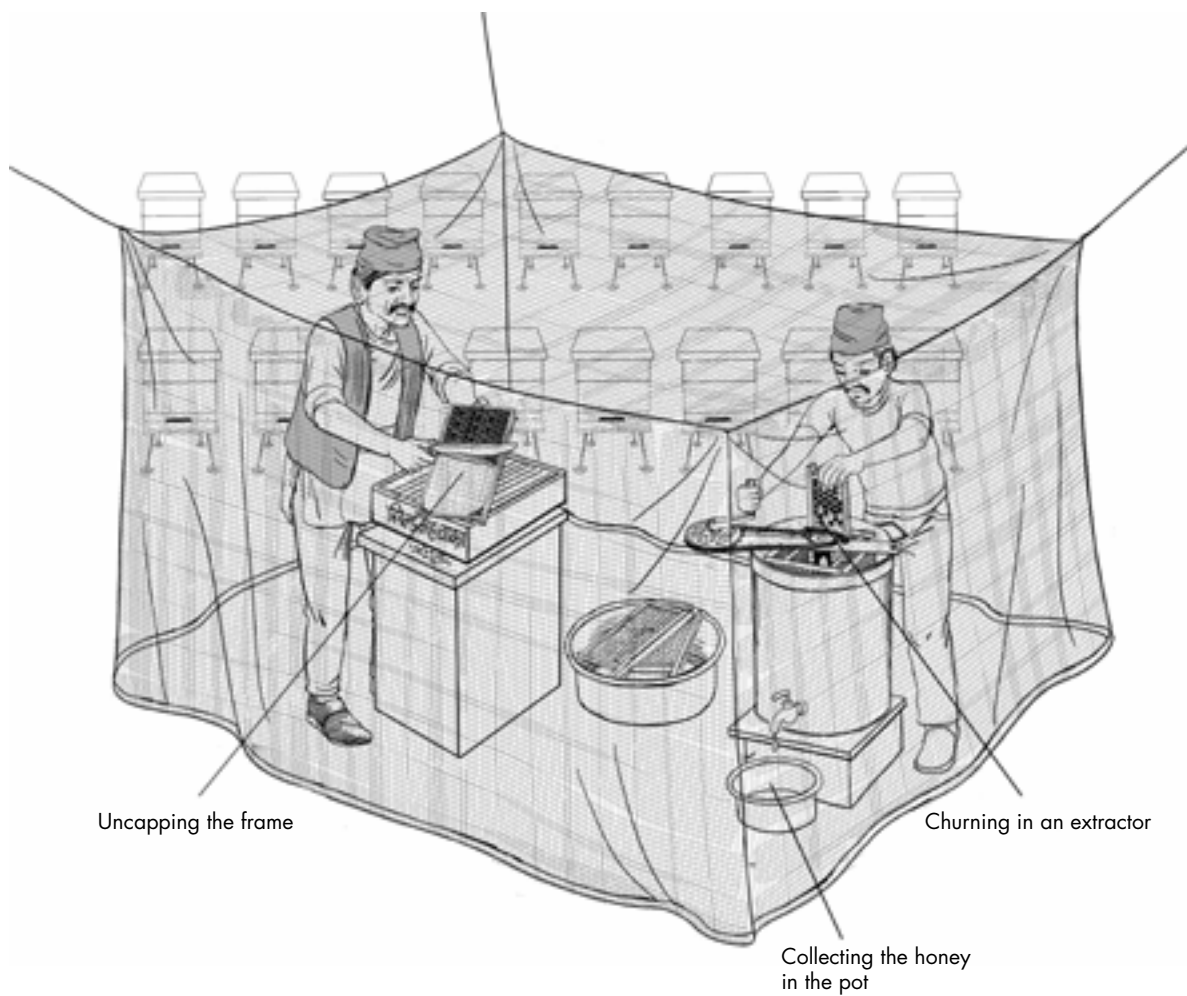
Honey is itself a processed product. The nectar collected in the crop of forager bees is passed to house bees and mixed with different enzymes to convert the sucrose into levulose and fructose before depositing in comb cells. Excess water is evaporated through fanning and heating and the cells are only sealed after the honey has ripened.

In honey production, processing mainly refers to removing any wax particles, brood, or foreign materials

Figure 85: Harvesting honey from an apiary



a) Choosing colonies for harvesting



b) Extracting honey inside a net

from the honey extracted from the combs, and on occasion treating the honey to obtain a particular consistency. The methods used for processing can have a marked effect on honey quality. Pay attention to the following in order to maintain quality:

- Processing should be carried out in a clean, dry environment.
- The processing area should be closed so that bees can't enter.
- The utensils used in processing should be made of good quality food grade stainless steel, glass, or plastic, and be clean and dry.
- The processing method may differ according to the diversity of the forage. Different methods are used for processing unifloral and multi-floral honey, and for producing liquid, solid, creamed, and comb honey.
- Honey should not be heated directly. The quality decreases markedly if heated beyond 40°C.
- You should consult with a honey technician if you intend to heat the honey during processing.

### Removing contaminants

Two main methods are used for processing honey to remove contaminants: sedimentation and heating. Occasionally, beekeepers need to evaporate excess moisture to prevent fermentation, especially with *Apis mellifera* honey. Evaporation takes place if the heating method is used to remove contaminants. If cold sedimentation is used, warm dry air can be blown across the surface of the cleaned honey to achieve the same effect. High moisture levels are less common if care is taken only to harvest combs in which at least 70% of the cells are capped.

You should consult with a technician before establishing a commercial honey processing plant.

### Sedimentation method

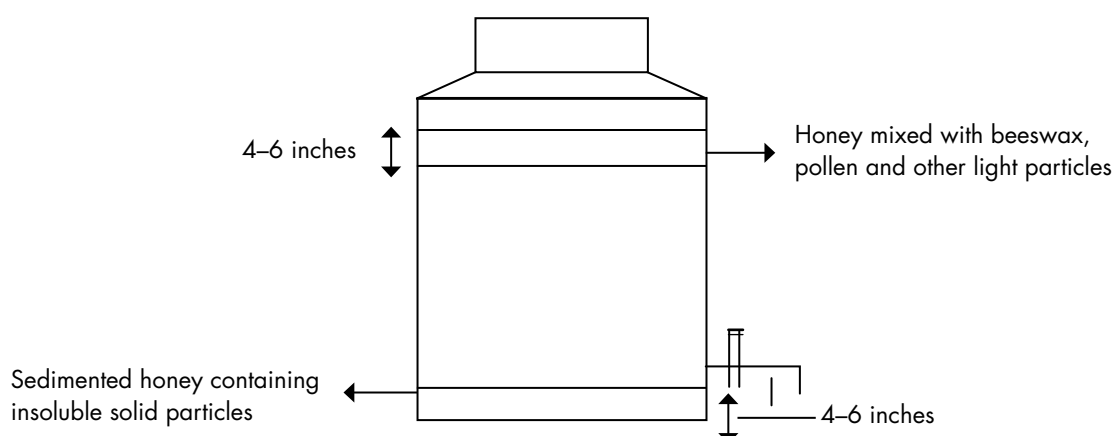
The honey is filtered through a double layer of muslin cloth and then allowed to sediment for at least 48 hours in a container holding more than 100 kg of the liquid (Figure 86). The portion at the bottom with sediment is removed through an outlet at the bottom of the container, and the remainder stored and used for bottling and sale. The honey with sediment can be used to feed the bees during the dearth period.

### Heating method

In the heating method, honey is heated in a water bath to a temperature below 40°C (Figure 87) and then filtered through muslin or steel mesh before cooling and storing in airtight bottles. Heating is also used to evaporate excess moisture and improve the keeping quality.

### Storage

Figure 86: Honey sedimentation



The following points should be noted to ensure that honey doesn't deteriorate during storage.

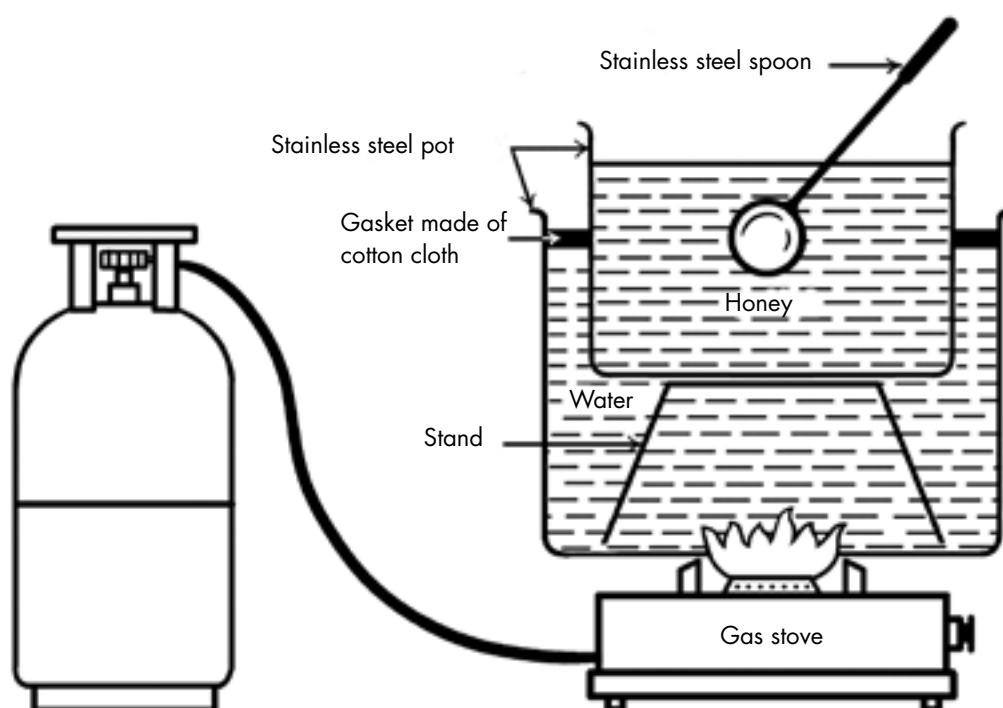
- Honey should be stored in food grade glass or stainless steel containers.
- Honey should be stored in an airtight container. It is hygroscopic and will absorb water and odours if stored open in an atmosphere with more than 20% relative humidity. The colour and taste may also change.
- Care should be taken to ensure that stored honey is free from contaminants and has not absorbed moisture to avoid fermentation and changes in colour.
- The room used to store honey should be dry, clean, and closed.
- The ideal room temperature for storing honey is 20°C.
- Always label the stored containers and include details of the harvesting date, treatment, and expected storage life.

## Ensuring Production of Quality Honey

Production of large amounts of high quality honey can be achieved by paying attention to the following:

- Requeen the colony with a quality queen 2 months before the start of the honey flow season.
- Migrate the colony to an environmentally safe pasture. Pay attention to the carrying capacity of the local pasture and exploit different sources of pasture based on market demand. Do not migrate bee colonies to pasture areas sprayed with pesticides. If pesticide spraying is observed, pack up the colonies and migrate them 5 km away.
- Adopt biological or botanical control measures instead of chemical pesticides for crop protection. If chemical pesticides have to be used, then only use them before or after flowering. Do not use pesticides in the apiary area.
- Create awareness among neighbours' and growers of crops that they should give notice to beekeepers if they are going to use dangerous pesticides. Confine the bees inside the hive for 2–3 days with sugar feeding when pesticides are sprayed on crops used as bee pasture.
- For organic honey production, don't use chemicals or antibiotics to control bee diseases and pests and follow an organic certification procedure.
- Only harvest honey from supers, and avoid mixing wax, brood, and pollen while harvesting.
- Harvest honey from combs in which more than 70% of the cells are capped (Figure 85a) while leaving sufficient stores to meet the requirements of the colony.

Figure 87: Heating honey to remove contaminants



- Use a pollution free environment and clean and safe equipment for harvesting and processing; never use utensils made of copper, iron, or brass like metals (Figure 85b).
- Filter extracted honey through a clean stainless steel mesh and collect in a clean stainless steel pot.
- Use sedimentation after filtering to ensure the honey is pure.
- Avoid adulteration of the processed honey to protect the chemical properties.
- Only store honey after proper processing and packing. Store at room temperature in a dry place to maintain the physical quality.
- For longer periods, store honey in an air tight container.

The precise composition of the purified honey varies depending on the floral source of the honey and the bee species. Table 12 shows typical values.

**Table 12: Typical values for the composition of honey**

Substance	%
Levulose	41.0
Dextrose	35.0
Sucrose	1.9
Dextrin	1.5
Minerals (potassium, chlorine, sulphur, phosphorous, manganese, calcium)	0.2
Essential oils (flavonoids, tannins, resins, volatile substances)	3.4
Water	≤ 20.0

## Uses of Honey

Pure natural honey contains more than a hundred kinds of rare and useful vitamins, minerals, and other ingredients. Honey has a long history of human consumption. It is mentioned as a perfect food in religious and spiritual scripts such as the Vedas and Puranas, and is used in both Ayurvedic and modern medicine. Honey can provide a rapid source of energy and strengthens resistance to disease. Regular honey consumption supplies essential nutrients to the human body. The following benefits are attributed to honey:

- Keeps the body active and restores energy
- Increases digestive ability and cures digestive diseases
- Bactericidal properties in general; helps to cure illnesses such as coughs and colds, hiccups, and diarrhoea
- Reduces the effects of diseases related to the liver, veins, and blood
- Reduces the symptoms of tonsillitis, sore throats, and similar diseases
- Helps to cure menstrual pain
- Increases memory power, helps in semen production and increasing sexual appetite
- Cures urinary infections
- Helps in the physical and mental development of growing children
- Makes the body, skin, and hair shiny, clean, and attractive, and counteracts skin wrinkles

Honey can be used as a food and a substitute for sugar and other sweeteners. It can be taken with cold water in summer, hot water in winter, and in warm milk. Honey is useful to all people more than a year old.

# Day 7

## **Review of Day 6**

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**Session 26:** Pesticide Poisoning and Integrated Pest Management

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**Session 27:** Other Hive Products

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**Session 28:** Honey Value Chains and Market Management

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**Session 29:** Beekeeping as an Enterprise and Institutional Development

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**Session 30:** Plans of Action, Evaluation, and Closing

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# Session 26 Pesticide Poisoning and Integrated Pest Management

## Sub-topics

- ▶ Introduction
- ▶ Symptoms of poisoning
- ▶ Pesticide safety
- ▶ Relationship between integrated pest management (IPM) and beekeeping

## Time: 1 hour

Theory: 30 minutes

Practical: 30 minutes

## Objectives

Trainees will

- know the symptoms of pesticide poisoning in bees, and precautions to be taken and pesticide safety, and
- understand the relationship between bees and IPM.

## Training Methods

- Lecture
- Practical exercise
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos, visual aids on IPM
- Movable frame hive with bee colony
- Colony inspection equipment
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture

Give a presentation on pesticide poisoning including recognizing the symptoms, precautions and pesticide safety, and the relationship between honeybees and IPM, as outlined in the resource materials (below). Use slides and photos to illustrate the talk, or large blown up photos and diagrams in areas where there is no electricity.

### Activity 2: Practical exercise

Trainees will learn how to recognize pesticide poisoning and what safety measures to use, and understand the relationship between integrated pest management and beekeeping.

**Step 1:** Let the trainees observe bees that have died from poisoning, or show them a colony which has bees dying due to pesticides, or take a video clip with a phone or simple camera if you find bees dying and show this.

**Step 2:** Explain which pesticides are harmful and show samples.

**Step 3:** Discuss pesticide safety and what precautions to take to protect bees from pesticide poisoning.

**Step 4:** Explain briefly the principles of IPM and how it can help keep bees safe.

### Activity 3: Discussion and question and answer

Use discussion and question and answer approaches to discover whether the trainees understand the problems of pesticides, can recognize the symptoms, and know how to avoid pesticide poisoning.

#### Take home message

- In order to produce quality hive products free of chemical residues it is important to avoid using pesticides and persistent chemicals to control diseases and pests in and outside of the hive.

# Session 26 Resource Materials

## Pesticide Poisoning and Integrated Pest Management

### Introduction

Honeybees depend on flowering plants for food. When pesticides (fungicides, herbicides, and insecticides) are sprayed on plants that bees are feeding from, they can be consumed and enter the bee chain. Pesticides are rarely used on natural or semi natural vegetation and in mountain areas have traditionally not been used heavily on cultivated crops. However, the use of chemical pesticides to protect crops against plant diseases and pests is increasing rapidly. Lack of knowledge about proper use and precautions means that these pesticides often pollute the environment – the soil, air, and water – and non-targeted animals and plants. Foraging bees may become contaminated through direct contact or collection of contaminated nectar, pollen, propolis, or water. Larvae fed with contaminated nectar and pollen may die, as can the nurse bees. Consumption of hive products (nectar, honey, royal jelly, pollen) contaminated with pesticide residues can affect human health.

### Pesticide Poisoning

#### Symptoms

A number of symptoms may indicate pesticide poisoning (Figure 88):

- Angry bees in the hive; bees becoming excited when poisoned bees enter the hive
- Bees trembling, crawling, unable to fly, rotating upside down, and vomiting
- Large numbers of dead bees in and around the hive
- Dead bees with an extended proboscis
- Rapid decline in the bee population

The number of dead bees seen after spraying provides an indication of the hazard level of a pesticide (Table 13).

Pesticides are classified and labelled based on levels of hazard to bees, humans and livestock (WHO 2010). In Asia, these are commonly designated by colour coded labels as described in the Indian Pesticide Rules (GoI 1971) and shown in Figure 89.

**Table 13: Pesticide hazard levels**

Number of dead bees daily at each hive entrance	Hazard level
≤ 100	Normal death rate
101–400	Low
501–1000	Medium
>1000	High

Source: FAO (1986)

### Pesticide Safety

Bees become contaminated while feeding on flowers in an area which has been sprayed with pesticides, usually agricultural crops. The following precautions should be taken to avoid poisoning bees:

- Wherever possible use alternative control measures and avoid using chemicals.
- If pesticides are required select non or less hazardous formulae such as botanical or plant based pesticides, avoid persistent pesticides, and use granules rather than powder or emulsifiable concentrate (EC).

Figure 88: Symptoms of pesticide poisoning

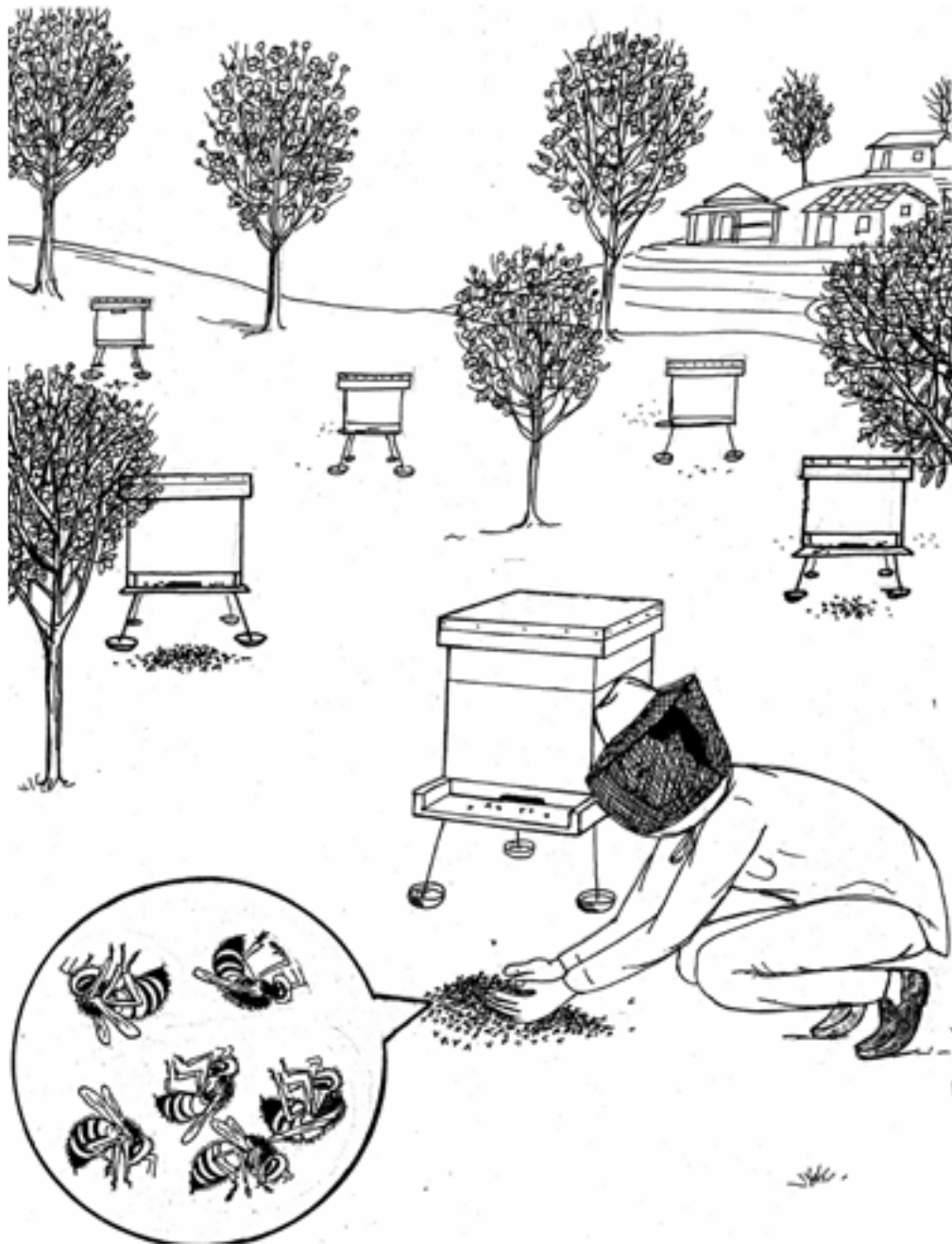
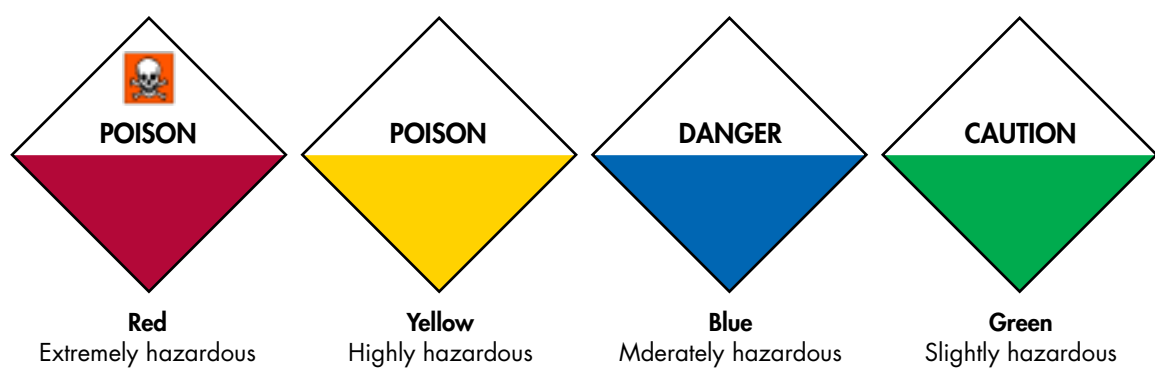


Figure 89: Pesticide classification based on hazard level (Gol 1971)



- Do not spray pesticides when crops are in flower.
- Spray in the evening or at night when bees are in their hives.
- Provide information to beekeepers 2 to 3 days before spraying pesticides.
- Beekeepers should confine bees to their hives during periods of pesticide use by providing sugar syrup for food and closing the hive entrance.
- Bee colonies can be migrated 5–7 km away from the area where pesticides are sprayed.
- Take care to avoid positioning an apiary in areas where there is a higher tendency to use pesticides for crop protection.

## Relationship Between Beekeeping and IPM

The flowers of wild and cultivated flora should be healthy and free from pesticide contaminants if beekeepers are to obtain maximum profit from their hive products. The huge amount of pesticides used for plant protection affects beekeeping directly. The problem can be avoided using an integrated pest management (IPM) approach, which is a safe and environmentally friendly alternative. National and international government and non-government organizations in the region are focusing on the development of IPM packages, capacity building, and scaling up its use. Essentially, IPM is a package of biological, physical, mechanical, and growing methods designed to reduce the incidence of pests. The main possibilities are described in the following.

### Methods of cultivation

These methods emphasize the use of healthy seeds, crop rotation, adjustment of planting times, sanitation, mixed cropping, use of resistant crop/varieties, and adoption of the best cropping pattern for crop protection.

### Use of resistant crop varieties

A large number of varietal options are being offered to farmers through crop breeding and variety maintenance programmes, including varieties that are resistant to major diseases and insect pests. Where possible, farmers should select disease and pest resistant crop varieties.

### Mechanical methods

Pests can be killed and repelled using a variety of mechanical methods including

- hand picking and killing: egg masses or young aggregating insect masses can be picked and crushed manually;
- catching with an insect net; and
- barriers such as sticky bands, trench traps, pit fall traps, and sticky glues.

### Physical methods

Pests can be caught by physical methods such as light traps and pheromone traps.

### Biological methods

Pests can also be controlled using biological methods involving predators, parasites, parasitoids, or microorganisms that attack the pest.

### Botanical pesticides

Botanical pesticides are safe and environmentally friendly organic pesticides. A typical example is 'jholmal', an anaerobically fermented mixture of plants and cattle urine.

### Recipe for an organic pesticide (jholmal)

- Mix 1 kg *Artemisia* sp., 1 kg *Acarus* sp., 1 kg neem, 3 kg fresh cow dung, and 1 kg cow urine thoroughly with 1 g yeast and 1 teaspoon of salt (NaCl).

- Allow to decompose in a closed 20 litre plastic jar.
- Stir once a day for a week, and then at weekly intervals for a month. Filter solution through a muslin cloth.
- Mix 1:10 with water before spraying.
- Use solution for up to 6 months after preparation.

The solution helps against insect pests such as aphids and other soft bodied insects and also functions as a growth promoter.

# Session 27 Other Hive Products

## Sub-topics

- ▶ Beeswax
- ▶ Pollen
- ▶ Propolis
- ▶ Royal jelly
- ▶ Bee venom
- ▶ Bee colonies

## Time: 1 hour 30 minutes

Theory: 30 minutes

Practical: 1 hour

## Objectives

Trainees will

- learn about methods for processing and storing beeswax;
- know about other hive products such as pollen, propolis, royal jelly, and bee venom, and how to harvest them; and
- know how to prepare bee packages.

## Training Methods

- Lecture
- Practical exercise
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- Wax comb
- Wax processing equipment (melting pot, solidifying pot, cloth bag or jute sack, stove, water)
- Movable frame hive with bee colony
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture

Give a presentation on beeswax processing and storage, and on other hive products such as pollen, propolis, royal jelly, and bee venom, as outlined in the resource materials (below). Use slides and photos to illustrate the talk, or large blown up photos and diagrams in areas where there is no electricity.

### Activity 2: Practical exercise

Trainees will learn where other hive products are located, how to harvest them, and how to process wax.

**Step 1:** Open the colony for inspection and help trainees locate pollen stocks and, for *Apis mellifera*, propolis.

Ask (and help) trainees to do the following:

- Step 2:** Look at the four pairs of wax plates ventrally on the abdomen of 12–18 day old worker bees
- Step 3:** Identify old combs and remove them from the hive
- Step 4:** Chop up the old combs, and clean by washing 2 to 3 times in clean water
- Step 5:** Put the comb pieces into a stainless steel pot, add water to cover, and heat to melt the wax slowly, stirring at intervals
- Step 6:** Pour the melted wax through a cloth bag or jute sacking into a clean stainless steel pot, and squeeze the cloth or sacking with a pair of sticks to extract all the wax.
- Step 7:** Leave the extracted wax to solidify in another container to produce the desired size of wax block

### Activity 3: Discussion and question and answer

Use discussion and question and answer approaches to discover whether the trainees have understood the steps in production and processing of beeswax and other bee products.

#### Take home message

- Beekeepers should take advantage of other hive products which can generate additional income, and help to reduce the production cost of honey.
- Products such as beeswax, pollen, propolis, royal jelly, and bee venom are extremely useful and should be promoted.

# Session 27 Resource Materials

## Other Hive Products

### Introduction

Income can be generated from beekeeping through the production of hive products such as beeswax, royal jelly, pollen, propolis, bee venom, and package bees, as well as from honey. The production of these products is described briefly below.

### Beeswax

Worker bees have four pairs of wax glands located ventrally on the abdomen which are usually active when they are 12–18 days old. Wax secreted from these glands flows onto wax 'mirrors' where it is in contact with the air and solidifies to form wax plates (Figure 90). The bees remove the wax plates with the help of their pollen rake, pass them to the mandibles, and chew and soften the wax by mixing with saliva before using to construct combs and seal cells. Beeswax is light yellow to white. Old combs turn brownish. Beeswax melts at 61–64°C and becomes cracked and powdery if very cold.

Figure 90: Wax plates on a bee



### Processing

Pure beeswax can be extracted from wild combs found by honey hunting, combs harvested from traditional hives, old drained combs from modern hives, combs from absconded colonies, and wax pieces collected when uncapping honeycombs to extract honey in modern beekeeping. The wax should be kept in an airtight container or bag until processed. Pure wax is extracted as follows (Figure 91).

- Cut the combs into pieces, wash with clean water, and soak for 24 hours.
- Re-clean the soaked pieces with clean water.
- Put the cleaned comb pieces into a stainless steel pot, add water to cover, and heat gently until the wax is completely melted.
- Filter the melted wax through a cloth bag or jute sacking and collect in a clean stainless steel pot.
- Squeeze the cloth or jute bag with two sticks to extract all the melted wax, and throw away the remains with the bag.
- Keep the wax safely in a room or at least in the shade until solidified (usually within 24 hours).
- Remove the solid wax block from the pot and scrape off the residue at the base of the block with a knife. Keep the clean and dry wax block safely in a plastic bag and store in a clean dry room.

### Precautions

- Wax is highly acidic so do not use copper, brass, or iron utensils during processing, solidification, or storage.
- Use aluminium, good quality stainless steel, tin, or plastic pots to prepare the wax.
- Heat slowly and do not boil when melting the wax.
- Do not heat for longer than necessary as the wax can become discoloured and the scent lost.
- Cool the melted wax slowly to avoid cracking.
- Collected and processed wax should be stored in air tight containers to prevent attack by wax moth.

Figure 91: **Steps in wax processing**

Step 1: Old combs



Step 2: Soaking cut up combs in water (24 h)



Step 3: Heating cleaned comb pieces covered with clean water in a stainless steel pot



Step 4: Filtering the melted wax through a cloth bag



Step 5: Squeezing the bag with two sticks to extract the remaining wax



Step 6: Scraping the sediment from the base of the solid wax block



Step 7: Clean solid wax block

Figure 92: **Bee with a prominent pollen load and extended proboscis**



Nabin Baral

## Pollen

Pollen collected by bees from flower anthers is rich in protein. It is very important for brood rearing and half of all foragers collect pollen during the brood rearing period. Pollen is collected in the morning (around 10–11 am) when it is moist and easy to collect (Figure 92). A worker bee can carry 10–19 mg of pollen per trip depending on the bee species. It is collected with the help of mouth, legs, and body hairs, is moistened with saliva and nectar, compacted by the bee's pollen press, made into a pollen ball as it is loaded into the pollen baskets on the hind legs, and then carried to the nest and stored in comb cells (Figures 93, 94).

## Harvesting

Honeybees collect more pollen during the pollen flow season than they need, creating an excess that the beekeeper can harvest without affecting brood production. Pollen can be collected by means of a pollen trap fixed at the entrance to the hive. The pollen baskets scrape on the trap as bees enter the hive and the pollen pellets are shaken out through a screen into a collecting tray. Pollen should only be collected in the pollen flow season. The trap should only be put in place for a limited period (a few hours per day, repeated after 2 to 3 days) so that bees can also collect pollen for brood rearing. Too regular use of a pollen trap can hamper brood rearing. The pollen trap should not be used when a colony is being prepared for colony multiplication or brood production, or being strengthened for honey production.

## Storage and use

Collected pollen should be dried in the shade or inside. Once dry, it should be packed in an airtight food grade container and stored in a cool dry place. Pollen can be used by people as a source of protein.

## Propolis

Propolis is a semisolid, sticky substance used by honeybees to seal cracks, crevices, and openings in the hive as a defensive material against natural pests and excess cold; to repair combs; and to fix frames and stop them swinging (Figure 95). Propolis is mainly used by *Apis mellifera* colonies. It is collected from plant bark and twigs and loaded into the pollen basket to bring to the hive.

Bee propolis contains glue, wax, volatile oils, pollen, vitamins, minerals, plant flavonoids, and volatile oils. It functions as an air freshener in the bee hive. Propolis

Figure 93: **Pollen stored in comb cells**



Nabin Baral

Figure 94: **Harvested bee pollen**



Uma Partap

Figure 95: **Propolis**



can be collected from bee colonies by using a propolis trap made with steel wire mesh put in place of the inner cover in the hive. The propolis can be scraped with a hive tool from the trap, top bars, and crevices in the hive during the propolis flow season. It has antibiotic properties and can be used directly as a medicine or by pharmaceutical industries in the preparation of more complex medicines.

### Royal Jelly

Royal jelly is a white creamy liquid secreted from the hypopharyngeal glands of worker bees (Figure 96). It has a tartaric taste and contains many components including water, proteins and amino acids, lipids, mineral salts, anti-oxidant enzymes, and vitamins, and is a nutritious energy provider. All larvae are fed royal jelly, but worker bee larvae receive it for only 3 days whereas queen larvae receive it continuously. Each queen cell contains about 250 mg royal jelly. Production of royal jelly requires special technical skills.

### Bee Venom

Worker bees have a poison gland in the last abdominal segment. The poison gland activates 18 days after the worker emerges and contains a bitter, scented, acidic, irritating clear liquid called bee venom. Bee venom is used in defence of the colony. The worker bee injects the venom into the victim while stinging (Figure 97). A single worker has about 0.5 mg venom. Bee venom is a rich source of pharmaceutically active components and has been suggested for use in treating different human ailments such as arthritis. Apitherapy using stinging bees or venom has been started recently in Nepal and other countries of the region. Production of bee venom requires special technical skills

### Bee Packages

A bee package is a nucleus colony without combs, containing about 1 kg of worker bees and a queen. It is equal to a five-framed bee colony and is prepared for personal use or sale. Packaged bees do not contain brood and combs. The bees are kept in a package or cage which can be transported easily over long distances. The cage is made of wood and steel netting. It is light and well ventilated (Figure 98).

### Method of production

- The brood frames are taken out of the hive and the bees brushed into a cage.
- The package should include bees from the brood comb which are likely to be young.
- A package cage holds about 1 kg worker bees with a queen, equal to a five-frame colony (10,000 bees in total).
- The package cage contains a feeder in the centre to facilitate feeding of sugar syrup during transportation.

Figure 96: **Opened queen cells (queen cups) showing queen bee larvae floating on royal jelly**



Figure 97: **Bee sting with venom sac after stinging**



Figure 98: **Prepared bee package**



# Session 28 Honey Value Chains and Market Management

## Sub-topics

- ▶ Introduction to honey value chains
- ▶ The honey market scenario (demand and supply)
- ▶ Honey and quality standards

## Time: 1 hour 30 minutes

Theory: 1 hour

Practical: 30 minutes

## Objectives

Trainees will

- know about honey quality standards,
- understand honey value chains; who the actors in the chain are from producers to consumers, what they do, and how they are related, and
- know how to map a honey value chain and compare local and commercial beekeeping value chains.

## Training Methods

- Lecture
- Practical exercise (case study analysis)
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- A specific case study or situation analysis (as described in the resource materials)
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities and Exercises

### Activity 1: Lecture

Give a presentation on honey, quality standards, market provisions, and honey value chains, as outlined in the resource materials (below). Use slides and photos to illustrate the talk, or large blown up photos and diagrams in areas where there is no electricity.

### Activity 2: Practical exercise

Trainees learn about value chains and value chain analysis by working on a case study or situation analysis.

- Step 1:** Divide the trainees into not more than four small groups and give each group a copy of the case study on honey value chain analysis.
- Step 2:** Ask the trainees to study the situation and compare the impact of each step.
- Step 4:** Ask them to identify and discuss the pros and cons of changes that could be made in the chain (intervention points) so that the beekeeper has a greater share in the total profit.
- Step 3:** Ask each group to present their findings to the plenary and discuss the results.

### Activity 3: Discussion and question and answer

Use discussion and question and answer approaches to discover whether the trainees understand about honey quality standards and honey value chains, their impact and analysis.

#### Take home message

- Each actor in the value chain should focus on maintaining quality, from the input supply, through production, to consumption.
- Value is added to honey at each level of the value chain from the input supplier, through the producer, to the end user. Each value added product reflects an increase in honey price. The increase in honey price should be justified at each level.

# Session 28 Resource Materials

## Honey Value Chains and Market Management

### Introduction

To gain the maximum benefit from beekeeping and honey production, it is first necessary to know the potential markets and their requirements, to plan production to meet market demand, and to understand the honey value chain so that the producer can obtain the maximum benefit from the end price.

### Differences Between Traditional and Commercial Bee Enterprises

In traditional beekeeping, honey is produced on a small scale mostly for home consumption and local markets using locally available traditional techniques with very low input costs for a small supplementary income. Honey production isn't targeted to a known market or planned to maximize profits. Commercial beekeeping is generally carried out on a larger scale using modern technologies and practices, and is planned to exploit market potential and maximize profits through market analysis and production management based on an understanding of the honey value chain. Small scale commercial beekeeping uses similar approaches on a smaller scale, generally supported by cooperative schemes that enable small producers as a group to gain similar benefits to single large-scale producers. Commercial beekeeping may also focus on pollination management as the primary source of income and/or benefit.

### What is High Quality Honey?

In general, the most profit can be made from production of high quality honey. Quality honey means that the honey has a natural essence, taste, and colour, is not adulterated, and is free from chemical residues. In order to produce quality honey, attention must be paid to the following:

- Bee pasture
- Beekeeping equipment and use
- Honey harvesting, extraction, filtration, processing, packaging, and storage
- Personal hygiene of beekeeper and staff
- Record keeping

Different countries have laid down different standards for quality honey, as summarized in Table 14.

### Producing Quality Honey

Attention needs to be paid at different points from production to marketing to ensure the production of quality honey. The specific activities at each level are summarized in Table 15.

### Market Management

Marketing is the exchange or sale of goods or services between a seller and the buyers. Market management means the competitive process of marketing goods and services according to market demand. Managing a honey market is about selling honey according to the interest and demand of end users while obtaining a competitive price for the seller. In order to manage the honey market, it has first to be analysed. Then honey production can be tailored according to the market conditions.

Table 14: **Honey quality standards in selected Hindu Kush-Himalayan countries and from the Codex Alimentarius Commission**

Parameter	Standard limits								
	China	India			Nepal		Pakistan*	Codex Standards	
		Special	A grade	B grade	Pure nectar honey	Other honey		General	Other
Specific gravity @ 27°C		Min. 1.4	Min. 1.4	Min. 1.35					
Moisture content (%)	Max. 18	Max. 20	Max. 22	Max. 25	Max. 23	Max. 23	13.4 – 19.0	Max. 21	Max. 23 (heather and clover honey)
Sucrose content (g/100g)	Max. 5	Max. 5	Max. 5	Max. 5	Max. 5.0	Max. 10.0	Max. 10	Max. 5.0	Max. 10.0 (honeydew honey, blends of honeydew and blossom, <i>Robinia</i> sp., <i>Lavendula</i> sp., citrus, alfalfa, acacia, red gum, sweet clover, leatherwood)
Reducing sugars (g/100g)	Min. 70	Min. 65	Min. 65	Min. 65	Min. 65	Min. 60		Min. 65	Min. 60 (honeydew honey)
Fructose/ glucose ratio	Min. 1.0–1.15	Min. 1.0	Min. 0.95	Min. 0.95	Min. 0.95	Min. 0.95			
Sum of fructose and glucose (g/100g)								Min 60	Min 40 (honeydew, blends of honeydew and blossom)
Ash or mineral content (g/100g)		Max. 0.5	Max. 0.5	Max. 0.5	Max. 0.5	Max. 0.5		Max. 0.6	Max. 1.0 (honeydew, blends of honeydew and blossom)
Aniline chloride test positive or negative		negative	negative	negative					
Acidity as formic acid (%)		Max. 0.20	Max. 0.20	Max. 0.20	Max. 0.20	Max. 0.20			
Water insoluble content (g/100g)					Max. 0.5	Max. 0.5		Max. 0.1	Max. 0.5 (squeezed honey)
HMF (hydroxymethylfurfural) (mg/kg)		Max. 50	Max. 50	Max. 50	Max. 40	Max. 40	Max. 80 mg/kg	Max. 40	Max. 40
Electrical conductance (mS/cm)							0.2 – 1.8 ml/cm	Max 0.8	Min. 0.8 (honeydew and chestnut honey)
Diastase unit (Schade scale)	Min. 8							Min. 8	Min. 8 (honey with natural low enzyme content)
Invertase (Siegenthaler unit)								Min. 50	Min. 50
Proline (mg/kg)								Min. 80	Min. 80

Table 15: **Quality measures at each level of the honey value chain**

Activity	Quality dimension	Potential advantages
<b>Production level</b> Grading of the pasture area Biological management of pests and diseases Use of good quality stainless steel utensils Harvesting of ripened honey	Good agricultural practices (GAP) Honey free from chemical residues Honey has better taste and medicinal value	Can sell at organic price Can receive comparatively higher price in the international market Global market promoted Sustainable market promoted
<b>Processing level</b> Avoid direct heating of honey Maintain standard recommended temperature while filtering and evaporating honey	Can maintain the natural quality of the honey	Sustainable market promoted at national and international level
<b>Storage level</b> Store in airtight food grade containers	Can maintain the natural quality of the honey	Sustainable market promoted at national and international level
<b>Marketing level</b> Packaging Labelling Branding Certification	Market access promoted High volume market developed with a separate identity for honey	Market access promoted, higher price gained, competitive international market created

## Market Analysis (the '4P's)

### Product (quality and volume)

Market analysis at the product level means analysis of the supply and demand for different types of honey, for example crystallized and non-crystallized, organic and non-organic, unifloral and multifloral (mixed), and so on.

### Price (market competitiveness)

Analysis of the price means analysing the potential price at market of different types of honey or other hive products (for example 'organic neem honey').

### Promotion (marketing)

Marketing analysis means analysing the results of surveys and other sources to discover which products will best satisfy the demands of the end users and how the market for that product can be promoted.

### Place

Analysing the place, means identifying the most appropriate market location and where consumers can best be targeted.

## Honey Product Management

Production of the end honey product should be managed to meet the demand that has been identified through market analysis. This means planning at different stages so that the appropriate types and quantities of honey are produced in a form that allows maximum exploitation of market potential. Management is at four main levels.

## Production

Management of the honey production itself involves input management (management of the beekeeping infrastructure and other inputs), identifying appropriate pasture areas, migration management, and colony management.

## Collection and storage

Management of collection and storage means proper planning and execution of procedures and mechanisms for collection and storage.

## Processing management

Management of processing means planning processing to ensure production of quality honey through processes such as moisture reduction, heating, and filtering, the use of clean, high quality equipment, and organization of an appropriate environment

## Marketing

Management of the actual marketing includes preparing the product to be attractive through packaging, labelling, branding, and certification; developing a relationship with wholesalers and retailers; ensuring that each product is offered for sale at the best location; and developing cooperative mechanisms and institutional coordination to enhance marketing.

## The Value Chain Approach

The value chain is a concept from business management. The value chain is the chain of activities from conception, through the different phases of production, transformation, marketing and distribution, to delivery to the final consumers, and final disposal after use (Kaplinsky and Morris 2003). Products pass through all the activities of the chain in order, and at each activity the product gains some value.

The primary producers and collectors of mountain products generally receive a relatively low share of the total returns as a result of a variety of factors including insufficient knowledge of market chains, lack of processing facilities, and inadequate quality control. The value chain approach can be used to help producers and other disadvantaged actors in the chain gain greater benefits from their products.

The chain is analysed to identify the points where most value is added and who benefits. Tracing the complete process means mapping all the actors and organizations, functions, and processes, including links and information flows, that are involved in bringing the product from production to consumption. The analysis reveals strengths and weaknesses, the boundaries between national and international chains, the buyer's requirements, and international standards. It also reveals the critical success factors that determine if a product will meet the requirements with regard to quality, price, dependability, volume, design, and speed of delivery. The functions of the main actors are studied in more detail to understand how they add value to, and retain value in, the chain. A clear picture of the functions that the different actors perform allows functions to be identified which could be performed by other actors in the chain in such a way that competitiveness is improved and more benefit goes to small producers, traders, and processors.

## Using the value chain approach

The basic steps when using a value chain approach are to map the chain in terms of functions, actors, and value addition; to analyse the chain; and then to design upgrading strategies to strengthen the chain in terms of increasing benefit to the producers. These steps are summarized briefly below and then the use of the approach is illustrated in a case study.

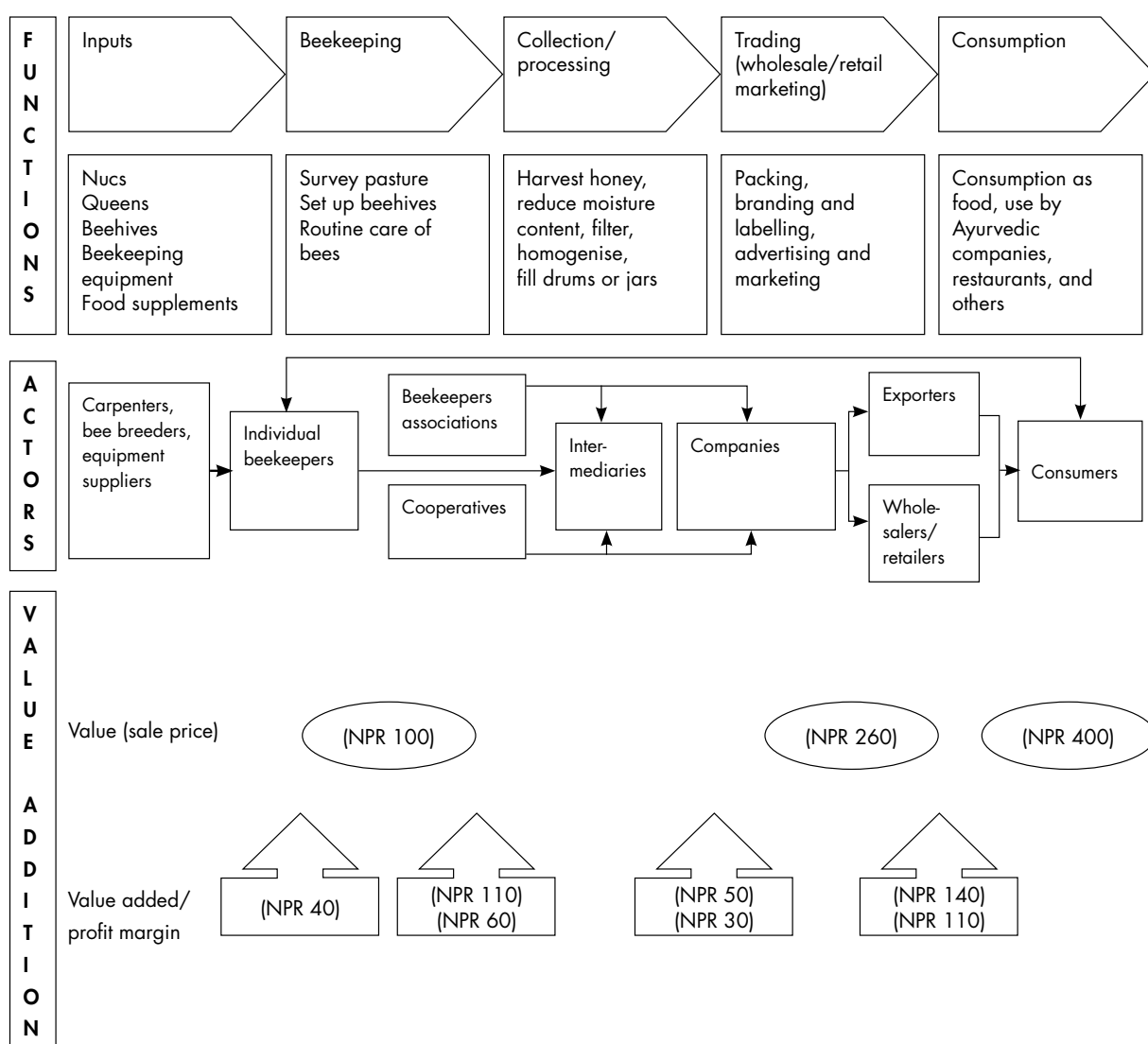
## Value chain mapping

There are a number of steps in mapping the value chain of a product:

- Map each function
- Define the role of each function
- Map the actors involved in each function
- Map the volume transacted at each step
- Map the value addition at each step
- Map the number of enterprises involved
- Map the integration level/ relationship of different actors in the chain and the governance system
- Map the meso and macro level actors supporting the chain

The map of functions, role of each function, and map of actors for each function in honey production is shown in Figure 99, together with a map of the value addition as an example. Example values are given for sale price, costs, and value addition per kg. The values are taken from the example in the practical exercise below.

Figure 99: **Map of functions, actors and value addition**



## Value chain analysis

The value chain can be analysed using the results of the mapping as a base. The analysis includes the following steps:

- Conduct a SWOT analysis (strengths/ weaknesses/ opportunities/ threats) over the whole chain
- Identify market opportunities and demand
- Identify market requirements
- Identify areas of comparative advantage
- Identify competitive advantages of competitors
- Identify the weakest point/ leverage point in the chain
- Carry out a cost-benefit analysis and identify the breakeven point

## Design of upgrading strategies

The results of the analysis will indicate areas where upgrading will have the maximum effect on increasing profit to the beekeeper. The next step comprises developing strategies to upgrade and improve the value chain so that more benefit accrues to the producers. These may include some or all of the following

- Identify the areas with the most value addition and the potential for increasing this addition and/or transferring the activity to different actors. Assess the potential for market linkages with buyers.
- Strengthen the beekeepers group.
- Assess support from the government and development organizations for beekeeping.
- Discover whether financial institutions and cooperatives can provide support to expand the business.

## Practical exercise: Analysis of the honey value chain in Nepal

Arjun Prasad is a producer, collector, processor, and packager of honey. He has 20 honeybee colonies and was able to harvest and sell 500 kg (5 quintals) of honey last year. He sold the honey at NPR 100 per kg (US\$ 1.4) to give a gross annual income of NPR 50,000 (US\$ 700). His costs of production were about US\$ 0.8 per kg (NPR 60) leaving a net profit of US\$ 0.6 (NPR 40) per kg, or NPR 20,000 (US\$ 280) which was not sufficient to live on.

Analysis of the value chain showed the following value addition at different points in the chain. Costs at different points in the chain include such items as packaging, transport and shop rental.

- Producer (Arjun Prasad) sold the honey @ NPR 100/kg (US\$ 1.4/ kg) to a nearby collector. Production costs were NPR 60/kg (US\$ 0.8/kg)
- The collector processed and packaged the honey and sold it to a wholesaler at NPR 210/kg (US\$ 2.9/ kg). His costs for processing and packaging were NPR 50/kg (US\$ 0.66/kg).
- The wholesaler sold it to a retailer at NPR 260/kg (US\$ 3.7/kg). His costs were approximately NPR 20/kg (US\$ 0.25/kg).
- The retailer sold it to the end user at NPR 400/kg (US\$ 5.6/kg). The retailer's costs were approximately NPR 30/kg (US\$ 0.4/kg).

Map the functions, actors, price, value added, and profit margin at each level and consider where and what changes could be made so that Arjun Prasad receives a greater share of the total profit.

# Session 29 Beekeeping as an Enterprise and Institutional Development

## Sub-topics

- ▶ Introduction to beekeeping as an enterprise
- ▶ Mobilization of institutions and groups and introduction to beekeeping policies
- ▶ Coordination among key stakeholders
- ▶ Infrastructural requirements for developing institutions to promote beekeeping

**Time: 1 hour**

## Objectives

Trainees will

- know what a beekeeping enterprise is and the infrastructure required for its development,
- learn about institutional or group mobilization and management,
- know about policies related to beekeeping,
- understand the need for coordination among key stakeholders for beekeeping development, and
- be familiar with the concepts and need for gender inclusion and good governance.

## Training Methods

- Lecture
- Discussion and question and answer

## Materials

- LCD projector and PowerPoint slides, diagrams, photos
- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities

### Activity 1: Lecture

Give a presentation on beekeeping as an enterprise, how to develop a beekeeping enterprise, coordination mechanisms and networking among key stakeholders, and policies related to beekeeping, as outlined in the resource materials (below). Use slides and photos to illustrate the talk, or large blown up photos and diagrams in areas where there is no electricity.

### Activity 2: Discussion and question and answer

Use discussion and question and answer approaches to discover whether the trainees understand the concept and requirements and whether they have queries and concerns.

### Take home message

- Cooperation and coordination among stakeholders are important for the development of effective and sustainable bee enterprises.
- Becoming a successful entrepreneur involves skill, planning, budgeting, cooperation and trust, links to markets, and determination in the face of market competition.

# Session 29 Resource Materials

## Beekeeping as an Enterprise and Institutional Development

### Beekeeping Entrepreneurship

#### Beekeeping as an enterprise

A business enterprise is an activity undertaken by an entrepreneur with the aim of gaining a profit. An entrepreneur should first look at the market opportunities, and then run the enterprise using the available resources and services to fulfil consumer requirements and demand. Consumer satisfaction is a prime aim as this determines market sustainability. A beekeeping enterprise is an agricultural business. It can be undertaken on a small scale with only a small investment and is thus particularly important for rural development as it can be taken up by almost anyone, including women, people from poor and marginalized communities, and the landless. Beekeeping not only provides self employment and generates income; it is also particularly significant in rural areas because it provides pollination services and helps increase crop production. Thus beekeeping is a particularly important enterprise which is technically feasible and has considerable promise for the future.

#### Institutional framework for beekeeping

The institutional framework for beekeeping can be based on a variety of different types of ownership including individual, partnership, group, and cooperative. There can also be a mixture of forms, for example a cooperative or jointly owned processing and/or marketing organization. The most appropriate approach should be selected based on the market analysis, available resources, and economic, geographical (access), and social situation.

#### Points to note before establishing the enterprise

The following issues should also be considered when setting up a beekeeping enterprise.

##### Selection of honeybee species

In general it is preferable to use *Apis mellifera* for beekeeping at lower elevations, i.e., in the foothills and plains areas and valleys in the mid hills, and *Apis cerana* for beekeeping at higher elevations, i.e., in the mountains; mid hills, and higher valleys.

##### Selection of area for forage

Where there is a choice, the selection of the best forage area or bee pasture should be based on the sources of nectar identified, information about the flowering time, information about local farming practices, especially pesticide use, and general location and access. The need of the local farmers for pollination services also plays an important role.

##### Timing

The best time to start beekeeping depends on the location. February, March, September, October, and November are excellent months to begin beekeeping in foothills and plains areas, and May or June in high mountain areas. Beekeeping should not be started during the rainy season or the coldest time (December to January).

#### Enterprise development

It is important for the beekeeping entrepreneur to make the right choice for the form of ownership. Where there is any form of joint or cooperative ownership, legal provisions should define the services to be provided

(diversification and/or specialization). The entrepreneur should pay attention to the following to provide the best conditions for success of the enterprise. The beekeeper

- should have a good basic knowledge of beekeeping entrepreneurship,
- be willing to search for and gather together appropriate information,
- have some capacity to bear risk,
- be willing to use his own money to start the enterprise rather than rely on others, although credit or a loan may be helpful if genuinely needed,
- should have self-confidence, and
- should accept accountability.

Enterprise development should be based on

- a value chain approach, knowledge of the market and availability of raw material, and consumer demand,
- a clearly defined objective and goal,
- ability to take risks if needed,
- a business plan for implementation aimed at meeting the targeted objective,
- use of processes that ensure production of quality bee products, and
- links with local agriculture.

Marketing should

- maximize gains to the producer, and minimize the number of middlemen in the transaction chain,
- develop a scientifically calculated pricing system based on cost-benefit analysis and the market situation.

## Gender and Equity

In rural development, beekeeping is an enterprise which is particularly useful as a source of income for people from poor and disadvantaged groups and women, as it is relatively easy to learn and requires only a small investment and very little land. Where individuals have small enterprises, they will generally need the support of a local organization or cooperative for processing and marketing, and even for development and maintenance of the enterprise itself, if the enterprise is to become profitable. Any institutions established specifically to support beekeeping should ensure gender and caste equity so that the benefits of beekeeping for development are achieved. Women and members of disadvantaged groups should be fully included in decision making, and their involvement in decision making should be encouraged in institutions established by others related to the beekeeping enterprise. Gender equality and good governance should be ensured for the sustainable development of these institutions.

## Establishment of Good Relations and Coordination Among Key Stakeholders

It is important for the development of the beekeeping enterprise that the key stakeholders establish and strengthen relationships with each other, with the support of the mandated organizations. For example, in Nepal the government institutions related to beekeeping development include the Nepal Agricultural Research Council (NARC); Department of Food Technology and Quality Control (DFTQC); Beekeeping Development Section (BDS) Godawari; Beekeeping Office, Bhandara; the district agriculture development offices (DADOs); and the Office of Small and Cottage Industries. Institutions representing beekeepers and entrepreneurs have also been established to support welfare, market management, and identification and management of pasture. They include the Federation of Nepal Beekeepers (FNBK), Nepal Beekeeping Central Cooperative, Apiculturists Network – Nepal (Apinet-N), and the Federation of Community Forest Users Nepal (FECOFUN). Beekeepers and beekeeping entrepreneurs can be affiliated to any of these organizations. In addition to these institutions, a number of donor, community, and non-government organizations and private firms in the region have links to beekeeping. Beekeepers and entrepreneurs should be aware of these organizations and gather as much information as possible about them, especially those that are active in their area, and develop contacts that can support the enterprise.

## Beekeeping Policies: The Example of Nepal

A country's beekeeping development policy is essentially a government 'plan of action' for the development of beekeeping, laying down the intended benefits and beneficiaries, concerns, precautions, considerations, institutional arrangements, and others, that the government intends to pursue in support of beekeeping. The policy is implemented through various forms of legislation (rules and regulations) and institutional arrangements. Every country in the Hindu Kush-Himalayan region has some form of policy related to beekeeping development in place. The policy in Nepal on beekeeping development and honey trade is described below as an example.

The agricultural policy of Nepal covers promotion of beekeeping through the Vocational Entomology Development Directorate in the Department of Agriculture. Selection of honeybee species according to geographical location is covered by this policy which states that *Apis cerana* bees are recommended for beekeeping in valleys, hills, and mountains, and *Apis mellifera* for the Terai and inner Terai. The Beekeeping Development Section, Godawari, and Beekeeping Office, Bhandara, provide technical support for beekeeping with both species. The plant protection unit in each district agriculture development office provides the necessary technical support for beekeepers and entrepreneurs, and distributes subsidies for beehives, bee colonies, and beekeeping equipment. They also recommend establishing more resource centres in the districts and village development committees (VDCs) based on pasture availability and feasibility of beekeeping, and are involved in mobilizing the organization of beekeeping in groups and cooperatives. Honey is included as an export led food item in Nepal

# Session 30 Plans of Action, Evaluation, and Closing

**Time: 1 hour 30 minutes**

## Objectives

The trainers will be able to

- ▶ assess whether the expectations participants expressed at the beginning of the training have been met, and
- ▶ receive feedback from the participants on how the training could be improved in future.

Trainees will

- prepare individual plans of action for implementation in their communities

## Review Methods

- Written exercise
- Discussion and question and answer

## Materials

- A whiteboard and board markers or blackboard and chalk
- A flipchart with stand and marker pens, or large sheets of brown paper with pens and masking tape
- Metacards and pens, soft board and pins

## Activities

### Activity 1: Preparation of action plans

The trainer(s) will help participants prepare an action plan based on their individual interest and the constraints they expect to face in applying the knowledge and skills learned in the training in their communities. Participants will be encouraged to find ways to solve problems on their own while maintaining contact with the trainer if further technical help is needed.

Discuss and introduce the concept of an action plan. Develop a clear action plan covering all the activities that are important to implement. Participants should suggest activities that could be included in the plan. Each participant should be asked to list the three most important activities that he/she will apply immediately after returning to their area. The following points should be considered.

- Activity: what you are going to do or what is the agreed priority action?
- Role/responsibilities: who is responsible for the action?
- Time scale: realistic time plan showing the sequence of actions
- Resources: where will the resources come from?

The trainees can use these plans to guide them when they return to their home base. The organizer of the training should keep a copy to use during the training follow up.

### Activity 2: Assessment of training expectations

Ask participants how satisfied they are with the training and the extent to which it met their expectations. Revisit the expectations the trainees expressed at the start of the training and assess how many of those expectations have actually been met. Ask each participant to make a list of expectations met and unmet using the following format and collect them for later analysis.

Expectations met	Expectations not met

### Activity 3: Feedback

It is useful to have an open feedback session after participants have completed their action plans. This is an open session where participants can share what they have learned in the training, give constructive feedback and recommendations, and share any good or bad experiences during the training.

The facilitator should first summarize the process of the training and then ask participants about what they liked, what they did not like, and what they learned during the training. Ask for feedback on the overall training content, training processes, and methods and seek suggestions on how to make the training more useful and participatory in future. Use metacards if appropriate and/or record the suggestions on a flipchart (or board). Assure participants that these will be used to improve the training in the future. Thank all participants for their suggestions and feedback. Take all feedback in a positive spirit and use for positive change in future training sessions.

### Activity 4: Closing

Immediately after the feedback session, organize a formal closing ceremony to thank all participants and other colleagues who took active part in making the training programme successful and enriching. It is good to conclude the training by distributing certificates, reiterating commitments from individual participants, and discussing a follow up plan with the training organizers.

#### Take home message

- Your willingness and commitment are very important for gaining real benefit from the training. Preparing a realistic action plan will help you to apply the knowledge and skills learned.

# Bibliography

- Ahmad, F; Joshi, SR; Gurung, MB (2007) *Beekeeping and rural development*. Kathmandu, Nepal: ICIMOD
- Bailey, L; Ball, BV (1991) *Honey bee pathology*. London, UK: Academic Press
- Crane, E (1990) *Bees and beekeeping: science, practice, and world resources*. Oxford, UK: Heinemann
- FAO (1986) *Tropical and subtropical apiculture*, FAO Agricultural Services Bulletin No.68/3. Rome, Italy: Food and Agriculture Organization
- Gol (1971) Insecticides rules, 1971 (GSR 1650, 9 October 1971). New Delhi, India: Government of India. <[www.cibrc.nic.in/insecticides\\_rules.htm](http://www.cibrc.nic.in/insecticides_rules.htm)> (accessed 18 January 2012)
- Kane, S; Lind, L; Told, C; Fisk, A.; Berger, D (2003) *Facilitator's guide to participatory decision-making*. Gabriola Island, BC, Canada: New Society Publishers
- Kaplinsky, R; Morris M (2002) *A handbook for value chain research*, prepared for IDRC by the Institute of Development Studies, University of Sussex Brighton, UK, and School of Development Studies, University of Natal, South Africa (mimeo, online). Available at <[www.globalvaluechains.org](http://www.globalvaluechains.org)> (accessed 7 January 2012)
- Neupane, KR (2007) *Beekeeping technology*. Yagyapuri, Nepal: Gorkha Mauri
- Neupane, SP (2004) *Bee farming in Nepal*. Lalitpur, Nepal: Hishi Printing Press
- Partap, U (1999) *Pollination management of mountain crops through beekeeping: Trainers' resource book*. Kathmandu: ICIMOD
- Shukla, AN (2000) *Beekeeping trainers resource book* (in Nepali). Kathmandu, Nepal: ICIMOD
- WHO (2010) The WHO recommended classification of pesticides by hazard and guidelines to classification: 2009. Geneva, Switzerland: World Health Organization. <[www.who.int/ipcs/publications/pesticides\\_hazard/en/index.html](http://www.who.int/ipcs/publications/pesticides_hazard/en/index.html)> (accessed 16 January 2012)

# Internet Resources

There are many resources available for beekeepers on the Internet. They include technical information on regulations and restrictions, information on diverse topics related to bees and beekeeping included in university courses, resources for professional beekeepers provided by beekeeping associations, and simple easy-to-follow descriptions and discussions aimed at amateur beekeepers. Most of the information is related to *Apis mellifera*, much is only relevant for beekeepers in industrialized countries, and almost all is in English. Nevertheless, there is a vast range of information that could be useful or interesting for the Himalayan beekeeper and this is a good place to search for answers to queries and problems. As with any source, the information is not always reliable and the beekeeper should use his/her judgement on what to follow.

Some useful links are given below.

American Beekeeping Federation  
<http://abfnet.org>

Apimondia – International Federation of Beekeepers' Associations  
<http://www.apimondia.com/en>

Apiservices (portal)  
<http://www.beekeeping.org/>

Australian Honeybee Industry Council  
<http://www.honeybee.org.au/>

Australia, New South Wales Government, Department of Primary Industries – Honey Bees  
<http://www.dpi.nsw.gov.au/agriculture/livestock/honey-bees>  
<http://www.dpi.nsw.gov.au/agriculture/livestock/honey-bees/pests-diseases>

Australian Native Bee Research Centre  
<http://www.aussiebee.com.au>

Australian Government Rural Industries Research and Development Corporation Honeybee R&D Program  
<http://www.rirdc.gov.au/RIRDC/>

BeeBase (GB Department for Environment, Food and Rural Affairs, Fera National Bee Unit)  
<https://secure.fera.defra.gov.uk/beebase/>  
<https://secure.fera.defra.gov.uk/beebase/index.cfm?sectionid=24> (pests and disease)

Bee Culture - the magazine of American beekeeping  
<http://www.beeculture.com/>

Beekeeping Times, India  
<http://www.beekeepingtimes.com>

Bees for Development, UK  
<http://www.beesfordevelopment.org>

BeeSource

<http://www.beesource.com/>

<http://www.beesource.com/build-it-yourself/>

<http://www.beesource.com/build-it-yourself/pollen-traps-trapping-pollen-from-honey-bee-colonies/>

British Beekeepers' Association

<http://www.bbka.org.uk>

Dadant and Sons, Inc., USA

<http://www.dadant.com/>

dummies.com – Beekeeping

<http://www.dummies.com/how-to/home-garden/Hobby-Farming/Beekeeping.html>

<http://www.dummies.com/how-to/content/how-to-detect-tracheal-mites-in-your-beehive.html>

Gandaki Bee Concern, Nepal

<http://www.gandakibee.com.np>

How stuff works – How Bees Work

<http://science.howstuffworks.com/environmental/life/zoology/insects-arachnids/bee1.htm>

ICIMOD (International Centre for Integrated Mountain Development) – Beekeeping

<http://www.icimod.org/bees>

Kejriwal Honey, Kejriwal Enterprises, W-42, Greater Kailash – II, New Delhi-110048, India

[www.Kejriwalhoney.com](http://www.Kejriwalhoney.com)

Mid-Atlantic Apiculture Research and Extension Consortium, USA

<https://agdev.anr.udel.edu/maarec/>

[https://agdev.anr.udel.edu/maarec/wp-content/uploads/2010/03/Pests\\_of\\_Honey\\_Bees\\_PM.pdf](https://agdev.anr.udel.edu/maarec/wp-content/uploads/2010/03/Pests_of_Honey_Bees_PM.pdf) (article on honey bee pests)

Stanford University, USA – Parasites and pestilence, honeybees

<http://www.stanford.edu/class/humbio153/AgriVetParasites/Background.html>

Tiwana Bee Farm, India (beekeeping equipment)

<http://www.tiwanabeefarm.com>





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