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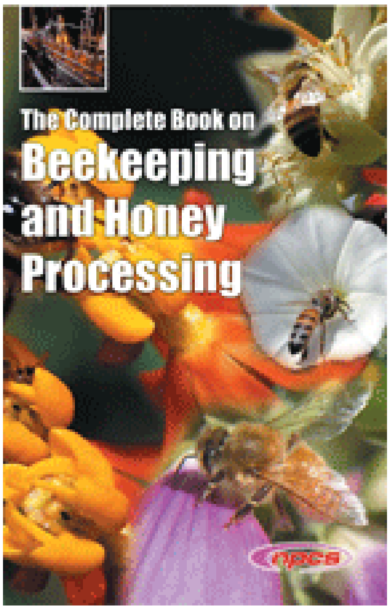
The Complete Book on Beekeeping and Honey Processing (2nd Revised Edition)



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Beekeeping is the maintenance of honey bee colonies, commonly in hives, by humans. Bees are accommodated in artificial lives where they live comfortably within easy reach of the bee keeper for examination and extraction of surplus lovely, after keeping of sufficient lovely in the combs for the bees. Honey is a part of bees, which gather sugar containing nectars from flowers. Honey should be processed as soon as possible after removal from the hive. Honey processing is a sticky operation, in which time and patience are required to achieve the best results. Careful protection against contamination by ants and flying insects is needed at all stages of processing. Bee honey is natural, unrefined food consumed as much in fresh or canned state. It is readily assimilated and is more acceptable to the stomach, particularly in the case of ailing persons, than cane sugar. It is an antiseptic and is applied to wounds and burns with beneficial results. Honey collection and its marketing in India are still not fully organised. The main uses of honey are in cooking, baking, as a spread on breads and as an addition to various beverages such as tea and as a sweetener in commercial beverages. Honey is the main ingredient in the alcoholic beverages mead, which is also known as honey wine or honey bear, honey is also used in medicines. A number of small scale industries depend upon bees and bee products. Honey and bees products finds use in several industries which are under; pharmaceuticals, meat packing, bees wax in industries, bee venom, royal jelly, bee nurseries, bee equipments and hives etc. There is considerable demand for the honey and other products. Outside the thousands of homemade recipes in each cultural tradition, honey is largely used on a small scale as well as at an industrial level.

Some of the fundamentals of the book are history of beekeeping in India present, all India co ordinate research project on honey bee research and training, future plan for development, the pattern of beekeeping today, development of beekeeping equipments, beekeeping industry and honeybee species, bee hive products, medicinal properties of honey, bees and agriculture, pesticidal poisoning to honeybees, handling bees, queen rearing and artificial queen, beekeeping and ancillary industries, honey based industries, honey in pharmaceuticals, honey in meat packing, beeswax in industries, bee stings precautions and treatment.

The book contains the steps of bee keeping in proper manner and details of honey processing. This book is an invaluable resource for new entrepreneurs, technocrats and also for established enterprises.

Tags

Bee keeping and honey processing book, Bee keeping and honey processing technology, Bee keeping and honey processing unit, Beekeeping and Honey Production, Beekeeping business plan, Beekeeping equipment manufacturers, Beekeeping technology book, Beekeeping: How to Keep Bees and Process Honey, Business plan for honey processing, Commercial production of honey, Creating a Beekeeping Business Plan, Food Processing Industry in India, From Honey to Money, Getting Started: Beekeeping Equipment, Honey and Bees Products, Honey bee business profit, Honey bee farming, Honey bee products and their uses, Honey Bees and Beekeeping, Honey bees farming beginners, Honey business plan in India, Honey business plan pdf, Honey business profit, Honey Business: Profitable Small Scale Manufacturing, Honey making process business, Honey processing and packaging, Honey processing Cottage industry, Honey Processing Industry in India, Honey processing plant, Honey processing steps, Honey processing technology book, Honey processing Tiny Industry, Honey processing unit, Honey production business, Honey production process, Honey: A Potential Item for Export, How Bees Make Honey?, How honey is made?, How is Honey Made: Honey Production?, How to Process Honey, How to Start a Beekeeping Business,, How to Start a Food Production Business, How to Start a Honey Bee and Honey Production Business, How to start a honey bee business, How to Start a Honey Production Business, How to start a successful Honey business, How to Start Food Processing Industry in India, How to Start Honey Processing Industry in India, Indian Honey Industry, Major Constraints in Beekeeping in India, Most Profitable Food Processing Business Ideas , Most Profitable Honey Processing Business Ideas , new small scale ideas in Honey processing industry, Opportunities and challenges of honey production, Products made from honey bees, Products of the Honey Bee Hive, Start a Honey Farm - Startup Business, Starting a Bee Farming Business, Starting a Food Processing Business, Starting a Honey Processing Business, What Do Honey Bees Eat, What is beekeeping?, What is honey and how is it made?

Content:

Sample Chapter:

History of Beekeeping in India Present Status and Future

After independence India launched a massive programme of rapid industrilization with the belief that the benefits would percolate down to the masses. Contrarily only elites got benefited and rural people continued to be poor resulting into movement of the unemployed to the cities.

As 80 percent of the population lives in rural India and depend on agriculture it received more emphasis in the second phase of development. Consequently huge investments were made in agricultural research and extension and India became self sufficient in food production ranking World s fourth largest grain producer. Special efforts were also made to develop various agro base industries like dairy poultry fish farming sericulture and beekeeping. Out of them beekeeping industry received inadequate attention resulting in its stagnation. Following paragraphs trace history and present status of beekeeping in India followed by suggestions to rectify the current state of affairs and give this industry a status it rightfully deserves.

History of Beekeeping in India

Although honey and honey bees are known to human beings since time immemorial still beekeeping is not a Strictly traditional industry in India. Efforts were made to introduce Apis mellifera the European honeybees in India since 1880. For various reasons these experiments did not meet with success. It was around 1910 that Rev. Father Newton designed a smaller hive suitable for the Indian honeybee Apix cerana indica in Kanyakumari and successfully maintained it in hives. Mahatma Gandhi realised the importance of beekeeping industry and included it in his rural development programme. Several freedom fighters were trained in his Ashram at Wardha in the art of maintaining honeybee colonies. These Freedom fighters from all over the country initiated beekeeping industry in their respective States. Swami Shambhavananda from Coorg District in Karnataka Y.M.C.A. Martandom and Dr. Spencer Hatch from Southern most coastal strip of India Shri S.K. Kallapur and Shri S.G. Shende from Western Peninsula Shri R.N. Muttoo from Central Himalayas Smt. Rama Devi and Manmohan Chaudhary from orissa Shri Rajdan from Jammu and Kashmir did pioneering work in the establishment of modern beekeeping in India. All these efforts however were restricted to small pockets only. After independence Government of India took a policy decision to revive various traditional industries and an All India Khadi and Village Industries Board was constituted to undertake this work. The task of development of beekeeping industry was also entrusted to this Board. This Board was later reconstituted as Khadi and Village Industries Commission a statutory body of Ministry of Industries. It was only after the establishment of KVIC at Central level and Khadi and Village Industries Boards at State level that beekeeping industry received serious attention for its development in a coordinated manner throughout the country through well knit organisations like Village Industries Boards Beekeepers Co operative Societies registered public Institutions etc. In addition to this a few states like Jammu and Kashmir Himachal Pradesh. Karantaka and Uttar Pradesh developed Departments of Beekeeping that functioned under Ministry of Agriculture or Industries.

Beekeeping Extension

The (KVIC) an Autonomous Statutory Body was established by an Act of Parliament in 1956 to plan organize and implement the programmes for the development of Khadi and Village Industries. Since beekeeping industry was included in the schedule of KVIC the Commission established Beekeeping Directorate with adequate staff at its Headquarters in Bombay and network of technical and extension staff in all states reaching through Districts to potential villages. The organisation of Beekeeping extension programme was as under

Khadi and Village Industries Commission

The KVIC had a Technical Staff of about 200 workers. The Beekeeping Directorate had evolved about ten different patterns of assistance for providing financial assistance to Beekeepers Co operatives Institutions and individuals. Some of the patterns of assistance are (i) Establishment of beekeeping sub stations (ii) Model apiary cum nursery (iii) Migration of bee colonies (iv) Construction of honey house (v) Purchase of beekeeping equipment (vi) Training in beekeeping etc. Every year developmental plan for each state was finalised and financial as also technical assistance was provided by the KVIC to State Boards Institutions or Co operatives for implementing the approved programme.

State Khadi and Village Industries Board

What is Khadi and V.I. Commission to Govt. of India is Khadi and V.I. Board to State Government. The state Khadi and V.I. Boards receive financial and technical assistance from Khadi & V.I. Commission for implementing development programme. Each State Board has its own beekeeping extension staff for implementing and supervising the programme. The State Khadi and V.I. Boards implement the developmental programme directly or through Co operatives and registered Institutions. At one time there were 600 Bee fieldmen working on contract basis on 600 Beekeeping substations all over the country.

Directly Aided Organisation

The registered institutions or the Co operative Societies established prior to the establishment of the State Boards were taken on the list of directly aided institutions by the KVIC. Kerala Sarvodaya Sangh Punjab Khadi Gramodyog Sangh Bihar Khadi Gramodyog Sangh are some of the very big organisations.

All India Beekeepers Association (AIBKA)

All India Beekeepers Association was established in Nainital in 1937. Shri R.N. Mutto Founder of the Association devoted his life for the development of beekeeping industry in Uttar Pradesh. In the initial years the Association organised All India Beekeeping Conferences which popularised modern beekeeping and brought awareness about pure honey extraction using centrifugal machine. The Association as a directly aided institution of KVIC took up beekeeping development programmes in Uttar Pradesh. This Association has been publishing for the last 50 years a Journal entitled Indian Bee Journal . Besides publication of journal other major activities of the Association are standardization of beekeeping equipment supply of beekeeping books charts and other audio visual aids/literature.

Beekeeping Research

Bee research in India like beekeeping industry has a very recent history. Its growth and development can be traced back to a little over four decades as follows

Department of Agriculture and Colleges

Prior to independence most of the earlier research on honeybees was confined to the entomology departments. The emphasis of this research work was naturally on the academic aspects of Indian honeybees and provided very valuable basic data.

Apicultural Research Laboratory Mahableshwar (M.S.)

The Bombay Village Industries Committee initiated beekeeping development programme in Mahableshwar way back in 1948 under the leadership of Shri S.G. Shende (now Chairman All India Beekeepers Association). During this extension programme Shri S.G. Shende associated Prof. G.B. Deodikar with bee research programme realizing importance of source to sink. A comprehensive programme of bee research was conceived which included research on standardisation of beekeeping equipment standardisation of bee management practices studies on bee botany bee genetics bee pathology chemistry and quality control of bee products etc. The Apicultural Research Laboratory was thus established in Mahableshwar in 1952 formally inaugurated by Shri Morarji Desai the then Chief Minister of Bombay State.

It was unique in the sense that it devoted to field oriented research and simultaneous attention was paid to different disciplines of bee science like botany management genetics and breeding pathology and quality control of bee products etc.

Central Bee Research and Training Institute (KVIC)

The Apicultural Research Laboratory Mahableshwar undertook various research projects of applied nature and published series of articles thus attracted the attention of KVIC which recognised this Laboratory as All India Training Centre for beekeeping and also provided financial assistance for the research programmes. The work of Laboratory however was confined to limited area of Mahableshwar plateau and surrounding valleys in Western Ghats. A need was then felt to expand the scope of bee research activities to entire country. KVIC with the help of Maharashtra State Khadi and Village Industries Board established Central Bee Research and Training Institute (CBRTI) in Pune on 1st November 1962.

The CBRTI in turn established Regional Bee Research Laboratories. Field observation Stations and experimental apiaries all over the country. It undertook field oriented research programmes under its Departments of Botany Melissopalynology Bee management Bee breeding Bee pollination Bee pathology and Bee Chemistry. The work done on different aspects was regularly published in national and international journals. More than 100 scientific papers were published by the CBRTI. It also prepared 10 to 15 drafts for secrutiny and adoption by Bureau of Indian Standards. Gradually CBRTI received national recognition by organizations like Bureau of Indian Standards and AGMARK. The University of Poona accepted it as a Centre for postgraduate studies on bees and beekeeping. Similarly International Bee Research Association London and the Canadian International Development Agency also sent their recognitions. Members of the National Commission on Agriculture (NCA) visited CBRTI and had series of meetings with the Scientists. The NCA in its final report to the Government of India (1976) wrote one Chapter on Apiculture and made many recommendations for the development of beekeeping in India. One of the major recommendations was that CBRTI should be developed as a primary national centre for honey and honeybee research & training. It was further recommended that the institute be treated at par with other Central Institutes of the ICAR and the necessary funds and facilities should be placed at the disposal of the institute.

The Department of Science and Technology at the request of KVIC provided funds for construction of building at Pune.

All India Co ordinated Research Project on Honey Bee Research and Training

The Ministry of Agriculture accepted the report of the NCA and passed it on to Indian Council of Agricultural Research for implementation. In light of the recommendations of NCA and the needs of a vast country like ours with climatic floristic and phenological heterogeneity a much larger and co ordinated programme was an obvious necessity. At CBRTI in July 1981 broad areas of research and training were identified for implementation at eight different co operating Centres under All India Co ordinated Research Project on Honeybee Research and Training with main co ordinating centre located at CBRTI Pune. The Headquarter of the Main Co ordinating Centre remained at Pune for a couple of years. Subsequently it was shifted to Haryana Agricultural University Hissar. Other Co operating Centres were located at Ludhiana (Punjab) Vijayrai (AP) Jorhat (Assam) Pusa (Bihar) Vallyani (Kerala) Pantnagar (UP) Solan (HP) Bhubaneswar (Orissa). Similarly one centre each at Indian Agricultural research Institute (New Delhi) and the Chithali station of Indian Institute of Hoticultural Research (Karnataka) was established.

World Scenario in Beekeeping

Beekeeping is practised over a greater area of the earth s surface than perhaps any other single branch of agriculture and on it depends the success of many other branches of agriculture. Honeybee originally belongs to the old world Europe. Africa and Asia and the bees spread to the new world after 1638 in America 1822 in Australia and 1842 to Newzealand. The real boost to scientific beekeeping took place with the discovery of moveable frame hive by Langstroth 1851. Later sequence of events took place by studying the biology of honeybees development of beekeeping methods identification of different castes queen mating role of bees in pollination etc. Although the beekeeping has since undergone tremendous change both in equipment and management but the basic principles have remained the same as advocated by Langstroth and Dadant and still form the basis of modern beekeeping. During the next half century i.e. between 1850 to 1900 beekeeping exploded in the New World.

Today most of the countries practise beekeeping with the European honeybee Apis mellifera which surpasses the Asian honeybee Apis cerana in almost all the departments. This species has an unusually large distribution which encompasses widely different environments. A. mellifera is one of the most successful species in the animal kingdom which has become independent from environmental conditions to a great extent one and the same species is able to survive in semidesert tropical regions as well as in cold temperate zones. Even countries like China and Japan which for a long time were practising beekeeping with Apis cerana are replacing the species with A. mellifera.

The Pattern of Beekeeping Today

We have now seen that honeybees live in all the parts of the world except polar regions. However the pattern of beekeeping in old and new worlds tends to be different. In general the new worlds tend to give richer honey harvest but the old world is densely populated with honeybees as it is with people. The new world provides more useful inventions for handling bees and their products whereas the old world still contributes more fundamental discoveries about bees. Broad distinction with exception is between the equipments used for beekeeping. Beekeeping equipment used in the new world tends to be simple uniform and mechanism perhaps due to expensive labour. Mainly Langstroth and Dadant hives are used. In European countries one man can look after 100 to 300 colonies. In Australia the figures are still higher the most mechanised beekeepers among all are in California where beekeeping started around 1850 and a beekeeper can run 1000 or even 2000 hives each.

In new world beekeeping is generally a means of livelihood and average honey yield in most of the countries ranges from 10 to 20 kg/colony and the average yield in best beekeeping district ranges from 100 kg to 150 kg or even 200 kg. Contrary to this in the old world the beekeeping is a hobby and sideline beekeepers are much higher each owning 5 10 or upto 50 hives and getting a harvest of 5kg to 20 kg/hive.

In good areas beekeeping is being adopted even without knowing great deal about the bees themselves and beekeepers are neither much interested in bees nor in beekeepers organisations. Contrary to this in European countries like Australia Czechoslovakia Germany Netherlands and Switzerland where there is much awareness with strongest beekeepers organisations per hive honey production is low mainly because of greatest density of hives. All these countries have more than 10 colonies per square mile and their honey yields are amongst the lowest in Europe.

Race of Honeybees

The most predominant species of hive honeybees in the world is Apis mellifera whose races can be divided into three

1. European races 2. Oriental races and. 3. African races.

One can determine some relationship between dark European bee and the North African Tell bee and between Caucasians Anatolian and Carniolan bees. However from point of view of economic value there are four races of Apis mellifera and they are

Dark bees A. mellifera mellifera L.

They are spread throughout Europe north and west of Alps and Central Russia. But in the last decade they lost ground almost everywhere and presently are confines to Spain France Poland and Russia. These are big bees with short tongue broad abdomen dark chitin with small yellow spots nervous in temperament good wintering weak disposition in swarming and susceptible to diseases.

Italian bees A. mellifera Ligustica Spin

Its original homeland is Italy (exclusive of Sicily) and is somewhat smaller than A. mellifera mellifera with slender abdomen. The bee is of light colour with scutellum hair have yellowish colour. These are very clam bees generally gentle build exceptionally strong colonies with high consumption of food. The good building instinct of this race has been praised many times.

Carniolans. A mellifera carnica (Pollmann)

With original homeland Austrian Alps this bee is generally quite similar to ligustica. Slender with long tongue its chitin is overwhelmingly dark with brown spots. Hair is grey. It is the quitest and the most gentle race. Diseases of brood are virtually unknown.

Caucasian A. mellifera caucasica Gorb

Original homeland is Central Caucasus. In shape and size it resembles carnica. Colour is dark with brown spots on abdomen. Hairs are grey brown. It is also gentle and calm. It raises strong colonies. Produces only weak swarms cold hardy.

Besides these important races. Apis mellifera adansoni has also been much talked about these days. This north African bee is a very small dark in colour highly aggressive in behaviour high tendency to swarm and migrating over long distances but excellent for honey production in extreme climate of Africa.

In addition to these races of Apis mellifera we have the Asiatic hive bee Apis cerana which closely resembles Apis mellifera in its body structure. It is relatively cold hardy. It is genetically separated from A. mellifera and attempted intermating produces lethal offspring. It does not produce a strong colony and is therefore kept in smaller hive. It is resistant to nosema disease. It produces relatively less honey and has great swarming and absconding instinct.

There are two other species of genus Apis in southern Asia which are entirely tropical. Both build only a single comb and nest in the open. Neither of them can be kept in a hive although honey can be obtained from nests of wild bees. These two species are a dorsata and A. florea.

Honey Production

The total honey production in the world is 1.1 million tones according to 1990 FAO estimates out of which 66 per cent is produced by 10 major honey producing countries of the world. In the foregoing account only the major honey producing countries have been briefly described.

Beekeeping in Europe

About a decade ago Europe (excluding USSR) had about 13 million colonies with an average 7 colonies/square mile a hive density seven times as great as in any other continents. The average honey yield was l0kg/colony/year. It was low as compared to the new world as a whole. Europe consumes more honey than it produces and Western Europe is the world s greatest honey importing region. In 1972 Europe imported 70 000 tons from New World of which 46 000 tons was imported by West Germany. The honey production in Europe was 2 00 000 tones.

According to the figures available for 1989 for European Economic Community (EEC) the average yield per colony was minimum at Luxemburg (7.7 kg/colony) and maximum at Denmark (35 kg/colony) (Table 1). Spain had maximum number of bee colonies (1.6 million) and Luxemburg the least (10 400). West Germany still Remains the world s biggest importer of honey which produced about 18 00 M. tons of honey in 1988 and imported 83 000 M. tons during the same period.

According to the 1984 estimate the erstwhile USSR had 10 million colonies which had been built after

World War II the earlier stock was mostly destroyed during the war. Its honey production was more than one lac tons (average yield 11 kg/colony). The entire produce is consumed in the country. Its beekeeping is on the pattern of Europe and even the equipment is similar to that used in Europe. Most of the beekeeping farms are run by the State each of which maintains as many as 6000 colonies. Since most of the activities are centrally governed there is virtually no conflict between beekeepers and plant protectionists and all beekeeping and crop spraying activities are systematically organised. The value of bees in fruit and seed production is very well realised and growers and beekeepers work in harmony. Efforts are a foot to become surplus in honey and wax production. The USSR had traditionally exported small amount of honey primarily to Eastern Europe. One of the constraints to Soviet export was lack of high quality packaging material which forced the USSR to sell honey wholesale as opposed to the more profitable retail market.

Asia Till recently Beekeeping in many Asian countries was a traditional household activity. It is only recently that its importance has been commercially realised in countries like China India and Pakistan as a result of the introduction of high honey yielding species of Apis mellifera. In other countries of this continent there are small beekeepers who keep one to five colonies of Apis cerana in different traditional hives and produce honey by squeezing method . The total honey production in Asia is only to the tune of about 2 50 000 M. tons.

China There are at present 8.5 million colonies in China out of which 7 million are kept in modern hives. Out of these 70 per cent are Apis mellifera and others are Apis cerana. The annual honey production is about 2 00 000 metric tons per year and total Royal Jelly and bee pollen production is 1 800 and 1 000 tons per year respectively. In addition bees wax and propolis are two other important hive products that are harvested. About 30 to 40 per cent of hive products are exported and rest are retained for domestic consumption. About 90 per cent of honey and all the Royal Jelly is produced from Apis mellifera. Royal Jelly is sold at a rate of US$100/kg. The Institute of Apiculture Sciences of the Chinese Academy is mainly responsible for beekeeping research and extension activities. There are more than 1 00 000 apiaries in China each having 30 to 80 hives. Beekeeping with Apis cerana is practised in mountain areas. Each A. mellifera colony produces from 0.3 to 0.5 kg of Royal jelly per year. Beekeeping got a boost in China between 1949 to 1959 after the introduction of European honey bee.

At present China is the world s largest producer and exporter of honey. Honey production in China is mainly a sideline activity engaged in by crop farmers to enhance income but others specialise in honey production. These producers move from region to region depending upon season and local flowering conditions. They sell honey to total supply and sale cooperatives which act as middlemen and re sell honey to retailers food and beverage processors producers of Chinese medicine or in case of honey destined for export market to the Native products Import/Export Corporation (TUHSU) .

India As per 1986 statistics (FAO) there are about 1 million bee colonies of A. cerana and A. mellifera in India and annual honey production is about 18 000 M tons. About half or more of this quantity is harvested from wild colonies of A. dorsata and A. cerana. Beekeeping covers 4 00 000 villages providing part time employment to 2 50 000 persons. India has the potential of accommodating 5 million colonies and a potential of producing 6 00 000 M tones of honey. Himachal Pradesh is the only area in Southern Asia which has announced support price for honey.

Pakistan Our neighbour Pakistan produces about 640 M tones of honey of which 14 to 18 per cent comes from A. mellifera and A. cerana kept in modern hives and the remaining from wild colonies of A. dorsata and A. cerana.

Nepal Its beekeeping is mainly with A. cerana and average yield is 5 to 6 kg although some beekeepers obtain as high as 25 kg/colony. It has mainly traditional beekeeping. Other species such as A. dorsatal A. Laboriosa and A. florea are erratic honey yielders.

Bangladesh Beekeeping is with A. cerana A. dorsata and A. florea. A cerana yields around 4 to 10 kg honey per colony. There are about 10 000 A. cerana colonies kept in different types of hives by about 8 000 beekeepers.

Japan In 1990 Japan produced 4 300 M tons of honey fulfilled only 77 per cent of the total annual consumption for a year. Japan is the second largest importer of honey in the world. In 1990 Japan imported 69 435 M tons of honey China being the dominant supplier accounting for 86 per cent of the honey for industrial use and only 35 per cent for table purpose.

In other countries of Asia like Bhutan and Burma beekeeping is virtually non existent and attempts are being made to boost beekeeping with A. mellifera however it will take sometime.

Beekeeping in India

Role of KVIC

Success of an Industry is measured by its achievement and the role of Khadi & Village Industries Commission (KVIC) in the upliftment of Beekeeping Industry is spectacularly well established.

Beekeeping is an ideal agro based subsidiary industry providing supplementary income to a target group of people from rural hilly and tribal tracts including horticulturists and agriculturists because of abundantly widely and well distributed bee flora. Apart from the direct benefits of honey and bee wax the indirect benefits through pollination etc. are almost impossible to quantify which may simply outclass the direct benefits.

KVIC

The KVIC is a statutory body created by an Act of Parliament (No. 61 of 1956 and as amended by Act No. 12 of 1987). It is charged with the planning promotion organisation and implementation of programme for the development of Khadi and other Village Industries in the rural areas in Co ordination with other agencies engaged in rural development wherever necessary. The Village Industry means any industry located in rural areas with a population not exceeding 10 000 which produces any goods or renders any service with or without the use of power with the fixed capital investment not exceeding Rs. 15 000/ per artisan or worker.

Thus the beekeeping fitted perfectly in the perview of KVIC as it being the only such organisation with a will to work and network in such areas.

Growth of Beekeeping under KVIC

Until 1953 the beekeeping in Indian subcentinent was in a badly disorganised shape until this activity was taken over by All India Khadi & Village Industries Board and subsequently by the KVIC in 1957.

The KVIC is responsible for taking Beekeeping Industry to the present height from a mere 16 557 colonies to 13.44 Lakhs colonies and the honey production consequently increasing from 0.21 Lakhs Kg. to 82.02 Lakhs Kg respectively.

The liberal financing by the KVIC coupled with the technical support in the form of technical manpower training literature supply of equipments followed by the marketing umbrella support to the beekeepers has led to the present scale development of Beekeeping Industry.

Thus making beekeeping in India and KVIC Synonymous.

Organisational set up of Beekeeping under KVIC

The organisational set up is the key to effective planning and implementation of beekeeping programmes.

Table 1

Growth of Beekeeping in different States/Areas

Being entirely an agro based industry bee keeping is feasible only in areas with adequate bee flora atleast for a period of 6 to 8 months with one major honey flow season. Initially beekeeping activity was concentrated in some southern states only. The KVIC is instrumental in spreading it to entire India except the states of Gujarat and Rajasthan where it is practiced at low key.

Table 2

The southern states of Karnataka Tamilnadu and Kerala contributed almost 40% of the total honey production till a fatal disease Thai Sac Brood Virus (TSBV) damaged the whole of Beekeeping activity in these States. Now the leading states are U.P. Bihar Bengal Punjab and Haryana.

In addition to directly aided institutions beekeeping programme is implemented mainly through institutions cooperatives and individuals financed by State Khadi & V.I. Board which receives funds from KVIC.

Role of Central Bee Research & Training Institute (CBRTI) Pune in research and technology development

While implementing the bee keeping extension programme the immense potential of bees to reap unlimited floral wealth of India was realised which resulted in the initiation of a KVIC sponsored comprehensive research programme relavant to Indian conditions at Apicultural institute in Mahabaleshwar (Maharashtra) in 1952.

Organisational set up under CBRTI Pune

This set up is unique in the sense that all the related aspects of the beekeeping research are undertaken under one roof. In case of Indian Council of Agricultural Research (ICAR) universities colleges institutions etc. the emphasis on research is mainly devoted to Entomological and pollination aspects whereas it is integrated on all aspects at CBRTI.

The achievement of CBRTI in different divisions/departments are summarised here.

Apiculture

Development of Beekeeping Equipments

It is an important task and CBRTI has designed lots of equipments

Bee hives ISI (A type B type and C type)

Bee hives stand (folding type and fixed type)

Honey extractor Tangential and radial type

Comb foundation sheets

Comb foundation mill

Travelling bee box

Wasp trap

Lay out of honey house

Lay out of honey processing plant

Solar wax extractor.

The above mentioned equipments have already been standardised by Bureau of Indian Standards (formerly ISI). The following approved drafts awaiting standardisation are

Cylinderical bee packages

Honey extractor tangential

Beeman s kit.

Role of RBRCs/FOS

The RBRC s and FOS s with apiaries in different agroclimatic conditions were established as per the recommendations of National Commission on Agriculture (1979) to perfect management techniques in different climatic conditions of India. The beauty of the idea is that after every 5 years they move to virgin areas. This has led to phenomenal recourse in managing different bee apiaries in different agroclimatic zones of India.

Some of these techniques include

- Management of apiaries year round
- Supplementary feeding in dearth period
- Swarm control
- Management for higher yields
- Apis mellifera management
- Migration both local and distant.

Introduction of exotic bees

The exotic bee Apis mellifera was initially introduced in Punjab Jammu & Kashmir on the individual level as well as by Agricultural University Ludhiana. After its successful introduction Apis mellifera bees was popular and it was taken up in Punjab on commercial basis. The KVIC after due experiments in the States of Bihar U.P. M.P. and Punjab approved introduction of A. mellifera in nothern States and approved the pattern of assistance of Apis mellifera under its scheme of beekeeping for the southern northern States. The experiment is in progress for introduction of A. mellifera in southern states.

Entomology

Achievements include identification extent of damage and management of pests parasites and predators of bees including green bee eater wax moth mites etc. The control of the mites was achieved employing advanced indigenously prepared strips impregnated with insecticides. The most important work includes isolation purification and identification of mandiculat gland pheromone of different bee species different insecticides with low LC 50 to bees were taken.

Bee Pathology

The section made detailed studies on the isolation fungal identification etiology and management of different bacterial and viral diseases including EFB TSBV etc. The hill variety of bees A.c. indica was found to be relatively tolerant to the TSBV which has played havoc on beekeeping industry.

Bee Botany and Melletopalyonology

This department has collected and classified more than 3000 plants species useful as bee plants. More than 300 spices and plants have been given to forest/ agricultural department. The polynarium with more than 4000 slides of pollen types of India is unique which serves as a reference task to the scientists from India and abroad. Analysis of pollen loads pollen stores and honey samples to identify its sources is another Analysis of pollen loads pollen stores and honey samples to identify its sources is another facility created.

Beekeeping Research Set UP ACHIEVEMENTS and Future Strategies

Honeybees and honey find special mention in the Indian epics and bee hunting for honey dates back to some 2000 to 2500 years. The innovation of movable frame hive in the west in 1950 s ushered an era of revolution in the field of Research in Beekeeping. Some attempts were also made in India by the end of 19th century to keep bees in moveable frame hives but nothing much was done till the recommendations of Royal Commission on Agriculture in 1928. During 1930 s and 1940 s some beekeeping stations were established in different parts of the country and some research was initiated at places like Coimbatore Pusa Lyalpur and Nagrota (H.P.).

After independence Village Industries Boards at state levels to promote cottage industries including beekeeping were established. For co ordination between the state boards the national Government established All India Khadi and Village Industries Board in 1953 which later became autonomous Khadi and Village Industries Commission in 1956.

One organisation set up after independence was Bombay village Industries Committee which was later re

organised as the Village Industries Board for earstwhile Bombay state and under its aegies appreciable beekeeping extension work was done in Mahableshwar hills. A Bee Research Centre was started at Mahableshwar in 1952 which was upgraded as Apiculture Research Laboratory in 1954. Work done in this laboratory especially in survey of bee flora palynology cyto genetics and honey analysis etc. provided good base for KVIC to establish a Central Bee Research & Training Institute at Pune in 1962. The CBRTI has been implementing research programmes through regional Bee Research centres and field observation stations. Some good popular articles and bulletins were published and research findings emanated till early 1900 s when the Institute suffered set back in terms of technical resource personnels.
Beekeeping as a matter of stark fact should have been a part of agriculture but to greater dismay the field remained neglected by the agricultural Universities and Indian Council of Agricultural Research. It is only recently that the beekeeping has come to be realised as an input of agriculture. Entomologists working in some Universities/Institutes in erstwhile Punjab Agril. University and later state Universities of Punjab Himachal Pradesh and Haryana have done some pioneering work in some respects. All these efforts had been fragmented approaches for resolution of research problems in apiculture. In 1980 a need was felt by the ICAR for multilocational Research and All India co ordinated Project on Honeybee Research and Training (AICRP) was perceived enroping six Institutes/Organisations where co ordinated Project on Honeybee Research and Training (AICRP) was perceived enroping six Institutes/Organisations where co ordinating centres were located. Later on the umbrella of the AICRP was broadened by adding more centres. The project now operates with co ordinating centres in important beekeeping states of the country. But these co ordinating centers are not provided with specialist scientists in each field of honeybee research and even now the research efforts are little less than systematic. Besides the co ordinating centres of AICRP there are only few state Universities like H.P. University Simla H.P. Krishi Vishva Vidyalaya Palampur Haryana Agril. University Hisar University of Agricultural Sciences Bangalore which have provided some set up for honeybee research.

Research Achievements and Future Strategies

Beekeeping Industry and Honeybee Species

Growth and development of beekeeping industry in India has not been satisfactory. Honeybees in India are estimated to be availing about one fourth of the floral resources available in the country. Thus there is enough scope for expansion of beekeeping in potential areas. The average honey production with Apis cerana indica is 5 10 kg per colony per year in most areas and this production can go upto 25 kg in some very good areas.
Three species of true honeybees viz. A.c. indica A. dorsata and A. florea are indiginous to India and the fourth A. mellifera (the exotic species) is now established in the country and serving the commercial beekeeping in many states. There is also likelihood of encountering the other three recently described species of the genus Apis. A. dorsata and A. florea are wild and honey hunters squeeze honey in forested areas. Some efforts have been made to semi domesticate and manage its bee colonies. These bees offer some scope for management on commercial lines.
Many unsuccessful attempts were made by various workers to introduce and establish A. mellifera in India since 1920 s. These attempts met with failures   possibly because of lack of basic knowledge of apicultural concepts and management skills. Successful introduction of A. mellifera in India dates back to 1962 66 and the credit goes to the foresight of Dr. A.S. Atwal. Two three and twenty eight queens of the English strain (developed by hybridising indigenous bees in U.K with Dutch and Itallian bees) the Italian strain and californian strain were imported from U.K. Italy and California (USA) respectively and one two and fifteen queens of the respective strains could be successfully introduced in A. cerana indica young worker bees. The combs of A.C. indica where gradually replaced by A. mellifera cell size foundations and thus the

colonies of the species were raised. Lateron 20 nuclei (two lots of 10 each) were obtained from California in 1964 and 1965. During 1966 24 nuclei each of Starline (mid west hybrid mixture of yellow and Caucasian blood) and Midnite strain (Caucasian hybrid) were imported from Florida (USA). Initially the colonies of the exotic species were maintained at Nagrota Himachal Pradesh (then a part of Punjab) and comparative performance of Indian bee and five strains/hybrids of the exotic species were studied. This was also the first successful example of inter specific queen introduction. The species has brought major revolution in honey production in some states of India Dearth periods in subtropical regions are relatively short and the bees that evolved there are poor honey gatherers. On the contrary bees of temperate region store large quantity of honey to survive during extended dearth periods.

Therefore temperate zone honeybees are better suited for commercial honey production for India. Average honey production with A. mellifera is 20 30 kg/year/ colony but through migration beekeepers are getting the high averages of 60 70 kg. Although the beekeeping with introduced A. mellifera is flourishing in some states the species should be quickly tested for its performance to spread to other potential regions with greater research and extension support.

Bee Flora

Information on different aspects of bee forage is essential for the efficient management of honeybee colonies. Management scheme for each apicultural region is closely correlated with the flowering of local honey and pollen producing plants as also the climatic conditions. Basic research in the area of forage ecology has been done and floral calendars for different regions have been prepared. On the basis of surveys potential beekeeping areas have been identified.

The most serious problem for Indian beekeeping has been the decline in flora due to deforestation and clearing of wastelands for extensive agriculture. Improvement of bee flora is not possible by individuals efforts and a beekeeper has to adopt and adjust only to the cropping patterns of the area and forest wild flora available in the locality. Recently central and state Governments and local organisations have helped in expansion of planted areas of bee forage along highways wastelands etc.

To get good results plantation of selective trees and shrubs is essential and this should be done on the basis of multiple use principle including bee forage as one of the uses. Flowers of many plant species are visited by bees for nectar and or pollen but relative importance depends on the quality and quantity of rewards available and also on the density of the plant species. Intensive research in this area has generated this type of information on many of the important flora. The knowledge accumulated can be made use of while planning plantations on the basis of accessibility of the potential bee forage areas and migration schedules can be worked out. Migratory beekeeping is practised by many commercial beekeepers in states like Himachal Pradesh Bihar and south India but micro regional survey of bee forage would be required for planning short and long distance migration schedules.

Equipment and Management

Efficient management requires the use of appropriate equipment and operations concerning the well being of bees. Many types of hives had been in use in India and attention of the scientists was attracted to standardise the hives and with these efforts the ISI (BIS) hive specifications laid down on the basis of body size (bee space). Increase in brood and super chamber capacities has been suggested keeping in view the colony build up capacity and length of build up and honey flow reasons. BIS have also formulated standards for other bee equipments.

Knowledge of biometry of bees is helpful in standardising bee equipment for breeding work and for gathering information on the races of a species. Good information on body size tongue length and other morphometric characters is available for A.c. indica. Egg laying capacity of queens and consequently colony build up capacity varies from south to north of the country. Therefore exhaustive studies are required for all the regions to develop suitable queen excluders comb foundation mills bee escape honey extractors pollen traps etc. For A. mellifera only standard Langstroth hive is being used everywhere in India whereso ever the species is present. In these and other areas need might arise to make suitable amends in sizes and number of frames etc. to suit different zones. Timber is becoming expensive and cost of hives is increasing. To keep the investment in beekeeping low some alternative materials like polurethene polystyrene and compressed sheets etc. shall have to be tried.

Many other practices for better management of honeybee colonies have been worked out and standardized. Mass queen rearing for colony multiplication is a very useful practice. The queens (30 40) reared in one queenless or queen right colony can be given to new divides just before the emergence. This saves the wastage of many days for queen rearing by each divide. Time and length of divides in regions have also been worked out. Oversummering is a problem in many parts of our country because bees are troubled by high temperature and it is also no flora period. Methods have been recommended for successful summer management which also includes feeding of pollen supplements and substitutes to make colonies to continue rearing some brood.

India presents a variety of ecological conditions from north to south and east to west. To some extent the art of beekeeping can be uniformly adopted but some management problems specific to different regions are needed to be tackled on priority. Similarly summer and rainy season dearth periods need immediate attention. Other problems that should attract the attention of bee scientists are strength of divides for colony multiplication etc. Little work has been done on the problem of swarming and absconding in A. cerana indica. In addition work on behavioural aspects of Apis spp. is needed to evolve the management calendar for bee apiaries. Limited information is available in India on communication behaviour foraging distance and nectar and pollen carrying capacity. Exhaustive information on these aspects is needed to standardise management practices for different ecological regions for efficient management of hive bees.

Genetics and Breeding

Information on genetics and reproductive biology is required for planned bee breeding and stock improvement programmes. It was hypothesised by Dr. Deodikar and co workers that during the course of its trans Himalayan migration the primitive tetraploid Indian honey bee might have gradually differentiated into an advanced tetraploid Apis mellifera. All along these migratory routes Apis mellifera differentiated further into a number of African European and Sino Japanes races. Cytogenetic studies of Apis spp. have shown that A. cerana indica has the same number of chromosomes as the European bee. The male has 16 chromosomes which occur in 8 homomorphic pairs showing pronounced somatic association it was inferred that the males though numerically haploid may be closely approaching diploid condition genetically. The females show a close approximation to a tetraploid condition. This inference has been corroborated by chromosomes in A. Florea and A. dorsata which have 16 chromosomes in female and 8 in the male. Reproductive biology is also worked out in Indian honeybee. The queens of the species can be inseminated with instrument but difficulties like production of low quality semen its separation from mucous and lesser concentration and activity of spermatozoa are encountered. Experiments on hybridization between two hive species have not proved successful. Intensive research in needed in reproductive biology and genetics of Indian honeybee and breeding of Apis spp. The present day A. mellifera stock has descended from varied and heterogeneous blood therefore we have to talk about inbreeding depression with caution and verifying the facts. We will have to be over cautious in importing more A. mellifera bees since it will run the risk of introducing diseases and enemies. Artifical queen bee insemination techniques has been standardised/ practised in our country therefore safest alternative would be to import semen and use for hybridisation as and when the need arises.

Major Constraints in Beekeeping

BEEKEEPING WITH APIS CERENA INDICA AND APIS MELLIFERA

The KVIC since 1952 promotes A.c indica the Asian honey bee. The number of colonies of this bee in India is about 0.96 million yielding 6300 metric tonnes of honey with an average yield of 6.7 kg per hive.
Various Agricultural Universities of (Punjab Haryana and Himachal Pradesh) for the last three decades promoted Apis mellifera the Italian honeybee. The colony number of which is about 0.1 million with a total honey production of 13 700 tonnes with an average yield of 13.7 kg per hive.
Compare this data to that of China which took up commercial beekeeping with A. mellifera around 30 years ago and now has 6 million bee colonies yielding 180 000 metric tonnes of honey and is the worlds largest exporter.
Obviously there is something wrong with the impetus direction and assistance given to beekeeping in India. This paper therefore attempts to define the constraints in this regard and suggest suitable measures for overcoming them.

THE MAJOR CONSTRAINTS FOR THE DEVELOPMENT OF BEEKEEPING IN INDIA ARE AS FOLLOWS

Using the Correct Species for Beekeeping

All over the world the Italian honeybee is acclaimed to be the choice for commercial beekeeping. However the controversy regarding the suitability of the species i.e. Asian honeybee A.c. indica and the European bee A. mellifera for beekeeping in India which has been going on for the last three decades gave a severe set back. Thank God this has now been resolved and the two species have been accepted to be complementary to each other. Even then if we are to put India on the world honey map we must decide to use A. mellifera for commercial beekeeping all over India.

Availability of Genetically Superior Queens for Increased Honey Production

America has developed hybrids of high yielding queens of A. mellifera Australia has a programme in New South Wales for developing superior queens of this species U.K. has the Buckfast bee developed by brother Adams. In India research programme needs to be oriented in this direction so that desired results may be obtained and we may increase the yield per colony to the desired level.
Queen breeding is a long and tedious developmental process. During our last 17 years experience of breeding A. mellifera at our own apiary we have managed to do line selection of queens giving upto 80 kg of honey per hive but because of the unavailability of queen insemination equipment we have not been able to standardize the genetic stock. Even though our queens are raised by grafting yet they mate in the air and drone population cannot be controlled entirely in the vicinity of the mating yards.
It is imperative that queen breeding by grafting and artificial insemination be taken up intensively to improve the genetic stock and develop line breeding and hybridization of both the species.
It is essential to give grants to private breeders and governmental breeding institutes to enable them to set up the requisite infrastructure for the production of large volumes of genetically superior queens for supply to the beekeepers.

Lack of Technical Knowledge for Efficient Management of Colonies for High Honey Yields

This is a major constraint. Beekeepers are not aware of international methods of efficient management.
Some of the wrong practices followed by beekeepers are
Few beekeepers use queen excluders Further the excluders that are locally available get rusted and damage the bees.
We have heard of outdated concepts like queen gates being recommended for bee colonies to prevent bees from absconding.

Efficient swarm control is not practiced by beekeepers and they are most unaware of these techniques. Most beekeepers just divide colonies to prevent swarming.

Although maximum yields from A. mellifera are obtained when the colonies go upto 3 to 4 chambers with populations of 50 000 to 70 000 bees yet few colonies with beekeepers are raised to that level.

Beekeepers do not know the concept of the food chamber as a measure of colony build up and mostly maintain colonies on a single chamber leading to weak colonies that die in dearth periods.

Few beekeepers change queens every season before the honey flow leading to loss of queens during the crucial honey flow.

Some beekeepers even do not use full comb foundation sheets and only use strips of wax sheets for the frames which leads to excessive drone comb construction besides wasting the time and effort of bees in making extra comb. Therefore there is a great scope for improvement.

4. **Lack of Infrastructure at the Grass Roots and National Level for Beekeeping**

This is the major cause for the use of wrong management practices by beekeepers and needs to be urgently attended to for the success of beekeeping in India.

Our agricultural universities do not have departments of Apiculture but only departments of Entomology where bees are just one of the insects in the department. Beekeeping has to be given the same status as poultry and dairying in our institutes and then only can we turn out beekeeping specialists from the universities who specialize in bee management breeding disease control quality control and so on. At the moment the universities only turn out entomologists who have knowledge of beekeeping and who in any case are too few to be able to have any impact in the field.

There is no concept of beekeeping inspectors or trainers in beekeeping at the village or even district level. Beekeeping by its nature has seasonal crises of disease management and so on. It is not sufficient to have a few people in universities for advise on beekeeping. The only way that China managed to take up beekeeping so fast and so successfully was the availability of trained field workers in beekeeping at the village level. We must therefore have a hierarchy of beekeeping experts and trainers in the villages blocks Tehsils Districts and then finally in the universities to be able to have effective feed back to and from the beekeepers.

There are no organized forums for the meeting and discussions amongst beekeepers which are essential and are available all over the world. In India beekeepers work in isolation and hence loose the benefits of interaction with others in the field. Whereas we have found during our visits and interactions with beekeepers in Europe Australia etc. that there is free flow of beekeeping information and knowledge amongst beekeepers in those countries. In the field of beekeeping all over the world new techniques and improved methods of beekeeping have essentially been developed in the field by this interaction amongst beekeepers and then scientists in the field.

It is thus essential to improve our infrastructure and communication for the success of beekeeping in India.

Poor Quality Control for the Production of Honey

This is a very important aspect of beekeeping and needs to be stressed on if we are to progress. It is not enough to produce large amounts of honey but that is more essential to produce quality honey. It is because of this reason which most Indian honeys do not come up to international quality standards. The beekeeper should therefore be quality conscious.

Some beekeepers extract honey from brood frames which process damages the brood and the honey extracted is of poor quality.

All beekeepers do not maintain separate super chambers for the production of honey. The honey is produced in old brood frames and so gets darker in colour and also is not so clean as if extracted from only super frames. Dark honeys fetch very low prices internationally.

Since many beekeepers do not use queen excluders the queen lays eggs in the honey chamber thereby

lower the honey quality.
Many beekeepers do not wait for the honey to be properly sealed before extracting. Honey only develops the flavour which is particular to each flower source if it is allowed to stay in the hive a little more after the bees seal the frames. Most beekeepers extract the honey while it is still fresh and not entirely sealed. This leads to high moisture content and low quality.
Beekeepers do not use the technique of keeping supers in warm rooms with a forced airflow before extraction. This produces honey with excess moisture. In the absence of desired warm extraction it cannot be sufficiently clear and so requires further heating before filtration which causes deterioration of quality. Honey from warm supers can be easily extracted and cleaned straight away by simple filtration through muslin.
In case unripe honey is extracted it is high in moisture content and lacking in colour flavour and quality. In order to be able to market our honey we must improve its quality.
Honey is also poorly stored by beekeepers in old tins which rust and so darken the honey further. Besides the honey in contact with the old tin plate becomes blackish in colour and loses flavour the tins being produced now are mainly for oils and ghee and do not have sufficient tin plating to be able to store honey cleanly. Lacquered tins are expensive and so beekeepers do not use them for storing honey. Food grade plastic containers need to be developed for storing honey.

Emphasis on Production of Honey Instead of other Bee Products

At the moment only honey is produced by the beekeepers. Honey bee can also produce pollen propolis royal jelly beeswax bee venom which can add to the overall income from the bee live.

Bees Wax

This is easily produced has great demand in the world market and is used in the cosmetic and pharmaceutical industries. The most important producer of beeswax in India is Apis dorsata. This is not so pure as the beeswax obtained from Apis mellifera which has a greater export demand. However to produce beeswax from the bee colonies supers must have only 7 to 8 frames instead of 9 frames so that beekeepers can produce larger quantities of beeswax from the bees.

Pollen

Pollen is not produced at all in India. Pollen is a natural vegetarian protein source containing many nutritive elements and minerals and can do much to improve the general nutritional intake in rural areas. It also has a great demand in the export market.
There is tremendous potential for pollen production by the bees particularly from coconut the mustard species of oilseeds maize sunflower etc. Pollen is easy to produce and beekeepers can use simple technology to supplement the income from the hive by inducing bees to collect pollen. Pollen can be produced in tons.

Propolis

Propolis is the resinous substance collected by bees from trees to seal cracks in the hive. Propolis has been found to be a natural antibiotic and has many medicinal qualities when used externally or internally and is valuable in the field of Apitherapy. There is great demand for propolis for export.
Propolis collection is by the use of special propolis screens and can be easily mastered by the average beekeeper.
A.c. indica does not collect propolis and there is great scope for the use of a mellifera for propolis collection.

Bee venom

This is an unexploited source of production from the bees in India Bee venom has various medicinal uses in Homeopathy Allopathy and systems of natural medicine. Extraction is complicated and can be done by beekeepers with great technical skill using special bee venom extractors in front of the hive.

Royal Jelly

This is secreted by the bees from special glands in their body and is used to feed the queen bee larva. It is supposed to have rejuvenant and beneficial properties like Ginseng. It contains various natural hormones and is a highly concentrated food. It has a great demand for exports. China has become a major producer and exporter of royal jelly. Royal jelly however can only be produced by beekeepers having high technical knowledge.

All the above by products from bees are not produced yet in India and can add to the income of beekeepers besides having great scope for exports.

Disease Prevention Control and Analysis

This is the major constraint for the development of beekeeping in India. We need to have regional and also central bee disease analysis laboratories. At the moment this is lacking and as has been seen in the recent outbreak of sac brood in the South the beekeepers could not get timely help or advice regarding the disease that was killing their bees.

We do not have disease control inspectors to visit the beekeepers all over India. These inspectors need to have detailed training in being able to identify all the bee diseases and also take samples from apiaries to have them tested.

There is no method of registration of apiaries and beekeepers all over India. In America disease inspectors are there in each state who register apiaries and take regular samples to declare them disease free.

Breeding apiaries must be registered as such and only those whose colonies are free of disease should be allowed to sell queens and bees all over India. This is followed in America where breeders get their bee colonies certified disease free before supplying queens to other beekeepers.

There is no control on the movement of bee colonies all over India. Only colonies free from bee diseases should be allowed to be moved all over for migratory beekeeping. This requires us to set up the infrastructure for sampling and analysis of bee colonies from each apiary.

Beekeepers use poor management techniques like continued use of old frames and extracting honey from brood chambers. Weak colonies are allowed to survive and have the danger of absconding and spreading disease. Honey is a carrier of brood diseases of honeybees and the practice of extracting honey from brood chambers is dangerous as brood can die when the honey is extracted and the dead brood in the frame is a source for the development of disease.

Beekeepers do not use good management practices of keeping their colonies clean and so the danger of disease is even more. Beekeepers need to be educated regarding these procedures.

As can be seen there is much to be done for disease analysis prevention and control at the National and regional level.

Lack of Sufficient Financial Help from Government and Lending Institutions for the Development of Beekeeping

Beekeeping requires long term loans at easy rates of interest. That is the procedure used by China to take up beekeeping in a big way. The bee colony produces honey only after almost a year initially and then seasonally. Beekeepers need help to be able to get finance for bee colonies and equipment.

Insurance of bee colonies needs to be done at a reasonable premium so that beekeepers can recover their losses in case of disease or the loss of bees due to other factors.

No Tax or other Monetary Benefits for Beekeeping

Beekeeping is neither considered an industry nor an agricultural activity and there is no tax benefit on beekeeping income. Beekeeping is a long term developmental activity and requires to be given tax incentives for people to take it up in a big way. China gave the beekeepers many incentives for them to take up beekeeping and so had a quick growth in this field.

Beekeeping is also a high risk activity and is dependent on the vagaries of the weather for production. Many times even though flowering crops are available nectar secretion is low because of climatic factors like moisture in the soil. Some times rain at the time of flowering causes the bees to collect little honey. The bee keeper has to be given financial support during seasons of bad honey harvest to sustain his colonies for the next season.

No Control on the Use of Pesticides by Farmers Leading to Death of Bee Colonies in Field Locations

The indiscriminate use of pesticides leads to the destruction of bee colonies in the field

There is no legislation restricting the farmer from the use of pesticides that are harmful to bee colonies. In many countries farmers are required to inform beekeepers in their area as to when they may be spraying pesticides on their crops. India has no such system and bee colonies perish by the farmers using pesticides harmful to bees.

Only pesticides that are not harmful to bees should be used and should be propagated with farmers. Bees are very important pollinators and destroying them is a national loss as well.

Pricing Structures for Honey

There is a lot of lobbying by farmers beekeepers and beekeeping societies to give the beekeeper high prices for honey. Himachal had fixed a support price for honey at Rs. 30 per kg. This has resulted in large stocks of honey lying unsold as beekeepers refuse to accept lower prices for their honey. International prices are around Rs. 20 per kg for the most superior quality honey. If Australia can meet that basic price with their high basic costs as compared to India why should Indian beekeepers expect more for their honey here which in any case is not even up to world quality standards? To get more income from honey yields should be increased and not prices.

MORPHOLOGY ANATOMY COLONY Organization and Life Cycle

The honeybee belongs to family Apidae of order Hymenoptera. It shares the general characters of class Insecta. But the organ systems are variously modified to lead a specific life that is food habits social life and other ways of life. A brief account of different organs and the way they have been modified to perform a particular function as essential for understanding the activities of bees is given below.

Morphology

Head. The head of adult bee bears a pair of geniculate antennae. The third portion (flagellum) has many sensory structures which are mainly chemo and mechano receptors. The compound eyes are placed on the lateral sides of the head. Bees can distinguish colour but are red blind. They can perceive ultraviolet rays but cannot perceive the red light spectrum that is beyond 620 m wavelength. Bees can also see polarized light. It is well known that bees communicate the food sources with reference to the position of the sun but even in cloudy days or when the sun is obscure the bees perform communication dance with reference to the position of the sun and this is done by receiving polarized light. In the top portion of head capsule the bee has three ocelli. The ocelli perceive only the degree of light and do not form an image on the retina.

Two mandibles are attached to ventro lateral part of the head capsule. The mandibles differ in the three castes of honeybee (Fig. 1). In workers the mandibles are narrower in the middle and broader at the base and at distal end. Each mandible has a channel both sides of which have fringed hairs. This channel leads to a groove which ends at the opening of mandibular gland. The mandibles are used for grasping scraping pollen from anthers feeding pollen and manipulating wax during comb building. Mandibles of the queen differ from those of workers in that they have bilobed distal end and there is no groove from the mandibular gland opening. Mandibles of drone are smaller in size and have faint groove covered with long hairs with

an apical projection.
Fig. 1. Head capsules and mandibles of castes of honeybees.
The mouthparts in worker bees are modified for sucking and lapping. The proboscis or tongue which is used for ingesting liquids is formed by median labium and two lateral maxillae. Labium has long glossae. At the time of sucking food galeae of maxillae and labial palpi form the anterior and posterior coverings and are appressed together with paraglossae forming the axial part of the food tube. The two paraglossae are united together. The tongue has a deep grove with a partition made by a rod which is curved backwards. One canal serves as salivary canal through which the saliva is ejected on the food before feeding and the food is ingested through the second canal. The tongue has a spoon shaped lobe at the end. With the lapping motion of the tongue the liquid food is drawn into the food canal of the proboscis and the food channel leads to mouth cavity. The preoral cibarium and postoral pharynx form sucking pump. With the help of sucking pump the food is forced into the oesophagous and honey stomach.
Worker bees feed the young larvae and the queen with the glandular food called royal jelly . The food is secreted by hypopharyngeal glands which are long coiled strings of small lobes and are present in the head region. The brood food appears at the base of the open mandibles of the nurse bees.
Thorax. As is common with other insects the second body region thorax consists of three segments and is joined to the third region abdomen by a narrow propodeum. Thorax carries the organs of locomotion the legs and wings. The leg of honeybee is composed of basal coxa femur long tibia tarsus and pretarsus. Tarsus is subdivided into tarsomeres and small pretarsus bears the claw. Besides locomotion the legs in honeybees are also modified to perform other functions. Prothoracic legs serve as antenna cleaner. The basal part of the basitarsus has a notch and small lobe projects from the distal end of tibia. The notch has two rows of spines. The flagellum of the antenna is placed on the notch and the tarsus is flaxed against tibia. The antenna is drawn upward and is thus cleaned in between the notch and the projecting clasp. The modification is met with in all the three castes of honeybees. Hind legs in worker bees are modified for pollen and propolis collection. The tibia has double row of curved hairs the space enclosed in between these is called corbicula or pollen basket. Adjacent margins of tibia and tarsus have notch. Notch on the tibial margin has a row of stiff spines and the opposite trasal margin is modified into a lip called auricle which is also fringed with hairs. Hairy brushes on the tarsi of fore and middle legs collect pollen sticking to head and thorax regions respectively. The pollen from fore leg is transferred to middle leg of the respective side. The spines on the tibial end of the hind leg brushes the pollen from opposite leg. The pollen falls on flat surface of auricle. By the upward movement of tarsus the pollen on the auricle is pressed against the outer surface of the tibia and thus a pollen load is accumulated.
Fig. 2. Mouth parts of worker bee.
Abdomen. The abdomen in adult worker and queen appears to be six segmented segments 8 to 10 are reduced in size whereas first is transferred to thorax during pupal stage. The abdomen bears sting wax and scent glands and genitals and also contains the principal viscera inside.
Fig. 3. Hind leg of worker bee.
Sting. In worker bee the egg laying apparatus (ovipositor) is modified into a sting. Sting is formed by three long stylets attached to the bulb. The ends of the stylets have two lancets which are hollow and when in contact with each other they form a poison canal. The bulb at the base of shaft made by lencets is supplied by poison sac which is the reservoir of poison gland. Venom is injected into the body of the victim with each movement of the stylet. These movements continue even after the sting has been inserted. The lancets have curved barbs and the sting apparatus is broken off from the bee s body in the attempt to pull it out. Queen has well developed poison glands with large poison sac but the lancets lack the curved barbs and she uses it for stinging the rival queens.
Wax glands. Wax glands are situated in the sternites of 4 to 7 abdominal segments. These are polished

plates (mirrors) and formed by the modification of epidermis. The wax glands become active in the worker bee at the age of 14 to 18 days. Wax is secreted in liquid form which solidifies into thin flakes.
Scent glands. The scent glands are present in the thin membrane connecting the last two abdominal terga. The Bee bends her abdomen and exposes the membrane to produce the scent. The odour produced by the cells is derived from scented waste products of metabolism.

Anatomy

The first part of the digestive tract consists of mouth pharynx and oesophagus with expanded honey stomach. Following the honey stomach (sac) is a valve which regulates passage of food into ventriculus. The valve can remove the pollen from nectar and by the action of this valve nectar can be retained in honey sac while the pollen passes to the ventriculus. Digestive enzymes are released by the epithelial lining of the stomach. Digested sugars are absorbed into the blood through the walls of the ventriculus. Digested proteins (amino acids) are absorbed in the small intestine. The small intestine leads to rectum which holds the faeces until it is discharged during flight.
Honeybee has open circulatory system formed by the heart and the aorta. The blood is pumped from the five chambered heart into the aorta. The chambers of the heart have ostial valves which allow the blood to enter into the heart but backward movement to body cavity is prevented. The blood is poured into the body cavity below the brain at the anterior opening of aorta. The organ systems freely bathe in the blood in the body cavity. The muscle movement of dorsal diaphragm helps in pumping the blood whereas ventral diaphragm beats in backward direction.
Respiration takes place through spiracles present on lateral sides of various segments of the body. Spiracular openings are attached to tracheae which ramify into trancheoles. The tracheae and tracheoles supply oxygen to respective segments of the body.
Excretory system is of generalized type. Many thin tubes called Malpighian tubules extend in the body cavity around various organs. They collect waste metabolites from the blood present in the body cavity.
Brain and ventral nerve cord constitute the central nervous system. Brain has three distinct parts the anterior most having optic lobes antennal lobes and mushroom bodies. Mushroom bodies are the centres of instinct and memory co ordination. Ventral nerve cord has seven nerve centres (ganglia). These centres innervate the various body regions. Sensory nerves extend from the receptive cells of the sense organ to central nervous system. Eyes are the important sense organs. On the body of the bee there are innervated hairs which perceive the mechanical stimulus. Small thin walled peg like hairs can perceive odour.
Female reproductive system is fully developed in queen but in workers the system is greatly reduced. Two large ovaries have a number of egg tubules or overioles which lead to lateral oviducts. The two lateral oviducts join posteriorily to form median oviduct which leads to vagina. Spermatheca is a pouch like structure and serves as storehouse for sperms. The spermatheca is connected to vagina by a spermathecal duct. Tongue like valve fold closes the opening of median oviduct when the sperms are pushed into the spermatheca. Bursa copulatrix accomodates penis at the time of copulation. The valve fold when raised makes the micropyle of the egg to come in contact with the sperm released from the spermatheca and the fertilization takes place. The ovipositor which is modified into a sting helps in depositing the egg. Soon after mating the sperms migrate from the vagina to the spermatheca which stores about five million spermatozoa. These spermatozoa remain viable get nourishment during storage and are released in small numbers for the fertilization of the eggs. Male reproductive system has paired testes with one vasa deferentia each. Both the vasa defrentia join posteriorly and form an ejaculatory duct which leads to penis. Two mucous glands unite with ejaculatory duct. On an average each drone produces 1 mm3 semen in A. mellifera and 0.16 mm3 in A. cerana indica.
Fig. 4. Reproductive organs of drone worker and queen.

Colony organization

Honeybees are social insects and live in colonies with a highly organized system of division of labour. There are three castes queen workers and drones. In a normal colony there is one queen 10 000 to 30 000 workers and a few hundred drones. In A. mellifera colony the number of workers before honey flow may go to 60 000 70 000.

Queen. The queen is the only perfectly developed female and is the mother of the colony. In the peak of the season she may lay large number of eggs in a day weight of which is almost twice the weight of her body. She mates with the drones the male bee in the air only once in her lifetime. The stock of male sperms received during mating is preserved in a pouch like structure spermatheca in her body. She draws upon it for a long time (which may be two or three years) to regulate the sex of the offsprings. She can lay fertilized or unfertilized eggs at her will. From the former workers and sexual females or potential queens and from the latter drones are produced. The differentiation in the workers and the queen is not due to the quality as previously believed but to the quantity of the food fed to the larvae. The partial stravation from about the third day of the female larvae that are reared in worker cells results in their differential growth and they become workers instead of queens which they would have become if they would have been lodged in the larger queen cells and had constant access to more food. The queen in her rounds over the combs lays eggs in the worker queen or drone cells. The eggs are generally laid in concentric circles. As the old queen shows signs of decline in laying fertilized eggs or if a colony is under swarming supersedural or emergency impulse new queens are reared in specially prepared queen cells. On emergence a new queen roams about on the combs feeds herself on honey and takes one or more orientation flights out of the hive after 5 to 10 days of emergence. On her mating flights she is followed by drones and have multiple matings in one or more days. Her mate dies during the act of copulation and falls on the ground. The queen returns to the hive with the mating sign the male reproductive organ attached to her reproductive opening which is removed by the worker bees. After 2 to 4 days she starts laying eggs first slowly then vigorously. The number of eggs laid depend upon the amount and kind of food she receives from the workers and the availability of other favourable conditions for egg laying and brood rearing.

The queen is heavily worked individual and quickly transforms the food given to her by the workers into eggs. She however lacks the motherly instinct and the function of nursing the young ones is performed by the worker bees. An A. mellifera queen lays up to 1 800 eggs per day during active brood rearing season but A. cerana indica queen lays from 500 to 1 000 eggs per day. Number of eggs laid by queen of Indian bees in Kashmir is comparable to A. mellifera. Egg laying rate diminishes with the age and in failing queens.

Worker. The worker bees are imperfectly developed females. Unable to reproduce but possess all the maternal instincts. They are responsible for the maintenance and welfare of the colony. Division of labour in worker bees is on a physiological basis which is explained elsewhere in this book.

A worker bee has no individual existence and throughout her life she labours for the good of the colony. The worker bee is capable of performing a definite amount of work and she dies when that is accomplished. Consequently during honey flow season when she has to work at a tremendous pace she lives only for about six weeks but during off season. as in winter or in cold climate her life extends up to six months. At Coimbatore in Tamil Nadu which has equitable climate A. cerana indica worker lives for 50 days the extremes being 44 and 54 days. Kapil found the life span to be 25 42 days from January to April and 45 days in May in Uttar Pradesh.

Drone. The only function of the male bee is to mate with the queen. Drone has short tongue but does not collect food from flowers. The tongue is used to receive food from worker bees. Drone has no wax and scent glands. Generally it takes 3 to 6 worker bees to feed a drone. Drones are reared and tolerated during the breeding season in spring and in some places in autumn when new queens are to be mated. They are driven out of the hive to die of starvation when not needed. The normal life span of an A. cerana drone has been worked out to be 57 days in Tamil Nadu.

The three castes of bees depend on each other for their existence. The lonely worker bee may not live for more than two or three days under the best of simulated environmental conditions. The queen bee also cannot form or even start a colony because she is physically incapable of secreting wax building a comb collecting food from the field or rearing brood. In fact she requires the services of several wokers to feed and groom her and to do other jobs for her. A drone would not last beyond four hours without food. A normal colony must have a fecundated queen capable of laying plenty of fertilized eggs and a large number of workers of varying age as the latters fitness to do different tasks depends on their age. A colony is termed weak or strong according to the number of worker bees it possesses. A colony of Apis cerana indica bees with 10 000 to 15 000 bees (906 1359 g) is considered an average colony at higher altitudes. Drones are not necessary to the normal welfare of a colony but they are needed only during the mating seasons to fecundate virgin queens.

Development

The honeybee undergoes an indirect development (metamorphosis). The four stages of development are the egg the larva the pupa and the adult. Duration of development of worker bee of A. cerana indica is given in Table 1. The mother queen glues or sticks a short delicate white tubular egg slightly curved on one side at the bottom of the cell of a comb. From this egg a tiny white larva hatches out and feeds voraciously on the food supplied by the nurse bees. When fully fed it weighs more than 1 500 times of its original weight. The cell is capped by the worker bees with a waxen cover. The fully fed larva spins a cocoon in the cell and enters a period of rest during which it transforms itself into pupa. The major changes in the structure of the body occur at the cost of the fat stored in the body by the larva. The pupa is similar in appearance to the adult bee having developed mouth parts legs wings and other appendages of the body. The adult bee emerges after cutting the cocoon and the waxen capping of the cell. Table 2 shows the time taken by the three castes of the Indian honeybee in the three stages of development.

Food of the Honeybees Bee Flora and Honey Flow Periods

Food of the Honeybees

The natural diet of the bees consists of carbohydrates proteins vitamins salts etc. The nectar of the flowers which the bees collect and convert into honey is the source of carbohydrates and vitamins. Pollen the yellow powder in the flowers is the main source of protein and it is mixed with honey before it is fed to the larvae. The winged bees when they are young also feed on this mixture. Soon they become strong and secrete the royal jelly which forms the food of the queen and of the larvae in the early states of growth. These young bees thus act as nurse bees but as they grow older they take up the field duties and feed on honey only. In a hive the nurse bees are often seen going from one cell to another feeding the young larvae.

For brood rearing it is important that there are plenty of flowers in nature as the source of pollen and honey. For the growth of one larvae of honeybees into an adult bee one cell full of honey and one cell of pollen is required. In other words two frames of honey and pollen are required by the bees to raise one frame of brood.

Bees can also use the sugar syrup as food (sugar dissolved in an equal quantity of water). Sugar is offered to supplement honey resources or in the extreme case to save the weak colonies from starvation. Early in the spring when the flowers are not in abundance bees can be stimulated to start brood rearing and it should synchronise with the main honey flow so that the bees can take best advantage of it. Under proper management not more than one or two kilograms of sugar are needed to be used in a year/colony. A colony of normal size should have at least six to eight pounds of honey (two or three frames) in reserve. When the stores fall below this level bees should be fed artificially. If sugar is given as a winter reserve the syrup should be thick prepared by mixing two parts of sugar with one part of warm water.

To prevent robbing by the bees of other colonies sugar feeding should be done in the late evening. The hive should be made bee proof that is all crevices holes should be closed. Then sugar is put in a feeder or in a wide mouthed cup and placed inside the hive. Small pieces of wheat or rice straw should be placed to serve as floats on the surface of the liquid. Bees will sit on these floats while feeding and will not get drowned or smeared with sugar. The sugar syrup can also be filled in the combs. For this purpose an empty comb is removed from the colony and is held in the standing position in a tray. The sugar syrup is poured on or made to run over the comb. When one side is full the other side can be filled. This is the safest and easiest method of feeding the bees.

Collection of food in honeybees is a social enterprise and more then 10 000 of foragers may be engaged together in collecting nectar and pollen. The foraging is designed in a way to achieve high efficiency. The foragers sacrifice their individual foraging efficiency for colony efficiency. When they have discovered a rich source of food they communicate the information through various types of dances to their hive mates. High foraging efficiency is achieved as a result of sharing information about location of rich food sources. Four important resources include nectar pollen water and resin. Nectar and pollen are diet water is used for evaporative cooling of the nest in hot days and resin is used for plugging the unwanted openings.

Colonies managed for honey production rear 1 50 000 to 2 00 000 bees annually and consume 15 to 30 kg of pollen and up to 80 kg of honey. The number of trips required to pool these materials could be quite astonishing. To collect 20 kg of pollen approx 1 3 million foraging trips are required. Each trip on an average measure 4 5 km of distance. Likewise to collect 60 kg of honey 3 million foraging trips are required. In brief each colony can be thought of as an organism which weighs 1 to 5 kg (biomass of bees 7700 bees/kg) rears 1 50 000 bees and consumes 20 kg of pollen and 60 kg of honey/year. To collect this food several million foraging trips are required and foragers fly about 20 million kilometers.

Bee Flora

Honeybees are entirely dependent upon flowering plants for their food requirement. This means that if there are no flowers in any season honeybees don t get their food. One of the major problems in beekeeping is the presence of floral dearth periods which result in dwindling and desertion of the bee colonies. Every locality has floral dearth periods of long or short durations. Beekeepers have to ensure regular supply of food to the bee colonies to run the industry efficiently.

Nectar is the sweet liquid which comes from floral and extra floral resources and is the raw material for honey. Pollen is highly protein aceous food for bees. The plants that yield both these substances are collectively called as bee pasturage . The period when good number of plants providing nectar and pollen are available to bees is called as honey flow period . If the nectar yield is copious from a good number of plants of a particular species is called as Major honey flow period . When the amount of nectar to be collected is small is called as minor honey flow period . The day when there is no honey flow period is called as Dearth period . Since nectar and pollen plants are basic requirements for beekeeping and honey production their knowledge is essential for beekeepers. Bee forage plants may be fruits vegetables oil seeds ornaments crops herbs shrubs bushes forest and avenue trees and weeds in field. Efficient beekeeping means managing honeybee colonies in such a way to obtain maximum colony population to coincide with the major honey flow in an area and to utilise the population for honey production and

pollination.
There are three basic problems. (1) To determine when the honey flow occurs. To build up colony population in preparation to this honey flow season. (3) What to do after main honey flow season?
To determine when the honey flow occurs.
Make seasonal survey to identify the nectar and pollen yielding plants. (2) Make survey to record the flowering period of these plants. (3) Determine whether the plants are visited by honeybees for nectar pollen or both (4) determine whether bees could collect surplus honey from some abundant crops (5) determine what are the nectar secreting flowering plants besides the major crops of the area? (6) How long a dearth period if any lasts? (7) Examine weather records data and altitudinal variations.
The suitability of beekeeping in a locality will depend upon answers to these questions. If nectar secreting plants are available in a large number that is there are one or two major honey flow periods with minor honey flow periods during other parts of the year and the dearth period of not long duration then beekeeping can be successful in that area.
During the honey flow period a good colony of honeybees may collect from one to two kg of honey per day. It should be kept in mind that a few fruit trees or flowering plants or a vegetable farm or garden cannot sustain any number of bee colonies leaving alone surplus honey is hoped for they must be able to take advantage of many across honey yielding pasturage.
April and May are usually considered to be the period of nectar flow. After honey flow there comes the hot months of June and July when most of the colonies stop brood rearing in the lower hills and in the plains. The bees which had put in hard work in collecting resources die of old age and strength of the colony depletes. Some bees are also lost in their effort to keep the hives well ventilated and cool.
The monsoon season starts in the first week of July and because of the heavy rains bees generally stay inside. Some of those which go out for field duties are lost in the heavy downpour and the strength of the colonies depletes further. This is a very difficult period for the bees.
The enemies of the bees such as wax moths wasps and ants become active and make the colonies abscond. During July and August pollen from maize becomes available and is used in brood rearing. The colonies thus further use their honey reserves. If such weak colonies are not fed on sugar they have a tendency to leave hives and abscond. The shortage of food and insufficient number of field bees are the main causes of this behaviour. Furthermore strong colonies acquire a tendency to attack the weak ones and ransack their poor honey reserves. This dearth continues throughout autumn and during these months therefore colonies need particular care and management.
The honey flow period dearth periods etc. varies from one location to another and with altitudes.
The flowering periods of even the same plant species vary in different geographical regions and agroclimalic zones.
For instance in the lower hills and valley areas of Himachal Pradesh the season for activities of bees starts right from the advent of the winter when sarson flowers are available in the fields. Then fruit crops provide flowers in the 2nd week of February. They are followed by the flowering of Eucalyptus Shisham (Dalbergia sissoo) Tun (Cedrella toona) and their flowers continue upto the end of April. After a gap of about one week the soapnut (Sapindus sp) starts blooming which provides the main honey flow. It continues upto the end of May and surplus honey is extracted in the end of May or the first week of June.
Under Punjab conditions surplus honey is stored from Eucalyptus shisham citrus stone fruits litchi and barseem flowers in March April and May. Then follows the dearth period up to September and during this period the bees visit a number of wild flowers and the blossoms of maize in the end of July. In the oilseed and cotton growing areas bees also store surplus honey from toria cotton arhar etc. in September and October.
In the higher altitudes of Himachal Pradesh winter is much colder and the bees are very much restricted in

their activities. The stone fruits including pear almond plum cherry apple apricot etc. blossom in the spring and the bees are stimulated to rear their broods. In the beginning of May barberry flowers provide minor honey flow periods followed by soapnut in the end of the June. Early in August maize inflorescences provide pollen for brood rearing to bees. The colony strength increases. At the end of August Plectranthus blossoms appear which continue up to the end of October. This provides the main honey flow season. Extraction is done towards the end of the October leaving sufficient honey reserves for the bees to tide over winter.

In Kashmir the activity is instigated with the appearance of early blossoms from Salix Narcissus Brassica Pyrus Prunus etc. in Feb March. During April June blossoms of Iris Robinia Corylis Castanea Aesculus Alianthus Rose etc. provide the requirements at the peak of brood rearing activity and occasionally also lead to a spring honey crop.

While fruit blossoms mustards and other early flowering herbs greatly help in encouraging brood rearing activity and in building up some reserves of nectar and pollen. Vegetable blossoms and other flowering annuals and trees which appear during May and June perform valuable sources. July and August are the dearth periods. During August September colonies are migrated to higher altitudes where pollen and nectar sources such as Zea Zinnia Thyme Mentha Cyanoglossum Balsam etc. play an important role in gearing up the bee activity. Among the various shrubs providing nectar or pollen or both Plectranthus rugosus Wall which flowers from mid August to mid October provides for a major part of the honey flow in autumn because of its abundance on many hillocks in Kashmir. Saffron (Crocus) blossoms during late October to mid November if availed are of immense value to bees for brood rearing even in late fall.

In Jammu April provides the major honey flow period June July August are dearth periods. During August September colonies are migrated to higher altitudes to utilise Plectranthus rugosus. October onwards rapeseed and mustard crops are available up to Feb followed by fruit blossoms etc. J&K state has varied climates habitats which support varied type of vegetation and cultivated crops. Broadly it may be divided into

Subtropical zone

Intermediate zone

Temperate zone

A list of the important honey plants in Jammu & Kashmir is presented in Table (1 2). Similarly floral calendars of beekeeping plants are available in different states. However a particular crop may be good bee plant in one locality but can be quite otherwise in another locality. Honey production from a crop in the same area may vary from year to year.

Diseases of Bees and their Enemies

There has been a revolution in the methods of beekeeping for efficient management of bee colonies. Prevention and control of diseases and enemies has been an essential aspect of management. Honeybees are affected by large number of viral bacterial and protozoan organisms ecto and endo parasitic mites insects and non insect enemies. The extent of losses varies from death of some brood or adults to complete annihilation of colonies. Colonies may survive the infection or infestation but any extent of severity leads to loss in honey yields. Diagnosis of maladies has been possible by refined methods with the help of sophisticated equipments. But essentially the need is to detect the infection at the initial stages because it is easy to treat the colonies at that stage.

Bee diseases are spread from one colony to another or from one apiary to another mainly by robber bees swarms or migration of colonies. Because of these quarantine measures within the country or between the countries which have geographical contiguity are not feasible. Restrictions on the movement of bees between the countries which are separated by barriers seem useful and practicable.

Spread of diseases is also frequent by manipulative operations in the apiary. Beekeeper may be required to transfer honey and pollen combs from one colony to another. Similarly weaker colonies may need to be strengthened by transferring brood frames or combs with adult bees. Even uniting of colonies has to be resorted to in certain circumstances. Providing water in a container in apiary is another hazardous practice. All these manipulations lead to spread of diseases and parasites from affected to healthy colonies. Disease spread is even possible through hands hive tools etc. while examining the colonies. Therefore beekeeping requires not only the knowledge of basic principles of colony management but beekeepers should be well familiar with the nature of bee diseases. Early diagnosis of disease infection and prompt application of control measures is very important.

Many diseases which affect honeybees in other countries are not yet serious in India but there are isolated reports of their incidence except for some viral diseases. Any known diseases in the West can be expected to appear in epidemic form in India too and therefore very brief account of all the diseases and enemies is given here.

Viral Diseases

Many viral diseases of honeybees are known but the extent and severity of different viruses vary. The bee viruses appear to be species specific. Three viruses viz. Apis irridescent virus Thai sac brood virus and Kashmir bee virus have been reported from India. Out of these three the first two have been devastating Apis cerana indica in some parts of the country.

Thai sac brood virus

This viral disease was first detected in India in Apis cerana indica in Meghalaya in 1978. The causative virus multiplies in adults which transmit the virus to larvae. Trophallaxis swarms and drifting are believed to be the reasons of spread of the disease. Exchange of brood combs in between the colonies is the reason of spread within the apiary. Sac brood disease which is a closely related virus disease in many other countries is not considered serious but Thai sac brood took up to 95% toll of Indian honeybee colonies during early eighties in northern India. The disease occurred with similar severity in south India during 1991 92.

Symptoms. (i) Brood die in prepupal but in unsealed stage. (ii) Dead larvae straighten out and lie on their backs with tip of the head capsule turned upwards (iii) Dead prepupae turn into sac like structure (iv) Affected larvae are yellow or greyish later darkening to blackish the change in colour first starts from mouth parts and head (v) Dead larvae and prepupae dry up in brood cells forming loose scales.

No definite preventive or remedial measures against the disease are available but keeping the colonies strong avoiding exchange of hive parts and restricted movement of bees are suggested. Natural selection of tolerant colonies is expected and in endemic areas the surviving colonies can be multiplied with screening for disease tolerance in each generation.

Apis Iridescent Virus

This viral disease was reported from north western states of India in the seventies. The virus is specific to A. cerana indica and even in mixed apiaries the disease does not appear in A. mellifera. It forms crystals in tissues where the virus multiplies. The crystals appear bright blue violet or green when observed under microscope with incident light. This is also revealed even with hand lens or in sunlight with the naked eye. The virus multiplies in the fat bodies and other tissues of adult bees.

Symptoms. (i) Infected bees form clusters on the inside and later on the outside walls of the hive hence it is also called as clustering disease (ii) Many crawling bees are found on the ground (iii) Worker bees stop foraging sit listlessly and even brood rearing is stopped (iv) Queen stops egg laying and the eggs laid are not attended by nurse bees. (v) Death of the entire colony follows.

Kashmir Bee Virus

The virus was first isolated from diseased samples of A. cerana indica from Kashmir. Strains of Kashmir bee virus have also been found in Apis mellifera in Australia. All stages of development die in the affected colony. The virus is transmitted by injection or even by contact of body surface and death is fast.

Bee Viruses not Found in India

There are several virues found infecting Apis mellifera in other countries but not yet reported from India. Now A. mellifera is established in India and is fast spreading therefore any of the diseases known in the West can appear in India too in future.

Sac brood virus. Infected larvae fail to pupate and lie stretched on their back with head turned upwards. The larva becomes sac like because fluid is filled in between the new integument and the unshed skin. Colour of the larva turns pale yellow and finally becomes dark brown the darkening starts from the head region. The virus multiplies in hypopharyngeal glands of adult bees.

Paralysis virus. The infected bees have trembling motion of wings and bodies. They are unable to fly crawl on the ground and bees become dysentric. There is no particular season of the year for viral infection but overcrowding is suggested to enhance infestation.

Black queen cell virus. Infected queen larvae turn yellow and resemble sacbrood infected larvae. The queen cell tips become black.

Bee Virus X and Y. Cloudy wing particle and Acute Bee Paralysis are other viral diseases of A. mellifera.

Bacterial Diseases

American Foul Brood

Bacillus larvae is the causative bacterium of the disease. The disease occurs in temperate and sub tropical regions of the world. There is solitary report of the disease incidence in India on Apis cerana indica but no incidence has been observed on Apis mellifera since its establishment in the country.

Infected brood is invariably found dead after spinning of the cocoon in the sealed cell. The dead prepupae lie straight with head towards the opening of the cell. Cell capping of infected brood becomes darker in colour sunken and perforated. A tooth pick inserted into the body of prepupa and drawn out shows ropiness. The putrefying brood turns brown and has fish glue odour. Dead broods dry up into scales which adhere to the cell bottom. Large number of spores is formed and is present in the scale. Hive bees pick up the spores while cleaning the cells and spread the disease. The spores germinate in the gut of the larvae the rods penetrate the gut wall and multiplication takes place in the body cavity. The spores are very resistant and they remain infective even under desiccation for 35 years. The disease may subside during some parts of the year and reappear later. There is no seasonal cycle and outbreak appears when the brood is present.

Destruction of affected colonies and the equipment though suggested is a costly and cumbersome measure. Fumigation can be resorted for sterilizing the equipment. Formaline @ 6 ml per litre volume space sterilizes the equipment in a fortnight. Ethylene oxide 1 g/litre space at 43°C for 48 hr is effective for sterilization but forms explosive mixture with air. Many antibiotics have been tested with variable efficacy. Terramycin 250 400 mg in 5 litres of sugar syrup fed to the diseased colony twice at weekly intervals is effective. Antibiotic treatment can be made as a routine prophylactic measure in case the disease appears in the country. Resistant bees have been selected in the USA on the basis of presence of genes responsible for the expression of bee behaviour in uncapping the cells of dead brood and removing the same. The resistant stocks are available in country like USA.

European Foul Brood

The causal bacterium was earlier placed in the genus Streptococcus but in 1981 Bailey and Collins showed that the bacterium have nucleic acid composition which qualifies to place it under different genus and it was named as Melissococcus pluton. Diseased larvae are killed usually when 4 5 days old. Diseased larvae become flaccid turn brown and give foul sour smell. European foul brood disease is present in most countries. Infection was once observed in Maharashtra in 1971 on A. cerana indica by Diwan and co workers. Bacteria on swallowing with food multiplies in mid gut and are discharged with faeces. Older larvae are less susceptible to infection. The extent of disease is higher in spring and there is recovery during honey flow. Control of the disease is achieved by sterlizing the equipment with ethylene oxide and Terramycin feeding as explained under American foul brood.

Pesticidal Poisoning to Honeybees

Tropical and subtropical climate of India presents suitable conditions for the outbreak and appearance of many pest problems. The pest problems have been further aggravated by the advancement in agricultural technology. Irrigated crops intensive agriculture introduction of crops and crop varieties and disturbing the indigenous and primitive cropping patterns have contributed in increasing the pest problem of crops. Reduction in uncultivated land corners and bunds destroy nesting and hibernating places of wild pollinators and succession of nectar and pollen yielding flowers round the year is destroyed. Weedicides are used to control the weeds and hence lead to starvation of pollinating insects. The advanced agricultural technology has helped to destroy the agriculture cycle through indirect effect. There is also a prominent negative direct factor i.e. the insect pollinators are killed by pesticidal usage in crop protection. There is increasing use of pesticides for the control of rodents mites insects nematodes and fungal and bacterial diseases of crop plants. The loss by bee kill is direct i.e. loss of honey production and indirect inadequate pollination of crops resulting in reduced productivity.

Entomologists have been loudly talking about pest management or integrated pest management. Virtually speaking there is hardly any form of integrated pest management in India and blanket pesticidal applications are given. Most farmers apply large quantities of pesticides at regular intervals and in most cases the pesticides are non selective coupled with untimely application. Unfortunately honeybees are susceptible to many pesticides used in pest control programmes. This problem is recently overshadowing all other problems in apiculture. Farmers in India have small holdings and hand sprayers/ dusters are commonly used for treating small area each day. This results into a continuous threat of chemical poisoning to bees. Moreover there is no coordination between the beekeepers and the farmers by any Government decree and therefore measures to save bees cannot be taken.

Large number of killed bees are found in front of the hives or in the fields by insecticidal poisoning. It is not possible to quantify the loss in terms of food production or to assess the financial value of the bees killed. Even more important is the loss in future crop yields because a beekeeper whose bees are killed gives up beekeeping and others too are discouraged to take up beekeeping. Therefore a balance sheet between the gains in crop yields by control of pests and losses due to decreased pollinator activity and honey production by bee kill should be worked out. While controlling pests the scientists and farmers are looking on to one aspect of the economic considerations in insecticidal applications. Our primary aim should be to assess how crop pests can be kept under control without killing insect pollinators and to ensure optimum pollination by these insects. Widespread destruction of beneficial insects (including pollinators) often occurs as a consequence of irresponsible and improper use of pesticides. It should be accepted that some loss is inevitable in certain circumstances and that a realistic aim should be an acceptably low level of loss rather than complete protection of bees. In short the following constraints are important

Use of inapropriate pesticides ill timed wrong methods of application wrong formulations and unnecessary high doses

Over reliance on chemical methods of pest control and

Absence of certain essential instructions and legislation for using pesticides.

How is Bees Exposed to Pesticidal Hazards

Many of the Indian crop plants need cross pollination and about one third of the cropped area is under entomophilous crops. These crops are infested by pests even during flowering and their depredations warrant the application of control measures. The pesticidal control of the pests of crops which also serve as bee forage pose serious danger and eliminates large population of insect pollinators. Some points on the use of insecticides for pest control vis a vis insect pollination in some of the important crops are highlighted here.

Cotton. It is the most dangerous crop for bees. As many as 15 20 insecticidal applications at shorter and regular intervals are recommended for the control of various cotton pests. The flowering continues for about 2 months and during this period insecticides are regularly applied for the control of many pests like bollworms aphids bugs etc. Foraging bees are killed by these sprays. New generation of bees develop in 3 weeks. Insecticidal applications at shorter intervals than this kill more adult bees than can be replaced and ultimately the colonies die. But co ordinated application of insecticides can minimize bee kill. (1) Flowering in cotton continues for about 2 months but flowers that set fruit appear within 3 4 weeks. Therefore use of insecticides during this period should be reduced so that bees can be moved to the crop. (2) Nectar in flowers and extra floral nectaries is exhausted by mid day and very few bees are foraging in the afternoon when insecticides can be applied with reduced hazards to bees. (3) Air spraying has picked up for cotton. In such a situation the colonies should be located away from the flight path of the plane.

Brassica and vegetable seed crops. These are attacked by aphids caterpillars and bugs during flowering and pod formation stage. These crops include oilseeds Brassica seed crops of cauliflower cabbage raddish turnip carrot fennel and coriander. In these crops too the flowering is greatly extended lasting for about l l½ months. These crops need insecticidal applications during flowering periods. But all these crops are also enthusiastically foraged by bees which are very useful pollinators of these crops. There is extensive pesticidal poisoning to bees on these crops. There are no specific recommendations to safeguard bees and only general guidelines to reduce bee kill can be followed though Singh (1969) sprayed Endosulphan on mustard to control aphids at 0800 0900 1630 or 1730 hrs and found that Apis spp. foraged between 1030 and 1530 hr without any effect on foraging intensity and no bees were killed.

Sunflower. Its cultivation is gaining importance in India. Bees contribute much in increased crop production by pollination services but bee losses have been reported by insecticidal sprays for the control of aphids and caterpillars. In India Endosulphan was found to be less toxic to honeybees than Fenthion Carbaryl or Parathion and seed set and yield were not affected since bee activity was not reduced in Endosulphan sprayed plots (Ramakrishna et al. 1974 Bhattacharya et al. 1982). Bees mostly forage in the forenoon and there is limited activity till early afternoon. Therefore evening or late in the afternoon is appropriate time for chemical control operations.

Sesame. It is automatic self pollinated but natural cross pollination also occurs. Honeybees are very active on the flowers of sesame. The crop at flowering stage suffers from the attack of aphids brown leafhopper sucking bugs whiteflies and caterpillars. Chemical application at blossoming would cause hazards to bees also.

Seed crops. Like lucern and clovers these are rich bee forages. Under semi arid tropics the legume flowers usually close in the afternoon and it allows time for safe application of pesticides afterwards against caterpillar pests.

Pulses. Like soybean cajanus and others are self pollinated crops but yield increases by bee pollination have been observed. Considerable mortality of honeybees from insecticide poisoning is reported in some countries but lack of knowledge in India is due to non monitoring of hazards.

Cucurbits. These require the control of fruit flies pumpkin beetle and aphids when in flowering. Cover sprays of insecticides are given against these pests. Honeybees visit the flowers of melon and other cucurbits. Steps to minimize bee kill from these sprays are required.

Tobacco. In this case self pollination is normal but honeybees and other insects visit the flowers for nectar effecting some cross pollination. Aphids whiteflies thrips and caterpillars are the pests which may warrant insecticidal application during flowering which consequently would lead to bee hazards. Flowering period in coffee is short and insecticidal applications can be avoided during coffee flowering. Coffee may be attacked by bugs leaf miner and thrips during flowering. In case of outbreak during flowering the crop should be treated when bees are not active and less persistent insecticides be used.

Pome and stone fruits. Apple peach plum apricot and almond are attacked by caterpillars at blooming time. Insecticidal use has been suggested by economic entomologists against blossom thrips though economic losses by thrips have not been ascertained. The recommendations are made in ignorance of insecticidal bee hazards. Therefore caution is important so that the huge benefits from bee pollination are not reduced.

Other fruit crops. Insecticides can be applied for pest control at flowering time in citrus litchi olive grapes coconut and cocoa. Care should be taken because they are also visited by bees for floral rewards.

Symptoms and Effects of Pesticidal Poisoning

Bees come in contact with pesticidal deposits while foraging on treated crops or weeds where the chemicals are deposited by drifting. The nectar and pollen can also be contaminated with pesticides and there can be stomach toxicity to bees and also to brood when fed on contaminated pollen. Some pesticides may even cause hazards by fumigant action. After gaining entry into body different pesticides have different modes of action. Atkins has given the detail of specific symptoms caused by poisoning of different groups of pesticides but general symptoms of pesticide poisoning are

Appearance of large number of dead bees in front of the hive. Bees also die in the field and in between the field and the hive.

Bees become paralytic lose the power of orientation legs wings and digestive tract stop functioning and poisoned bees show unco ordinated movements.

Abdomen becomes distended.

Bees are irritated and become aggressive they sting heavily and guard bees are confused.

Regurgitation of gut contents can occur.

Brood chilling can occur due to reduced adult bee population.

Contaminated pollen can be collected by bees and stored as bee bread. This pollen fed to brood results into dead brood inside the colonies young emerging bees are also killed.

Sometimes the queen is also affected. Queen may stop laying eggs or lays eggs in irregular pattern there may be brood in only some of the cells of the brood area as in case of colonies suffering from foul brood disease. In colonies which survive queen may be superseded. Sometimes queenlessness may develop.

Longevity of adult bees is reduced due to sub lethal doses of pesticides.

Pesticides and their Relative Toxicity to Bees

Some remarkable studies have been conducted on relative toxicity of pesticides to Apis mellifera and Atkins has categorized the pesticides on the basis of their relative toxicity. Exhaustive reviews and summary of the results of their laboratory and field studies with large number of pesticides are very illuminating and serve as an important reference. As per their categorization the pesticides in use in India are listed in tables ahead. The list is very important in choosing the appropriate pesticide particularly when alternate choices for a pest control are available.

Some insecticides have been screened in laboratory in India for their toxicity to bees. First study in this field was carried out by Cherian and Mahadevan with DDT and Gammexane against Apis cerana indica.

Hameed allowed the worker bees of Apis mellifera to forage on cut flowers of mustard to which systemic and contact insecticides had been sprayed. On the basis of safety index Formothion Vamidothion Dimethoate and Phosalone were considered to be relatively safer to bees. Contact toxicity to Apis cerana of insecticide applied as sprays was compared with Menazon by Kapil. Taking the LC50 for Menazon as 100 the comparative values for Endosulphan Eormothion Methyl demeton Endrin Dieldrin Malathion Parathion Phosphamidon Lindane Phorate and Mevinphos were 1.17 1.18 14.00 15.70 17.79 22.25. 26.01 28.45 36.99 57.96 and 64.24 respectively. Singh tested 15 insecticides and reported that Menazon and Endosulphan were least toxic and were considered nontoxic to Apis cerana at their recommended doses. According to Thakur et al.. (1981) Fenitrothion and Fenthion were highly toxic as compared to Endosulphan and Trichlorfon and Hinosan were moderately toxic as determined by residue film method. Comparative toxicity of organophosphates chlorinated hydrocarbons and carbamates was worked out by Bai Attri also assessed the contact and oral toxicities of some insecticides. Toxicity of several organophosphates to Apis cerana was determined in the laboratory using topical application method. Determination of the kinetic parameters of the reactions by the authors showed that differences in anticholinestrase activity were due mainly to differences in affinity rather than to different chemical structure of the compounds.

Cholinestrase inhibition by insecticides in Indian honeybee was studied by Dale Bai reported that signs of poisoning in Apis cerana indica were first observable when acetylcholinestrase inhibition exceeded 35% and death occurred at 96% or more inhibition.

Reddy reported the inhibition of magnesium activated adenosine triphosphate as the criterion to determine the degree of organochlorine insecticide poisoning to Apis cerana indica. Digestive amylase and protease of Apis cerana indica were inhibited to the same level by the insecticide poisoning from different groups of insecticides. Studies on the level of ions of amino acids in the haemolymph of worker bees of Apis cerana indica treated topically showed pronounced stimulatory effect with organophosphates a relatively strong inhibitory action with chlorinated hydrocarbons and an intermediary effect with carbamate pesticides.

Bee Pasturage

Honeybees have closed links with the flora because adults and young ones live solely on nectar and pollens. Usefulness of a flora depends upon the quantity of food and energy harvested and the energy requirement of bees. Nectar is secreted by nectaries and is usually a reward for the visitors bringing about pollination. In general the quantity of nectar secreted is directly related to the pollination requirements of the crop. Honey is made by bees from the nectar collected from floral and extrafloral nectaries. Sometimes honeydew is also an important source in certain localities but the well being of bees is greatly dependant on the value of the flora. For the selection of the apiary site it is essential to know the plants which provide nectar or pollen to bees. Data on different aspects can be gathered for couple of years to establish the potentials of an area for beekeeping. Scale colony provides useful information. Weight of the scale colony is regularly recorded and the changes in weight are correlated with the flowering plants which are being visited by bees and also the weather conditions. Flowers present nectar and pollen during specific time of the day therefore bee activity on the flora should be carefully recorded. Recording the bee activity at different day hours should give useful information. Melissopalynological studies are essential to ensure as to which plants are availed by bees. Pollen analysis of honey samples taken at different time of the year and comparing with reference slides give the exact information about the floral sources for bees in vicinity. Bee flora should be studied from different angles to find out the value of bee forage though the total nectar production per flower is important. Some flowers secrete nectar only for one day and few others for short time and still there are flowers like Schefflera wallichiana which continue nectar secretion for about a fortnight. The time for which nectar plant blossoms are another important point determining the value of flora. In some forages the duration between the start and end of flowering is very short whereas in others like Brassica spp. there is a succession of flowering and it lasts for about a month. Trees present larger number of flowers as compared to bushes shrubs and crop plants unless the latter are growing in large continuous areas. Concentration of nectar sugar gives an objective measure. Total sugars per flower per day is the sugar value which is normally estimated for such studies. Sugar value is the number of mg of sugar secreted by one flower over a period of 24 hr. However total quantity of nectar produced and the amount available to or harvested by bees give valuable information.

Nectar sugar Concentration

Nectar concentration in most bee forages varies between 20 50% but may be as low as 6% in Bombax ceiba L. to 15% in pear and as high as 79% in silver oak (Grevillea robusta). Nectar and sugar concentration (%) has been worked out for some flora in India. For example Grevillea robusta had 79% sugars in the nectar 23 plants including Tecoma grandiflora had 14% peach and pear 70% Brassica juncea 52% Barberis 48% some citrus spp. 40 44% Sapindus detergens 40% Plectranthus 38% Cidrella cerata 36% Carvia callosa 35% Thelepaepale ixiocephala 35 64% Impatiens balsamina 16 25% Nephelium litchi 61 78% Plectranthus 26 54% Woodfordia floribunda 10 12% Brassica campestris var. toria 38.5 53.5% and onion 59 75.5% Gupta found that there were considerable differences in the amount of nectar sugar production in the flowers of different cultivars of cauliflower and in the attraction of bees to them. Average nectar sugar contents varied from 0.035 to 0.150 mg/flower/24 hr. On the basis of such studies honey potentials per unit area are estimated for cultivated crop/fruit plants. For wild flora the density per unit area is estimated by sampling and honey potentials of the flora in the area are worked out. Honey potentials of forage are only estimates but it serves as a useful guide. Honey potentials of forage are liable to change. This is happening fast in developing agriculture in India where changes in land use patterns have been very frequent. Under extensive agriculture vast wastelands are cleared for cultivation and this reduced the wild flora. Land may be put to urbanization or industrialization causing reduction in cultivated and wild bee flora. There are introductions and extension of cultivation of new crops like sunflower safflower and other oilseed crops and this has substantially changed the scenario with regard to beekeeping potentials. There are many agricultural practices which affect the bee flora. Mechanized agriculture reduces the weed plants which may be serving as bee forage. The use of weedicides is another agricultural practice which reduced the weed forage for bees.

The nectar yielding plants contributing to nectar/honey flow are specific to different areas and they have definite micro regional habitats. Even in rich floral areas continuous succession of nectar yielding plants throughout the year is lacking. In some localities there is single surplus honey flow and in good areas 2 surplus flows may be available. In north western hills of Himachal Pradesh and Jammu and Kashmir the lower and mid hills present spring early summer flow and in areas like Kashmir and parts of Himachal Pradesh there is rich flow from Plectranthus in autumn. Bees face protracted dearth period in winters and only subsistence flora is available in rainy season but heavy downpours are hazardous to bees. In north Indian and Gangetic plains major flora of Brassica is available from September through early February. This build up and surplus flow is followed by spring and summer surplus honey flow from Eucalyptus Dalbergia sissoo and other trees and berseem is availed by bees till May. Hard summers are also no flora availability period but some weeds and crops present subsistence forage in rainy season. In Western Ghats and South India there is medium to major flora available from October to May and important sources being jamun hirda carvi soapnut rubber plant Schefflera etc. but June to September is a dearth period. Therefore for beekeeping sub tropics may have an inactive period of 1 or 2 months. In tropics it is dry season or excessive rainfall and in hills it is winter which are troublesome to bees. Surplus flow season may vary from 1 or 2 and rarely 3 in a year.

Beekeeper to maximize his honey crop should have a thorough knowledge of the floral cycle onset of major honey flow and dearth period. The bee colonies should be managed in a way so as to have maximum foraging strength to avail major flow and economical or minimum strength in dearth period.

Nectar Composition

Nectar is a solution and total solids in nectar are mostly sugars. There are only few exceptions where lipids are present in nectar. Chromatographic studies help to know the sugars in nectar. Monosaccharides glucose fructose and disaccharide sucrose are the common sugars in nectar. In general flowers with tubular corolla secrete sucrose dominant nectar. In open flowers such as Brassica only glucose fructose and sucrose are present. Bee s preference to nectar is also governed by the sugar balance and the nectars with equal amount of glucose fructose and sucrose are preferred by bees. Minute amounts of other substances such as amino acids minerals essential oils organic acids and other components usually comprise less than 0.03% of total dry weight. Essential oils impart characteristic aroma to nectar and honey and bees are attracted by this aroma to flower nectar. Solid particles in the form of pollen grains yeast cells fungal spores and bacteria can be found in small amounts.

Attempts have been made by Indian scientists to gather information on the nectar composition of bee flora. Sucrose fructose and glucose (28 1 1) make up to 60% of the total solids of Thunbergia grandiflora nectar. They also detected small amounts of aspartic acid alanine glycine serine and valine by paper chromatography. Moringa pterigosperma Gaertn nectar contained 0.90% of reducing and 11.81% of non reducing sugars. Wakhle analysed nectars from 4 species nectar of Carvia callosa contained fructose glucose maltose raffinose and an unidentified sugar nectar of Thelepaepale ixiocephala had only fructose glucose and sucrose whereas nectars of Schefflera roxburghii and Grevillia robusta had only fructose and glucose. Only these 2 sugars were observed by Mishra in Woodfordia floribunda nectar. Soapnut (Sapindus emerginatus) nectar had 85.5% sucrose and 7.25% each glucose and fructose. Sihag analysed the nectars of 44 plants visited by Apis florea and Apis dorsata. Nectar of Tecoma stans and all 11 cruciferous plants Althea rosea Prunus persica P. domestica and Petunia alba contained glucose dominated sugars and sucrose and fructose were in very small fractions. Bahadur analysed nectar of 103 plants from 100 species and revealed that 54 plants had 3 sugars viz. sucrose (S) glucose (G) and fructose (F). In addition to these 7 plants had 4 or more sugars 6 having S+G+F+1 unknown sugar one having S+G+F+2 unknown sugars. Forty plants had 2 sugars (29 S+G 3 S+F 8 G+F) and 2 had only one each (1 G 1 S). In the nectar of these plants 24 had dominant sugar as sucrose 7 had S+G 2 had G and one had G+F and there was no plants having either S+F or F dominant sugar. Six plants had balanced S+G+F sugars 3 plants had S+G and there was no plants having G+F balanced sugars. In 90 plants amino acid was present whereas in 15 plants the amount was double than the remaining ones.

Factors Affecting Nectar Secretion

Honey flow from the same plant is not the same under varying weather soil and vegetation habitat conditions. The nectar secretion in a plant is the function of specific features of the forage and other external factors. Factors related to a plant species are age of the flowers and the cultivar or varieties. In Woodfordia floribunda Salisb the flowers continued to secrete nectar for 3 days it was maximum on second day and minimum on first day of flower opening. The differences in nectar secretion have also been found in many plant species and differences with age of the flowers and cultivars have been reported in peach and cauliflower in India. Nectar secretion in flowers after opening is expected to be correlated with the degree of receptiblity of the stigma. Fertilization in flowers is also known to activate a feed back mechanism to switch off nectar secretion. After certain period of flower opening there is reduction in amount of nectar sugars. This happens because of reabsorption of nectar. Reabsorption only of nectar sugars takes place and not of water. Therefore the reabsorption at the end of nectar secretion leads to lowered nectar sugar concentration. The total amount of nectar secretion over a period by a flower is more when it is periodically removed than in case of its non removal by insects. Besides these growth regulators have also been found to affect nectar volume and nectar sugars. The effect of GA3 was more pronounced in mustard and cauliflower than with other growth regulators.

Sunlight and temperature. Sunlight has a direct bearing on photosynthesis. Photosynthesis produces carbohydrates which are secreted in nectar. Effect of sunlight and consequently of photosynthesis may not be immediate because stored carbohydrates do make good but ultimate effect is there. Temperature has direct relationship with nectar secretion. For every plant species there is a specific threshold temperature at which the nectar secretion is started and it increases when the temperature is optimum. This is the range of temperature at which enzymes responsible for nectar secretion are activated. On the other hand very high air temperature may result into water stress in plants and the waste stress causes more water loss than the uptake. The imbalance results into lowered nectar secretion through reduced sugar transport in the conducting tissues.

Relative humidity. Nectar is hygroscopic in nature and for this reason atmospheric humidity is inversely linked to nectar sugar concentration. After secretion nectar sugar concentration changes and attains equilibrium with the moisture in the air. Water is always lost from nectar unless the relative humidity is near 100%. High relative humidity causing reduction in sugar concentration can affect the attractiveness of the source to bees. Conversely higher sugar concentration at lower relative humidity can affect the nectar column in the tubular flowers and bees may be unable to reach and imbibe the nectar. Water loss in the plant is also a function of relative humidity as also of air temperature.

Soil. Optimum soil moisture is essential for good plant growth. With soil water as a limiting factor the number of flowers is reduced and nectar secretion is also adversely affected. Balanced nutrient level in soil which supports good plant growth also favours nectar production. Phosphorus and potassium increase nectar production but high level of phosphorus reduces it. A balance between the 2 elements should be beneficial. Excessive application of nitrogen causes abnormal vegetative growth and comparatively lesser number of flowers are produced. Some of the bee forages have been briefly discussed in this chapter.

Bee Flora of India

Avenue Amenity and Timber Tree

Eucalyptus spp. (Fam. Myrtaceae). These are evergreen trees and are indigenous to Australia. In Australia most species are bushes and shrubs but fortunately in India Eucalyptus spp. attain gigantic size. Different species and even varieties flower during different parts of the year but main bloom is available in spring. Eucalyptus plantations have expanded very fast on road sides canals even waste lands and thus presenting vast potentials to bees. Honey is light amber coloured and granulation is fairly quick.

Hirad (Terminialia chebula Retz Fam. Combretaceae). Hirad is distributed in the Western Ghats and in submountainous regions. The fruits have medicinal value and also a source of dyes and tannins. It is a major flora in beekeeping areas of Maharashtra. It flowers in April to June. Hirad honey is composed of 17% water 35% glucose 40 41% fructose sucrose maltose melezitose ash and it also contains calcium phosphorus iron magnesium sodium potassium and silicon. Tartaric citric malic succinic acids are also present. Honey is light yellow coloured granulation is slow and has characteristic pungent aroma and tastes akin to fruit tannins. Terminalia arjuna (Rob.) Wight and Arn. has been widely planted in forests and as avenue plantation. It is also a nectar and pollen source but details of value as bee forage have not been worked out. T. bellerica (Gaertn.) Roxb. has also both nectar and pollen forage but no data on nectar and honey is available.

Jamun (Syzygium cumini Skeels Fam. Myrtaceae). Jamun is widely planted avenue cum fruit tree and naturalized as forests in many parts of India. It is a predominant flora of Western Ghats. It is reported to be a major flora in Bihar Maharashtra Punjab Tamil Nadu and Uttar Pradesh. Its flowers are dirty white and bloom in April May. The honey flow extends over a period of 2 or 3 weeks. Nectar sugar concentration is very high up to 72% but may be as low as 9%. Jamun is also a pollen source. Chemical composition of honey has been given by Narayana. Fructose is high (43.30%) and glucose is 32.26% sucrose maltose reffinose and melezitose are present in jamun honey. Protein (0.656%) dextrin (1.55%) ash (0.182%) and riboflavin ascorbic acid thiamine and niacin are also present in honey. It is light reddish brown and has characteristic taste of jamun fruit. The honey does not granulate for years.

Karanj (Pongamia pinnata (L. Pierre) Fam. Leguminosae). Karanj grows well in humid tropical area. P. glabra is grown as avenue and shade tree in drier climate. Leaves are used as fodder. It blooms in April May and both nectar and pollen are availed from karanj. Data on nectar production honey characteristics and honey potentials are not available but it is considered to be good flora by the beekeepers.

Moulsari (Mimusops elegni L. Fam. Sapotaceae). Moulsari is evergreen tree with whitish flowers. It has good nectar flow in May June in Bihar and also in Uttar Pradesh. Bees also collect pollen from this flora. No information on nectar and honey from moulsari is available.

Phalsa (Grewia asiatica L. Fam. Tiliaceae). Phalsa shrub is grown for its fruits. It blooms from April to August and yields nectar to bees. The extent of its cultivation is less. G. oppositifolia Roxb. is a medium sized tree which is planted for lopping its foliage for fodder for its best fibre for ropes and for timber. It blooms in April May and is a nectar source to bees. These species of Grewia are only minor sources.

Rubber (Hevea brasiliensis Muell. Arg. Fam. Euphorbiaceae). Rubber plant is deciduous tree with male and female flowers on the same inflorescence. Nectar is available to bees only from the extra floral nectaries at the base of young buds. The nectar flow is there for about 2 weeks when leaves are young. Rubber is a major flora in Kerala where large plantations are grown. Honey potential is estimated to be 3 kg per tree. Rubber honey is clear straw coloured.

Schefflera wallichina Harms. (Fam. Araliaceae). It grows as a strangler or small tree in forests or cardamom estates of Coorg area of Karnataka. Schefflera blooms in April June and is a rich nectar source. Most honey in Coorg is obtained from this source. Pollen availability to bees is very low.

Shisham (Dalbergia sissoo DC. Fam. Leguminosae). Shisham s habitat is very varied from lower hills to dry plains normally planted on banks of canals or roadside as shade tree. This is a source of valuable timber especially for furniture. Pale yellowish flowers are put forth in April. Corolla is tubular but narrow tube has nectar well up to the reach of bees. Wind blows flower from branches and nectar availability is adversely affected. It is a major nectar source for bees in many states especially Himachal Pradesh. Punjab Haryana and Uttar Pradesh. Shisham honey is dark amber with moisture 18.75% glucose 34.6% fructose 39.1% sucrose 1.04% and ash 0.18%. Honey flavour is strong and not attractive.

Silver oak (Grevillea robusta A. Cunn. ex R. Br Fam. Proteaceae). Silver oak is planted in coffee plantations and also as shade and avenue tree. It profusely flowers and is an important nectar source and nectar secretion is abundant with 17 79% nectar concentration. Honey is reddish black with prominent flavour and it granulates rapidly.

Soapnut (Sapindus spp. Fam. Spindanceae). Soapnut is an avenue and forest tree fruits are used as substitute to soap. S. emerginatus Vahl is a species found in Andhra Pradesh Karnataka Orissa and Tamil Nadu. The species flowers in October December. It gives 20 25% of total honey yield in some parts of Andhra Pradesh. S. emerginatus nectar has 85.5% sucrose and 7.25% glucose and fructose.

Tamarind (Tamarindus indica L. Fam. Leguminosae). Tamarind is a large evergeen shade tree cultivated in many parts of India for pods which are used in curries. The tree has many other uses like fuel timber etc. It blooms in April July and is a good nectar and minor pollen source in South India. Honey is rich golden and has sour flavour.

Toon (Toona ciliata M. Roem. Fam. Meliaceae). Toon grows as timber and avenue tree in lower hills and

plains of northern India especially in moist soil. It is also lopped for fodder but is not to the liking of cattle. Toon is a major nectar source in Himachal Pradesh Kashmir Punjab and Uttar Pradesh. It is a minor source of pollen. Large number of trees has recently been cut and floral source has declined. Nectar sugar concentration varies from 26 to 72% in freshly opened to 48 hr old flowers. Average nectar sugar value is 2.38 mg/flower/day and nectar is secreted for 4 days. Honey is light amber in colour with pronounced flavour. Normally its honey is mixed with Dalbergia sissoo honey and is obtained in May.
Whayati (Thelepeaple ixiocephala (Benth.) Bremk Fam. Acanthaceae). Whayati is a tree of moist forests of Western Ghats of Maharashtra and Karnataka. Whayati flowers after every 8 years. It blooms in November January and is a major nectar source. Sugar concentration of nectar is 35 46%. Honey contains 38% glucose and 39% fructose sucrose maltose raffinose and melezitose are present. Sodium potassium calcium magnesium iron phosphorus and silicon are contained in whayati honey. It is light yellow and granules rapidly but granulation is uniform.
There are many other avenue and forest trees which are good source of nectar and pollen but their number is small and at best serve as subsistence sources. These trees are bottle brush (Callistemon lanceolatus DC.) pride of India (Lagerstroemia indica L.) drum stick (Moringa oleifera Lam.) Indian laburnum (Cassia spp.) puna (Ehretia acuminata B.) siris (Albizzia spp.) willows (Salyx spp.) and chestnuts (Aesculus sp. Castanea sp.)

Fruits

Banana (Musa spp. Fam. Musaceae). Perennial herb stem formed by leaf petioles. Flowers are large and monoecious. Musa spp. flowers throughout the year and is a medium to good source of nectar which has 25 30% sugar concentration. Banana flowers are also visited by bees for pollen which is in abundance. Banana plantations are common in many states of India.
Cashew (Anacardium occidentale L. Fam. Anacardiaceae). Cashew is cultivated in South India. It is an evergreen tree flowers pink small and fragrant. Devadason has advocated migratory beekeeping to avail cashew flow. It is also a pollen source value of the flora and honey characteristics are not known.
Citrus spp. (Fam. Rutaceae). These are C. aurantifolia (Christm) Swingle C. grandis (L.) Osbeck C. limon (L.) Burm. C. paradisi Macfad. C. reticulata Blanco and C. sinensis (L.) Osb. These citrus species flower during February March. Nectar production and nectar sugar concentration is medium. Citrus spp. also serve as pollen source. Citrus honey has delicate flavour. In India Citrus mostly serves as a build up flora and surplus is not extracted anywhere though large areas are under citrus and it is widely distributed.
Coconut (Cocos nucifera L. Fam. Palmae). It is grown in coastal regions. Flowers are small monoecious both male and female flowers have nectaries. It blooms in May June and bees collect abundant pollen from staminate flowers in spathes.
Jujube (Ziziphus mauritiana Lam. Fam. Rhamnaceae). Indian jujube is cultivated in tropical parts of India advantageously below 600 M.S.L. It tolerates severe heat and is drought resistant. It flowers during July to October and flowering is very protracted. The flora gives surplus honey when the colonies are strong but bees get nectar source when there is no other flora. Some pollen is also availed and therefore it is very useful forage for bees. The jujube honey is yellow brown with very sweet flavour.
Litchi (Litchi chinensis Sonner Fam. Sapindaceae). Litchi has become very popular in sub mountainous regions for expensive fruits. It blooms in March and is a rich source of nectar to bees. Sugar concentration of nectar is high. Juice from damaged fruits is also availed by bees. Litchi honey is light golden coloured with very pleasing aroma.
Pome and stone fruits. Apple pear plum peach apricot cherry almond and their closely allied wild species are included in this category. They flower from February to April and bees gather both nectar and pollen. These fruit trees have local importance and have good build up sources before surplus honey flow

season. Pear nectar is very low in sugar concentration. Therefore it is normally avoided in favour of other competing flora. Surplus honey is not gathered from these cultivated fruit trees. But wild cherry Prunus puddum Roxb. flowers in October to November when no other flora is available in mid and lower hills of Himachal Pradesh. On an average a flower secretes 35ml nectar for 4 days with 3.47 mg nectar sugar per flower. Nectar sugar concentration varies from 12 to 18%. Chromatographic separation revealed glucose fructose sucrose and one unidentified sugar in the ratio of 39.6 40.7 12.3 and 7.5.

Queen Rearing and Artificial Queen Bee Insemination

Drones which are reared from the unfertilized eggs are haploid and carry the genomes of their mother. The males and queen contribute to the heredity of the offspring workers. Under natural conditions a beekeeper cannot exercise control on parentage and drones from the vicinity can take part in fertilizing a queen. But good queens can be reared from better performing colonies so that the hereditary characters contributed by the mother can be improved to a greater extent. In an apiary many queens may be required for requeening and colony divisions. Therefore mass queen rearing is discussed here.

Selection of Mother Stock

Requeening of some or all the colonies in an apiary becomes a feature of annual management. With some additional effort an element of multiplying a better stock can be introduced. All the colonies in an apiary are not equally superior performers. Beekeeper is concerned with higher honey production but honey production is directly correlated with amount of brood rearing as also the queen s egg laying capacity industriousness of workers swarming and absconding tendency frugal behaviour and disease resistance. Apiary records for these attributes are essential to select the best colonies for queen rearing. In the absence of records for all these attributes only the honey yield records of colonies can serve an important criterion for selecting colonies for mass queen rearing. Superior colonies can also be induced to rear drones. Though the mating with these drones cannot be assured yet the chances can be increased by making these colonies to rear more drones.

Biological Basis of Queen Rearing

Queen bee lays fertilized as well as unfertilized eggs. Both the workers and the queen develop from fertilized eggs. A larva from a fertilized egg can be reared into a worker or a queen. There seems to be no or very little genetic bias in caste determination. Worker and queen larvae are fed on glandular food for the first 2 or 3 days and there is hardly much difference in the quality of food of the 2 castes. Moreover supply of food is more than the requirement. At about the age of three days there is a shift in food to worker larva whereas queen larva continues to get the nutritious glandular secretion food. Honey and pollen is mixed in the food of worker larva and also the feeding is progressive or in other words the developing larva is starved to some extent.

Larvae from fertilized egg is plastic for caste determination up to the age of 72 hr but the queens reared from larvae older than 72 hr may develop into intercastes. Diet is the major caste determining factor. Though the better food is responsible for higher JH titre in queen larvae which consequently affects the development of reproductive organs. Feeding of stored royal jelly is also not a perfect food for queen rearing which indicates that the royal jelly has some labile fraction.

A colony rears queens only when certain favourable conditions are available. The bee colony must be crowded so that the bees feel the necessity of rearing queens under swarming impulse. This condition can be altered in case of queenlessness where the influence of queen or queen cell building and queen rearing is removed. For feeding queen larvae large number of young nurse bees are required because worker bees of the age of 6 to 12/13 days have well developed and active food glands. Food glands of worker bees remain actively secretory if they get a continuous supply of pollen. Therefore continuous income of pollen and nectar also creates favourable conditions for queen rearing. The queen rearing is possible if these prerequisites are naturally available or are artificially created by manipulations.

Methods of Queen Rearing

Queen rearing is inhibited by pheromone secreted by the mandibular glands of the queen and spread over the queen s body to be licked by the workers. Certain level of this pheromone would be required to suppress the queen rearing urge. The level of the queen pheromone available to the workers may be reduced when the colony population is very high. Such overcrowded and populous colonies rear queen cells under swarming instinct. The reduced amount of queen pheromone is available to the workers in a colony when the queen is old and is exhausting. The bees feel the necessity of superseding the old failing queen and queen cells are raised on the face of the comb but are fewer in number. The queen can be reared from the eggs or the larvae. Failing queen herself lays eggs in the supersedual cells raised by the workers. In case of sudden loss of queen the queen cells are built under emergency impulse and these queens are reared from worker cells with larvae of certain age. Therefore they are built on the face of the comb and the queens vary in development stages.

Queen rearing is triggered off when any of the above 3 conditions are available or artificially created. When few queens are required a beekeeper can remove the queen from a colony and few emergency queens are raised by the bees. Modified swarm box method used for swarm control can be profitably used without removing the queen. As discussed under Damree method of swarm prevention the queen with a brood comb honey and pollen comb and remaining frames with empty combs or comb foundation is restricted to the lower chamber. All other frames with sealed and unsealed brood are kept in upper chamber with a queen excluder in between the two. The second super if already there can be placed in between the 2 chambers. Few queen cells are built above the queen excluder and the sealed queen cells can be carefully removed from the base and the emerging queens can be used.

Alley developed a queen rearing method where the comb with young larvae is cut into small strips. Larvae in alternate cells are destroyed so that enough space is available for raising queen cells. The cells of desired larvae are shaved off and the pieces of comb are attached to the bar on comb so that the desired larvae hang with their openings facing downwards.

In Miller method 2 or 3 in wide strips of foundation with V shaped top are attached to the top bar of a frame. This prepared frame with many strips with space in between is given in the brood nest. Comb is built on these foundation strips and queen lays eggs. When this is achieved the cells of desired larvae are shaved off and the frame is transferred to cell builder colony prepared few hours earlier. The cell builder is a queenless colony with sufficient young nurse bees. Combs with young brood should preferably be removed with the queen so that the queens are reared only from the brood in prepared frame from breeder colony.

Doolittle or grafting method is most commonly used for mass queen rearing. This method requires the grafting of young larvae in queen cell cups. The cups can be plastic or made from pure bees wax with inside diameter of 8 12 mm for Apis mellifera and 6 9 mm for Apis cerana indica. Single forming stick can be used for preparing queen cups when only few queens are to be raised. For preparing large number of cups the single forming stick is not practicable and multiple forming sticks are useful. The multiple forming stick is a bar made by attaching 10 15 cell forming sticks of same length to a thick strip of wood with a spacing of about 2.5 cm from centre to centre. Wax is melted in a tray on thermostatically controlled hot plate or in a water jacketed tray. The wax for attaching the cups to the bars is melted just above the melting point. The cell bar is laid over the pan of wax for attaching the cell cups to bars. Wax is put over the upper surface and the sticks with the cell cups are rested on the bar and more wax is put along the sides and between the cups. The sticks are held in position till the wax has cooled. The forming sticks are then lifted off by putting an even pressure on the ends of the bar. A strong well fed and superior performing colony is selected for obtaining larvae for grafting. The bees are shaken off and the frame containing sufficient young larvae is taken to grafting room. A temperature of 24ºC and relative humidity of about 50% is suitable. Grafting in the open may lead to drying and desiccation of grafted larvae if the temperature and humidity conditions are not closer to the requirements and the larvae get chilled if the atmospheric temperature is low. A bright lamp is placed so that light shines directly on the bottom of the comb cells when the comb containing the larvae to be transferred is little tilted towards the operator.

For grafting a grafting needle with flat upward bent is used. For more extensive queen rearing the use of automatic grafting needle is advisable. Automatic grafting needle has retractable tongue which is extended about 1.5 mm before it is slipped side ways under the larva. This grafting tool also transfers sufficient royal jelly along with the larva and is very successful in dry grafting. While placing the larva at the base of the queen cell cup the level of the grafting needle is released so that the tongue retracts back and larva is left on the base of the cup. Less experienced operator may need priming of cell cups with royal jelly to achieve better results.

Queen cell builders. There are several methods for starting the queen cells but swarm box is a common method. Little before the newly grafted queen cells are given the box is stocked with 2.5 kg of bees taken from active brood nest. Two pollen combs are given on either side of the frame with grafts. Combs with stored honey are given to the cell starter and continuous supply of sugar syrup is useful. A useful modification of this queenless swarm box is profitably used. The modified swarm box is a cell starter in which the bees are confined above the two storey colony for 24 36 hr while cells are being started. Queen is confined beneath the excluder in the bottom body with sealed brood and empty combs and combs with young brood are moved to the upper body. A full depth body is prepared by putting 2 pollen combs 2 or 3 combs with honey stores and division feeder full of sugar syrup. The frame with grafted cell cups is placed in between the 2 combs with pollen stores. All the young bees from above the queen excluder that is second hive body is shaken off in the prepared starter body below which a 8 mesh hardware screen is fastened. The combs with young brood are returned to the second hive body. The bees cannot move from the second to the third hive body and bees are confined there for 24 36 hr by which time the cells are drawn and queen larvae are being reared. The screen is then removed and the hive is reduced to 2 body with an excluder in between the two. The cells are sealed and removed a day before emergence and put in incubator for emergence.

Cell builder colonies can be repeatedly used for starting the cells. The cells once started can be given to cell finisher colonies for completion. The cell finisher colony can be a strong 2 storey queen right colony. Queen is confined to the lower body by an excluder and cells are completed in the upper body.

Double grafting is also practised to ensure good quality queens. In double grafting the first grafts are removed after the cells have been started and second graft is given in the same cell cup. This is to avoid starving of the graft and the second graft will get food supply immediately.

Artificial Mating

Artificial queen bee insemination technique is now available and mating in the open can be bypassed. There are distinct advantages of the technique. By artificial queen bee insemination method the parentage can be controlled. The virgin queens can be inseminated with the semen from desired drones and hence the technique is the only method for bee breeding but for commercial beekeeping the artificially inseminated queens are less suitable. The queen insemination can be possible at any time of the day and even in bad weather. But the disadvantage is that the operator should be experienced to achieve high success. Success of instrumental insemination also depends on the simplicity and reliability of insemination apparatus. Mackensen and Roberts were the first to develop it in 1948 which met these requirements. During the same year. Laidlaw also developed artificial insemination equipment. Mackensen and Roberts apparatus is more widely used because of its simple construction and easy handling. Several improvements have since been made in this apparatus.

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