E-BOOK

Promoting Scientific Beekeeping For Livelihood Security

2024

Edited By

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This e-book is a compilation of resource texts obtained from various subject experts for the Collaborative Online Training Programme of Amity Centre for Extension Services, Amity University, Noida, Uttar Pradesh & MANAGE, Hyderabad, Telangana on "Promoting Scientific Beekeeping for Livelihood Security". This e-book is designed to educate extension workers, students, academicians, beekeepers and entrepreneurs about best beekeeping practices. Neither the publisher nor the contributors, authors and editors assume any liability for any damage or injury to persons or property from any use of methods, instructions, or ideas contained in the e-book. No part of this publication may be reproduced or transmitted without prior permission of the publisher/editor/authors. Publisher and editors do not give warranty for any error or omissions regarding the materials in this e-book.

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29 August 2024

MESSAGE

Beekeeping has been in practice from an ancient time in India. It is one of the potential sectors to generate the employment and increase the farmers' income in India. Beekeeping is landless and marginalized based farming provides the economic, nutritional and ecological benefits. Honey bees are the best pollinating agents which help in increasing the yield of several crops. Bees are mainly reared for their honey. Besides that, we also obtain beeswax through beekeeping. Honey is an important ingredient in many food dishes, beeswax holds a lot of commercial significance too. It is used in the cosmetic and medical industry, as well as a coating for cheese and as a food additive. It is also used as the main component for making candles, preparing polishes for the shoe, furniture, etc.

Prime Minister Narendra Modi launched the Sweet Revolution in 2016 with the goal of doubling farmers' income by 2024. In 2019-2020, the Ministry of Agriculture and Farmers Welfare, Govt. of India launched the National Beekeeping and Honey Mission (NBHM) to help achieve the Sweet Revolution's goals. The NBHM is a centrally funded scheme that focuses on capacity building, training and input support for promotion and production. ICAR research institutes, SAUs and other organizations/centres focuses on developing best practices technologies on beekeeping for the benefit of farmers, taking these scientific practices to the doorstep of farmers is very important and challenging task.

In this context, a 3 days collaborative online training on ***'Promoting Scientific Beekeeping for Livelihood Security'*** was organized by the Amity University Uttar Pradesh, Noida with MANAGE, Hyderabad during 29-31 July 2024. More than 300 participants were participated from different states and got enriched their knowledge about significance and best practices of scientific beekeeping.

I am glad that the organizers have taken initiative to bring out e-publication on ***'Promoting Scientific Beekeeping for Livelihood Security'***. This publication will surely help the extension system, teaching faculties, beekeepers / entrepreneurs, students and young people. The Program Directors namely Prof. Lakhan Singh, Advisor, ACES, Amity University, Noida and Dr. Shahaji Phand, Deputy Director, MANAGE, Hyderabad deserve appreciation for their efforts in publishing this document.

(Nutan Kaushik)

डॉ. शहाजी फंड
उप निदेशक
कृषि-संबन्धित क्षेत्रों में विस्तार केंद्र तथा
प्रधान समन्वयक - एसी एवं एबीसी योजना

Dr. Shahaji Phand
Deputy Director
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MESSAGE

National Institute of Agricultural Extension Management (MANAGE), Hyderabad is an autonomous organization under the Ministry of Agriculture & Farmers Welfare, Government of India. The policies of liberalization and globalization of the economy and the level of agricultural technology becoming more sophisticated and complex, calls for major initiatives towards reorientation and modernization of the agricultural extension system. Effective ways of managing the extension system needed to be evolved and extension organizations enabled to transform the existing setup through professional guidance and training of critical manpower. MANAGE is the response to this imperative need. Agricultural extension to be effective, demands sound technological knowledge from the extension functionaries.

Scientific beekeeping is a traditional practice that offers long-term security for communities, promoting environmental stewardship and food security. By integrating modern techniques with traditional knowledge, beekeepers can optimize honey production, improve bee health, and ensure the sustainability of the environment. This approach is crucial in the face of challenges like climate change, declining bee populations, and increasing demand for natural products. Promoting scientific beekeeping can provide economic empowerment, food security, environmental conservation, and community development. Bees play a critical role in pollination, contributing to global food security. Scientific beekeeping fosters a deep connection between humans and nature, promoting biodiversity and ecosystem resilience. To promote scientific beekeeping, it is essential to invest in training, research, and outreach programs, and strengthen partnerships with governments, NGOs, and the private sector, to create enabling environments for beekeepers.

This e-book covers an array of subjects, Promoting Scientific Beekeeping for Livelihood Security. I want to extend my appreciation to, team of AMITY University & EAAS Centre, MANAGE, Hyderabad for the tremendous effort in compiling this e-book. I also thank the authors, editors, and designers who have contributed to this e-book creation.

Dr. Shahaji Phand

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PREFACE

Apiculture has huge potential for creating healthy life and higher crops production. About 75 percent of the world's crops are dependent on it for pollination. Honey and other products have medicinal values and the role of bees as pollinators makes them crucial for food supplies. Since, it can be practiced with limited resources and locally available materials, beekeeping provides a source of regular income for those living in severe poverty, helping to improve the resilience and livelihoods of rural and village communities. There is a need to promote actions that government, the private sectors, farmers' organizations and people can take to protect bees and other pollinators and their habitats, promote their diversity and promote sustainable beekeeping practices. There is an urgent demand to build-up the capacity of young people towards scientific beekeeping and convey the message that investing in youth-led beekeeping initiatives accelerates innovation, creativity and technological advancement that can help address the emerging challenges facing small pollinators, including extreme weather events, the use of pesticides in agriculture and the spread of pests. Hence, there is a need to value the Honey Bees and protect them for our survival.

In this context, a 3-day training on *'Promoting Scientific Beekeeping for Livelihood Security'* covered all the chapters, which were submitted by well experienced resource persons/successful entrepreneurs. Based on their deliberations, as an output e-book is brought out.

We got inspiration with blessings of Dr Ashok K. Chauhan, Hon'ble Founder President of Amity Education Group at different platforms to deliver quality with excel. We are indebted for his concern and action to make the India super power. We express our sincere gratitude to Dr Balvinder Shukla, Vice Chancellor, Amity University Uttar Pradesh, Noida; Dr P. Chandra Shekara, Director General, MANAGE, Hyderabad; and Dr W. Selvamurthy, President-ASTIF & Chancellor, Amity University, Chhattisgarh for their kind support and guidance towards organizing this collaborative training. Dr Nutan Kaushik, Director General, AFAF, Amity University, Noida deserves appreciation for her encouragement. We also acknowledge the valuable help received from accounts section of the Amity University, Noida and MANAGE, Hyderabad. We appreciate the support and help of Dr Neetu Singh, Mrs Bhagwati Joshi, Mr Ankur Nawani and Mr Roshan Lal for facilitating the program. Whole hearted thanks are extended to all the resource persons and contributors for submitting their chapters well in time.

We hope this publication will inspire beekeepers, young people, extension functionaries, policymakers, researchers and other stakeholders to promote scientific beekeeping for livelihood security.

Editors
Lakhan Singh
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Opening Remarks and Outcome

A 3 days Online Training on '**Promoting Scientific Beekeeping for Livelihood Security**' which was jointly organized by MANAGE, Hyderabad and Amity Centre for Extension Services, Amity University Uttar Pradesh, Noida during 29 – 31 July 2024. The training was inaugurated by Hon'ble Chief Guest, Dr Balvinder Shukla, Vice Chancellor, Amity University Uttar Pradesh, Noida on 29 July 2024.

At this occasion, Dr Naveen Kumar Patle, Additional Commissioner (Horticulture), Ministry of Agriculture & Farmers Welfare, Govt. of India; Dr Nutan Kaushik, Director General, Amity Food and Agriculture Foundation, Amity University Uttar Pradesh, Noida; Dr S.P. Singh (Retd. IFS), Domain Head (Natural Resources & Environmental Sciences) and Former Chief Conservator of Forests, Assam; Shri Bipin Jagtap, Deputy CEO (Industries), KVIB, Mumbai; and Dr Shahaji Phand, Deputy Director, MANAGE, Hyderabad were the Guests of Honour. During valedictory session, Dr S.S. Singh, Director Extension Education, Rani Lakshmi Bai Central Agricultural University, Jhansi and Ex-Director, ICAR-ATARI, Kolkata was the Chief Guest. Dr. Shantanu Kumar Dubey, Director, ICAR-ATARI, Kanpur; Dr. P.K. Singh, Director Extension Education, SVPUAT, Meerut; and Dr Shahaji Phand, Deputy Director and Dr Sushrirekha Das, MANAGE Fellow from MANAGE, Hyderabad were the Guests of Honour at this occasion. Dr Lakhan Singh, Professor & Advisor, Amity University, Noida welcomed the participants and made opening remarks.

In this training, 14 lectures were delivered by renowned experts in the field of beekeeping. Resource persons were invited from AICRP on Honey Bee & Pollinators, ICAR-IARI, New Delhi; 3 Experts from CBRTI, Pune; RLBCAU, Jhansi; PAU, Ludhiana; KVK Baramati; KVK, Palghar; KVK, Kolhapur; MANAGE, Hyderabad; Amity University Uttar Pradesh, Noida; and two successful Entrepreneurs/Beekeepers from Hyderabad (Telangana) and Latur (Maharashtra). In total 345 participants got registered in this virtual training.

As an output / outcome of the training, the following major points were emerged during deliberations are given below:

Outcome of the Training

- To ensure food security and nutritional security with healthy life, scientific beekeeping may be integrated with farming for livelihood security.
- Institutional arrangement for capacity building of farmers for scientific beekeeping is essentially required.
- Essential bee management practices including hive maintenance, seasonal management and best practices for healthy colonies should be popularized. Use of equipments in beekeeping should be increased.
- Scientific beekeeping trainings on quality honey production including regular periodic colony inspection report, comb renewal, selection of brood less, sealed comb for honey extraction, extraction of honey in covered and closed room, honey collection in SS container with air tight cover or lid etc. as per BIS standards may be organized.

- Quality testing of extracted honey to decide the needful processing steps including preheating, pre-filtration, processing to kill yeast cells, moisture reduction, micro filtration, cooling and settling, bottling, labelling and packaging should be done.
- Proper quality testing and its authentic report should be obtained from recognized laboratory for every batch, type or sources for geographical and botanical origin.
- Encouraging the production of value-added products like royal jelly, beeswax and propolis to increase income is needed.
- Quality Certification: Initiatives to standardize honey quality and certify products to boost consumer confidence and export potential.
- "Brand" and Specific benefits of honey should be publicized widely for promotion and consumption of honey.
- Research on bee pest and diseases should be continued and latest knowledge on beekeeping should be shared among beekeepers and other stakeholders.
- Establishment of Cooperatives, Associations and FPOs is needed to improve market access and reduce dependency on middlemen.
- Public-Private Partnerships: Encouraging collaborations between government, private sectors and NGOs to support the beekeeping ecosystem.
- Providing easy access to credit and insurance schemes to mitigate risks associated with beekeeping.
- Benefits of subsidy under different schemes should be used by the beekeepers. Every village should be converted in to *Honeybee Village* for increasing crop production and creating livelihood options.
- Collect 25 per cent of incoming pollen by installing pollen trap on *Apis mellifera* colonies without reducing colony productivity.
- Install bee venom collector for 60 min at 8 or more bee-frames strength *Apis mellifera* colonies at weekly interval for bee venom collection.
- For mass queen bee rearing graft less than 24 hour age larvae from breeder colony into queen cells cups @ 30 cell cups per colony and provide them into a strong queen less cell builder colony.
- Extract royal jelly from queen cell cups 72 hours after grafting 90 queen cell cups per queen less cell builder colony.
- Extract beeswax using hot water/submerged sac/solar wax extractor method and remove impurities adhering to lower surface of the beeswax cake.
- Harnessing the potential of digital platform in promoting scientific beekeeping.
- Successful Case Studies of Beekeepers should be documented and shared on large scale. Some of the Beekeepers may convert into Master Trainers for educating different stakeholders.

Editors

Chapter-1

Beekeeping for Agricultural Sustainability and Livelihood

Milind D. Joshi, Dheeraj A. Shinde and Alpesh H. Wagh
Agricultural Development Trust's Krishi Vigyan Kendra, Baramati, Pune.

Introduction

Beekeeping has been in practice from an ancient time in India. It is one of the potential sectors to generate the employment and increase the income for the people in India. Beekeeping is landless and marginalized based farming provides the economic, nutritional and ecological benefits. The symbiotic relationship between honey bees and the environment underscores the potential of beekeeping as a sustainable practice. Bees as pollinators, play a crucial role in ecosystem health and biodiversity conservation. Their pollination services are essential for the reproduction of numerous plant species, including many crops that constitute the backbone of agricultural economies. Beekeeping can diversify income sources, reducing dependence on single crops and enhancing household resilience to economic shocks. The aim of this paper is to explore the multifaceted role of apiculture as a tool for sustainable rural development. In conclusion, apiculture holds immense promise as a tool for sustainable rural development, offering a pathway towards economic prosperity, social inclusion and environmental stewardship. By harnessing the synergies between bees, biodiversity and community development, beekeeping has the potential to transform rural landscapes and livelihoods. However, realizing this potential requires concerted efforts to address the challenges and barriers that hinder the widespread adoption of beekeeping practices. Through collaborative action and integrated approaches, it can unlock the transformative power of apiculture and build resilient, vibrant and sustainable rural communities for generations to come. Beekeeping produces a number of quite different outcomes.

- Pollination of flowering plants both wild and cultivated, is vital for continued life on earth. However, this essential process is difficult to quantify.
- People everywhere like honey, the best-known beekeeping product. Honey is a traditional medicine or food in most societies. Whether sold fresh at village level or in sophisticated packaging, honey generates income and can create livelihoods for several sectors within a society.
- Beeswax is a valuable product of beekeeping and much of the world's supply comes from developing countries.
- Beekeeping products such as pollen, propolis and royal jelly can be harvested and marketed, although special techniques and equipment are needed for some of these products.
- Beekeepers and other community members can create assets by using honey, beeswax, and other products to make secondary products such as candles, skin ointments and beer. Secondary product brings a far better return for the producer than selling the raw commodity. This work strengthens people's livelihoods.
- Products of beekeeping are used for apitherapy in many societies.

- Honey, beeswax and products made from them such as candles, wine and food items, have cultural value in many societies and may be used in rituals for births, marriages, funerals, and religious celebrations.
- Beekeepers are generally respected for their craft. Bees and beekeeping have a wholesome reputation. Images of bees are used as symbols of hard work and industry, often by banks and financial institution

Current development of beekeeping sector, revenue growth and employment opportunities: According to the Beekeeping Development Committee, the honey production in India in 2017-2018 was 1.05 lakh metric tonnes (MTs) compared with the production of 35,000 metric tonnes (MTs) of honey in 2005-2006. In 2005-2006 India had 8 lakh bee colonies which now increased to 35 lakh colonies. In January 2019, number of beekeepers, beekeeping companies and honey societies increased to 9091. The export rate of honey by India is now 207 per cent higher. The Indian Government plans to establish an Integrated Beekeeping Development Centre in the 16 states, these are -- Andhra Pradesh, Tamil Nadu, Jammu and Kashmir, Haryana, Uttarakhand, Himachal Pradesh, Delhi, Punjab, Uttar Pradesh, Madhya Pradesh, Bihar, Manipur, West Bengal, Tripura, and Karnataka (Marar, 2019). Significantly, the production rates improved through the fertilisation of honey bees on plantations (Verma et al., 2018). Agricultural Experts claim that the yield obtained after pollination is 15 to 20 times more than the profits generated by hive products (Marar, 2019). According to the Indian government's survey, the large-scale beekeeping sector jobs are expected to produce three lakh man-working days through the establishment of 10000 colonies (Singh *et al*., 2016, Marar, 2019).

Pollination

Pollination means the transfer of pollen from the male part of the flower, the anthers to the receptive female part, the stigma.

Types of Pollination

- Self-pollination
- Cross pollination

Importance of Pollination

- Pollination is a pre-requisite to the fertilization.
- Some fruit trees may carry thousands of flowers, but unless there is adequate pollination, little if any fruit will be produced.
- No pollinator = No pollination = No Fertilization = No Fruit and Seed formation.
- To get good yields farmers are emphasizing on various factors like using fertilizers insecticides, irrigation, weeds removal etc.

- Pollination is totally ignored by the farmers due to lack of knowledge.
- Crop production can be increased by 25 to 40 % only by pollination

What are Different Pollinators?

The various types of pollinators include-

1) Birds, **2)** Bats, **3)** Wind, **4)** Water, **5)** Animals, **6)** Insects etc.

Insect Pollination

- Insects play vital role in the pollination of many plants including most important cultivated plants. This fact is not known by most of the farmers.
- In nature wild insects do the pollination generally but due to utilization of insecticides and pesticides beneficial insects are also eradicated.
- Now the situation is that we must use honeybees for pollinating the crops.

Why Honey Bees?

- Most important natural pollinator.
- Plants and honeybees are symbiotically related
- Plants supply nectar and pollen.
- While bees help plant in pollination
- Social insect
- Can be nurtured.
- Can be transported from one place to another easily.
- Can be multiplied-Bee rearing

Role of Bees as Pollinator

- Among all the insects' honeybees are best pollinators because of its floral fidelity. Once they choose the plant species, they visit only on the same species.
- They can be domesticated in the hives.
- Besides the pollination they provide honey, pollen, wax, propolis, royal jelly and venom. It will be an additional income to the farmer.
- Optimum yields of high quality fruit/ seed should be the aim of every farmer. Honeybee pollination can help to achieve this aim and help you obtain the best price from the market.
- Quality is the major factor that causes customers to pay top prices for fruit. High yields are important, but it is important that the fruit is of the best quality attractive in both size and shape. Honeybee pollination can improve the quality of many fruits.

• Commercially managed honeybee pollination services can provide the right number of bees at the right time to ensure that growers achieve these goals.

• Number and strength of hives necessary for pollination

• For pollinating the crops at least two strong colonies per hectare are necessary

• For pollination strong colonies with more foragers are better. At least 4 frames brood and enough adult bees to cover 6-8 frames (cerana) 7-10 frames (mellifera)

World Estimates of Animal Pollination Benefits to Crops

Since Levin (1967) quantified economic benefits of bee pollination in USA at $ 6 billion based primarily on crude method of proportional contribution of pollinators to crop production (% increase in yield in bee pollinated plots compared to plots devoid of insect pollination), many workers improvised the methodology based on novel primary data to estimate bee pollinate benefits at approximately 1/3rd of human diet and put its global value at €157 billion (Klein *et al.*, 2007).

Indian Beekeeping Scenario

Despite its falling contribution, agriculture (including forestry and fishing) remains the largest sector of Indian Economy providing livelihood to almost half of the workforce (48.9%). Indian agriculture presently faces greater technological, resource and ecological challenges besides the ambitious initiative of the Prime Minister of India of doubling the profitability of Indian farmers by 2022. NITI Aayog guidelines (Anon., 2015) call for integration of multiple potential vehicles but sadly miss on the role of Apiculture in alleviating farmer's income.

Contrary to the advanced world where FAO and USA President strongly pitch for the role of pollinators in increasing crop productivity and vouch for special efforts to conserve them, Apiculture in India is generally a poorly understood subject amongst the policy planners and even agriculturists preventing its rightful place in the main stream agriculture.

Table 1. Increase in Yield due to Bee Pollination

Crop Plants	Yield Increase (%)	Reference
Radish	22-100	Anonymous, 1997
Cabbage	100-300	Anonymous, 1997
Carrot	9.10-135.4	Alamet al., 1995
Brinjal	35-67	Anonymous, 1996
Cauliflower	302-1338	Sinha and Chakrabarti, 1985
Onion	354-9878	Kumar et al., 1989
Cucumber	127-275	Krishansawmy, 1990
Bottle gourd	200-350	Alam and Quadir,
Tomato	8.3-27.40	Cribb, 1990

Crop Plants	Yield Increase (%)	Reference
Linseed	2-49	Effect of honey bee pollination on fruit and seed development (Mishra 1997/98).
Mustard	13-222	
Sunflower	21-3400	
Safflower	4-114	
Apple	180-6850	
Cherries	56-1000	
Citrus	7-233	
Cucurbits & Squashes	21-6700	
Litchi	4538-10246	
Pears	240-6014	
Strawberry	17-125	

In this background, world's largest study was initiated to quantify the contribution of honey bees and pollinators to Indian agriculture (Chaudhary and Chand, 2017), improving significantly in scale (211 crops including 21 commodities) and methodology (15-year primary data), upon the previous global efforts (Klein *et al*., 2007; Eilers *et al*. 2011; Gallai *et al*., 2009).

Honey Bee and Pollinator Benefits to Indian Agriculture

More than half (51.2%) the crops (108%) are dependent on bee pollination for their production although dependence of 44 crops (20.9%) could not be ascertained due to lack of research studies or non-availability of information and only 59 crops (28.0%) were not dependent on bee pollination. The economic value of bee pollinated crops was a staggering Rs. 4,10,094.77 crore of the total agriculture output of the country (Rs. 12,91,369.63 crore) and the unknown segment further contributed Rs. 2,28,533.15 crore.

Bee pollination was essential for 14 (6.6%) crops, as in their absence, a reduction of 90-100% in their yield occurred. Dependence of 34 crops (16.1%) was great (40-90% reduction), modest for 29 (13.7%) crops (10-25% reduction) and little (reduction of up to 10% in yield) for 31 (14.7%) crops.

1. Cereals and millets: The major staple food is the largest contributor (28.33%) to total output value of agriculture but being self or wind pollinated are not dependent on animal pollination except buckwheat or kuttu.

2. Oilseeds: All the 15 major oilseeds (14 crops and 1 commodity) are bee pollination dependent except olive, four (rapeseed and mustard, sunflower, niger and taramira) depend greatly and 7 (sesame, castor, safflower, soybean, coconut, linseed, and cotton as cottonseed) modestly. In mustard, with a mean production of 6.64 million tonnes, the economic value of pollination is huge at Rs. 19,355.70 crore and for sunflower is Rs. 1,153.40 crore.

The contribution of pollination in 6 other major oilseeds (sesamum, castor, coconut, linseed, soybean, and cottonseed) with modest dependence was Rs. 18,821.69 crore. Groundnut was the only major oilseed with little insect pollination benefits still estimated at Rs. 1,036.40 crore. Non-oilseed crops including cotton, soybean and coconut too are significant contributors to oilseed production. In cottonseed production of 7.37 million tonnes contribution of animal pollination was Rs. 3,242.0 crore. Likewise, soybean and coconut with modest yield increase contribute Rs. 12,528.72 and 2,817.38 crore, respectively. Oilseeds, as a category are highly dependent on bee pollination with a mean contribution of 34.1% in yield valued at an astonishing amount of Rs. 43,993.08 crore.

Table 2: Pollination dependence of Indian crops and their economic value of pollination

Crops / commodities	Mean Production (MT)	Dependence on animal pollinators	Depen-dence rate	Economic value (Rs Crore)	
				Crop output	Pollination service
Rapeseed & Mustard	6.64	Great	0.65	29778.00	19355.70
Castor seed	1.14	Modest	0.25	8894.00	2223.58
Sunflower	0.91	Great	0.65	1774.00	1153.40
Sesamum	0.67	Modest	0.25	4286.00	1071.58
Cottonseed	7.37	Modest	0.25	12968.00	3242.00
Coconut (Hundred million nuts)	150.66	Modest	0.25	11270.00	2817.38
Soybean	9.29	Modest	0.25	50115.00	12528.72
Groundnut	6.91	Little	0.05	20728.00	1036.40
Safflower	0.17	Modest	0.25	233	58.30
Niger seed	0.11	Great	0.65	325	211.55
Oil palm		Little	0.05	-	0.00
Olive		No increase	0.00	-	0.00
Others		Unknown	0.00	842	0.00
Total Oilseeds				129143.00	43848.73
Increase in production due to pollination (%)					34.0

3. Fruits: Fruits are important source of quality nutrition with huge export potential. Pollination markedly improve production and lack of it leads to development of misshapen fruits, a major loss to the production. Out of 55 fruits two third (41) need insect pollination and only 4 (7.3%). Apple (1835.9 MT production) with an economic value of Rs. 5,577.16 crore are the most benefitted with and estimated economic value of pollination of Rs. 3,625.15 crore (DR=0.65) followed by cashew nut (Rs. 3,483.87 crore), oranges (Rs. 2,332.67 crore), guava (Rs. 1,858.31 crore), mango (Rs. 1,775.74 crore), litchi (Rs. 764.22 crore), pear (Rs. 447.37 crore), papaya (Rs. 190.42 crore), almond (Rs. 84.55 crore) and cherry (Rs. 46.82 crore).

In fruits, economic value of insect pollination service was estimated at whopping Rs. 17,142.27 crore representing 13.29% of the total output value of fruits despite the availability of data for only 16 fruits (29.1%) and the scenario is likely to improve vastly with increased research efforts.

Table 3: Economic value of animal pollination services to Indian agriculture

Crops / Commodities	Crop product value (Rs crores) at current prices (EV)	Proportion to total value of output from agriculture (%)	Economic value of pollination (EVP) (Rs Crores)	Increase due to animal pollination (%)
Cereals	3,65,793.00	28.33	0.00	0.00
Oilseeds	1,29,143.00	10.00	43,993.08	34.07
Fruits	1,29,030.05	9.99	17,142.27	13.29
Floriculture	19,193.83	1.49	0.00	0.00
Vegetables	1,75,777.81	13.61	1,9498.20	11.09
Fibers	73,917.05	5.72	17,290.66	23.39
Condiments & Spices	39,684.57	3.07	10,121.19	25.47
Drugs and Narcotics	42,059.98	3.26	1,986.97	4.72
Pulses	67,574.00	5.23	1,236.13	1.83
Indigo and Dyes	109.00	0.01	27.25	25.00
Sugars	80,971.92	6.27	0.00	0.00
Other Crops	1,68,115.75	13.02	1,319.99	0.79
Grand Total	12,91,369.63		1,12,615.73	
Contribution of animal pollination (%)			8.72	

4. Vegetables: Like fruits, majority of vegetables are consumed fresh, alluding apparent bee pollination benefits. Only 38.0% (19) vegetables needed pollination, 42% (21) did not depend while for 20% (10), such values are yet to be ascertained. Cucurbits (bottle gourd, bitter gourd, pumpkin, squash etc.) and custard apple were essentially dependent on insect pollination but their EVP could not be estimated. Tomato is major beneficiary from animal pollination with an EVP of Rs. 11,977.90 crore. Brinjal and okra were modest in pollinator dependence with EVP of Rs. 4,841.97 and 2,603.48 crore, respectively. Despite huge information gaps, EVP from vegetables was estimated at Rs. 19,498.20 crore annually.

5. Fiber crops: Cotton is the major fiber crop (93.5%) followed by jute (6.14%). Cotton being highly entomophilous and visited for floral and extra-floral nectar has modest dependence on insect pollinators, estimated at massive value of Rs. 17,279.79 crores annually (Table 2). Sann hemp although a minor crop with modest pollination dependence has a meagre share of Rs. 10.87 crore. Jute and mesta are not benefitted by insect pollination.

6. Condiments and spices: The economic value of insect pollination in condiments and spices was estimated at Rs. 10,121.19 crores, accounting for 26.90% of their total output value of Rs. 37,629.42 crores although data for 16 of the 26 crops was unavailable. Cumin seed production was greatly attributed by animal pollinators reflecting in Rs. 4,029.22 crores value of pollination followed by coriander (Rs. 1,549.79 crores), small cardamom (Rs. 1,104.70 crores), nutmeg (Rs. 275.98) and fennel (Rs. 232.17 crores). Chilli, the spice with most economic value of output (Rs. 10081.00 crores) was modest in its response to pollinators but still Rs. 2,520.25 crores were attributed by this precious input. The little pollinator benefitted spices viz. areca nut, chilli pepper and tamarind had insect pollination component of Rs. 397.32 crores.

7. Drugs and narcotics: Share of insect pollination in these stimulant crops seems minor at Rs. 1,986.97 crores but is highly significant for improving the quality of coffee (Rs. 1,818.92 crore) and cocoa berries (Rs. 163.25 crore). Huge chunk of crops including beetle leaf, isabgol, saffron and other drugs (41.74%) remained unexplored for their animal pollination dependence although two major crops tea and tobacco reported no decrease in yield in absence of animal pollinators.

8. Pulses: of the 18 pulses, 10 are benefitted by animal pollinators to little extent. Pigeon pea with a production of 2.57 MT and economic value of output of Rs. 11,149.90 crore resulted in EVP of Rs. 557.49 crore followed by urd, moong and moth at Rs. 317.65, 259.29 and 101.69 crores, respectively totalling to an EVP of Rs. 1,236.13 crore.

Proportion of different animal pollinators: Amongst a host of agencies reported as crop pollinators, the data provided a crystal-clear picture of overwhelming dominance of insect pollinators to the tune of 97.4% in crops under review. Birds, mainly humming birds (1.7%) and bats (1.0%) were the other animals contributing to the pollination of their especially co-evolved hosts. The contribution of bees (79.2%) as pollinators was vivid, overwhelmed by the honey bees (40.6%) and further from solitary (21.1%) and bumble bees (13.5%). Flies from order Diptera (9.6%) also contributed significantly.

Livelihood Support

Honey bees provide a wide range of benefits to humans from honey, other bee products, pollination of food crops and ecological services. Beekeeping is practiced around the world, and can provide a valuable source of income to people in developing regions with relatively little investment. The best-known primary products of beekeeping are honey and wax, but pollen, propolis, royal jelly and bee venom are also marketable primary bee products. There are additional uses where bee products are an ingredient of another product. Due to the quality and sometimes almost mystical reputation and characteristics of bee products, the addition to other products usually enhances the perceived value or quality of these secondary products. This can increase the profitability of many beekeeping operations.

1. Honey

The honey market in India is expected to grow significantly in the coming years, with some estimates suggesting a 10% compound annual growth rate (CAGR) between 2022 and 2027. Honey is commonly referred as golden liquid because of its unrivalled properties along with colour resemblance. Honey is composed primarily of fructose and glucose but also contains fructo-oligosaccharides and many amino acids, vitamins, minerals, and enzymes.

Composition of honey varies based on the nectar it was made. Decapping of the sealed wax layer of honey combs is done using a sharp, thin and long knife or decapping knife. Extracting the honey from honey combs is done with the help of honey extractor (works on the principle of centrifugal force) in the case of Indian and Italian bees and squeezing of honey combs in the case of rock bees, little bees, and stingless bees. Processing of honey is done to prevent granulation and fermentation. In India, most of the apiaries, process the honey by traditional method of indirect heating in which a vessel containing honey is heated by placing it in another vessel containing hot water, so that the honey gets its required heat from the hot water. The yeast cells present in honey are killed while heating/ processing making honey less susceptible to ferment. For large scale processing of honey, honey processing units are used.

Indian Scenario

India's arable land area of 159.7 million hectares is the second largest in the world. Based on the area under cultivation in India and bee forage crops, India has a potential to have about 200 million bee colonies while the current figure is about thirty-four lakh colonies. The country has the prospective to increase honey production many folds from today's (2017-18) figure of 105.0 thousand tonnes. (However, the data available with FAO shows a production of 64.9 thousand tonnes in India during 2017. This discrepancy needs to be scientifically verified). Increasing the number of colonies not only increases honey production, but also substantially boosts the productivity of agricultural and horticultural crops. Hence there is vast scope for increasing the number of bee colonies and development of beekeeping industry in the country.

The volume of export of honey has increased from 29.6 to 51.5 thousand tonnes between 2014-15 and 2017-18. The value of export of honey has not increased proportionately probably due to fluctuating global price of honey. The value of honey export was about Rs. 6500 crores during 2017-18. The domestic consumption of honey has remained stable around 50 thousand tonnes during the last four years. The number of bee colonies maintained by beekeepers in India is on the rise. It was 22 lakhs in 2015 and has increased to about 34 lakhs in 2018 Out of this A. cerana is estimated to account for about 5 lakh bee colonies and *A. mellifera* the rest. Honey production has also increased correspondingly in India during this period from 80 to 105 thousand tonnes.

When we look at the honey production in India in the last twelve years, we can see a gradual increase in production from 51 thousand tonnes to 115 thousand tonnes (2018-19 value is a projected one) This increase could be because of the efforts taken by the government to adopt scientific ways of honey production in India.

The honey production data in India is collected by the NBB based on estimates obtained from leading beekeepers in various states which is pooled and expressed. There is no mechanism to find out if adulterated or fake honey was also included in the estimate. However, a better way of estimating honey production would be to find out the number of beekeepers, number of managed bee hives and colonies, number of wild honey bee hives, estimate of feral colonies of domesticated hive bees, actual honey extracted etc. which will help to get a more accurate estimate of honey production in India. Among the different states of India, the maximum honey production is from four states namely Uttar Pradesh, West Bengal, Punjab, and Bihar which account for more than 50% of total honey production in India. Rajasthan, Himachal Pradesh, and Haryana also produce considerable quantities of honey. These states derive the honey mostly from *A. mellifera* colonies while part of its honey comes from the wild bees or rock bees *A. dorsata* particularly in Sundarbans of West Bengal. The Southern states account for about 25 % of the honey produced in India that is obtained from the Indian bees, A. cerana and the rock bees *A. dorsata*.

Honey Production in metric Tonnes in India during 2016-17 to 2020-21

Sr. No	Year	Production in Metric Tons (MTs)
1	2016-17	94,500
2	2017-18	1,05,000
3	2018-19	1,20,000
4	2019-20	1,25,000
5	2020-21	1,25,000

(Source: National Bee Board, GoI)

Export of Honey

Sr. No	Year	Quantity (MT)	Value (Cr.)
1	2020-21	59999	716
2	2021-22	74413	1221
3	2022-23 (Jan 23 end)	69327	1446

World Scenario

In 2017-18, China ranked first in honey production with 551 thousand tonnes while India ranked eighth among the world countries with 64.9 thousand tonnes (FAOSTAT, 2018). As per 2016-17 data of FAO, China ranked first in exports with 131.6 thousand tonnes while India ranked fifth with 35.8 thousand tonnes. (However, the honey production and export data pertaining to India taken from FAOSTAT varies from the data available with NBB, MoA&FW. With respect to the values given in this document, world figures have been taken from FAOSTAT and Indian figures have been taken from NBB.) USA, Germany, Japan, United Kingdom and France were the top honey importers of the world with USA importing 167 thousand tonnes. The honey consumption in kg/capita/year was highest in New Zealand (2.02) followed by Slovenia (1.61), Greece (1.55), Switzerland (1.41), Austria (1.32), Canada (0.79), USA (0.67), UK (0.66) and only 0.02 in India much lower than the world average consumption on 0.36 kg/capita/year

Various Types of Honey

1. Natural honey, Raw honey

2. Forest honey or Wild honey

3. Comb honey or Chunk honey

4. Squeezed or Pressed honey

5. Extracted honey

6. Liquid honey

7. Crystallized honey

8. Floral types of honey

9. Uni-floral: Litchi, Sunflower, Mustard

10. Multifloral

11. Extra floral: Rubber

12. Medicinal honey like Tulasi, Eucalyptus

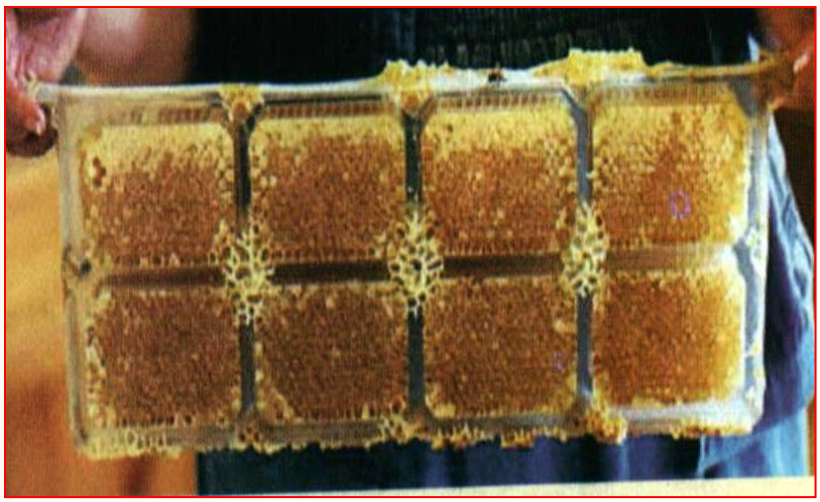
13. Spice honey like Cardamom, Allow, Coffee

14. Geographical types like Himalayan, Kashmir, Coorg, Mahabaleshwar

15. Honeybee species wise honey from Dorsata, Cerana, Melliffera, Trigona

16. Organic honey

17. Honey Dew honey, from nectar collecting insects/aphids



➢ **Honey Value Added Products:** Honey chocolate, Honey ice cream, Honey fruit salad, Honey dry fruits, Honey lemon, Honey biscuits, Honey Aonla, Honey Cake, Honey Malta, Honey cookies.

➢ **Infused Products:** Ginger infused honey, Tulsi Infused Honey, Garlic infused honey, Haldi Infused Honey, Cinnamon infused honey, Clove Infused Honey, Cardamom infused honey.

Colour of Honey

Colour	Floral Source
White	Eucalyptus, Plectrathus, Cotton
Light Yellow or Golden	Sunflower, Mustard, Litchi
Amber	Berseem, sandal wood
Dark Amber	Jamun, Tamarind, Ajwain
Dark	Sheesha, Neem

2.Royal Jelly

The global royal jelly market is expected to grow significantly in the wellness and natural supplements sector, and emerging countries are likely to grow at a CAGR of more than 7% from 2022 to 2031. The Asia-Pacific region is also expected to dominate the market by the end of 2031. Factor for growth Food & Beverage, Cosmetics and Dietary Supplements etc. Royal jelly is a secretion of hypopharyngeal glands and mandibular glands of nurse bees in a ratio of 1:1. Royal jelly plays a vital role in caste differentiation of honey bees. Queen bee is fed with this nutritious royal jelly throughout its life time, while the drone and worker bees are fed for short time (2/3 days in their immature stages). As a result of the complex composition of royal jelly (lipids, proteins, mineral salts, vitamins, enzymes, oligo-elements, and natural antibiotics), it is also said to have specific vital factors that act as biocatalysts in cell regeneration processes within the human body. Production of royal jelly is related to rearing of queen bees and so the technology for royal jelly production is like that for mass queen rearing. It is because the queen larvae cannot consume the royal jelly at a rate at which it is supplied to them and there is always surplus of it surrounding the larvae which can be extracted at the cost of the queen larvae. Royal jelly has a low shelf life and so it must be kept in refrigerator (0o C to 5o C). Since royal jelly is an emulsified product and not cellular tissue, freezing presents no problem and common household freezers can be used. It can be kept in a freezer for about 6 months.

- Royal jelly is sold at very high prices in international market as dry powder in capsules or as formulation with honey. Commercial production of royal jelly is restricted to A.mellifera in India and that too by a very few beekeepers. Lack of awareness about the demand for the products and its production technologies are the reasons for its low production in India. Royal jelly is known for its anti- aging, cholesterol-lowering, anti-inflammatory, wound healing, antibiotic components, and antibacterial agents.
- **Royal Jelly Products:** Royal jelly capsules, Honey with royal jelly, Royal jelly cream, Royal jelly lotion, Royal jelly with pollen

Uses

- Internal Use: Tonic, Stimulant, General health improvement, increased appetite, increased resistance to viral disease.
- External Use: Skin conditions, Epithelial stimulation and regrowth, Anti-wrinkle, Sebaceous secretions

3. Pollen: Bee Pollen Market is likely to grow at compounded annual growth rate (CAGR) of 5.7% between 2024 to 2030. Bee Pollen Market is dominated by the pharmaceuticals segment and the Asia-Pacific region holds the highest market share in 2023.

Pollen collected by honey bee and carried back to the hive is called bee pollen. Bee pollen is the chief source of protein, lipids, amino acids, minerals, vitamins etc. in the honey bee diet. Pollen is also considered as a complete food for human beings. It is used in apitherapeutic treatments as it is said to have properties such as antifungal, antimicrobial, antiviral, anti-inflammatory, immune stimulating, and local analgesic and facilitates the burn wound healing. Pollen is carried back to the hive on the third pair of legs of the honey bee, which are specially modified for this purpose. Only a tiny amount can be carried back to the colony at each trip (around 10 mgs per load) and bees in a hive need about 20 kilograms for their annual development. It is clear that this constitutes a remarkable feat of social co-ordination by the bees - in fact this takes 2 million pollen collecting trips for the colony every year. Pollen is mixed with enzymes and nectar in a way that allows it to be stored by the bees for a considerable time.

Pollen is collected by placing the pollen traps at hive entrance at which the pollen packed in the hind leg corbicula of the returning bees will get discharged. Pollen trap designing is a crucial factor for the welfare of the colony. It should also not stress the colony by trapping too much of pollen or else it will lead to reduced brood rearing and honey production. A trap that removes 50-60% incoming pollen during nectar flow is ideal and can be kept in place for the year round with little adverse effect on the colony. Bee pollen is sold in market for prices ranging from Rs. 2000 to 20000 per kg depending on the crop from which it is collected by bees. There is vast scope for increasing its production based on demand in local and international market.

Pollen for Human Consumption

Pollen is used as a human food because pollen is an excellent nutritional supplement.

It contains an amazing spectrum of nutrients: 22 amino acids, 18 vitamins, 25 minerals, 59 trace elements, and 11 enzymes or coenzymes

Bee pollen rejuvenates body, stimulates organs and glands, increases appetite and hemoglobin content, enhances vitality, and brings about a longer life span

Cures & Benefits: Cancer in animals, Colds, Acne, Male sterility, Anemia, High Blood Pressure, Nervous and endocrine disorders

Improvements: Athletic performance, Digestive assimilation, Rejuvenation, General vitality, Appetite, Hemoglobin content, Sexual prowess

Pollen Products: Pollen with honey, Pollen tablets, Pollen capsules

4. Beeswax

According to the Food and Agriculture Organization, India produced 24,593.61 tons of beeswax in 2022, contributing significantly to global beeswax volume production, which was valued at 65,063.47 tons. This abundant supply from India caters to domestic needs while also supporting the demand in other Asian countries. Bees produce wax from the wax secreting glands and they use this wax for construction of comb, in which their immature stages live and they also store pollen and honey in the hexagonal cells of the comb which is made up of beeswax. Pure fresh form of beeswax is white in colour but later turns into yellow as a result of the presence of pollen and other substances. And so brown or yellow coloured beeswax is available in the market. Wax is secreted by 14-18 days old worker bees. And to produce one part of wax, bees have to consume

about 4-7 times as much honey. Beeswax has resistance to the action of acids and is also insoluble in water and cold alcohol. But wax can be dissolved partially in boiling alcohol, and completely in chloroform, in carbon disulfide and in the essence of hot turpentine.

The beeswax is used in several industries such as cosmetic, electric and textile industry, church candles, carbon paper, metal castings and mouldings and shoe polish. Apart from these, it can also be used in beekeeping industry for preparation of comb foundation sheet. Beeswax is also used in food processing industry for coating metal containers internally against the effects of acids from fruit juices and honey. Beeswax is the bee product that is produced in large quantities next to honey in India. The market price of beeswax is Rs.400 to 700 per kg.

Value added Product: Soap making, Candle making, Metal castings and molding, Cosmetics, Printing, Varnishes and polishes, Medicine, Food processing, Industrial technology, Textiles.



5. Bee Venom


Bee venom is injected by honey bees using their sting to defend themselves from the intruders. Bee venom has a history of healing back pain, musculoskeletal pain, and skin diseases. Quantity of bee venom produced by worker bees vary between 100 to 150 kg. Bee venom is collected by making bees at hive entrance to come in contact with metal strings connected to direct current of low voltage and giving mild shock so that the bees sting and release venom that can be collected on glass plate placed under the strings. Enzymes, proteins, physiologically active amines, amino acids, sugars Phospholipids and volatile compounds are the major components of bee venom.

Product: Liquid / Diluted bee venom, Bee venom injection, Bee venom cream, Apitherapy kit, Pure Dried Bee

Use: Used for curing Arthritis, migraine, tropical ulcers, cancer, asthma, Sore throat, ligament injuries, chronic pain, dilates capillaries and Arteries, decreases blood cholesterol level etc.

6. PROPOLIS: -

The word propolis has Greek origin, 'pro' meaning 'in defence of' and 'polis' meaning 'city,' i.e. defence of beehives. It is produced by Italian and stingless bees and not seen in Indian bee, rock bee and little bee. Honey bees use propolis for sealing the cracks and crevices and unwanted holes in the hive; for spreading around the hive entrance as repellent to the intruders like ants. It is collected by bees from tree resins, flower-buds and other vegetal tissues. At the time of collection, bees mix their wax and collected resins to make propolis. Propolis has different compounds such as esters, fatty acids, carbohydrates terpenoids, vitamins, and inorganic substances and has numerous therapeutic properties, such as antibacterial, anti-inflammatory, healing, aesthetic, anticariogenic, antifungal, antiprotozoal and antiviral activities. It can be collected by scrapping off the hive parts or by using the protolyzing plastic screens, which are placed on the top bars of the hive.

Different Product: Raw propolis, Propolis Liquid extracts, Propolis chewable Tablets, Propolis capsules, Propolis chinks, Propolis powder, Propolis tincture, and It has antibacterial, anti-fungal and antiviral activity.

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Chapter-2

Introduction of Indian Honeybee & Maintenance of Indian Bee Colony

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Introduction

India, a land of diverse flora and fauna, is home to a vibrant population of bees that play a crucial role in pollination and honey production. Among the 20,000 known species of bees worldwide, India boasts an impressive 1,000 species, with the Indian honeybee (Apis cerana indica) being the most prominent. In this article, we delve into the fascinating world of Indian bees, exploring their species, habitats, importance and the challenges they face. *Apis cerana indica*, commonly known as the Indian honeybee, is a vital pollinator and honey producer native to the Indian subcontinent. This incredible insect plays a crucial role in maintaining the health of ecosystems and supporting agriculture.

Importance of Indian Bees

Indian bees are vital pollinators, contributing to food security, ecosystem health and honey production.

Food Security: Pollination of crops like many fruit crops (mango, guava, coconut, litchi etc.), coffee, many spices, vegetables (tomato, brinjal, cucumber, bitter guard etc). Honeybees are essential and play important role in seed production of many crop plants (onion, carrot) and oilseed crops (sesamum, sunflower, mustard etc.).

Ecosystem Health: Maintenance of plant diversity and forest regeneration. Due to the presence of honeybee in the forest area regeneration & production of seeds of new plants can possible. Without bees, forest can't maintain properly.

Honey Production: Indian honeybees produce high-quality honey with unique flavour profiles. Honey is called as a complete food. Only bees can produce honey, which is consumed by human.

Species of Honeybees in India

1. *Apis Cerana Indica* (Indian Honeybee)

The most common species, known for its distinctive black and yellow stripes. *A. cerana* found in various habitats, from tropical forests to urban gardens. Produces high-quality honey, with unique flavour profiles. In India this species produces 5 to 10 kg honey from the colony in one year.

2. *Apis Dorsata* (Giant Honeybee)

The largest bee species in India, found in forests and known for its aggressive behaviour. It produces a distinctive, strong-flavoured honey. This is an important pollinator of forest ecosystems. Some tribal people harvest 15 to 25 kg honey from the colony on tree or mountain

3. *Apis Florea* (Little Honeybee)

A small, docile bee species found in urban gardens and forests. It produces a mild, and delicate honey. This is an important pollinator of urban ecosystems. Beekeepers harvest 0.5 to 2 kg honey from the natural colony.

4. *Trigona iridipennis* (Blue Bee)

A stingless bee species found in tropical forests, known for its iridescent blue colour. This produces a unique and fruity honey. It is important pollinator of forest ecosystems. Farmers uses this species for the pollination in polyhouses and green houses. This species collects very low honey i.e. 200 to 400 gm honey in one year.

5. *Megachile lanata* (Mason Bee)

A solitary bee species found in urban gardens, known for its distinctive nesting habits. It produces a high-quality dark honey. It is important pollinator of urban ecosystems.

India's diverse range of honeybee species is a testament to the country's rich biodiversity. Each species plays a vital role in pollination and honey production, contributing to the health of ecosystems and the economy. By understanding and appreciating these incredible creatures, we can work towards their conservation and protection, ensuring the long-term sustainability of apiculture in India.

Habitats and Distribution

Indian bees inhabit diverse habitats ranging from:

1. Tropical forests: Home to *Apis dorsata* and *Trigona iridipennis*.

2. Western Ghats: A biodiversity hotspot, home to *Apis cerana indica* and *Megachile lanata*.

3. Eastern Ghats: A region of high bee diversity, home to *Apis florea* and other species.

4. Indo-Gangetic plains: A region of intense agricultural activity, home to *Apis cerana indica* and other species.

5. Urban gardens: Home to *Apis florea*, *Megachile lanata* and other species.

Challenges Faced by Indian Bees

Indian bees face numerous threats including:

1. Habitat loss and fragmentation: Due to urbanization, deforestation and agriculture.

2. Pesticide use and chemical pollution: Affecting bee health and population.

3. Climate change and temperature fluctuations: Disrupting bee behaviour and pollination patterns.

4. Varroa mite infestations and diseases: Affecting bee health and colony survival.

5. Wax moth infestation to the comb, so bees can leave the colony.

Conservation Efforts

To protect Indian bees, initiatives focus on:

1. Habitat preservation and restoration: Protecting and restoring natural habitats.

2. Sustainable beekeeping practices: Promoting eco-friendly beekeeping methods.

3. Research and monitoring: Studying bee behaviour, ecology, and population dynamics.

4. Awareness and education: Educating farmers, beekeepers and the public about bee importance and conservation.

Indian bees are incredible pollinators and honey producers, playing a vital role in maintaining ecosystem balance and food security. As we face the challenges of climate change and environmental degradation, it is essential to prioritize the conservation and protection of these buzzing wonders. By supporting sustainable beekeeping and conservation efforts, we can ensure the long-term survival of Indian bees and the ecosystem services they provide.

Physical Characteristics of *Apis cerana indica*

The most common species of honeybee in India is *Apic cerana indica*. The physical characteristics of this species are as under.

This is small to medium size (10-12 mm) bee with dark brown to black body with a distinctive white or yellow stripe on the abdomen. Fuzzy body with a rounded abdomen, long, tube-shaped tongue (proboscis) for nectar collection.

Behavior and Social Structure

This is highly social creatures, living in colonies with a single queen bee. Colonies typically consist of 10,000 to 50,000 individuals. Worker bees (females) perform various tasks like foraging, caring for young, defending the colony. Males (drones) primarily focus on mating.

Habitat and Distribution

This species is found in various habitats like tropical forests, urban gardens, agricultural landscapes etc. Widespread distribution across India, Sri Lanka and parts of Southeast Asia

Honey Production

Produce high-quality, unique honey with distinct flavour profiles. Honey is stored in hexagonal wax cells within the hive. Bees collect nectar from diverse flora resulting in varied honey flavours. *A. cerana* collecting honey often weighing up to 5 to 10 kg in one year.

Pollination Services:

A.cerana indica plays a vital role in pollination for pollinators of various fruit crops like mangoes, coconut. apple, jamun, guava etc., vegetables like cucumber, brinjal, tomato etc, seed production of carrot, onion etc., coffee, spices, and more. So, it plays very important role and contribute to the reproduction of countless plant species.

Threats and Conservation

- Face threats from habitat loss, pesticide use, climate change, and diseases

- Conservation efforts focus on habitat preservation, sustainable beekeeping practices and research

Interesting Facts

- Communicate through complex dance patterns and pheromones

- Have a highly developed sense of smell and taste

- Can fly at speeds of up to 15 km/h

Indian honeybees (*Apis Cerana Indica*) are a vital part of the country's ecosystem, playing a crucial role in pollination and honey production. These small, dark-coloured bees are native to the Indian subcontinent and are well adapted to the region's diverse climate and flora. They are highly social creatures, living in colonies with a single queen bee and a strict caste system. Indian honeybees are skilled foragers, collecting nectar and pollen from a wide range of flowers and crops, and are known for their high-quality honey, which is prized for its unique flavour and medicinal properties. They are also important pollinators of many crops, including mangoes, coffee, and spices, and contribute significantly to India's agricultural economy. Despite facing threats from habitat loss, pesticide use, and climate change, Indian honeybees remain a resilient and vital component of India's biodiversity.

The Giant Honeybee: *Apis Dorsata*

Apis Dorsata, commonly known as the Giant Honeybee or Rock bee, is a species of honeybee native to South and Southeast Asia. This impressive insect is renowned for its distinctive size, unique behaviour, and significant ecological role.

Physical Characteristics

- Large size (17-20 mm), significantly bigger than other honeybee species

- Dark brown to black body with a distinctive white stripe on the abdomen

- Long, pointed wings and a robust body

Behavior and Social Structure

- Highly social creatures, living in colonies with a single queen

- Colonies typically consist of 10,000 to 50,000 individuals

- Worker bees (females) perform various tasks: foraging, caring for young, defending the colony

- Males (drones) primarily focus on mating

Habitat and Distribution

- Found in tropical forests, mangrove swamps, and urban areas

- Widespread distribution across India, Sri Lanka, and parts of Southeast Asia

Honey Production

- Produce a distinctive, strong-flavoured honey

- Honey is stored in large, exposed combs, often weighing up to 10 to 50 kg

Pollination Services

- Vital pollinators of various crops: mangoes, coffee, spices, and more

- Contribute to the reproduction of countless plant species

Unique Characteristics

- Known for their aggressive behaviour when threatened

- Perform a unique "heat ball" defence, where bees gather and vibrate to generate heat

- Can fly at speeds of up to 25 km/h

Threats and Conservation

- Face threats from habitat loss, pesticide use, climate change, and diseases

- Conservation efforts focus on habitat preservation, sustainable beekeeping practices, and research

Interesting Facts

- Have a highly developed sense of smell and taste

- Can collect nectar from flowers up to 10 km away from the hive

- Are considered a keystone species in their ecosystems

Apis dorsata is an incredible species that plays a vital role in pollination and ecosystems. By understanding and protecting these magnificent creatures, we can ensure the long-term health of our environment and food security. The *Apis dorsata* hive is a remarkable structure, showcasing the incredible engineering skills and social cooperation of these giant honeybees. Built in exposed locations, such as tree branches or rock faces, the hive is a large, single comb made of wax produced by the bees themselves.

Construction and Architecture

The hive's framework is constructed from a combination of wax and plant resin, carefully shaped and moulded by the bees to create a sturdy and durable structure. The comb is typically 1-2 meters in length and 0.5-1 meter in width, with a thickness of around 10-15 cm. The hexagonal cells within the comb are precisely crafted to store honey, pollen and brood.

Colony Organization

The *Apis dorsata* colony is a highly social and organized unit, with different castes performing specific roles. The queen bee lays eggs at the centre of the comb, while worker bees tend to the brood, forage for nectar and pollen, and defend the hive. Drones or male bees are responsible for mating with the queen.

Honey Production and Storage

The *Apis dorsata* hive is renowned for its high-quality honey, produced from the nectar of various flowers. The bees store the honey in the hexagonal cells, sealing them with a wax cap to preserve the contents. The hive can produce up to 10 kg of honey per year, making it a valuable resource for both the bees and humans.

Defense Mechanisms

The *Apis dorsata* hive is fiercely defended by the bees, which employ a range of strategies to protect their home. These include the "heat ball" defense, where bees gather and vibrate to generate heat, and the release of alarm pheromones to alert other bees to potential threats. The *Apis dorsata* hive is an extraordinary example of insect engineering and cooperation, showcasing the incredible social organization and resourcefulness of these remarkable bees.

Management of Indian Honeybee

The management of Indian honeybees (*Apis cerana indica*) involves several practices to maintain healthy colonies, promote honey production and support pollination services. Here are some key aspects of Indian honeybee management:

1. Hive setup and maintenance: Beekeepers use traditional or modern hives, ensuring proper ventilation, protection from pests, and easy handling.

2. Colony health checks: Regular monitoring for diseases, parasites, and pests, with appropriate treatments applied when necessary.

3. Queen bee management: Beekeepers replace old or weak queens, introduce new queens, or split colonies to maintain genetic diversity.

4. Nutrition and forage: Providing supplemental feeding during lean periods and ensuring access to diverse forage for nectar and pollen collection.

5. Honey harvesting: Beekeepers extract honey, leaving enough for the colony's needs, and extract beeswax for various uses.

6. Pest and disease control: Managing threats like Varroa mites, small hive beetles, and American foulbrood disease through integrated pest management techniques.

7. Migration and pollination services: Beekeepers migrate colonies to facilitate pollination for various crops, enhancing yields and quality.

8. Record keeping and monitoring: Tracking colony performance, honey production, and pest issues to inform management decisions.

9. Training and extension services: Educating beekeepers on best practices, new technologies, and market trends to improve their skills and livelihoods.

10. Marketing and value addition: Promoting Indian honey and beeswax products, developing value-added products like beeswax candles, and supporting local economies.

By adopting these management practices, beekeepers can optimize the health, productivity, and profitability of Indian honeybee colonies, contributing to the country's apiculture industry and ecosystem well-being.

The Future of Indian Honeybees

As we face the challenges of climate change and environmental degradation, it is essential to prioritize the conservation and protection of Indian honeybees. By supporting sustainable beekeeping and conservation efforts, we can ensure the long-term survival of these buzzing wonders and the ecosystem services they provide. Indian honeybees are a vital part of our ecosystem, playing a crucial role in pollination and honey production. It is our responsibility to protect and conserve these incredible creatures, ensuring the health of our environment and our food security. *Apis cerana indica* is an incredible species that deserves our appreciation and protection. By understanding and supporting these vital pollinators, we can ensure the long-term health of ecosystems and food security.

Maintenance of Bee Box

Maintaining a bee box, also known as a beehive, requires regular inspections and tasks to ensure the health and productivity of the bees. Here is a checklist for maintaining a bee box:

1. Regular Inspections: Check the hive every 7-10 days during peak season (spring-fall) and less frequently during winter.

2. Cleanliness: Remove debris, dead bees, and excess wax from the hive.

3. Pest Control: Monitor for pests like varroa mites, small hive beetles, and wax moths. Use integrated pest management techniques as needed.

4. Disease Management: Check for signs of disease like American foulbrood, nosema, or deformed wing virus. Act promptly if you suspect disease.

5. Queen Bee Health: Ensure the queen is present, laying eggs, and healthy.

6. Honey Harvesting: Extract honey when the hive is strong and has excess stores.

7. Record Keeping: Track inspections, pest management, and honey harvests to monitor hive health and make informed decisions.

8. Hive Expansion: Add new boxes or supers as the colony grows.

9. Winter Preparation: Prepare the hive for winter by ensuring adequate food stores, reducing entrances, and providing wind protection.

10. Bee Health Supplements: Consider adding supplements like sugar water or pollen substitutes during times of low nectar flow.

Remember to always follow proper beekeeping safety protocols and best practices to avoid harming yourself or the bees.

Common Pests and Diseases

Indian honeybees suffer from many pest and disease problems like varroa mites, Americal foul brood virus, Nosema disease, small hive beetles, wax moth etc.

1. Varroa mites: This is an external parasite that feed on bee blood, weakening colonies.

2. American foulbrood (AFB): A bacterial disease-causing brood death and colony collapse.

3. Nosema: A fungal disease affecting bee digestive systems.

4. Small hive beetles (SHB): Pests that damage combs and consume honey.

5. Wax moths: Larvae that feed on wax, causing damage to combs.

Management of Pest and Disease of Indian Honeybee

Indian honeybees (*Apis cerana indica*) are vital pollinators and honey producers, but they face numerous threats from pests and diseases. Effective management of these issues is crucial for maintaining healthy colonies, ensuring honey production, and supporting ecosystem health.

Management Strategies

1. Integrated Pest Management (IPM): Combine physical, cultural, biological, and chemical controls.

2. Monitor colonies regularly: Inspect for signs of pests and diseases.

3. Maintain good beekeeping practices: Ensure proper hive hygiene, ventilation, and nutrition.

4. Use resistant bee stocks: Breed bees with natural resistance to pests and diseases.

5. Apply control measures: Use medications, essential oils, or other treatments as needed.

Control Measures

1. Varroa mites: Use formic acid, oxalic acid or thymol treatments. Mites can be managed by dusting micronized sulphur on the frames or by burning Folbex strips (Bromopropylate) as a fumigant inside the hive. The mites can also be controlled by keeping absorbent cotton soaked in 65 per cent formic acid. Mites are microscopic and are ecto or endo parasites of honeybees.

2. AFB: Apply antibiotics, like oxytetracycline, and destroy infected combs.

3. Nosema: Treat with fumagillin or other medications.

4. SHB: Use traps, essential oils, or insecticides.

5. Wax moths: Control with diatomaceous earth or other insecticides.

Best Practices

1. Record keeping: Track colony health, pest presence, and treatment applications.

2. Colony splitting: Divide strong colonies to prevent overcrowding.

3. Hive cleaning: Regularly clean hives to prevent disease buildup.

4. Beekeeper training: Educate beekeepers on pest and disease management.

Conclusion

Effective management of pests and diseases is crucial for maintaining healthy Indian honey bee colonies. By adopting IPM strategies, monitoring colonies regularly, and applying control measures as needed, beekeepers can protect these vital pollinators and ensure the long-term sustainability of apiculture.

Indian Beekeepers Face Several Challenges including:

1. Colony Losses: High rates of colony losses due to pests, diseases, and environmental factors.

2. Pesticide Use: Exposure to pesticides and chemicals affects bee health and productivity.

3. Habitat Loss: Decline of natural habitats and forage sources due to urbanization and agriculture.

4. Climate Change: Changes in temperature and precipitation patterns impact bee behavior and honey production.

5. Lack of Infrastructure: Inadequate access to modern beekeeping equipment, storage facilities, and market linkages.

6. Limited Extension Services: Inadequate training, guidance, and support for beekeepers.

7. Pests and Diseases: Management of varroa mites, small hive beetles, and diseases like American foulbrood.

8. Market Fluctuations: Fluctuations in honey prices and demand affect beekeepers' income.

9. Bee Migration: Seasonal migration of bees to find forage sources can be challenging.

10. Lack of Research and Development: Limited research on Indian bee species and lack of new technologies

11. Government Support: Limited government support and initiatives for beekeeping development.

12. Beekeeper Training: Limited access to training and capacity-building programs for beekeepers.

Addressing these challenges is crucial for the sustainable development of Indian beekeeping and the well-being of beekeepers.

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Chapter-3

Honey Bee: Pollinators and Beehive Produces

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Introduction

Honey bee (*Apis mellifera*) is a social insect renowned for their pivotal role in pollination, highest bee hive productivity, mild in nature and sophisticated hive organization. As members of the Apidae family, they exhibit complex behaviours and communication systems. Honey bees, often hailed as one of nature's most diligent insects, play a crucial role in ecosystems. These remarkable creatures are well-known for their ability to produce honey, a sweet substance that has been cherished by humans for ever since time immemorial. Honey has been used in medicine and diet since immemorial time because of its well known nutraceutical properties. Its various bioactive compounds enhance its efficacy in wound healing and support its use as a natural remedy (Al-Waili*et al.,* 2011). Nevertheless, the contributions of honey bees extend far beyond just producing honey, they also produce a range of other valuable beehive produces viz. bee-wax, propolis, royal jelly, bee pollen and bee venom. Each produce has its own unique set of benefits and uses. Beeswax is highly valued for its use in cosmetics, pharmaceuticals and as a natural sealant, owing to its emollient and protective qualities. Its effectiveness in skincare products and as a barrier against environmental pollutants is well-documented (Alinezhad *et al.*, 2015). Propolis is prized for its potent antimicrobial and anti-inflammatory qualities, which support its usage in a range of therapeutic applications. Its demonstrated efficacy in promoting immunological function and wound healing were reported by Kujumgiev *et al.* (1999). Royal jelly is high nutritional profile and potential health benefits, including immune system stimulation, skin health support and antioxidant characters that collectively improve metabolic health. (Kwon *et al.,* 2016). The corbicula pollen of honey bee is appreciated for its unique nutritional profile and potential health advantages, including its antioxidant and anti-inflammatory properties. Research has demonstrated that it can improve overall health and energy levels (Saeed *et al.,* 2014; Mirończuk-Chodakowska *et al.,* 2016). Bee venom also known as Apitoxin (Trumbeckaite *et al.,* 2015; Hellner *et al.,* 2007) is a natural toxin produced in the venom glands of worker and queen honeybees (Schmidt and Buchmann 1999) and is essential for the defence of bee colonies.

Honey bees are not only skilled nectar gatherers but also efficient pollinators. Honeybees endow pollination service by transfer of pollen from anther to stigma enabling many ovules to get fertilized and by virtue of which crop quality and productivity were enhanced and also supports plant biodiversity. In angiosperm about 80 per cent crops rely on insect pollination and known as entomophili. Out of which most of the plants rely on bee pollination and are called mellitophily plants. Pollination process is crucial in the fertilization for seed/ fruit setting of wide range of crops, including vegetables, fruits, clovers, oilseeds, alfalfa, nuts and flower seeds. Understanding honey bees and their diverse products reveals a fascinating interplay between nature and human industry.

Importance of honey bees can be divided in to 3 sub heads

1. Honey bee as an efficient pollinator
2. Bee-hive produces
3. Employments

1. Honey Bee as an Efficient Pollinator

Honey bees are critical to agriculture and ecosystems due to their primary role as pollinators, which significantly enhances the productivity of numerous crops. Their efficient pollen transfer facilitates cross-pollination which is essential for the reproduction of many angiosperms to produce fruits, vegetables, nuts and seeds. This pollination activity directly supports agricultural yields and biodiversity, emphasizing the honey bee's vital contribution to global food security and ecological health (Klein *et al.*, 2007). Assessing the economic impact of bee pollination highlights its significant role in global agriculture. Honey bee pollination services are vital for improving crop quality ad yields with substantial economic benefits. Gallai *et al.* (2009) estimated that the global economic value of pollination services provided by bees and other insects ranges from $235 billion to $577 billion per year, underscoring their importance in maintaining agricultural productivity and food security. Furthermore, the U.S. Department of Agriculture (2017) reports that honey bees contribute about $15 billion annually to the U.S. agricultural sector through their pollination activities, demonstrating their essential role in both crop production and broadening the economy. Honey bee pollination has been shown to significantly enhance quality and yield across a wide range of crops. Some examples are as follows.

- **Almonds**: Honey bee pollination is critical for almond production with studies showing an increased yield by 40-50 per cent due to augmentation of bee pollination services (Morse & Calderone, 2000).
- **Blueberries**: Honey bees' pollination improves blueberry fruit set and size and an increased productivity of 25-40 per cent in commercial orchards (Gong *et al.*, 2013).
- **Apples**: Honey bees' pollination increases apple fruit set and weight, leading to yield improvements of up to 25 per cent (Nicolson & Thornburg, 2007).
- **Cherries**: Honey bees' pollination influence fruit productivity and enhance cherry fruit quality, with increases of approximately 20 per cent in some studies (Klein *et al.*, 2007).
- **Cucumbers**: Research data of cucumber pollination by honey bees showed that 20-30 percent fruit quality and productivity were enhanced (Free, 1993).
- **Pumpkins**: Honey bees' pollination increase pumpkin fruit productivity up to 50 per cent and enhance fruit quality (Mayer & Lunden, 1986).
- **Watermelons**: Honey bees' pollination increased watermelon fruit productivity up to 35 per cent and also enhance fruit size and quality (Hendrickson *et al.*, 2005).

- **Melons**: Honey bee pollination enhances melon fruit set and quality, leading to an increased yield of about 20 per cent (Cunningham, 2004).
- **Sunflowers**: Honey bees' pollination in sunflower fields can lead to a 30 per cent raise in seed productivity and enhance oil percent and seed germination (Berg *et al.,* 2013).

2. Bee Hive Produces

Bee hive produces a variety of valuable products each with distinct benefits and uses. Honey, the most well-known beehive product, is utilized for its natural sweetness, antimicrobial properties and has versatile use in culinary and medicinal applications (Molan, 1992). Beeswax, another key product, has a wide range of applications in preparation of comb foundation sheet, bee-wax candle, skincare products etc. due to its natural emollient and protective qualities (Sauer, 2006). Propolis, a resinous substance that is collected by honey bees from different parts of the trees, has been found to possess noteworthy antimicrobial and anti-inflammatory properties, making it useful in natural remedies and health supplements (Pettis & Shimanuki, 1999). Royal jelly, a secretion used to feed the queen bee, is rich in proteins, vitamins and minerals. It is often used in dietary supplements for its purported health benefits including improved skin health and enhanced vitality (Kwon *et al.,* 2016). Bee pollen or corbicula pollen collected from the anther of flowers is valued for its nutritional content and antioxidant properties, contributing to its use as a dietary supplement (Zhang *et al.,* 2014). Royal jelly is rich nutraceutical jelly which has promising health benefits such as boosting immune function, development of ovary, supporting skin health and also has positive effects on metabolic health and its antioxidant properties (Kwon *et al.,* 2016). Bee venom is a natural toxin produced in the venom glands of worker and queen honeybees (Schmidt and Buchmann 1999) has medicinal value and is used for the defence of bee colonies. Beyond getting honey each of these products highlights the economic and health benefits of beekeeping.

Honey: It is prepared by honey bees starting with worker bees gathering nectar from nectar gland of the flowers. The conversion of nectar into honey is a complex process involving several steps that occur both outside and inside the beehive. Following process are involved in honey preparation:

- **Nectar Collection**: Worker bees collect nectar from nectary gland of flower by using their proboscis, which is a specialized mouthpart adapted for lapping up liquids. Nectar is stored in a specialized stomach called the honey stomach or crop (Crane, 1990).
- **Transport to Hive**: Once the honeybee's crop is full, it returns to the hive. During this trip the nectar begins to undergo initial enzymatic changes as it is mixed with bee saliva (White, 1978).
- **Nectar Transfer**: Upon arrival at the hive, the bee regurgitates the nectar and transfers it into hexagonal wax cells in the honeycomb (Crane, 1990).

- **Enzymatic Conversion**: Inside the hive, the nectar undergoes a series of enzymatic transformations. Bees add enzymes such as invertase to the nectar. This enzyme breaks down sucrose in the nectar into simpler sugars like glucose and fructose (White, 1978).
- **Evaporation**: To reduce the moisture content of the nectar and prevent fermentation bees fan their wings vigorously to create airflow, which speeds up the evaporation process. This process reduces the nectar's water content from about 70 per cent to less than 20 per cent (Molan, 1992).
- **Ripening**: As the water content decreases from raw honey, the viscosity of ripened honey increases. This ripening process involves further enzymatic activity, including the breakdown of complex sugars into simpler ones. The honey is then sealed with a wax cap by the bees to complete the maturation process (Crane, 1990).

2.2 Properties: Honey possesses a variety of properties that make it unique and valuable. It is known for its natural sweetness, viscosity and its ability to inhibit microbial growth due to its low water content and acidic pH. Honey also has antioxidant properties which contributes the health benefits (Molan, 1992). The colour and flavour of honey vary depending on the floral sources of the nectar ranging from light amber to dark brown colour and mild to robust flavours (Bogdanov, 2009).

2.2.3 Chemical Composition: The chemical profile of honey is complex and varies with its floral source. However, it contains:

Sugars: Honey is primarily composed of sugars with about 38% fructose, 31% glucose along with minor quantities of sucrose and maltose. (White, 1978).

Water: Water content in honey usually below20% which contributes to its hygroscopic nature (Bogdanov *et al.*, 2004).

Acids: Honey contains organic acids such as gluconic acid, due to which it has acidic pH and also preserves its antimicrobial properties (Molan, 1992).

Minerals and Vitamins: It includes trace amounts of minerals *viz.* Potassium, Calcium, Magnesium and Vitamins such as B2 (Riboflavin) and B6 (Pyridoxine) (White, 1978).

Enzymes: Honey contains enzymes such as diastase (amylase) and invertase, which plays an important role in the breakdown of sugars (Crane, 1990).

2.2.4 Uses of Honey: Honey is a multifunctional substance with diverse applications, starting from cooking and medicine to cosmetic uses. Key uses of honey are given below:

Culinary Uses: Honey is widely used as a natural sweetener in cooking and baking. Its distinct flavour and sweetness make it a popular substitute for refined sugars in recipes. It can be used in sauces, dressings and beverages to add depth and complexity (Molan, 2001).

Medicinal Uses: Honey is renowned for its antibacterial, anti-inflammatory and antioxidant properties. It is often used to treat wounds and burns because of its ability to promote faster wound healing and demean infection. Clinical studies have demonstrated its effectiveness in wound healing (Molan, 1992).

Cosmetic Uses: Honey is commonly included in cosmetic products due to its moisturizing and soothing properties. It is used in face masks, shampoos, lotions to hydrate and improve skin and hair health (Heggers *et al.*, 1988).

Nutritional Supplement: Honey is a source of essential nutrients including vitamins, minerals and antioxidants. It is often consumed as a dietary supplement, as an instant and sustainable energy also promotes overall health (Bogdanov *et al.*, 2004).

Cough Suppressant: Honey is a traditional remedy for coughs and sore throats. Its soothing properties help to alleviate throat irritation. Honey shows promising effect for reducing severity and frequency of cough (Paul *et al.*, 2007).

Allergy Relief: Consuming local honey reduces allergy symptoms by gradually desensitizing individuals to local pollen. However, scientific evidence supporting this claim is mixed (Ernst, 2005).

Preservative: Due to its low moisture content and acidic pH, honey has natural preservative qualities. It has been used in the preservation of fruits and other foods for centuries (White, 1978).

Digestive Health: Honey can aid digestion and soothe gastrointestinal issues. Sometime used in traditional remedies for digestive discomfort and also to improve gut health (Khan *et al.*, 2012).

Energy Booster: The natural glucose in honey provides a quick source of energy and natural fructose in honey provides sustainable energy making it a popular choice for athletes, to active the individuals looking for a natural energy booster (Wong and Li, 2003).

Skin Care: Honey's humectants properties make it a valuable ingredient in skincare products. It helps to retain moisture in the skin and is used in treating various dry skin problems (Heggers *et al.*, 1988).

Bee Wax: The term "wax," is originated from the Old English word "weax," exclusively referred to the wax of the *A. mellifera* in the initial stages of discovery. However, in the early 19thcentury, the term began to encompass other natural substances with similar properties to beeswax such as ozocerite. Beeswax has been regarded as a precious material for many centuries (Tulloch, 1980). The wax of the honey bee has been referred to as humanity's first valuable substance (Callow, 1963). The western honey bee (*A. mellifera* L.) produces a complex lipid-based organic compound known as wax. This natural wax is generated by worker bees through four pairs of specialized glands located on the inner sides of their 4thto 7thabdominal sternites. Beeswax is secreted in the form of scales which is transferred to their mandibles using their forelegs. In their mandibles, the wax scales are chewed and combined with salivary secretions before being used in comb construction. This chewing process transforms the anisotropic texture of the wax scales into isotropic comb wax (Svečnjak *et al.*, 2019).

Beeswax obtained from the wax comb of *A. mellifera* is a complex lipid-based mixture containing over 300 different fractions. It includes hydrocarbons (14%), monoesters (35%), diesters (14%), triesters (3%), hydroxy monoesters (4%), hydroxy polyesters (8%), acid esters (1%), acid polyesters (2%), free acids (12%), free alcohols (1%), and unidentified substances (6%) (Tulloch, 1980).

2.2.1 Uses of Beewax: Here are some notable uses of beeswax.

• Cosmetic products: Beeswax is widely used in cosmetics for its emollient properties, helps to prevent moisture reduction and protect the skin. It is frequently used in lip balms, lotions and creams. Its natural ability to form a barrier on the skin makes it effective in moisture retention (Stern, 2007).

Candle Making: Beeswax is prized in candle making due to its clean-burning properties and pleasant natural scent. It burns longer and more evenly compared to paraffin candles and is less likely to produce soot (Leahy, 2011). The use of these candles in church is a status of elite symbol.

Food Wraps: Beeswax is used to make reusable food wraps, an eco-friendly alternative to plastic wrap. The natural antimicrobial properties of beeswax help preserve food and prevent spoilage (Drewnowski & Almirall, 2009).

Wood Finishes: Beeswax is used as a natural wood finish and polish. It provides a protective coating that enhances the degree of water resistance (Gibson, 2006).

Crafts and Art: In art and crafts beeswax is used in encaustic painting, where it is mixed with pigments to create vibrant and durable artworks. Its ability to hold colour and provide texture makes it a preferred medium for artists (Wilcox, 2008).

Pharmaceuticals: Beeswax is used in the pharmaceutical industry as a base for ointments and salves due to its ability to provide a stable, protective barrier on the skin and also facilitates the controlled release of active ingredients (Soni & Kaur, 2013).

Polishes: Beeswax is used for polishing various products like leather, metal and furniture. Its natural properties allow it to provide a smooth finish and protect surfaces from moisture and wear (Crawford & Roberts, 2005).

Dental Products: Beewax is used as orthodontic wax which helps to protect the gums from the irritation caused by braces and other dental appliances (Kwak *et al.*, 2017).

Pharmaceutical Ointments: Beeswax is utilized in ointments and topical creams due to its ability as a water proof agent which forms a protective barrier on the skin and helps in healing and moisturizing (Miller *et al.*, 2014).

Royal Jelly: Royal jelly is a nutrient-rich secretion by honey bees, specifically by the nurse bees to nourish the queen bee and developing queen larvae. The production process involves several key steps as follows:

- **Secretion by nurse bees:** The worker bees (nurse bees aged between 5 and 15 days) secrete royal jelly from their hypopharyngeal and mandibular glands.

- **Feeding larvae:** All bee larvae are initially fed with royal jelly for the first three days of their life and after this period only those larvae destined to become queens continue to receive royal jelly.
- **Queen bee development:** The continuous feeding of royal jelly to a selected larva triggers its development into a queen bee. The body stature of queen bee is 1.7 times larger than that of the worker bees. Queen has a well-developed ovary and other organs. As fertile female it has12- 15 times longer lifespan compared to worker bees.

Chemical Composition

Royal jelly is a substance which highly nutraceutical in nature with a rich chemical profile. Its composition includes:

Water: Approximately 60-70%

Proteins: 9-18%, including Major Royal Jelly Proteins (MRJPs)

Sugars: 7-18%, mainly fructose and glucose

Lipids: 3-8%, including fatty acids like 10-hydroxy-2-decenoic acid (10-HDA)

Vitamins: B-complex vitamins such as B1, B2, B6, B12, biotin, folic acid, and inositol

Minerals: Trace amounts of Calcium, Magnesium, Potassium, Zinc, Iron, and Manganese

Amino Acids: Essential and non-essential amino acids

All those above components make Royal jelly a unique substance with potential health benefits (Fratini *et al.*, 2016).

2.3.5 Importance and Uses

Royal jelly has significant importance in the hive and has various uses for humans:

In the hive:

- **Queen Bee Development:** Royal jelly's exclusive feeding ensures the growth of a queen bee which is vital for the colony's reproduction and survival.
- **Larval Nutrition:** It provides essential nutrients for the initial growth phase of all larvae.

For humans:

- **Nutritional Supplement:** Royal jelly is marketed as a dietary supplement for its potential health benefits including boosting the immune system, reducing inflammation and providing antioxidant effects (Siavash *et al.*, 2011).
- **Cosmetic Products:** Due to its purported anti-aging properties Royal jelly is used in skincare products to promote skin elasticity and reduce wrinkles.

- **Medicinal Uses:** Royal jelly shows promising results in ovary development and Gynaecologists are suggesting royal jelly for the same. Some studies suggest that royal jelly may help in wound healing, improving cholesterol levels and managing menopausal symptoms (Fratini *et al.*, 2016).

2.4 Propolis: The propolis is collected by only *A. mellifera* species in apidae family. This is commonly referred to as "bee glue," a sticky, resinous substance gathered by honey bees from tree buds, sap flows and other botanical sources. Bees use propolis to seal crevices in the hive, reinforce its structure and protect the colony from harmful pathogens. The production of propolis involves several important steps as follows:

- **Collection:** Worker bees gather resinous materials from various plants including poplar, pine and birch trees.
- **Processing:** The gathered resins are mixed with beeswax and the enzymes which are produced by the bees forming the substance known as propolis (Parolia *et al.*, 2010).
- **Application:** Bees apply propolis to seal the cracks, crevices and gaps in the bee boxes creating a sterile environment that acts as a defence against bacteria, viruses and fungi (Sforcin & Bankova, 2011). It also prevents the entry of gravid female Wax moth into the hives, also prevents the movement of hot air in summer and chilled air in winter season into the hives.

Chemical Composition: Propolis is a complex substance whose composition varies depending on the geographic location and the specific plants available to the bees. Its general composition typically includes:

Resins and Balsams: 50-60%, mainly composed of flavonoids and phenolic acids (Sforcin & Bankova, 2011)

Waxes: 30-40%, **Essential oils:** 5-10%, **Pollen:** 5%

Organic Compounds: Including aromatic acids, esters and ketones (Parolia *et al.*, 2010)

2.4.5 Importance and Uses

Propolis plays a crucial role within the hive and has a variety of applications for humans:

In the hive:

- **Antimicrobial Properties:** Propolis helps in maintaining a sterile environment inside the hive, protecting the bees from the pathogens.
- **Structural Integrity:** It strengthens the hive structure and seals openings cracks, crevices to prevent entry of enemies and environmental elements.

For Humans:

- **Medicinal Applications:** Propolis is highly regarded for its antimicrobial, anti-inflammatory and antioxidant effects. It is frequently employed for treating wounds, burns, and infections (Sforcin & Bankova, 2011).

- **Oral Health:** Propolis is used in dental care products such as toothpaste and mouthwash which helps in preventing cavities and gum disease (Parolia *et al.*, 2010).
- **Dietary Supplements:** It is marketed as a health supplement to support immune function and overall well-being.
- **Cosmetic Applications:** Due to its skin-benefiting properties, propolis is included in skincare products to aid in healing and to protect against infections (Sforcin & Bankova, 2011).

2.5 Bee Pollen: Bee pollen (corbicula pollen) is gathered from the anthers of various flowers. It is an essential part of the bees' diet and plays a crucial role in their nutrition. The production and collection involve several steps:

- **Collection:** Worker bees collect pollen from anthers of flower of various angiosperms by using specialized structures called corbiculae or pollen baskets which are on their hind legs (Krell, 1996).
- **Processing:** The collected pollen is mixed with nectar and bee saliva to form pellets. These pellets are then transported back to the hive.
- **Storage:** Inside the hive, the pollen pellets are stored in hexagonal cells of the comb near the brood area for their feeding (Friedman, 2014).

2.5.4 Chemical Composition

Bee pollen is a highly nutritious substance with a diverse chemical composition that varies depending on the plant sources. Its general composition includes:

Proteins: 20-35% of its dry weight, containing essential amino acids (Haydak, 1970).

Carbohydrates: 30-55%, mainly sugars such as glucose, fructose and sucrose (Pérez *et al.*, 2017).

Lipids: 2-10%, including fatty acids such as linoleic acid and oleic acid (Gorinstein *et al.*, 2001).

Vitamins: Bee pollen contains elevated amounts of B-complex vitamins such as B1, B2, B3, B5, B6, and B7 along with vitamins A, C and E (Santos *et al.*, 2018).

Minerals: Includes Calcium, Magnesium, Potassium, Iron and Zinc (Khalil *et al.*, 2018).

Phenolic compounds: Includes flavonoids and phenolic acids contributing to its antioxidant properties (Tsvetkov *et al.*, 2009).

Importance and uses

Bee pollen is valued for its nutritional and therapeutic properties. Its importance and uses include:

In the hive:

- **Nutritional Source:** Bee pollen serves as a vital protein and nutrient source for the colony, especially for the developing brood (Krell, 1996).

For humans:

- **Nutritional Supplement:** Bee pollen is used as a dietary supplement due to its high nutrient content and potential health benefits such as enhancing energy levels and overall well-being (Friedman, 2014).
- **Antioxidant Properties:** The phenolic compounds in bee pollen have antioxidant effects which protect the cells from oxidative stress and reduce inflammation (Tsvetkov *et al.*, 2009).
- **Skin Health:** Due to its vitamin and mineral content, bee pollen is used in skincare products to promote healthy skin and support healing (Santos *et al.*, 2018).

2.6 Bee Venom: Bee venom is a sophisticated substance produced by honey bees mainly for defence. It is secreted by the venom gland and injected through the stinger. The production process involves:

- **Venom Production:** The venom is produced by venom gland which is located in the abdomen of worker bees (Kwak *et al.*, 2003).
- **Storage:** The venom is stored in the venom sac which is connected to the stinger.
- **Injection:** When a bee stings, it injects beevenom into the target through the stinger (Lattin, 1993).

Chemical Composition: Bee venom is an intricate blend of proteins, peptides, and various other compounds. Its general composition includes:

Melittin: A peptide that constitutes about 50% of the venom's protein content and is responsible for most of its inflammatory effects (Lattin, 1993).

Phospholipase A2: An enzyme that breaks down phospholipids in cell membranes contributing to the inflammatory and pain-inducing properties of beevenom (Kwak *et al.*, 2003).

Hyaluronidase: An enzyme that facilitates the spread of venom by breaking down hyaluronic acid in connective tissues (Lattin, 1993).

Adolapin: A peptide with anti-inflammatory properties that can modulate immune responses (Kwak *et al.*, 2003).

- **Storage:** The venom is stored in the venom sac which is connected to the stinger.

Apamin: A neurotoxin that affects ion channels in nerve cells contributing to the venom's pain-inducing properties (Lattin, 1993).

Importance and Uses

Bee venom has significant biological and therapeutic applications due to its complex composition:

- **For Honey Bee:** Bee venom serves as a defence mechanism against predators, protecting the hive from threats (Lattin, 1993).

For Humans:

- **Medical Treatments:** Bee venom therapy or Apitherapy is used for treating conditions such as arthritis, multiple sclerosis and chronic pain due to its anti-inflammatory and analgesic properties (Kwak *et al.,* 2003).The components of bee venom such as melittin and apamin are studied for their potential to develop new treatments for various diseases including cancer and neurological disorders (Lattin, 1993).
- **Cosmetic Applications:** Bee venom is used in skincare products for its purported anti-aging and skin-rejuvenating effects (Kwak *et al.,* 2003).

3- Employments

In India, as the population increases the demand for employment also increases. Beekeeping can provide employment to a large population because it has vast potential for employment particularly for the rural people. To maintain 10,000 bee colonies about 3,00,000 man days are required. Besides this, it also opens other ways for employment viz. manufacturing of appliances, processing, packaging and marketing sectors of beehive produces.

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Chapter-4

Role of beekeeping and pollinators in Livelihood Security

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Introduction

Beekeeping is an agricultural practice that generates various products. It serves a wider range of functions that benefits plants, animals, humans and ecological systems. Pollination is a valuable ecosystem service and also of high economic value through enhanced agricultural production especially of fruits, seeds, vegetables, fibre crops and nuts (Costanza *et al.*, 1997; Gordon and Davis, 2003). Interestingly, most of the crops benefited from bees are sources of protein and fat, the nutrients our people need most. Over the past decade, the international community has increasingly recognized the importance of pollinators as an element of agricultural diversity supporting human livelihoods. Yet mounting evidence points to a potentially serious decline in populations of pollinators. Several studies have attempted to estimate the economic value of honey bee pollination to agricultural production. The value of insect pollination for worldwide agricultural production is estimated at 153 billion $, representing 9.5% of the value of the world agricultural production used for human food in 2005 (Gallai *et al.*, 2009).

Many studies have focused on the role of beekeeping in enhancing food security. Bee improves food security through pollination. It increases crop yields and promotes diversity. Beekeeping as the process of rearing bees for commercial purpose and primarily obtaining products such as wax, pollen, propolis and honey. Arguably, most communities keep bees for the purpose of honey, but in the process, other repercussions such as pollination, ecological benefits and diversification of agricultural practice are attained (Etxegarai-Legarreta & Sanchez-Famoso, 2022; Patel *et al.*, 2020; John *et al.*, 2017). For instance, Klein *et al.* (2006) affirm that honeybees are considered the most important pollinating agents globally due to their efficiency and ability to navigate across the globe. Besides, they play a critical role in pollinating for food production. Apiculture utilities can be classified into three broad categories: ecological, social cultural and social economic. Each of the tenets has been broadly studied and the outcomes are forthcoming. Aryal *et al.* (2020) important role of the pollination performed by wild animals including bees. The outcome indicated that they play a vital role in ensuring the ecosystem balance, primarily by increasing the pollination rate. The process is essential because it improves flora biodiversity, increases the variety of seeds and plants, which provides food to wild animals and lessens repercussions of soil degradation.

Apart from crop production, horticulture production and dairy production, there are other businesses in India to promote agricultural production which are helpful in promoting the economy of India, one of them is apiculture, which we can earn millions of rupees by installing from small to big level. It also plays an important role in providing employment to the unemployed people. Beekeeping is one such enterprise that is very less costly and can be used by every class of farmers whether they are small or big or landless farmers to increase their

income. We can get a variety of products from bees such as honey, beeswax, bee propolis, royal jelly and bee venom etc. And by selling them in the market, you can get an income of lakhs. In addition to these, beekeeping also plays an important role in increasing agricultural production and horticulture production, as bees carry out pollination activity in flowers, giving an additional one-fourth increase in crop production.

Role of Pollinators

Pollinators provide pollination services that are crucial for enhancing crop productivity and sustaining ecosystem services. Honeybees are the important pollinators of various fruits, vegetables, oilseeds, pulses and fibre crops. In order to achieve sufficient pollination to improve productivity of crops, beekeeping industry needs encouragement. The status of pollinators is a matter of national interest because the lives of over 200,000 plant species worldwide depend on pollination, the process by which pollen grains, containing male sex cells, are transferred to stigmas, or female floral parts, to bring about fertilization, a necessary step in producing seeds. Pollen delivery presents a challenge to flowering plants, most of which spend their lives rooted to the ground and approximately three-fourths of them rely on mobile animal partners, pollinators to achieve this end.

Honey bees are the most important pollinators as their complete colony depends on the plant for various products like wax, nectar, honeydew etc. Plants that provide nectar to honey bees are called nectariferous bee flora. While some plant provides both nectar and pollen to honey bees Bhalchandra, (2014); Waykar *et al*., (2014); Pande and Ramkrushna, (2018). According to Ollerton, *et al.*, (2011), 87.5% of plant species are pollinated by animals and bees have a major role in the agriculture, with this 5% of plant species depends only on bees for pollination service, without complete information we cannot utilize this efficient flower visitor to enhance pollination. Example: Onion flowers are not capable of self-pollination because it has protandry conditions. These flowers require pollination by wind and animals. Honey bees contribute 87% of pollination in onion crops, also increases onion bulb growth, size and production of seeds (Saurabh Padamshali and S. K. Mandal, 2018).

Beekeeping and Livelihood

Apiculture and related trades can be sources of valuable strength to countless numbers of rural people's livelihoods. Rather than just a 'hobby', beekeeping may be seen as an important occupation and part of rural life worldwide. Beekeeping tends to be perceived as 'a hobby', or as 'a side-line activity'. These descriptions may often be true, but a resilient livelihood, one that keeps people out of poverty, is one that has access to a range of options. In rural communities where access to income is limited, small-scale beekeeping can contribute significantly to livelihood security. Apiculture and related trades tends to be underplayed in both policy and planning. One reason may be the focus of rural development, wherein crop production and livestock rearing are taken to be dominant activities in rural areas. This perspective can render invisible the part beekeeping occupies in social life, culture and local economies (FAO 2009).

Beekeeping as a Business Enterprise and Market Potential

Beekeeping is a lucrative trade even using simple management techniques, but needs to consider local culture and economy for it to be successful. Beekeeping as an enterprise fits in very well with small- scale farmers' livelihoods. It is not invasive; bees work along the natural patterns of local agro-ecological zones and provide positive impacts to the fauna and flora found within. It is an enterprise that can provide for employment, income and economic security for the farm family and others in rural areas. It requires little start–up investment, does not require complex technologies and techniques to start with and bees usually look after themselves with little need for tendering. Bees provide a plethora of products (honey, wax, pollen, royal jelly, propolis, venom etc.) and are well known in many local markets. This provides a portfolio of products that a small-scale farmer can sell from a single farm enterprise. These products can also be 'transformed' into value added products with minimal processing, for example wax can be processed into candles, and honey can be made into mead (honey beer) (FAO 2006 a and FAO 2003).

Benefits of the Livelihood Activity

Household Level Beekeeping

Beekeeping is a family undertaking in a many countries, where men provide for honey harvesting, while women and children tend to extraction and processing of honey. However, the family can successfully use beekeeping as a livelihood enterprise. It can be located around the farm household; it does not require excessive labour and time to manage, as bees do the majority of the work. The family women do not have to travel far to tender the enterprise and it can be a ready source of cash in times of need, as bee products can be sold to neighbours or in local markets. This enables women to be part of an economic activity, which can provide them with income and an independence that can support them in difficult times. It is also a flexible activity, where there is no need for constant tendering, for example as with livestock and crops, and hence allows women to follow other matters on farm as well.

Integrated Farming System

Beekeeping fits in very well to small scale farming systems. Beekeeping does not require land to be owned and/or rented and soil fertility is not an issue to consider. Feed is also not an issue as they forage on otherwise unused resources: nectar and pollen. In other words beekeeping does not compete for other resources needed by livestock and crops. Bees complement crops with their pollination of farmed crops and this in turn can increase crop yields. Some crops, for example that benefit from pollination services are sisal, cashew, papaya, coconut, oil palm, citrus, sunflowers and clover. Some of these also provide to be good nectar sources for bees. Many of the inputs required for beekeeping can be sourced and made locally and do not impinge on other farm activities and required investments. Products that derive from a beekeeping enterprise use little or any farm inputs, apart from labour in harvest and processing periods. Beekeeping have been in practice for many years. By introducing beekeeping as a business and building on pre-existent skills will improve the knowledge and capacity of small-scale farmers (FAO, 2011).

Benefits of Honey in Diet for Human Health

Bee products provide for improved nutrition and consequently better health for farm families and others in local communities. Honey is a useful source of high-carbohydrate food, and commonly contains a rich diversity of minerals, vitamins and others, adding nutritional variety to human diets (FAO, 2009). Honey provides for improved physical performance, resistance to fatigue and improved mental efficiency (FAO, 2006a). Honey also is said to improve food assimilation (FAO, 2006a). It is commonly indicated as a 'lifesaver' for people in critical health (CTA, 2005b). Pollen also contributes to nutrition; however pollen that is consumed needs to derive from different plant sources to provide various nutrients to humans. Pollen contains a range of constituents: 30 per cent protein, including all amino acids, a full spectrum of vitamins and minerals, lipids, trace elements, etc. (FAO, 2009) Propoils is mainly consumed for its medicinal value, while royal jelly is claimed to provide, very much like honey, increased physical resistance and improved intellectual performance. However these properties have not been confirmed by scientific evidence. Bee brood and adult bees are consumed in many countries and in some are considered as a treat. Brood and adult bees contain reasonable amounts of protein (FAO, 2006a).

Components of Various Bee Products

Components and weight in %					
Product	Water	Protein	Fat	Carbohydrates	Ash
Honey	17 - 21	0.4	0	79 - 83	0.1
Pollen	25 => 11	22	5	31	3
Bee bread	20 => 14	20	3	24 - 35	3
Royal jelly	67	11	6	9	1
' => ' refers to the moisture content after drying					

Source: CTA. 2005. Bee products; properties, processing and marketing, Agrodok No. 42, Wageningen, the Netherlands.

Honey Processing in Farm Level

Beekeeping and its products, by their very nature, require on farm processing prior to being sold. This provides for opportunities in learning new skills and subsequent capacity building in small-scale farmers in terms of primary processing for example cutting honey comb, extracting honey and honey filtering. This is a first step in setting up a processing enterprise on farm. Moreover with some minimal training small-scale farmers can learn valued-added processing methods for bee products, referred to as secondary processing (FAO, 2009). This can produce such value-added products as honey sweets, honey soap and so forth. This importantly demonstrates to small-scale farmers that on farm processing, pending on market demand, can be an important source of value-added and increased income. Processing is not only important for higher incomes, but also for food security and availability. Bee products that have been appropriately processed are available year round for farm family consumption, but also for consumption by customers in local communities (FAO, 2011).

Benefits of Farm Level Honeybee

Some of the benefits of enhanced biosecurity management to the industry and individual honey beekeeping operations. It may be improved food security through the supply of healthy crop pollinators, better honey production and pollination by stronger colonies. It reduced losses and economic impacts from pests, risk of exposure, introduction, and spread of pests. To improved domestic and international marketability of honey bees and bee products and a marketing advantage if selling used equipment or providing pollination services (FAO, 2011).

Social Benefits

Bees provide benefits to many within rural livehood communities. This is improved crop yields as a result of pollination by honeybee, to improved food and nutrition, an assured supply for traditional medicine and improved community health. In many cultures bee products are valued in festivals and other ceremonies, such as birthdays and marriages (FAO, 2009). This reinforces social ties and traditions. Once more advanced beekeeping methods have been understood and practised for sometime it is not uncommon to find training in beekeeping methods conducted by farmers for younger people in the community.

During some beekeepers visits observed, local schools give practical demonstrations to students. Beekeeping can also create social benefits as for example when small-scale farmers join together to form an association, either formal or informal. This collaborative work, which fits in very well with beekeeping, especially during honey harvest time, can create scope for working together within a community and the people involved can see and experience the advantages and benefits of collaboration and social harmony.

Conclusion

Beekeeping is an old tradition method in India that is used to produce honey, bee wax and other products, in modern times after understanding the relationship between honeybees and crop pollination, beekeeping is united with agriculture by various farmers. In onion seed production flowers require pollination by wind and animals. Honeybee contributes 87% of pollination in onion crops, also increases onion bulb growth, size and production of seeds. Honeybees are the important pollinators of various fruits, vegetables, oilseeds, pulses and fibre crops. Beekeeping also help in other ways as pollinators, are regularly declining due to several factors like pesticides pathogens, parasites, environmental changes, habitat fragmentation, habitat degradation etc. We can use bees to compensate for this loss, damage control, restoration of the ecosystem. Honey is a useful source of high-carbohydrate food and commonly contains a rich diversity of minerals, vitamins and others, adding nutritional variety to human diets. Pollen also contributes to nutrition; however pollen that is consumed needs to derive from different plant sources to provide various nutrients to humans. Pollen contains a range of constituents: 30 percent protein, including all amino acids, a full spectrum of vitamins and minerals, lipids, trace elements etc.

Beekeeping in Village

Pollination in Onion seed production

Farm level training

Honey Extraction

Reference

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Chapter-5

Bee Management

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Bee Management

Four Pillars of Successful Beekeeping

Good bee-forage, Good beekeeping equipments, Good training and Good Management are the four pillars of successful beekeeping.

Routine Management

The following bee equipments are required during Colony Inspection:

1. Bee veil: A Protective head gear used during colony inspection to protect the beekeeper from bee stings on the face and neck.

2. Smoker: A metal container with attached bellows to generate smoke. It is used to control aggressive behavior of bees during colony inspections. Materials like dried leaves, cotton cloth, etc. can be used to burn the smoker.

3. Hive tool: It is used for cleaning of bottom board etc.

4. Hand gloves: It is protective hand glove used while operating a bee colony.

5. Uncapping Knife: A stainless steel knife used for uncapping the sealed wax capping of ripe honey prior to extraction.

6. Swarm Net: It is used to capture swarm bees from the forest to start a new bee colony. It is used usually made of cotton/nylon materials and open at one side and cylindrical in shape.

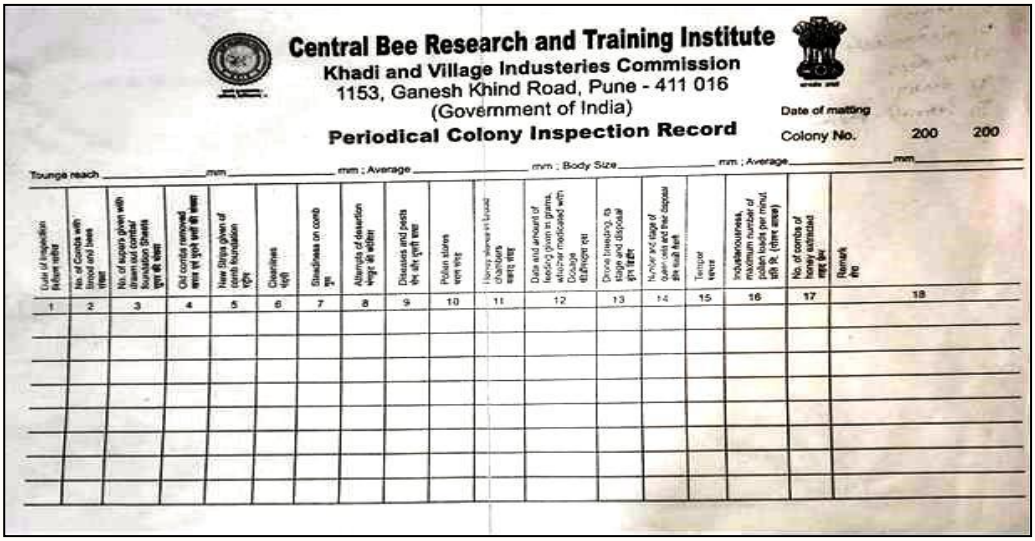
7. Brush: It is used to brush off bees from their comb for easy hive operation and also for cleaning the hive. The tip of the brush must be soft enough to protect the bees and not injure them.

Bee hives, nuclei and extractor are the most important amongst the beekeeping equipments. Bad quality hives instigate bees to sting. In modern beekeeping, a beekeeper is required to interchange hive parts from one colony to another. This is particularly so, while uniting or dividing colonies, extraction of honey and replacements of super frames and super chambers, adding supers to strong colonies during flow period etc. All the hives parts, and particularly the frames, should be manufactured as per standards prescribed by the Bureau of Indian standards. Before opening a colony, a beekeeper should be properly dressed. A bee-veil, full pant and a full shirt with loose fitting are desirable. Shoes, paint rolled in socks and wearing veil is advisable. This prevents stinging at odd places and facilities easy movement, with above outfit and a smoker in one hand and hive tool in another, a beekeeper is well armed without a fear of getting stung.

Colony Inspection

Inspection of Bee colonies at periodic intervals is routine management. There is no hard and fast rules about the period between two inspections. Depending upon the floristic and climatic conditions, the frequency of colony inspection should be determined.

Generally a colony may be inspected once in a fortnight. During swarming period however, a colony needs to be inspected on every 5th day, while during dearth period or adverse climatic conditions a colony may not be disturbed for even a month or so.



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(Government of India)
Periodical Colony Inspection Record

Date of mating
Colony No. 200 200

Tounge reach _____ mm _____ mm ; Average _____ mm ; Body Size _____ mm ; Average _____ mm

Date of inspection	No. of Combs with brood and bees	No. of supers given with drawn out combs/ foundation sheets	Old combs removed	New Strips given of comb foundation	Cleanlines	Steadiness on comb	Attempts of desertion	Diseases and pests	Pollen stores	Honey stores in brood chambers	Date and amount of feeding given in grams, whether medicated with Dosage	Drone breeding, its stage and disposal	Number and stage of queen cells and their disposal	Temper	Industriousness, maximum number of pollen loads per minut	No. of combs of honey extracted	Remark
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

A record chart is maintained and entered every fortnight (after every 15 days) of once visit to each bee colony. Record keeping should include information on performance of the respective colonies like,

1. Date of Inspection.
2. No. of combs with brood and bees.
3. No. of Supers given with drawn out combs/foundation sheets.
4. Old combs removed.
5. New strips given of comb foundation sheets.
6. Cleanlines.
7. Steadiness on comb.
8. Attempts of desertion.
9. Diseases and Pests.
10. Pollen Stores.
11. Honey store in Brood chambers.
12. Date and amount of feeding given in grams, whether medicated with dosage.
13. Drone breeding, its stage and disposal.
14. Number and stages of queen cells and their disposal.
15. Temper.
16. Industriousness maximum number of pollen loads per minute.
17. No. of combs of honey extracted.
18. Remarks.

Special Bee Management

During routine colony inspection, a beekeeper may come across a situation in a colony that warrants some corrective measures or special management. Some of such common special management practices are described below:

1. Comb Foundation Sheets: Honey bees consume about 10 to 15 kg of honey to secrete 1 kg. of beeswax for constructions of combs. In modern beekeeping, techniques of preserving of combs and increasing the life of combs so as to conserve honey stores, energy and time of the bees are practiced. If we carefully observe the natural comb, constructed by the bees, we notice that there is a thick mid- rib at the base of the comb on which on both sides hexagonal cells are constructed. The mid-rib is the foundation of comb and needs good amount of wax.

2. Sugar Feeding: When the honey store in the colony is not adequate and at the same time there is no income of nectar, the colony needs sugar feeding for maintenance. Similarly during colony multiplication, after migration and during comb building period colony should be fed with sugar syrup. Sugar and water is equal proportions (50:50) is desirable in all seasons except during winter. One kg. of Sugar and one litre of water makes sugar syrup of 50 per cent concentration. If weighing balance is not available one cup of sugar and same cup of water also makes 50 per cent sugar syrup. Good white crystal and clean drinking water should be used to prepare sugar syrup.

3. Pollen Supplements: Pollen availability is necessary for commencing the egg laying by the queen. Various substitutes for pollen were tried by the bee scientists for feeding the colonies during pollen dearth periods. These included roasted gram powder, milk powder, honey etc.

4. Colony Division: In the month of February and March in South India and in the month of March and April in North India, plenty of nectar and pollen are available. This is the period when most of the colonies prepare for swarming. In the strong colonies in the apiary, swarming signs are seen earlier compared to other colonies. The signs are overcrowding, cluster of bees near the entrance, egg laying even in super chamber and constructions of drone brood patches on brood frames. It is therefore better to divide the colony earlier and satisfy the natural instinct of swarming in the colony.

5. Uniting: During swarming period, many colonies are divided and there are virgin queens in those colonies. During orientation or mating flights, at times accidentally, queens are lost and the colony becomes queen less. During routine colony inspection also, very rarely, we come across a colony that has lost its queen. The colonies without queens have no existence and such colonies are required to be united with queen right colonies so that the bees and the brood in such colonies are profitably utilized.

6. Queen Introduction: For rapid development of colony and for higher honey production, young and prolific queen is a basic need. Many commercial beekeepers conduct queen rearing or bee breeding programmes and produce quality queens. A small beekeeper, whenever possible, should procure such type quality queens and introduce them in their colonies after removing old or failing queens.

7. Robbing: During nectar dearth period, string colonies are tempted to attack weak colonies and rob their honey stores. This behaviour is predominantly seen at the end of honey flow season.

8. Desertion : Young prolific queen, newly drawn combs, presence of eggs, larvae and Sealed brood and good stores of honey and pollen is an ideal condition of a colony. Such colonies do not desert. But if there is shortage of food, if colony is inspected off and on or if it is disturbed by pests and predators, the bees desert the hive and settle somewhere.

9. Migration: Abundance of nectar and pollen yielding plants, flowering sequentially round the year in any locality is very rare. Migration of bee colonies to places, where abundant flora is available i.e. migratory beekeeping, is always profitable than stationary type of beekeeping. There are two type of migrations, (a) Short distance or local migration within 10 to 15 km radius. and (b) Long distance migration above 100 km for colony multiplication and honey production purpose.

10. Protection of Colonies from Insecticides: When modern beekeeping was introduced in India, the beekeeping extension programme was mainly undertaken in forest areas and the beekeepers never faced the problems of pesticides or pollution of air, water etc. Bee management techniques gradually developed, migration of bee colonies from forests to nearby agricultural areas became a routine management practice in many parts of the country. Thousand of bee colonies are now regularly migrated from forests to farms and vice-verse for taking advantage of agricultural and horticultural crops. Many of these crops are regularly sprayed with different pesticides as a routine agricultural practice. Along with harmful insects, useful pollination insects like honeybees also get destroyed due to indiscriminate uses of pesticides. A farmer will always try to protect his crops from harmful insects using pesticides etc. Beekeepers should take care of his colonies by taking into confidence the farmers and impressing upon them the utility of honeybees in increasing the crop yields through crop pollination. Further, following precautions may also be taken by the beekeeper to protect his colonies.

1. The Farmers may be persuaded to use pesticides that are less harmful to bees and in concentrations recommended by the manufacturer and Agriculture officer.

2. Dusing is more harmful to bees and may be avoided as for as possible.

3. Previous intimation may be obtained from farmers about spraying details.

4. Spraying during flowering should be avoided. It should be done prior to flowering of the crop and then after the flowering period is over.

5. Spraying may be done in the evening after sun set.

6. Colonies may be temporarily shifted if heavy spraying schedule is fixed.

7. If shifting of colonies is not possible, the colonies may be fed with 200 ml. sugar syrup. The gate may be closed using wire screen for the day of spraying.

8. Colonies may be covered with gunny cloth. One end of the gunny cloth should be hanging over the entrance gate.

Seasonal Management

1. Monsoon Management: At the end of main honey flow season, enough honey may be left in the hive alive during the monsoon dearth that follows. The colony must be well protected from rain and wind, from enemies attempting to enter the hive and from unhygienic condition that can present great problems later. A reversible bottom is very useful in monsoon period. After every week the bottom board should be dried and reversed. This reduces wax moth infestation and unhygienic condition.

2. Winter Management: A beekeeper will learn by experience how much pollen and honey his colony need to survive the winter dearth. Colonies must be checked to make sure that they have adequate stores, if not; about 300 to 500 ml of thick sugar may be fed to colonies in the evening. The hives should be well protected from winter rains and strong winds. The colonies should be inspected once a fortnight without much disturbance.

3. Migratory Beekeeping: The most commercial or semi-commercial beekeepers undertake local or long distance migrations, moving colonies to new pollen and or nectar sources in the region. In tropical countries honey flow or swarming seasons often alternate in forests and agricultural areas. Migratory beekeeping is therefore especially profitable in transitional belts of forests and farms for survival, strengthening, increasing the colony number and/or honey production.

A commercial beekeeper with large number of bee colonies at his disposal and following migratory beekeeping has an advantage to conduct selective breeding programme. He should keep record of all bee colonies about their performance round the year. From this data he should select about 5 to 10 per cent bee colonies having combination of desirable characters such as high honey yield, industriousness, high egg laying capacity of queen ,resistance to disease etc. and categories them as drone breeders and queen breeders.

Honey Flow Management

Management of bee colonies for flow and during flow is also an important aspect of modern beekeeping.

1. Uniting of Weak Colonies

It is always advisable to have few strong colonies than to have large number of week colonies at the time of commencement of honey flow season. Two week colonies do not makes as much honey as one strong colony makes. If there are few week colonies, they may be united. Removal of old or failing queen and mixing the bees and brood with another colony is one simple method. Removal of old queen and mixing bees with one colony and brood frames with another colony is another method of making two colonies strong from one colony.

2. Super Chambers

If the queen is less than one year old, the colony normally does not try to swarm but start storing honey. On such colonies, a super chamber withdrawn out super frames with comb foundation may be added. The total number of honey frames in the super may be one less than the capacity

of the super chamber. The frames may be equally spaced to cover the entire width of the chamber. These complete bees to increase the depth of the combs, little outside of the frames, resulting into bulging of the comb. It is very convenient to uncap such bulged super frames at the time of honey extraction.

Adequate Ventilation

The nectar collected by the bees has about 40 per cent sugar and 60 per cent water. Bees reduce the water content to about 20 per cent and then cap the honey cells. During brick honey flow period, therefore, the bee-hive should have adequate ventilation to remove the moisture generated in the hive in the process of conversion of nectar into honey.

1. Honey Extraction

Honey should be extracted when more than 75 per cent of cells in the honey frames are sealed with wax by the bees. Sealed honey is ripe and does not ferment when properly stored.

2. Preservation of Drawn Out Supers

The drawn out super frames are very valuable material for the beekeepers. In the next honey flow season, these can be used and ready drawn out super frames are available to the bees to immediately start storing honey in them. After extraction of honey, super frames should be stored carefully so that they are not broken or attacked by wax moths.

3. Preventing Robbing

The end of the honey flow season is the time for robbing. Strong colonies at times attack weak colonies and rob their honey. Robbing tendency is very seldom or nil during peak honey flow season and is often observed after the end of flow. The timing of honey extraction and colony inspection should be carefully determined to avoid robbing and fighting.

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Chapter-6

Diversification in Apiculture for Livelihood Security

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Introduction

Dependence of entrepreneurship on single product is always having risk of reduction in profitability because of price fluctuation or reduction in demand for the product or increase in competition for the product. Therefore, diversification is very important. As in agriculture, now a days the focus is also on diversification in apiculture. The scope of diversification in apiculture (Table 1) lies in the production of royal jelly, pollen, propolis, bee venom, queen bees, etc.

Table 1: Potential of diversification in Apiculture with *Apis mellifera*

Hive product	Yield/colony
Honey	50 kg
Beeswax	800 g
Pollen	4 kg
propolis	300g
Royal jelly	800 g
Bee venom	500 g

Mass Queen Bee Rearing: Apart from the above mentioned hive products queen bees can also be a good source of income from apiary. Since queen bees in honey bee colonies need to be replaced about every year to maintain colony productivity, there is great scope of rearing large number of good quality queen bees for selling to other beekeepers. The most commonly followed technique for mass queen bee rearing is Doolittle or Grafting method which is described below:

In this method artificial queen cell cups made of beeswax or plastic are used. These cell cups are primed with royal jelly and then the larvae of less than 24 h from selected colonies are grafted into them. This method involves following steps :

i) Preparing Queen Cell Cups : Pure bees wax and a mandril (cell cup forming stick) 9-10 mm diameter are required. Melt beeswax indirectly heating it through a water bath. Dip the mandril into honey water solution. Then dip the mandril into the molten wax to a depth of maximum 10 mm for a while and take it out. A layer of beeswax will be deposited on it. Repeat the process thrice but every successive dip into molten wax should be lesser than the previous dip. When the wax solidify on surface of mandril give a twist with fingers and thumb to remove the cell cup from the mandril.

ii) Fixing Cell Cups on Bars of Queen Rearing Frame : Pour molten beeswax on bars of queen rearing frame before fixing queen cell cups. The prepared queen cell cups are then fixed on wooden cell bars of the queen rearing frame with the help of molten beeswax.

iii) Grafting of Larvae : Larvae of less than 24 hours age are taken out on a grafting needle/tool tip and is then transferred into the queen cell cups one in each cell cup. Grafting of larvae can be done after priming the queen cell cup with royal jelly or without priming the cell cups.

iv) Giving Queen Rearing Frame with Grafted Larvae into Cell Builder Colony: The frame with the grafted larvae is then given to the queenless cell builder colony prepared 24 hours earlier. The combs in cell builder colony are arranged in the following pattern:

H S S E Y C P E S H

where

H = Honey comb

S = Sealed comb

E = Emerging bees comb

Y = Comb with young larval brood

C = Frame with queen grafted larvae in cell cups

P = Pollen comb

v) Transplanting Queen Cells: As a large number of queen cells are prepared in this process simultaneously, prepare required number of mating nucleus colonies, 24 hours before transplanting sealed queen cells into these nuclei. Remove the sealed queen cells from the bars of queen rearing frame cell builder colony and transplant in the brood area of mating nuclei.

Royal Jelly: Royal jelly is a mixture of secretions from hypophrangeal glands and mandibular glands in 1:1 ratio. Royal jelly is produced by nurse worker bees and is fed to larvae destined to be queen bees and also fed to adult queen bee. Royal jelly is a creamy milky white, strongly acidic, highly nitrogenous substance and somewhat sour in taste. Royal jelly is never stored in the honey bee combs. Technology for royal jelly production is similar to mass queen bee rearing technique.

i) Royal Jelly Production Technique: Royal jelly commercially is produced in queenless strong honey bee colonies. For commercial production of royal jelly, Doolittle or grafting technique is the best. PAU has standardized the royal jelly production using Doolittle Method of mass queen rearing technique. For royal jelly production in *A. mellifera* colonies, less than 24 hour old worker larvae grafted in 120 queen cell cups during spring and in 60 queen cell cups during autumn should be given in a 10 bee-frame queen less cell builder colony. Royal jelly should be extracted 72 hours after larval grafting. With this method an *A. mellifera* colony of 10 bee-frame strength can yield about 800 g of royal jelly annually.

ii) Royal Jelly Extraction Technique: Royal jelly is extracted from the queen cell cups 72 h after grafting. The cell walls are cut to the level of royal jelly with the help of a sharp blade and the larva present in the cell is removed with a sterile needle. Then royal jelly is extracted by using a fine brush, non-metallic spatula, an aspirator or motorized suction pump. PAU, Ludhiana has designed and developed a very light weight, portable, cheap and very efficient royal jelly extractor which work with running tap water for vacuum suction and does not need any electricity.

iii) Filtration and Storage of Royal Jelly: Royal jelly must be filtered using a fine nylon net to remove fragments of larval exuvae and beeswax. Fill royal jelly in dark/coloured glass vial or in food grade plastic vials/plastic containers, avoiding any excessive exposure to air and light and immediately store it in a freezer. Storage in deep freezer or freeze drying further increases shelf life of royal jelly. After freeze-drying, the royal jelly becomes extremely hygroscopic and must be protected from the humidity of the environment by storage in an airtight container.

iv) Uses of Royal Jelly : Royal jelly can be sold in its fresh form, unprocessed except for being frozen or cooled, mixed with other products, or freeze-dried powder form. Sometimes, fruit juices and vitamin supplements are enriched with freeze-dried royal jelly. Royal jelly is also widely used in beverages. Royal jelly is also sold in a jelly made from honey, sugar, jam and pectin.

Bees Wax

Bees wax is produced by worker bees and is secreted through four pairs of wax glands present on the 4th-7th abdominal sternum of the 14-18 days old worker bees. Bees secrete wax in liquid form which solidify into wax scales after coming in contact with the air. Worker bees use their mandibles to mould these wax scales for comb construction or for capping brood and ripe honey. To produce one part of wax, worker bees have to consume about 4-7 times as much honey. Freshly produced bees wax is whitish to yellowish in colour with honey like smell. Colour of bees wax may vary depending upon the food of the honey bees. Bees wax is soft at warm temperature and becomes brittle at low temperature. Density of the bees wax is 0.95- 0.96 and the melting point is 62.5°C.

i) Extraction of Bees Wax : Bees wax can be obtained from cell cappings, bur/ brace combs, and old discarded or damaged combs of hive bees as well as wild bees. Cappings removed during honey extraction and light coloured broken comb pieces, burs and brace combs yield good quality wax. Cappings from ripe honey yields bees wax which is about 2.0-2.5 per cent of extracted honey. For purifying bees wax, the comb pieces are melted in hot water at a few degree higher than the melting point of bees wax and then filtered, through thick cloth, in a utensil with narrow base and broader open end. Bees wax being lighter than water will float on the surface of water and will slowly solidify into a wax cake on the water surface. Other methods of wax extraction are submerged sac method, and solar wax extractor.

ii) Uses : In apicultural industry, bees wax is mainly used to prepare comb foundations. Bees wax is also used in preparation of church candles, cosmetics, shoe polish, car /mason polish, carbon paper, crayon colour industry, for scientific decorative models, chewing gums, etc. Beeswax is also used for coating of drugs and pills. Bees wax is also used in food processing industry.

Bee Venom

Bee venom is a clear watery material having somewhat sharp and bitter taste, hydrolytic blend of proteins with basic pH and is used by the bees for their defense. Venom proteins exhibit various degrees of allergic reaction to the victim of stinging. In human beings, it is used for curing rheumatoid arthritis, many diseases of nervous disorders, suppressing oedema, as anti-inflammatory agent, and for treatment of individuals hypersensitive to bee stings. Bee venom extracts and Venom injections in some countries are also available. Bee venom is also raw material source for enzyme – phospholipase A2.

i) Bee Venom Collection Technology: Commercially, bee venom is collected by using bee venom collector/extractor consisting of thin steel or copper wires, approximately 6 mm apart and suspended 1-3 mm above collecting surface. The wires are alternatively grounded and charged to DC current of 9 volts. When bees alight on the wires of the venom extractor they get a mild electric shock and sting in response to mild current. Bee venom secreted at the tip of the sting is deposited on the surface of a glass plate placed below the wires. Since bees do not lose their stings in this process the stinging bees are not killed. Venom dries up rapidly on glass plate and can be scrapped off with a sharp blade. Store bee venom in a coloured glass vial in freezer.

Propolis

It is gummy and resinous material collected by the bees as exudates of buds, bark and wounds of plants/ trees. The honey bees use this material for plugging the cracks and crevices and unwanted holes in their hive and around the hive entrance as repellent to the intruders like ants. The larger objects like dead mouse, moths etc. which can not be removed from the nest are frequently sealed with propolis.

i) Properties and Composition: Main constituents of propolis are waxes and fatty acids (30%), resins and balsams (55%), etheral oil (10%) and pollen (5%). Propolis also contains flavonoids, phenolic and aromatic compounds. Propolis is reported to be collected by foraging bees from a variety of plants especially the buds of trees like Poplar (Populus spp.), pine trees and Australian grass trees. Since propolis is a mixture of locally available plant exudates, it may slightly differ in composition from locality to locality and colony to colony. Propolis is soft and sticky at warm temperature and at cool temperature, it becomes brittle. Propolis coated layer inside the hive also serve as a moisture barrier to maintain humidity inside and also checks the excessive moisture following heavy rains and a barrier against microbial growth as it is known to have antimicrobial properties.

ii) Propolis Collection Technology: Propolis may be collected by scrapping off from the top bars of the frames or by using the propolis collection screens placed on the top bars of the bee frames. After the holes of the screen are plugged with propolis, the screen is placed at low temperature in the deep fridge for sometime and then taken out and twisted to remove the propolis bits. Hive scrapping is an easier but a crude way because the collected propolis may be contaminated with wood chips or paint etc. and thereby is of poor quality.

Clean propolis collection is possible with flexible plastic screens. The plastic screen is 3 mm thick flexible plastic sheet, with rows of slanting slots. These slots are 2mm wide on one side and 4 mm wide on the other side. The screen is placed below the inner cover with wider side of the slots towards bee frames and narrower sides towards inner cover. The bees fill the slots with propolis. The slots are such that bees can not pass through, therefore bees try to plug these with propolis. The propolis from these screens is harvested by placing these at low temperature for few hours. The propolis becomes brittle and lumps of propolis are dislodged by twisting the screen.

Propolis Extraction Techniques

1. Extraction in Ethanol: Extraction of propolis may be done in 95% ethanol. Put about propolis in alcohol about 30-40 per cent by weight and leave for 1-2 weeks. Shake the contents at regular interval to extract maximum propolis. Filter the liquid through muslin cloth. Extraction efficiency depends upon concentrations of ethanol and proportion of propolis to alcohol used for extraction and the time taken for extraction. The extract in alcohol may be used as such or the solvent is allowed to evaporate and the resultant paste may be used or sold.

2. Extraction in Oil: Put 10 g propolis in 200 ml of olive oil or 100ml of linseed oil. Heat gently in water bath for 10 minutes at 50°C, stir continuously, filter and store in sealed containers in dark. Refrigerated storage is recommended.

3. Extraction in Water: Aqueous extracts can also be obtained by soaking propolis in water for several days or by boiling propolis in water. Yield of active ingredient is lower than the extraction with alcohol but it does show bactericidal and fungicidal properties.

4. Extraction in Liquid Ammonia: Extraction can also be done with liquid ammonia and be used for painting hive parts or other wooden articles.

Uses of Propolis

Propolis has antimicrobial and anti-inflammatory properties. It is considered to cure human ailments like sore throat, cold, skin problems, wounds, burns, stomach ulcers, gum diseases etc. In food technology it is used as oxidant, antimicrobial and antifungal. It can also be used in post harvest treatment of fruits. Propolis is also available in tablets combined with ingredient such as pollen, royal jelly and non-hive products. Propolis is also a constituent of several dermatological and cosmetic creams. It is used as tincture extracted in alcohol; as additives to skin lotions, beauty creams, soaps, shampoos, lipsticks, chewing gums, gum paints, toothpastes, mouthwashes and sun screens. Propolis tincture is used for treating sore throat, wounds and skin rashes. It is also used in various ointments and paints. Its traditional use is as wood preservative and in varnishes.

Pollen

Pollen, the male reproductive cells, produced by anthers of flowering plants is another important product collected by bees from the stamens of flowers. It is the main source of protein, lipids, amino acids, minerals, vitamins etc. in diet of the honey bees especially nurse bees.

i) Composition of Pollen: Protein is the major component of corbicular pollen with an average value of 24 per cent. Carbohydrates constitute 27 per cent of corbicular pollen. Its higher than the carbohydrates in pollen collected directly from flowers because sugars are added by bees for binding the pollen grains into pollen pellets. Pollen from grasses also contains starch (18%). Pollen on an average contains about 5 per cent crude fat and substantial quantities (3%) of minerals (K, Ca, Fe, Mg, Zn, Cu & Mn). Corbicular pollen is also rich in vitamin B (thiamine, niacin, riboflavin, pyridoxine, pantothenic acid, folic acid and biotin) and has variable levels of vitamin C. Pollen lacks lipid soluble vitamin D, K and E.

ii) Pollen Collection Technology: Pollen is collected by foraging worker bees from flowers and is brought into the colonies in the form of pollen pellets into the corbicula present on the hind legs of bees. The pollen load is removed as corbicular pellets from the legs of returning bees by using pollen traps installed at the entrance of honey bee colony. Pollen loaded worker bees are made to pass through the pollen trap screen or strip fitted in a pollen trap which is already fixed on the hive entrance. When the pollen loaded bees try to enter into the colony through the holes of the pollen trap strip, the pollen balls attached to the hind legs get dislodged and fall into a tray placed below. The tray is covered with a mesh. It has been observed that 25 per cent of incoming pollen can be collected without any deleterious effect on colony development. A honey bee colony can yield about 4 kg of pollen / year if good bee flora is available for providing surplus pollen to bees.

iii) Processing and Storage of the Pollen: The collected pollen should then be cleaned to make it free from insect parts, wax moth larvae/ pupae, debris, moulds etc. and dried in controlled conditions to less than 10 per cent moisture before packing into polythene and storing under refrigerator conditions.

iv) Uses of Pollen: Major use of pollen in apiculture is feeding pollen to honey bee colonies during pollen dearth period. Since it is a very good source of protein and other nutrients, it is also being used in human dietary supplements and as a part of diet also.

In general, the protein content of pollen is comparable to that of beans. The datepalm (*Phoenix dactylifera L.*) pollen is used to treat/ cure sterility in humans. Daily consumption of pollen is also good for muscle building. Pollen is formulated for human consumption into several appealing products including pastes, tablets, pollen granules, oral liquids (extracts), candy bars etc. Pollen has been reported to be beneficial for the treatment of several ailments in human beings also. Pollen is useful for race horse care, poultry birds, piglets and as an ingredient of artificial diets of experimental insects and in aquaculture.

Chapter-7

Honey Bee Diseases and Pest Management in Apiculture

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Introduction

On this earth each and every living individual has to suffer from one or the other disease or infection or attack by their natural enemies and honey bees of the genus Apis are not exception. Honey bees suffer from infections, parasites that affect their health and life. Infections in honey bees create serious problems which must be met not only by the beekeepers but also by the bees themselves. The diseases of honey bees can be divided into two main categories.

I -Adult Bee Diseases

1. Acarine Disease

First detected in Uttar Pradesh, Himachal Pradesh, Punjab and J & K. Still it is prevalent in some pockets of North India for Apis cerana. It is caused by a minute mite called Acarapis woodi living and feeding inside the breathing tubes of the adult worker and queen bee. When their number increases, the breathing passage is progressively blocked. Only young bees up to 5 to 6 days old get infected. Therefore the spread is rapid in the colonies where the young bees are plenty. The infestation of the disease from colony to colony is through drifting, robbing and uniting or division of colonies.

Symptoms

1. Large number of crawling bees in front of the hives.

2. Fore and hind wings get separated developing 'K' winged condition.

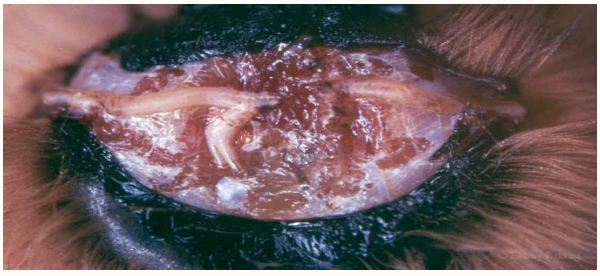
3. Crowlers move away from hives and do not return.

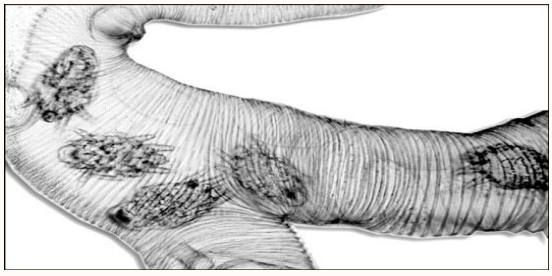
4. Yellow droppings due to dysentery may appear in some cases on and in front of the hives.

5. Bees have distended and shining abdomen.

6. Bees become sluggish and even paralytic.

7. In the colony they do not cover the brood in the normal manner but form scattered clusters.





Control Measures

Use of Methyl Salicylate

Fill the 15 ml. Methyl Salicylate in the penicillin bottle. Make a small hole in the centre of the rubber stopper and pass a cotton wick through this hole and allow its one end to remain immersed in the liquid in the bottle and the free end outside the stopper. Keep this bottle on the Bottom Board inside the brood chamber in one corner. The liquid will evaporate through wick. The fumes of the acaricide kill the mites.

Management Practices

1. Prevention of stray swarms.

2. Prevention of robbing and drifting.

3. Proper spacing of the colonies in the apiary.

4. Restriction on the movements of the colony.

5. Selection and breeding of the disease resistant colonies.

2. Nosema Disease

The disease was first detected in some parts of U.P. and then further spread to J & K, Punjab, Haryana, H.P. It is caused by an amoeba or a single celled microscopic protozoan called Nosema apis Zander. It enters the food canal of adult bees in the form of spore and germinates in the cells of the walls of the digestive track. These spores are voided with excreta. These are picked up by other bees in their act of cleaning activity. Thus the spread of disease takes place.

Symptoms: Some times no symptoms are visible though infection is there in the colony.

1. Inability to fly.

2. Droppings of loose excreta on the combs or on alighting board or other hive parts.

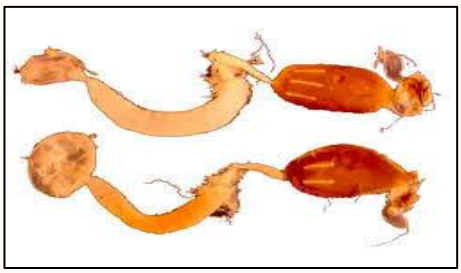
3. Presence of a number of dead or half dead bees on the ground in front of the hive.

4. Weakening of the colonies due to premature death of a number of forager bees.

5. Poor collection of honey.

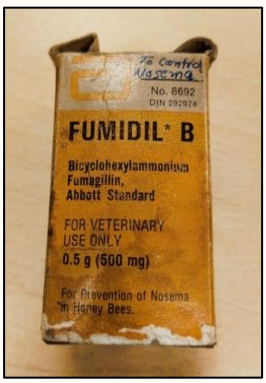
6. Infected queens stop egg laying.

7. Infected nurse bees do not work normally and cannot produce enough royal jelly.



Upper: Infected Mid Gut, Yellow Extreta on Bottom Board, Lower: Healthy Mid Gut

Control Measures



Use of an antibiotic,'Fumagillin' or 'Fumidil B'. It may be given in sugar syrup consisting of 100 mg Fumigillin per colony in 250 ml. cold sugar syrup for 10 days continuously. The solution may be spread on bee body also. Apart from above the management practices which are to be followed for Acarine disease may also to be followed for this infection.

II. Brood Diseases

1. European Foul Brood Disease (EFB)

It was first noticed in Mahabaleshwar in Maharashtra then in Castle Rock in Karnataka. It is caused by a gram positive bacterium called Mellisococcus Pluton. The bacterium enters the larval gut through food and grows there. The disease is spread through house cleaning and nurse bees. As well as through robbing, drifting and uniting of colonies.

Symptoms

1. Colony strength reduces.

2. Total absence of sealed brood.

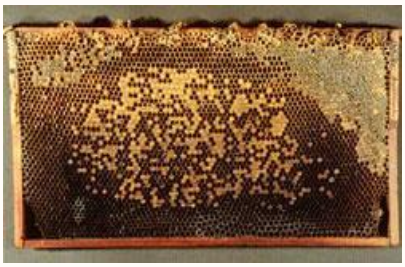
3. Appearance of dead larvae.

4. Larvae die in curled position.

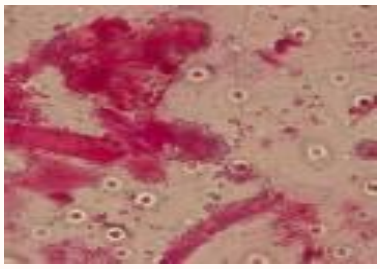
5. Some foul or sourish odor is emitted.

6. Appearance of patchy brood.

Affected Larva



Patchy Brood



Bacteria

Control Measures

Use of antibiotics called 'Terramycin'. Add 100 mg terramycin in one cup normal cold sugar syrup. Stir it well so as to dissolve the powder. Add this solution in one liter of sugar syrup. Feed the colonies with 150-300 ml. medicated syrup three times at an interval of 7 days. This treatment should be given at the commencement of fresh brood rearing.

Management Practices

1. Uniting the weak colonies.

2. Isolation of infected colonies.

3. Restrictions on exchange of combs or other equipments.

4. Sterilization of equipments by using formalin before use.

5. Restrictions on movement of the colonies.

2. Sac Brood Disease

The disease first appeared in Meghalaya. Then spread to North India and then in 1991 in South India. In M.S. it appeared in 1996-97. It is caused by a virus called Thai Sac Brood Virus (TSBV).

Symptoms

1. Death of the larvae before pupation.

2. Typical sac formation in pupal stage.

3. Infected combs show perforated capping.

4. Affected larvae become yellow or grayish and slowly become black.

5. The dead larvae become straight.

Control Measures:

Being viral infection, no medicines are available. Only management practices can be adopted.

Management Practices

1. Requeening of the colony if queen is old.

2. Diseased colony should be destroyed to avoid further spread of disease.

3. Sterilization of bee hives and other equipments.

Typical Sac Formation

Infected Larva

Stages of Sac Brood Disease

III. Pest, Predators and Enemies

Parasitic Mites

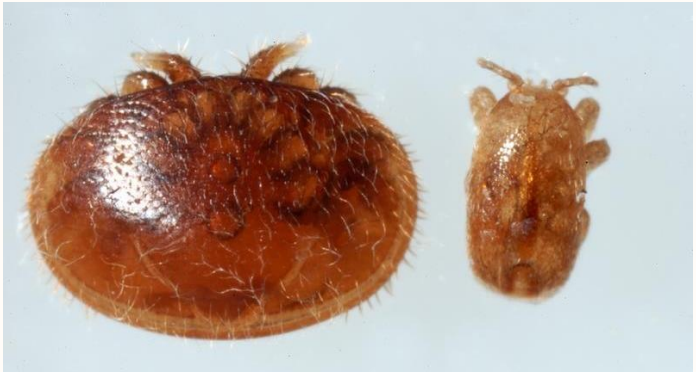
There are only few of ecto-parasitic mites. They are usually found on the external surface of the host and suck the haemolymph for their survival.

a) Tropilaelaps clareae

This mite is a native parasite of the gaint honey bee, rock bee widely distributed throughout the Indian sub-continent, China and South East Asia. It is also found on *Apis dorsata* and *Apis laboriosa* in Nepal. It is a serious pest of *Apis mellifera* in tropical Asia.

b) Varroa Jacobsoni

It is probably the most widely distributed of Asian mites. In the European bees the varroa mite can infest both drone and worker brood. The mite is red-brown, oval in shape and around 1.5 mm by 1-1.2 mm. Affect adult as well as larval bees. On adult bees they are found on neck portion and on abdomen. When it affects larvae the emerging bees will be with deformed wings.



Varroa **Tropilaelaps**

Varroa infested Wingless bee

Treatment

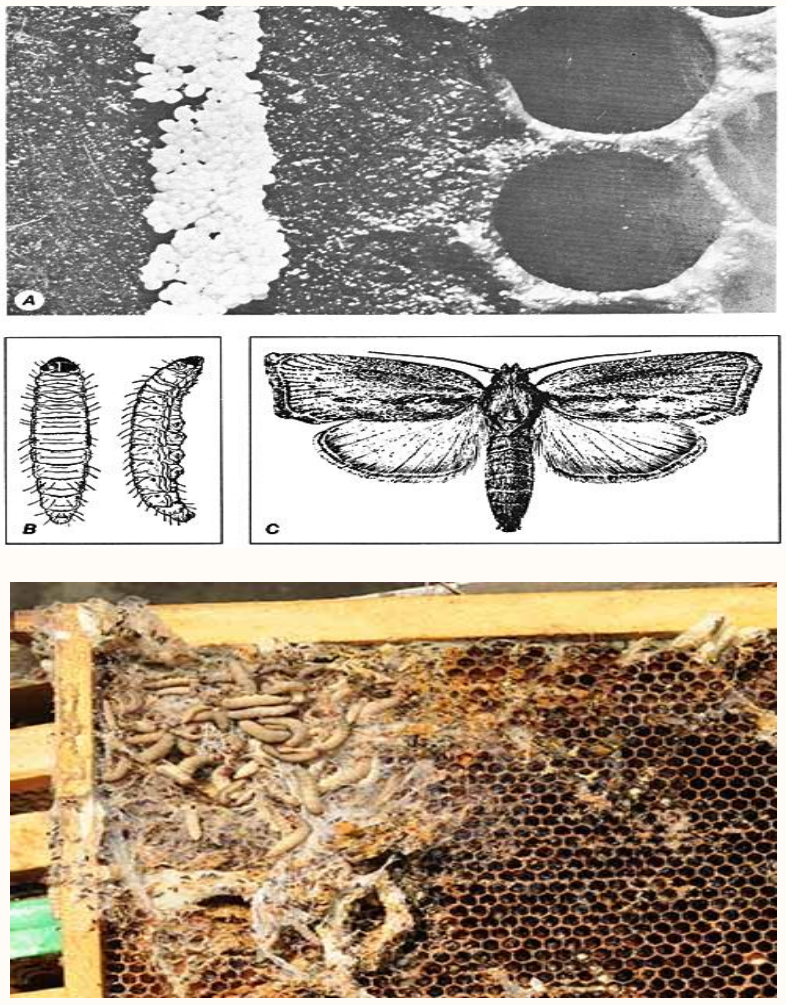
The most effective control of varroa can be gained by using a combination of both biological methods and chemical methods. Using chemicals like sulphur dusting, Formic acid treatment, Thymol, Oxalic acid, acaricide like Amitraz (12.5%). (Two applications at an interval of 7 days), etc. helps in reducing the infestation of the mites.

Wax Moth

There are two types of wax moths, the greater wax moth (*Galleria mellonella*) and lesser wax moth (*Achroia grisella*). The wax moth attack is more during monsoon season. Old dark combs attract wax moth females to lay eggs. Emerging larva feed on wax and thus form tunnels or galleries. Such combs become useless for beekeeping.

Control Measures

Comb renewal, use of Para Dichloro Benzene (PDB) for storing drawn out supers.



Wax moth affected comb

Wasps

Seven species of wasps are major enemies of honey bees. These are carnivorous in habit and largest social insects. They are physically able to prey on honey bees with aese. They may attack in large numbers to cause severe losses to an apiary.

Control Measures

Use of wasp trap. To destroy wasp nest during night time by using phosfum tablets.

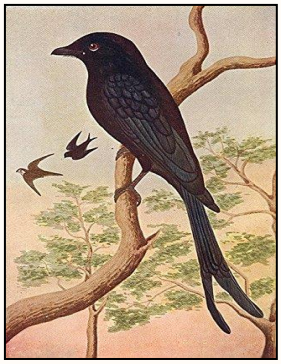
Wasp Trap

Yellow Banded Wasp

Birds

Green bee eater and king crow are predators of honey bees. They attack bees during foraging. The attack is more during monsoon season.

For controlling the birds crackers can be fired.



Bear

Bear is a vegetarian animal and fond of honey. During night time it attacks the colonies and disturb whole colony and eat honey. As its skin is very thick, there is any adverse effect of bee stings on it. As per wild life conservation act bear cannot be killed.

Bee Hunters

The human beings those who damage, destroy bee colonies mercilessly are the main enemies of honey bees.

Bee Death due to Insecticidal Hazards

- Many times there are no symptoms of any disease but bees are dying. The death is due to insecticide spray on agri-horticulture crops. The main symptom is dead bees show extended proboscis.
- There should be proper understanding between a beekeeper and the farmer while spraying the insecticides on the crops. Generally biologically originated insecticides such as neem seed oil or tobacco water should be sprayed which not hazardous to honey bees. The insecticides from neonichotinides group should be avoided.
- Spraying should be done after sun set. If necessary colonies should be packed by providing feeding inside for 1 or 2 days to avoid bee death.

Chapter-8

Technology and Management for Honey and Bee Products

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Introduction

Honey is well known since ancient times and used in India and the world. Besides honey, valuable hive products produced by honeybees such as wax, pollen, propolis, royal jelly and bee venom also produced by honeybees. The modern days beekeeping practiced in developed countries mainly for enhancement in agri-horticultural crop production by managed bee-pollination. Recently honey and bee products are in great demand for its commercial applications in nutritional, medicinal, cosmetics and other industrial products. Therefore, the beekeeping industry is now sunrise industry in India and most prospective in rest of the world.

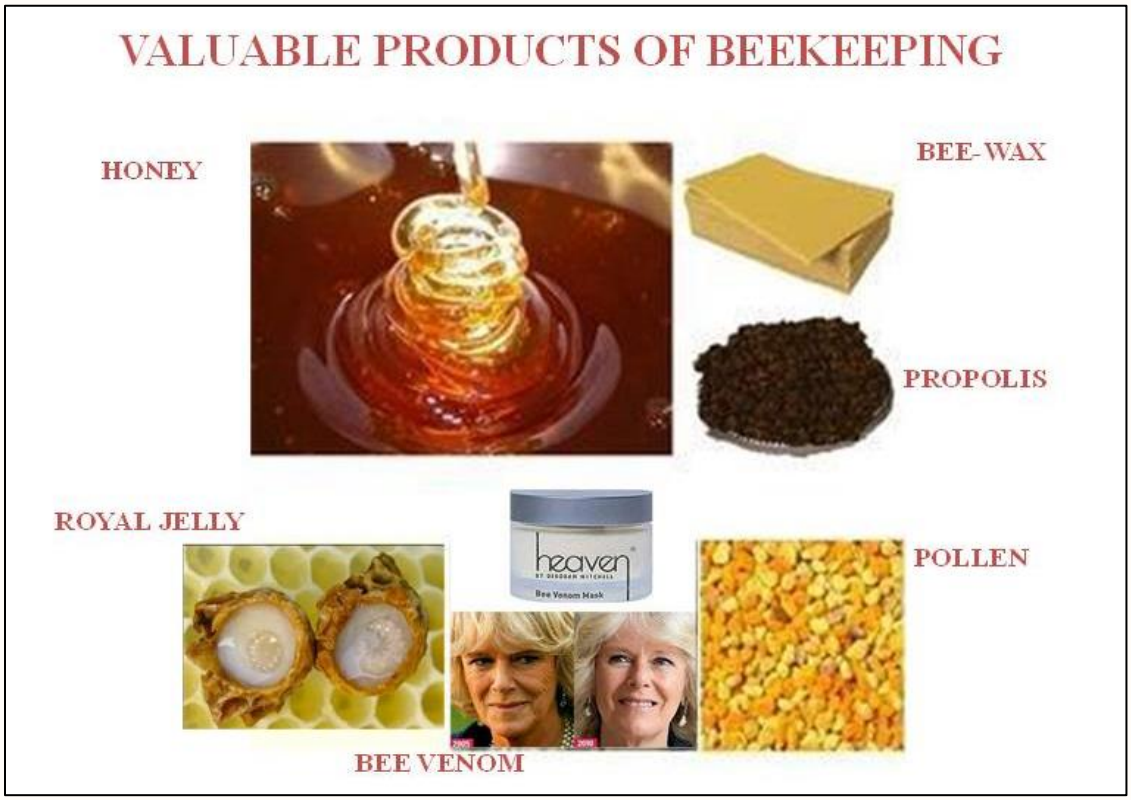

Fig.1. Valuable products Beekeeping.

Production of Honey

Honey as prepared by honeybees from nectar of flowers, converted in to honey by inversion and evaporation, digested / regurgitated, stored in to the cells of the comb, ripened and sealed is termed as honey. In India, about 12,699 beekeepers and 19.34 lakh honey bee colonies are registered with National Bee Board. India is producing about 1,33,200 MT of Honey (2021-22), (Source: APEDA- FAO and Madhukranti Portal- MoA & FW).

Honey produced in India in small or large quantities by different species of Apis dorsata (Wild Giant / Rock bees), Apis cerana (Indian native hived bees), Apis florea (Small wild bees), Trigona iridipenis (Stingless bees) and Apis mellifera (European / Italian hived bees). Therefore, the assessment of the actual production of honey is still to be exercised.

The honey is unique because it is pre-digested by honeybees and stored in its comb. Honey is viscous with 20% water and almost 80% dissolved solids including complex constituents mainly fructose, glucose, maltose, minerals, proteins, amino acids, vitamins, enzymes etc. Since ancient times like in Ayurveda, honey has been prescribed with every medicine to take with honey as yogwahi especially for cough, cold, throats ailments. Then famous surgeons Charak and Sushruta practiced honey for treatment on serious burns, cuts, wounds etc. The medicinal value of honey is mainly due to its anti-oxidant, anti-bacterial, anti-fungal, anti-viral, anti-diabetic effect etc. That makes it most nutritious and medicinal.

Uni-floral honey from single dominant floral source like litchi, mustard, sunflower, jamun, drumstick etc. packed separately for its unique characteristics. Different local sources have its own importance and demand. Honey from nectars of medicinal plants carry respective medicinal characteristics is specially termed as medicinal honey e.g. aonla, eucalyptus, ajawain, tulsi etc. and the world famous Manuka honey from Newzeland.

Multi-floral or Mix flora honey produced by honeybees from more than one nectar sources of flowering plants mostly collected in forests. It has similar properties like other honeys, however no specific dominant characteristic like unifloral honey. It is similar to those of other honeys in colour, flavour or taste.

Extra-floral honey from nectar secretions from other than flowers like leaves of rubber plants produced in coastal Kerala, Tamil Nadu and Konkan area of Maharashtra. Rubber honey is very light in colour and high tendency of crystallization.

Processing of Honey (IS 14522: 1998)

Honey is hygroscopic and liable to spoil due to granulation and fermentation depending mainly on its moisture content, other constituents and environmental conditions. Therefore, honey need to be processed properly to prevent its spoilage under controlled temperature and time so to maintain its consistency and natural properties. The concept of scientific beekeeping and processing of honey under peculiar Indian tropical conditions, beekeeping practices and quality control was pioneered by the CBRTI, Pune since its inception in 1962 (Phadke *et al.* 1967, 1968, 1978). After continuous long research CBRTI developed modern honey processing with moisture reduction unit (Wakhle *et al.* 1988, 1990, 1992, 1995, 1996).

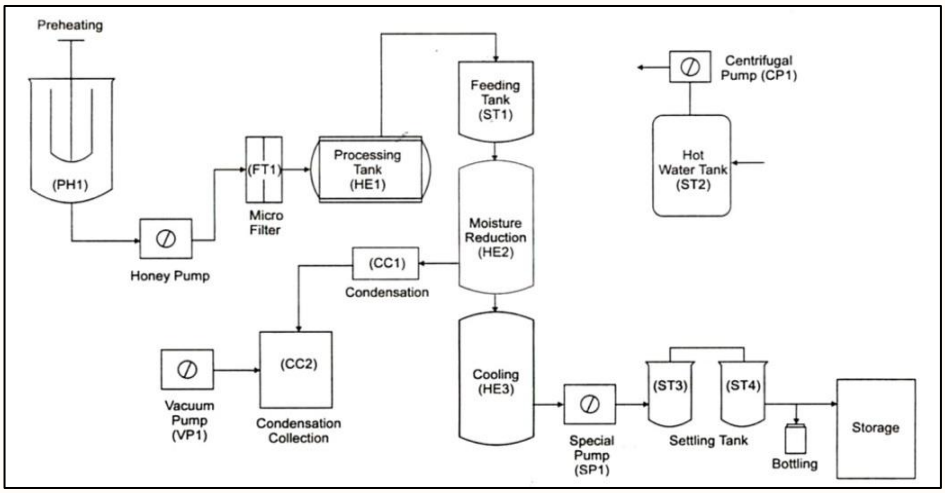

Fig.2. Honey processing cum moisture reduction unit

The main principle of honey processing by indirect heating is:

A. Liquefy granulated honey and make homogenous liquid to delay granulation. And

B. To kill sugar tolerant osmophilic yeast cells to prevent fermentation.

It consisted:

I. Preheating to liquefy at 40 ℃ and make homogeneous liquid honey (PH-1)

II. Filtration to remove insoluble particles of wax, bee parts, dust, dirt etc.

III. Processing at 60 ℃/20 minutes to 80 ℃ for 5 minutes and so on to kill yeast cells (HE1

IV. Reduction of excess moisture content if necessary (HE-2)

V. Microfiltration to improve clarity, if necessary

VI. Cooling to room temperature (HE-3)

VII. Settling to remove scum or foam (ST-3, ST-4)

VIII. Bottling, packaging and labelling as desired.

IX. Storage in honey house at ideal conditions (IS 7849 : 1975)

Based on these principles several honey processing plants installed all over India. Due to this the quality (IS 4941:1994; IS 14522: 1998), market and export of honey is boosted.

Quality Control of Honey

CBRTI, Pune for the first time in India, laid down the quality standards of honey as member of Apiary Industry Sectional Committee of the Bureau of Indian Standards were approved, prescribed and published as per BIS (IS 4941:1974-78). Earlier Honey Grading and Marking Rules under AGMARK (1984) including quality parameters and procedure of analysis of honey. Recently as per Food Safety Standards Authority of India FSSAI (2018-19) merged

different quality standards of honey. It is necessary to maintain natural quality of honey as produced by the bees. Beekeepers are supposed to follow the scientific techniques in bee management. Bureau of Indian Standards have published about 20 booklets on beekeeping, hives and equipments. Beekeepers should follow it very strictly and make it a practice to achieve the best quality of its products. Generally people are not aware of benefits of honey. To improve the consumption of honey as nutritious food need wide publicity, small packs and affordable price. “Natural honey” is pure, as produced by beekeepers from honey beekeeping. However, some traders to get high profits and short term gains adulterate honey by cheap sugar syrups, rice syrups, High fructose Corn Syrup (HFCS), etc. Detection of such adulterants needs modern laboratories that cost very high charges. Even contamination of honey with insecticides, pesticides and other drugs and chemicals need to be checked in laboratories with high tech facilities.

Value Addition of Honey

Bottling and Packaging of honey in proper materials and shapes as per size with well designed bottles or jars and lids will add value to the honey. Further attractive labeling and information with proper colour combination to catch the sight of common consumer and feel happy about it. By highlighting its own unique characters like Primary (Pre-digested) Natural food, Sugar Free, Fat free, Glucose rich, Other Nutrition Facts, etc. Natural honey in different forms like comb honey, chunk honey, wild honey, forest honey, honey cream, honey butter etc. Honey as flavouring agent, nutrition supplement, nutraceuticals, honey in products of milk, confectionary, bakery and other foods and fruits, honey drinks etc. will further enhance its demand in domestic as well as industrial sectors. Besides honey in Cosmetic products, the demand is rapidly increasing in Ayurveda as well as Allopathic pharmaceutical industries

Fig.3. Bottling and labelling of honey

Marketing of Honey

Honey of different brands in different attractive packaging and labelling sold in market mostly as medicine at very high price. Hence demand is restricted. Whereas honey is most nutritious natural food. It should be promoted as nutritious food supplement. However purity and quality of honey be assured. There is great demand for export of Indian Natural Honey in various countries, provided purity, quality and consistency is maintained to compete with the world leaders like China. It is difficult but not impossible. In view of the recent developments in modern technology and application of honey for health purposes, we in India, have great opportunity, if we are very serious and honest in practice of scientific beekeeping to bring India on top. India has variety of Natural Honeys in colour, flavour, taste and properties depends mainly on floral/plant source. Due to wide publicity and awareness the consumption of honey has increased from initial 0.4 g to 5-7 g that may further enhance to about 10 times i.e. 40-50 g per capita in next 2-3 years. The rapid increase in demand of honey in domestic and international market will compel doubling the production and beekeeping in India. Thus, the present scenario may be considered as great opportunity and prepare to take full advantage of great scope of beekeeping.

Bee Characteristics, Uses and Wax Extraction

When bees need space for storage of brood, food-nectar (honey) and pollen, honeybees secret wax from its body called wax glands in abdominal segment. They construct hexagonal comb from secreted wax very skillfully. All the stored food and brood remain safe and unaffected from any contaminations from environment or climatic conditions. Initialy beewax when secreted in scale forms is liquid and transparent but becomes solid and soft when comes in contact with surrounding temparature.

Old combs and blackened due to contaminants from coloring pigments from stored hoey, pollen and brood used for wax extraction. Small pieces of such old combs taken in a cotton bag and tied. The bag with comb pieces immersed in hot water to melt wax. The melted wax settles at the top layer is transfered as liquid wax through a clean filter cloth in cold water pan to solidifye. The cold water is removed and pure solid wax cake separated. About 200-300 g wax may be collected from a single colony. Thus freshly extracted beeswax is pale whitish in colour, mainly consists of fatty acids. Its characteristic is antibacterial, antifungal and antiviral etc.

Fig.4. A. Old comb wax pieces, B. Bee Wax Rendering Unit, C. Bee wax cakes

Beeswax used in several medicinal ointments, skin lotions, creams and other cosmetic formulations like lip-gel etc. Its applications in surface coating like vanrnishes, paints furniture polish etc. Besides used in holy candles, toys, moulds, amunition coating etc. Most important use of beeswax in making comb foundation sheets for honey bee colonies as essential comb renewal management in scientific beekeeping.

Bee-Pollen Characteristics and by Pollen Trap

Bees collect Pollen as food / protein source, pack as pollen load in basket on hind legs, carry it to the hive and store in comb cells. It is actually the male seed of a flower blossom which are collected by the honey bees and mixed with the bees' digestive enzymes. Bee-pollen is low in calories but rich in proteins, amino acids, vitamins, minerals, enzymes, beneficial fatty acids, carbohydrates, and bio-flavonoids which are anti-viral, antibacterial and helpful in lowering cholesterol, stabilizing and strengthening capillaries. Its ability to rejuvenate the body, stimulates organs, enhances vitality and accelerate rate of recovery makes it a popular tonic among athletes and sportsmen. Collection of Bee-pollen from *Apis cerana* by pollen trap developed and tested successfully by CBRTI during 1980-81 and from *Apis mellifera* in 1992-93, respectively.

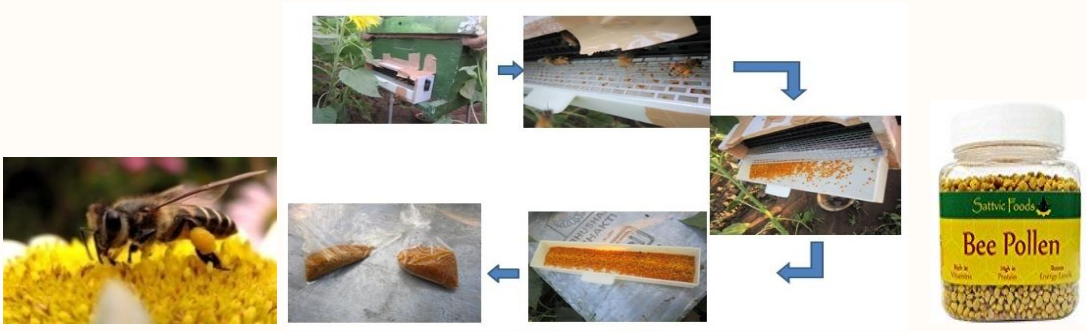

Fig.5. Bee Pollen Trap

Bee pollen used as Health/Natural Food As Nutraceutical, Medicine, Protein substitute, and Energy Revival, also Allergy Treatment and as in various forms as liquid Tonic, Tablets, Capsules, also in applications of Cosmetics–Paste, Lotion, Creams etc. Price of Bee Pollen-30-50 USD per kg.

Characteristics Uses and Production of Royal Jelly

Fig.6. Royal jelly in Queen Cell

Royal jelly fed ordinary egg-larva, develops in to “queen” which is most fabulous, healthy, fertile, female. Fairly fluid, paste like whitish pale, with sour flavour and taste.

Rj contains: 50-70 % water, dry rj contains:17-45 % proteins, 18-52 % sugars, 3-19 % lipids, 2-3 % minerals.

It is Natural revitalizer Royal jelly is secretion of brain glands of worker bees when new queen required. Rejuvenate effect, highly nutritious food, Cosmetics preparations for skin and hair, Capsules, tablets, powder.

Production, Characteristics Use of Propolis

Propolis is natural resin produced by the honey bee colonies of *Apis mellifera* and *Trigona iridipenis* i.e Stingless bees only. Collection of propolis from hive by applying Propolis net and processed / refined for further application. It contains mainly resins 45 – 50 % ; (flavonoids, Phenolic acids & Esters); Waxes & fatty acids 25 – 35 %; Essential oil (Volatiles) 10 %; Other Organic minerals 05 %; Pollen content 05 % etc. Propolis shows Antibacterial, Antiviral activity, and Fungicidal effect.

Fig. 6. Propolis collected from honeybee colony

Propolis used as natural resin for surface coatings in cosmetics and medicines.

Characteristics, Uses and Production of Bee Venom

Bee Venom is initially colorless, clear, watery liquid but dries quickly. Dry venom is light yellow. Gross composition: Water (Liquid venom) 80 – 90 %; Dry Venom contents - Proteins & Peptides. Mellittin 50 %; Apamin 3 %; Mast Cell Degranulating Peptide 2 %; Histamine, Dopamine 0.5 %; Amino acids 1 %; Phospho-lipids 5 %; Volatile comp 4 %. CBRTI, Pune had developed (1986) wired frame with timer and battery operated venom extraction unit for *Apis cerana* bee colonies and tested successfully.

Bee venom is an essential part of APITHERAPY and Used in injections for rheumatism, arthritis, toxic effects.

Fig.8 Bee Venom Extractor

Basically beekeeping is practiced for production of honey. The additional knowledge and advance training required for commercial production of valuable bee products.

Chapter - 9

Empowering Farming Community through Apiculture (Honey Bee Village): Status, Case and Scaling

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Noida, Uttar Pradesh

Introduction

Apiculture or beekeeping is increasingly recognized as a crucial agricultural practice in India, reflecting its potential to significantly impact the country's economy, environment and food security. The practice involves the maintenance of bee colonies for the production of honey, beeswax and other bee products as well as for the essential service of pollination. The importance of apiculture in India can be underscored by the country's diverse flora and favorable climatic conditions, which create an ideal environment for beekeeping. beekeeping. Economically, apiculture plays a vital role. India is one of the top honey producers in the world with an annual production of approximately 120,000 metric tonnes as of 2021. The domestic demand for honey is growing, driven by its widespread use in traditional medicines, culinary applications and an increasing awareness of its health benefits. Moreover, Indian honey has a significant presence in the global market. In the fiscal year 2020-21, India exported honey worth USD 72.57 million, contributing substantially to the national economy. This export value reflects the increasing quality and competitiveness of Indian honey in international markets. The growth of the honey industry not only boosts the income of beekeepers but also contributes to the country's export earning. Beyond honey production, apiculture offers substantial employment opportunities, particularly in rural areas where job options are often limited. Beekeeping requires minimal land and investment, making it an accessible venture for small and marginal farmers. According to the National Bee Board, there are over 300,000 beekeepers managing approximately 3.4 million bee colonies in India. This widespread participation in beekeeping highlights its potential as a tool for rural development and poverty alleviation. The sector provides a sustainable source of income, helping to stabilize the rural economy and improve the livelihoods of many families.

Environmental benefits are another crucial aspect of apiculture. Bees play an indispensable role in the pollination of various crops, which is essential for the production of fruits, vegetables and seeds. According to the Food and Agriculture Organization (FAO), approximately 75% of the world's food crops depend on pollination to some extent. In India, the role of bees in pollination is vital for the agricultural sector, which employs about 58% of the population and contributes around 17-18% to the Gross Domestic Product (GDP). The Indian government has recognized the importance of apiculture and has implemented several policies and programs to support the sector. The National Beekeeping and Honey Mission (NBHM), launched in 2020, aims to promote scientific beekeeping, enhance the quality and production of honey, and provide necessary infrastructure and marketing support to beekeepers.

Efficient pollination by bees can increase crop yields by up to 30%, thereby enhancing food security and agricultural productivity. This increase in productivity is particularly important for smallholder farmers who rely heavily on crop production for their livelihood security. Additionally, beekeeping has a positive impact on biodiversity. By promoting the growth of various plant species through pollination, bees help maintain the ecological balance and support diverse ecosystems. This biodiversity is crucial for the resilience of agricultural systems, particularly in the face of climate change and other environmental stresses. The presence of healthy bee populations can lead to more robust ecosystems that are better equipped to withstand and recover from adverse conditions.

Despite the numerous benefits, the apiculture sector in India faces several challenges. The primary threats include the use of pesticides, habitat loss, climate change, and the spread of diseases and pests affecting bee colonies. Pesticides, in particular, pose a significant risk as they can lead to colony collapse disorder (CCD), a phenomenon where worker bees abandon the hive, leading to the collapse of the colony. To address these challenges, there is a need for concerted efforts from both government and non-governmental organizations. Initiatives such as promoting organic farming practices, creating awareness about the importance of bees, and providing training and support to beekeepers are essential steps towards sustaining and enhancing the apiculture sector. Such initiatives are crucial for the development and sustainability of the apiculture industry in India. Apiculture is an essential agricultural practice in India with significant economic, environmental and social benefits. The industry's contribution to the economy through honey production and exports, its role in providing employment and improving rural livelihoods, and its critical function in pollination and biodiversity conservation highlight the multifaceted importance of beekeeping. With continued support and the adoption of sustainable practices, apiculture in India can thrive, ensuring food security, environmental health and economic prosperity for the nation.

Scope of Growth in Apiculture

The apiculture market is poised for significant growth with an estimated compound annual growth rate (CAGR) of 4.3% between 2020 and 2025. The Asia–Pacific region leads as the dominant producer, reflecting its strategic importance in the global market. A report by IMARC highlights that the Indian apiculture market is on a robust growth trajectory, projected to reach a value of Rs 33,128 million by 2024, expanding at a remarkable CAGR of nearly 12%. This growth underscores India's status as a major player in the global honey market, being the sixth largest exporter of natural honey. In the fiscal year 2019–20, India exported 59,536.75 metric tons of natural honey, generating revenue of Rs 633.82 crore. The primary export destinations included the USA, Saudi Arabia, Canada, and Qatar. This increasing international demand for organic honey offers an excellent opportunity to promote organic beekeeping practices in India. At present, about 12,699 beekeepers and 19.34 lakh honey bees colonies are registered with National Bee Board and India is producing about 1,33,200 Metric tonnes of Honey (2021-22 2nd advance estimate).

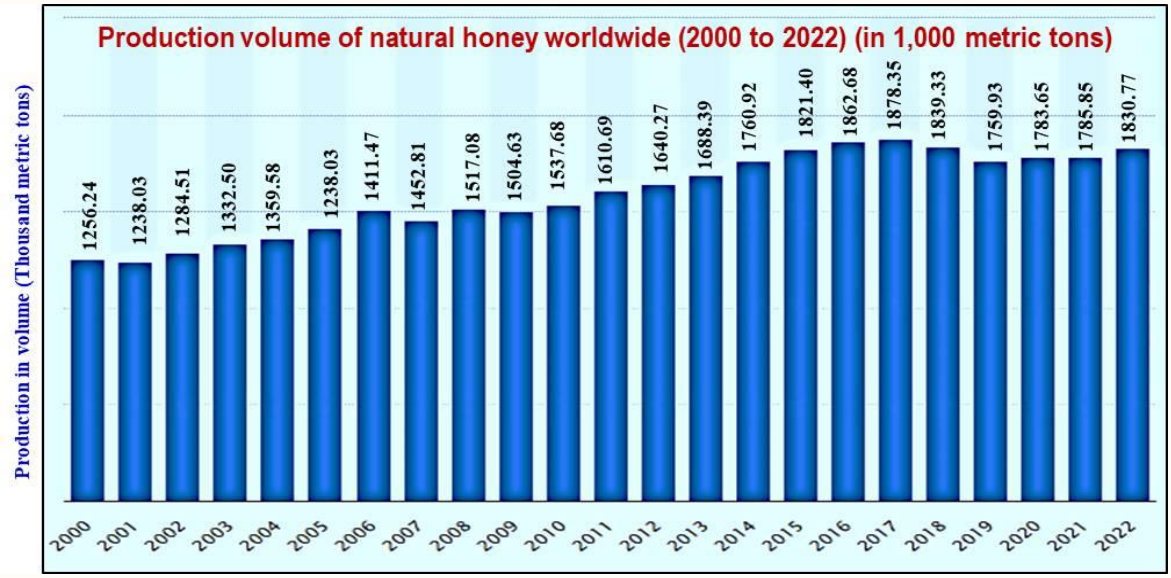
India is one of the major honey exporting countries in the World and has exported 74,413 MT of Honey worth Rs. 1221.17 crore during 2021-22. More than 50% of the honey production in India is being exported to other countries. India export honey to about 83 countries. The major markets for Indian honey are USA, Saudi Arab, United Arab Emirates, Bangladesh, Canada etc. Mustard honey, eucalyptus honey, lychee honey, sunflower honey, pongamia honey, multi-flora Himalayan honey, acacia honey and wild flora honey are some of the major varieties of honey exported from India.

To further develop the apiculture sector, expanding the landscape for beekeeping and diversifying the species on a commercial scale are crucial. India is uniquely positioned with four of the seven known bee species. Two of these species are domesticated: *Apis cerana* (oriental honey bee) and *Apis mellifera* (European honey bee). The other two, *Apis dorsata* (giant/rock honey bee) and *Apis florea* (dwarf honey bee) are wild species.

Table.1. Year-wise details of Honey Production for last 6 years (2012-13 to 2017-18) estimated by NBB

Year	Production (Thousand MTs)	Percentage of growth	Value in (Rs. Cr)
2011-12	68.87	5.00%	978
2012-13	72.30	5.00%	1027
2013-14	76.15	5.33%	1082
2014-15	80.53	5.75%	1144
2015-16	88.90	10.39%	1263
2017-18	94.50	6.30%	1342
2018-19	105.00	11.11%	1491
2019-20	117.60	12%	1669
2020-21	135.24	15%	1920

Bees are essential for pollination, playing a vital role in the agricultural ecosystem. Major crops that benefit from bee pollination include oilseeds, orchard crops, legumes, vegetables, timber trees and ornamental flowers. The conservation and multiplication of bee populations are highly dependent on the density and composition of local flora, which provide the necessary food resources for these pollinators. India boasts around 500 flowering plant species that serve as major or minor sources for foraging, resulting in a diverse array of natural honey flavors. These include rapeseed/mustard honey, eucalyptus honey, lychee honey, sunflower honey, karanj /pongamea honey, multi-flora Himalayan honey, acacia honey and wild flora honey. This variety creates lucrative opportunities for the beekeeping industry, enhancing the market appeal and value of Indian honey.



(**Source**:https://www.statista.com/statistics/755215/natural-honey-production-volume-worldwide/)

An organized and technology-driven bee-farming sector can significantly contribute to employment generation through skill-building projects. The development of this sector aligns with several Sustainable Development Goals (SDGs). Specifically, it supports Goal 1 (No Poverty) by creating job opportunities and fostering economic growth. Goal 2 (Zero Hunger) is addressed through the enhancement of agricultural productivity via effective pollination. Goal 3 (Good Health and Well-Being) is promoted through the production of natural, healthy honey and related products. Lastly, Goal 15 (Life on Land) focuses on the conservation of biodiversity and vibrant ecosystems, which is intrinsically linked to the health of bee populations and their habitats.

The Indian apiculture market is set for substantial growth, driven by both domestic and international demand for honey and honey products. Strategic initiatives to promote organic beekeeping and commercial expansion can further enhance the sector's contributions to economic development, environmental sustainability, and social well-being. By leveraging the rich biodiversity and the existing expertise in beekeeping, India can strengthen its position in the global apiculture market, creating a sustainable and prosperous future for the industry.

Sweet Revolution Helping in Atmanirbhar Bharat

The Sweet Revolution, an initiative aimed at promoting beekeeping and honey production, has the potential to significantly contribute to the vision of Atmanirbhar Bharat (Self-Reliant India) through various economic, agricultural and environmental benefits. According to the National Bee Board, the Indian apiculture market is poised to grow substantially, with the country's honey production increasing from approximately 65,000 metric tons in 2005 to over 120,000 metric tons in 2020. This growth reflects the sector's capacity to generate substantial rural employment and diversify income sources for farmers, who can integrate beekeeping with traditional agriculture for an additional

This is particularly important for the empowerment of rural women, who can engage in beekeeping within their communities, promoting economic independence and social upliftment. The agricultural benefits of the Sweet Revolution are profound. Bees are essential pollinators, and their activity can lead to a 20-25% increase in agricultural yields, significantly enhancing the quality and quantity of crops such as oilseeds, fruits, vegetables, and legumes. Enhanced pollination supports food security and increases farmers' incomes, directly contributing to economic stability. Furthermore, the demand for organic honey, which grew at a CAGR of 10% between 2015 and 2020, drives farmers to adopt organic farming practices, improving soil health and reducing reliance on chemical fertilizers and pesticides.

Environmental sustainability is another critical aspect of the Sweet Revolution. Bees play a crucial role in maintaining biodiversity by pollinating a wide variety of plants, helping to preserve various species and maintain ecological balance. India, with its rich flora, provides an ideal environment for beekeeping. The country hosts approximately 500 flowering plant species that are key sources of nectar and pollen, contributing to diverse honey flavors such as mustard, eucalyptus, lychee, sunflower and Himalayan multiflora honey. Beekeeping also supports forest conservation, where honey production from forest flora can provide economic benefits while encouraging the preservation of forests and native plants. The industrial and market expansion opportunities offered by the Sweet Revolution are significant. The honey processing industry, including the production of by-products like beeswax, royal jelly, propolis and bee venom, holds immense potential. These products have numerous industrial and medicinal applications, creating new business opportunities and boosting the economy.

India's honey exports, which amounted to 59,536.75 metric tons valued at Rs 633.82 crore in 2019-20, highlight the sector's export potential. Enhanced production can help capture a larger share of the global market, contributing to foreign exchange earnings and strengthening India’s economic position internationally. Technological advancement and innovation are critical to the success of the Sweet Revolution. Promoting modern beekeeping techniques, such as advanced hives and better disease management practices, can improve productivity and efficiency. Investment in research and development can lead to improved bee breeds, better pest control methods and superior honey quality. Collaboration with educational institutions and research centers can drive innovation in the apiculture sector, ensuring sustainable and progressive growth. Government support is pivotal in realizing the potential of the Sweet Revolution. Policies that provide subsidies, low-interest loans, and incentives for beekeepers can significantly boost the sector. Infrastructure development, such as storage facilities and transportation networks, can enhance market access and profitability for beekeepers. Training and capacity-building initiatives, including workshops and certification programs, are essential to equip beekeepers with necessary skills and knowledge. The Sweet Revolution aligns perfectly with the goals of Atmanirbhar Bharat.

By leveraging the potential of apiculture, India can achieve greater self-reliance, improve rural livelihoods, promote sustainable agricultural practices and strengthen its position in the global honey market.

Challenges and Effective Solutions for the Honey Bee Sector in India

The honey bee sector in India is vital for agricultural productivity, rural employment and biodiversity. However, it faces several challenges that impede its growth and sustainability. Addressing these issues requires a comprehensive understanding of the challenges and the implementation of effective solutions.

Challenges

1. Pesticides and Chemical Use

The widespread use of pesticides and chemical fertilizers in Indian agriculture poses a significant threat to bee populations. Pesticide residues in honey can be as high as 20-30%, leading to colony collapse disorder (CCD). According to a study by the Indian Council of Agricultural Research (ICAR), pesticide exposure is a leading cause of bee mortality.

Solutions: Regulating Pesticide Use

Implementing stricter regulations on pesticide usage can protect bee populations. Promoting Integrated Pest Management (IPM) practices can reduce the reliance on harmful chemicals. According to the Ministry of Agriculture, training farmers in IPM could decrease pesticide use by 30-40%.

2. Climate Change

Climate change affects bee foraging patterns and plant flowering cycles, leading to reduced honey yields. Extreme temperatures, droughts and unseasonal rains disrupt the natural lifecycle of bees. A 2020 report by ICAR indicated a 15-20% decline in honey yield due to adverse climatic conditions.

Solutions: Climate Adaptation Strategies

Developing climate-resilient bee species and promoting climate-smart beekeeping practices can mitigate the impacts of climate change. Research institutions should focus on breeding bees that can withstand extreme weather conditions. Additionally, beekeepers can be trained in adaptive practices such as shifting hive locations and providing supplementary feeding during adverse conditions

3. Habitat Loss

Urbanization, deforestation and agricultural expansion result in the loss of natural habitats for bees. The Forest Survey of India reports a decline in forest cover, which reduces the availability of diverse floral resources necessary for bee nutrition. This habitat loss leads to nutritional stress and weakened bee colonies.

Solutions: Habitat Conservation

Protecting and restoring natural habitats is crucial for bee health. Initiatives like planting bee-friendly flora, establishing pollinator corridors and conserving forests can enhance the availability of foraging resources. Community-based conservation programs can involve local populations in habitat restoration efforts.

4. Lack of Modern Beekeeping Techniques

Many beekeepers in India still rely on traditional methods, which are less efficient and productive. According to the National Bee Board (NBB), only 30% of beekeepers use modern techniques, resulting in lower productivity and higher vulnerability to diseases and pests.

Solutions: Promoting Modern Beekeeping Techniques

Encouraging the adoption of modern beekeeping methods, such as advanced hive designs and improved disease management practices can increase productivity. The government can provide subsidies and training programs to help beekeepers transition to modern techniques. According to NBB, modernizing beekeeping practices can increase honey yields by 20-30%.

5. Limited Research and Development

Investment in apiculture research is insufficient. In 2019, the Indian government allocated only Rs. 25 crore for apiculture research, a small fraction compared to agricultural research funding. This underinvestment hampers advancements in bee breeding, disease management, and technology development.

Solution: Increasing Research and Development

Boosting investment in apiculture research is essential for sector growth. Allocating more funds for research can lead to advancements in bee health, pest control and honey production. Collaboration between research institutions, universities and the private sector can drive innovation.

6. Market Access and Infrastructure

Many small-scale beekeepers struggle with market access and infrastructure. The NBB reported that 70% of beekeepers face difficulties in marketing their products due to inadequate storage, transportation and market linkages. This limits their income and profitability.

Solution: Improving Market Access and Infrastructure

Developing better infrastructure for storage, transportation and processing can enhance market access for beekeepers. Establishing cooperatives and farmer producer organizations (FPOs) can help small-scale beekeepers collectively market their products, negotiate better prices and access larger markets.

7. Price Fluctuations

The honey market in India is highly volatile with prices fluctuating due to seasonal production variations and market demand. Beekeepers often lack the bargaining power to secure fair prices. For instance, the price of raw honey can vary from Rs. 150 to Rs. 300 per kilogram depending on the season and market conditions.

Solutions: Stabilizing Honey Prices

Implementing price stabilization mechanisms can protect beekeepers from market volatility. The government can set minimum support prices (MSP) for honey and create buffer stocks to manage supply fluctuations. Additionally, promoting the export of high-quality honey can open up new markets and reduce domestic price volatility.

Addressing the challenges in the honey bee sector in India requires a multifaceted approach involving regulation, education, research and infrastructure development. By implementing these solutions, India can enhance the sustainability and productivity of its apiculture industry, contributing to rural livelihoods, agricultural success and environmental conservation.

Successful Case of Honey Bee Village in Patagaon, Kolhapur, Maharashtra

Patagaon, located in the Kolhapur district of Maharashtra, having a population of 1500 in 375 households is full of natural resources has emerged as a successful example of promoting beekeeping through its Honey Bee Village initiative. This village has a long tradition of honey production. This community-driven project aims not only to enhance honey production but also to improve rural livelihoods, conserve biodiversity and promote sustainable agricultural practices. The presence of bees in Patagaon has enhanced pollination activities, leading to better crop yields and promoting biodiversity conservation. Beekeeping supports the growth of various agricultural crops and wild flora. Studies indicate a 15-20% increase in crop yields of key agricultural crops such as oilseeds, legumes and fruits due to improved pollination services provided by bees in the region. This Village perfectly exemplifies the concept of Atmnirbhar Village.

Key Features

Agencies Involved

Maharashtra State Khadi & Village industries Board, Mumbai and District Planning Committee, Kolhapur implemented the concept of **“Honey Bee Village” (Madhache Gaon Patgaon)** in association with National Bank for Agriculture and Rural Development (NABARD), Kolhapur and other local institutions. Government funding of approximately Rs. 2 crore has been allocated for the development of apiculture infrastructure and capacity-building programs in Patagaon over the past five years.

Community Engagement and Participation

Patagaon's Honey Bee Village initiative has actively involved the local community, including both men and women. Women in particular, have been empowered through beekeeping, contributing significantly to household incomes. It has involved the beekeepers from villages like Shivdav, Anturli, Mathgaon, Bharamalwadi, Dele, Chandamwadi Mani, Tali Bhatwadi. Over 200 beekeepers are working for the honey collection. Among them 42 are organic beekeepers. Households in Patagaon are actively engaged in beekeeping activities, with women accounting for nearly 40% of the participants. This has paved the path for beekeeper for selling their honey with appropriate packaging and labeling. With the help of NABARD they have also established an FPO named “Patagaon Madhutpadak Shetkari Company” and they will be trained for at least 03 years. They have been encouraged to purchase at least five beehives.

Training and Capacity Building

Regular training programs and workshops are conducted to educate beekeepers on modern apiculture practices. These sessions cover topics such as hive management, disease prevention, honey extraction techniques and sustainable beekeeping practices. More than 200 beekeepers in Patagaon have received training through government-sponsored programs and initiatives by NGOs, improving their skills and knowledge in beekeeping. The major training institutes are Maharashtra State Khadi & Village industries Board, Mumbai, NABARD and Rural Self Employment Training Institute (RSETI) Kolhapur. Batches of beekeepers have also received trainings from Bee Keeping Training and Research Institute, Pune.

Honey Production and Quality

Patagaon produces a variety of honey, including multifloral and monofloral types, leveraging the diverse flora of the region. The honey is known for its purity and quality, attracting buyers locally and regionally. The annual honey production from Patagaon exceeds 20 metric tons, with an average yield of 20-25 kilograms per hive per season during peak flowering periods. The common collection centre at village has also been started for certified beekeepers. They have different roles to play like live demonstration of quality and purity of honey beekeepers/collection centre. They have also a setup of Common facility centre, Lab testing, processing and packaging.

Economic Impact

Beekeeping has significantly contributed to the local economy by providing additional income sources for farmers. It has helped diversify livelihoods, reducing dependency on traditional agriculture. The Honey Bee Village initiative has increased household incomes by approximately 30% on average, benefiting more than 300 individuals directly involved in beekeeping activities. Total production of about 20 Metric ton has provided employment to the locals also in tourism.

Extension Activities and Popularization

To attract the tourist the village has been displayed with attractive boards, hoardings, selfie points and use of CDs, Booklets, brochures etc. Different live demonstration has also been done for honey bee literacy. Government is also planning for honey bee breed centre. This village has also been new attraction for tourism.

Best Rural Tourism village Award (Bronze Category)

Patagaon has been awarded with Best Rural Tourism village Award (Bronze Category), a prestigious completion held at national level by central Tourism ministry. Thus, the farmers from this region are gaining popularity on a national as well as international scale.

In fact, even Patgaon has been included on the maps for its Madhache Gaon. Patagaon was the only entry from Maharashtra for the rural section in this national-level competition.

The Government is taking efforts to ensure that the honey reaches all over the world as an independent honey brand by the name 'Patagaon'. The government was said to focus on developing trained manpower for honey production. Apart from this, GI tagging and trademarking will also be carried out. A Honey Garden establishment is also in the pipeline.

Applaud the Efforts of MadhuSakhis

40 women of Patagaon's Shiv Shakti Mahila Gram Sangh (a Group of all SHGs in the region) had decided to actively participate Honey bee Village. A batch of around 30 women candidates have been trained in beekeeping along with some training in honey processing. Mobilizing women, especially in the hilly terrain of Patagaon is not an easy task; RSETI was the training institute for them.

RSETI provided the following substances:

- RSETI offered core skill training in beekeeping and also Entrepreneurship Development Training, Financial Literacy, and Leadership building training.
- A veteran beekeeper promptly registered as a Master trainer and paving the way for upcoming batches.
- All the women are part of various Self-Help Groups hence better credit linkages will happen after training.
- The certificate that they will get will be from the Government of India, providing pan-India validity and recognition.

Maharashtra State Khadi and Village Industry Board (MSKVIB) provided women with the benefits of Madh Kendra Yojana i.e. a 50% subsidy for purchasing bee boxes and equipments.

Each woman buy a Bee Box and these 35 bee boxes managed by Shiv Shakti Gram Sangh with the help of veteran Beekeeper in the region. Income generated from the initial stage without bee breeding is as follows:

Number of Bee Boxes	Price of Bee Boxes (With MSKVIB's Subsidy)	Honey Collection (In kg)	Income Earned (Considering MSP of Rs. 500/kg)
1	1850	7	3500
35	64,750	245	1,22,500

So, with an investment of around Rs. 65 thousand women can earn twice as much as their input cost. To make this model a reality RSETI as well as MSKVIB will handhold these women for the next 2 years. Since all these women are now certified beekeepers they will be registered as the members of newly registered Patgaon Honey Farmer Producer Company which is an anchor of the entire honey village project. They will be involved in the production of honey also the processing and sale of honey and value-added products. Hence, these MadhuSakhis has provided a much-needed base for this entire project.

Scaling Strategies

Honey bee villages, promoting beekeeping as a sustainable income source for farmers, hold promise for rural development in India. Here are some scaling strategies to empower the farming community through this approach:

- Establish FPOs linking honey producers, processors and marketers. This facilitates knowledge sharing, bulk procurement of beekeeping equipment at lower costs and collective marketing for better bargaining power.
- Partner with government bodies like the National Beekeeping Board and NGOs for training, financial assistance and infrastructure development.
- Organize training programs on beekeeping practices, honey processing, value addition techniques, and beehive management. Partner with agricultural universities and research institutions for technical expertise.
- Connect experienced beekeepers with beginners for on-the-ground guidance and mentorship.
- Set up centralized honey processing units in villages to ensure quality control, value addition (like producing beeswax products) and better storage facilities.
- Develop market linkages with supermarkets, organic stores and online platforms to expand reach and ensure fair prices for honey producers.

- Develop mobile applications for beekeepers to access information on beekeeping practices, market prices, weather forecasts and disease control measures.
- Promote apiculture not just for honey production but also for pollination services, which can benefit nearby farms and increase crop yields.
- Encourage organic beekeeping practices to produce high-quality honey and fetch premium prices.
- Create a distinct brand identity for honey produced in these villages, highlighting the ethical and sustainable production methods.
- Promote beekeeping using native honeybee species adapted to the local environment.
- Educate farmers about the importance of bees in pollination and the dangers of pesticide use.
- Support research on improving beehive designs, disease control methods, and honey production techniques.

Successful Case-I

Abreeze Honey and Madhushakti Honey: A Case Study on Beekeeping

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Introduction

India has one of the world's largest youth population, with nearly 600 million people under 25 years. Agriculture is vital to the Indian economy, contributing to food security, rural development and employment. However, the sector faces a significant challenge in attracting and retaining young people. The growing youth population, India must find innovative ways to engage the younger generation in agricultural activities. Young people bring fresh perspectives, innovative ideas and an eagerness to adopt new technologies, which can contribute to the growth and modernization of the agricultural sector. Agriculture offers diverse career prospects for young people across various sub-sectors including crop production, livestock, agro-processing and agri-inputs.

A major part of the Indian economy still lies in the rural areas and villages of the country. Though, a huge mass of people are constantly moving to the urban sectors, development of the villages cannot be neglected. With their excellent managerial and entrepreneurial skills, few Indian youth have taken up the duty to raise the standard of living in Indian villages and have been really successful at it. Youth entrepreneurs are constantly re-writing the history with their skills and confidence and providing a new face of life to the rural population through innovative ventures. The young entrepreneur who has made invaluable contributions to rural industry especially in the field of apiculture (bee-keeping); an essential allied agricultural activity (Dharmaraj, S. (2021). Bee-keeping plays an important role in the sustainable agriculture as it contributes significantly for diversification of agriculture. Beekeeping is an interesting hobby, an ideal agro-based subsidiary enterprise, providing supplementary and sometimes major source of income to the farmers, especially to the small farmers (Refer Annexure for Apiculture Market in India). It is an ideal, eco-friendly and non-land based rural enterprise, which does not tax the farm resources and provide sustainable livelihood to the rural people including landless, woman and youth (Karan Bansal *et al*, 2013). Bee-keeping or Apiculture in general, has been taken-up as hobby or at micro level as an additional income generation activity in rural folks. Undertaking apiculture as a full-fledged entrepreneurial venture by an individual, except certain business enterprises is rarely found. Not many find their way to the proverbial land of milk and honey, but Rujeet Meher and Onkar Chikhale slow and steady steps took her there. Her enterprise called Abreeze Honey and Madhushakti Honey. Her success is priceless as it comes after huge personal losses.

Problem Faced

In jurisdiction of KVK, women farmers and farmers are growing many crops like cereals crops, pulses crops, oilseeds crops, fruit crops and vegetable from many years. Since last 4 to 5 years the pollination of rates of many crops are low due to no honey bee available in field then the decreased the yield up to 20 % to 70%. So, the production of fruits, vegetables, pulses oilseed, cereals etc. does not profitable and framers loses their money. So we could find the option for beekeeping training for rural women's of Self Help Groups. The beekeeping is having a byproduct like honey, pollen, Royal jelly etc. in this product was high medicinal value, export potential and good returns in terms of money.

Innovation for Rural Youth Attracting in Apiculture

The Krishi Vigyan Kendra, Narayangaon, Bee-Positive, New Delhi and the Central Beekeeping Research & Training Institute (CBRTI), Pune launched the Madhu Shakti - a project focused on empowering rural youth and farm women through beekeeping. The project is being financially assisted by the Bee Positive and PHD-Rural Development Foundation, New Delhi. Around 295 participants attended a Sensitization Workshop held in June, 2019 at the KVK, Narayangaon. After the workshop, a hundred of these participants were enrolled for the Madhu Shakti Project. They were trained through the classroom and practical sessions in the month of August, 2019 at the KVK, Narayangaon for certifying them as certified Beekeepers. After successful training completion each participant provided Bee-boxes. Total 500 bee boxes given to 100 farmers on group based approach. Different apiaries were formed in different villages in Junnar (05), Ambegaon (02), Khed (03) talukas.

Rujeet Anil Meher: The Agripreneur (Entrepreneur in Agriculture and Allied Activities

The Shreejeet Foods Private Limited (Abreeze Honey: **CIN:** U15490PN2018PTC177791/ **PAN:**ABACS6031R/ **MSME Registration:** MH26B0126808) was formed in July 2018 by its Co-Founder Director Mr. Rujeet Meher in Narayangaon, Pune, Maharashtra. The company has been operational since March 2019 with total plant capacity to package 7,48,800 honey sachets (8-grams each) per month which is around 6000 kg. Our company has a strong financial backing from the Directors and Investors which is crucial for executing government contracts. In order to fulfill the demand from the Indian Armed Forces, our company has the capacity to expand the production line in the existing facility. Shreejeet Foods Private Limited procures honey from professional bee keepers who are certified with ISO 22000, GMP and HCCAP to ensure quality honey supply. It is also working with KVK, Narayangaon and Delhi based NGO named Bee ++ to develop network of beekeepers from which it procures honey and other bee hive products. This activity is helping to earn extra income and also resulting in increased agriculture and horticulture production in surrounding areas. In view of the pressing need of employment and economic uplift for farmers and workers, honey industry can be a very useful and productive alternative. Honey along with supporting rural economy but will take care of the health and fitness of our people.

Onkar Dattatray Chikhale: The Entrepreneur in Agriculture and Allied Activities

Shri Onkar Dattatray Chikhale, an entrepreneur from Nandur, Ambegaon tehsil, Pune district undergone training in scientific beekeeping and honey production technology under the National Beekeeping & Honey Mission at Krishi Vigyan Kendra, Narayangaon Pune, Maharashtra. He was inspired from the training. He initiated honey production, maintaining and rearing hives, and providing them on rent for pollination to local farmers. Around 295 women participants attended a Sensitization Workshop held in June at the KVK, Narayangaon. After the workshop, a hundred of these women were enrolled for the Madhu Shakti Project. They were trained through the classroom and practical sessions in August, 2019 at the KVK, Narayangaon for certifying them as certified Beekeepers. After completing training, each woman was provided Bee-boxes. Total 500 bee boxes supplied to 100 women farmers on group based approach. Different apiaries were formed in different villages in Junnar (05), Ambegaon (02), Khed (03) tehsil.

Launching of Madhushakti Project

Training to Farmers & Rural Youth

Practical demonstration to farm women Setup of Apiary Unit at Field

Impact

KVK Narayangaon, Pune is providing the technical backup to Bee Keeper for branding of honey and giving the marketing platform for selling the product. After completing the training, each farmer obtained Bee-boxes. A total of 500 bee boxes were distributed to 100 farmers in group under different villages. KVK Narayangaon extended technical support for branding honey and facilitated a marketing platform for product sales. The output and outcomes of the project include:

Particulars	2020	2021	2022	2023
Honey production (Kg)	1500	3300	3950	5000
Honey Sale (Kg)	1200	3000	3600	4800
Honey sale rate/Kg	300	300	300	300
Honey Box on rent	50000	45000	65000	75000
Labour Cost & others	226000	570000	684000	912000
Total Net Profit (Rs.)	184000	375000	461000	603000

Some of the farmers are giving Bee boxes on rental basis to nearest farmers for pollination purpose in crops like pomegranate, onion seed production etc. at the rate Rs. 1000 per box/month basis.

Honey Extraction and Brand Development- Madhushakti Platform for Selling Honey

Conclusion

The Shreejeet Foods Private Limited (Abreeze Honey) have tried to take a step in the direction of self-reliance economy and health through our honey production. The size, quantity and quality of our honey sachets will certainly be very helpful to the military personnel for their fitness and energy. In turn, it will support our farmers, employees, workers and families dependent on them. Honey sachets are containing 8 gram (net weight) honey. These sachets are designed for easy to tear and sip or pour honey. It is easy to carry and store. The Madhu Shakti Honey stands as a successful initiative in empowering rural youth like Shri Onkar Chikhale through beekeeping, not only enhancing their livelihoods but also contributing to increased crop yields and ecological sustainability. The collaboration between KVK, Bee-Positive and CBRTI showcases a holistic approach to address agricultural challenges, creating a model that can be replicated in other regions.

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Successful Case-II

Income Generation through Migratory Beekeeping: A Profitable Business

Dinkar Vitthalrao Patil, Entrepreneur, Patil Bee Keepers, Chakur
Gauri Natural Foods, Chakur, Latur, Maharashtra

Introduction

In the year 2005, I started beekeeping business with 5 boxes. Initially trained from CBRTI, Pune and Maharashtra State Khadi Gramodyog Mandal Mahabaleshwar. After that I travelled to different states and got information about the flowers and seasons. The first five years were spent in learning the trade and after that good production of honey started. Patil Bee Keepers started providing bee boxes for pollination to farmers at reasonable rates.

Bee colonies are in high demand among farmers due to pollination which increases the yield of crops. Bee breeding is done in huge amount by Patil Bee Keepers. Since the honey is collected by own hands and no harm is done to the bees, the honey is in huge demand in the market.

To supply that demand Gauri Natural Foods was established in 2016 and started selling honey through the brand Real Honey. In order to bring pure honey to the consumers at very affordable rates, Real Honey outlet was opened at Latur so that the pure honey is easily available to the consumers. Honey is sent to customers all over the country through courier facility.

Experience

I have been practicing migratory beekeeping since 2005. I have been migrating in various states of India like Rajasthan, Madhya Pradesh, Uttar Pradesh, Karnataka, Maharashtra, Jammu and Kashmir, Haryana, Punjab, Gujarat, Jharkhand, Chhattisgarh etc.

I reared the bees of the species *Apis mellifera*. It is a bee species imported from Europe that lives in the dark. There are eight to ten frames in a bee box. One bee colony usually yields 25 to 30 kg of honey per year. We do the migration of bees to different flowers throughout the year such as mustard, babul, coriander, tulsi, multiflora, karanj, litchi, ajwain, jamun, eucalyptus etc.

Most of the time we live in tents beside the boxes in those fields. The quantity of pollen nectors brought by bees has to be checked from time to time. Care should be taken to prevent the bee box from getting infected by insects and also from being attacked by green bee eaters. From migratory beekeeping, we collect honey from different flowers throughout the year. In that ajwain honey, acacia honey, sesame honey, saunf honey, eucalyptus honey, litchi honey, tulsi honey, karanj honey, coriander honey and sunflower honey etc.

I used to bring this honey extracted from different parts of the country to my unit Gauri Natural Foods in Chakur. The honey brought into this unit is maintained between 18 to 22 degrees of moisture. This honey is bottled and labelled for the market with brand Real Honey and some honey also sold on wholesale basis.

The honey packaged by Gauri Natural Foods is delivered to consumers through outlet in Latur, Real Honey. Real Honey is available in attractive packaging at very affordable prices. This honey is gifted in attractive packaging. Honey bottles gift boxes are more in demand in the markets.

There is a huge demand for bees among farmers for pomegranate, drumsticks, watermelon, sweet melon pollination. I also provided bee boxes for onion seed production. I used to produce 50 to 60 tonnes of honey per year through migratory bee keeping. I have provided bee boxes for pollination to thousands of farmers. Pollen is collected by placing a trap in front of the gate of the bee box.

This pollen is brought to the market after moisture reduction. There is a huge demand in the market for different colored honey of different flavours collected from different flowers.

Conclusion

Honey bees are very important for pollination in different crops. The yield of various crops are increased through pollination. Crops pollinated by bees show a significant increase in yield and improved fruit quality. Hence, there is a huge demand for beehives for pollination in different districts and states. Honey is rich in all kinds of nutrients. Regular consumption of honey in daily diet makes immunity strong. Since, pure honey is not easily available in the market, so beekeeping has become a very profitable business. Different types of honey collected from different flowers are in huge demand in the market.

Major lessons learned are as follows: In-depth training on scientific beekeeping is required before staring apiculture. Beekeeping should be started on small scale. Exposure visits to the successful entrepreneurs should be made. Special care for protecting bees and bee management should be taken. Quality of honey and other value added products should be maintained. Branding of honey and other produces is essentially required for making place in the market for regular income on sustainable basis. It will also help in exporting the branded honey and other products in long run. Possible marketing strategy should be developed considering local demand, available local resources and harnessing benefits of different schemes / programs related to beekeeping.

Successful Case-III

Sweet Success of Kalu Wangad: A Tribal Entrepreneur

Vilas Jadhav, KVK, Palghar (Maharashtra)

Introduction

An entrepreneur is a person who organizes and maintains an enterprise assuming the risk for the sake of profit or is an economic man who strives to maximize his profits by innovation. However, the entrepreneur is not a simple innovator, he is the person with a will to act to assume risk and to bring about a change through organization of human efforts. In case of tribal entrepreneurs, they are known to be involved in bee keeping since a long time. In the last two decades beekeepers and planners have started realizing the importance of mobilizing the tribal youth for beekeeping as a self-employment. Studies have been emerged on beekeeping and agriculture in tribal areas. Thus, it helped to make invisible tribal entrepreneur to become a more and more visible. Such studies on tribal are of extreme importance, to get an insight about their role in beekeeping the motivation factor, the financial difficulties, information seeking and managerial skills in such activities. Thus, the present case study was taken up for in-depth analysis of beekeeping.

Methodology

The pilot survey of the area around Kosbad Hill village was made to identify tribal youth entrepreneurs in bee keeping who had already trained. One of young farmer i.e. Shri Kalu Wangad could be identified who had running bee unit efficiently. Thus it was decided to take up a case study on his bee activities. The study used an open-ended interview schedule as well as observation method as a tool to conduct case study.

Process Documentation

Shri Kalu Wangad, a young enthusiastic hard-working farmer resides at Kosbad Hill village in Dahanu tehsil of Palghar district in Maharashtra. After completion of 10th standard education, he had undergone training for beekeeping at KVK, Palghar. After completion of one-month training, he started beekeeping unit from 02 bee colonies. Shri Kalu Wangad started his beekeeping enterprise by initially capturing and made up of bee colony boxes of local bee species *Apis cerana indica* available in his locality and then setting them up in his own apiary at his native village of Kosbad Hill and nearby areas. By that time, he also took training in beekeeping from the KVK, Palghar and the Khadi & Village Industries Board for learning scientific beekeeping and better bee management practices.

Information about Bee keeping activities

Location: The bee keeping unit is located in Kosbad Hill village, Taluka – Dahanu, Palghar District, Maharashtra. The residence surrounded with agriculture fields and few shrubs owned by the family.

Beekeeping Activities: Mr. Kalu Wangad took interest in beekeeping after he completed his education when he was working as a carpenter. His interest in beekeeping was triggered by a beekeeper, Mr. Rajesh Wangad, his nephew who approached him to make beehives and who also gave him practical knowledge about the subject. There is a bee keeping unit having size about 10 colonies, the entire activities managed by him. Basically, he is from carpenter family, took initiative for the preparation of bee boxes along with capturing bee colonies. He started this work. He provides the bee boxes along with bee colonies of *Apis cerena indica* for the farmers of Palghar as well as other districts of Maharashtra state. He is also engaged in maintaining and consulted 165 farmers towards the bee hives of surrounding Palghar, Dahanu and Talasari tehsils of Palghar district.

Employment: Shri Kalu Wangad and his family working in beekeeping regularly. He did not require of hiring any labour. Preparation of bee boxes, collection of bee colonies and maintenance of bee boxes of surrounding areas etc. work being done by himself. Management and supervision whenever required, done by themselves.

Outcome: After successful running the various activities of beekeeping, he attained average income of Rs. 20,000/- per month. So, he earned an amount of Rs. 2,40,000/- in the year 2012 and realized net benefit of Rs. 1,30,000/-. Now he has expanded his business with manufacturing the bee boxes and iron stands for installation of bee colony. He is involved in doing other beekeeping works like capturing the bee colony from forest, increase the number of bee colony by division process and queen rearing method. He also started giving service to other bee keepers for handling the bee colony like cleaning the bee colony and box, extraction of honey, capturing the colony from nature and transfer into wooden box etc. Consequently, his earning is increasing day by day. Last year, he achieved Rs.3.45.000 in a year from a small and tiny bee keeping business.

Sr No	Items	Nos	Rate per Item (Rs.)	Amount (Rs.)	Production Cost (Rs.)	Net Income (Excluding labour charges & expenditure) in Rs.
1	Wooden Bee boxes	150	2000	3,00,000	1,50,000	1,50,000
2	Bee colony	100	2000	2,00,000	1,00,000	1,00,000
3	Honey	50	600	30,000	-	30,000
3	Service Charges	25	1000	25,000	-	20,000
4	Iron Stand for installation of colony	100	900	90,000	45,000	45,000
	Total					3,45,000

Impact: Today he is maintaining 125 bee colonies and has been identified as a bee-breeder by the Khadi Village and Industries Commission and works as a Master Trainer of KVK for its mission for bee colonies multiplication and supply to beekeepers. He has helped over 165 beekeepers in Palghar, Dahanu and Talasari tehsil of Palghar and other districts. His tiny bee-box manufacturing unit supplies 500 bee-boxes and other accessories every year to the beekeepers and other agencies.

Future Prospects: It is the fact that tribal youth can manage bee keeping enterprise. Although he got formal training but with his keen interest and determination, he could achieve success. He advised that unemployed members of the family, should take up the enterprise on a small scale. After that, it may be expanded to earn higher income on regular basis. It is good example of his success for motivating other tribal people to start the beekeeping. There is need to conduct vocational trainings for the tribal people and also organize exposure visits to commercial bee entrepreneurs.

Kalu Wangad observing the bee colony in his Apiary

Kalu Wangad's workshop of making wooden bee boxes

Chapter - 11

Entrepreneurial Motivation for Beekeepers

Lakhan Singh, Professor & Advisor, ACES, AMITY University
Noida, Uttar Pradesh
Sunil Kumar, SMS (AE), KVK, Kaneri, Kolhapur, Maharashtra

Introduction

India's agricultural landscape is dominated by small and marginal landholdings, which despite their size, contribute significantly to the nation's food security and diversification. These farmers, however, face several challenges including limited access to credit, technology and markets. To overcome these hurdles and enhance their livelihoods, fostering an entrepreneurial spirit is crucial. While small-scale farming often presents economic challenges, it also offers unique opportunities. Diversification into areas like mushroom cultivation, horticulture, sericulture and even aquaculture can significantly boost farmers' incomes. Apiculture or beekeeping, is particularly promising given India's vast agricultural and horticultural expanse. It's a traditional practice with immense potential for commercialization, providing employment and additional income streams for farmers especially women and youth. To fully realize agriculture's potential, nurturing a new generation of agripreneurs is essential. These individuals, equipped with business insight and innovation, can transform traditional farming practices. By supporting entrepreneurship in rural India, we can not only improve the lives of farmers but also contribute to the nation's economic growth and sustainability.

Beekeeping is a compelling entrepreneurial opportunity rooted in agriculture and horticulture. It stands out for its low technological requirements, minimal capital investment and uncomplicated infrastructure. This makes it an ideal complementary activity for farmers, boosting their overall income. Beekeepers tend to hives to harvest honey and other valuable products like pollen, beeswax, venom and royal jelly. Beyond product generation, beekeeping plays a vital role in pollinating crops, enhancing their quality and increasing yields. This agricultural synergy significantly benefits farmers. Furthermore, beekeeping offers substantial employment opportunities, particularly in rural areas. It provides self-employment for local residents and creates jobs in product collection, processing and marketing for educated youth. In essence, beekeeping is more than just a business; it's a sustainable practice that contributes to both economic growth and environmental health.

Achievement Motivation

Achievement motivation is a psychological drive that compels individuals to set and pursue challenging goals, seek excellence and derive satisfaction from accomplishments. It is characterized by a desire to succeed, a preference for tasks of moderate difficulty and a persistent effort to achieve goals despite obstacles. This motivation is rooted in intrinsic factors, where the satisfaction comes not from external rewards but from the internal sense of achievement, growth, and mastery.

People with high achievement motivation are goal-oriented, self-disciplined, and focused on improving their skills and performance. They are often driven by a need for personal accomplishment, seeking situations where they can take responsibility, excel, and receive feedback on their progress. The motivation is vital in various aspects of life, particularly in entrepreneurship.

Importance of Achievement Motivation in Entrepreneurship Development

Entrepreneurship is a challenging and dynamic field that requires a combination of skills, mindset and motivation. Among these, achievement motivation stands out as a critical factor in the success and sustainability of entrepreneurial ventures.

Goal Setting and Vision: Entrepreneurs with high achievement motivation are inclined to set clear, ambitious and attainable goals for their business. They are driven by a vision of what they want to achieve, whether it is market leadership, innovation or social impact. This vision provides a roadmap for their actions and decisions, guiding the direction of their business. The ability to set and pursue long-term goals is essential for tackling the complexities of entrepreneurship.

Persistence and Resilience: The entrepreneurial journey is full of challenges, uncertainties and setbacks. High achievement motivation fosters resilience, enabling entrepreneurs to persist in the face of adversity. Entrepreneurs who are motivated by achievement view failures as learning opportunities rather than as deterrents. This mindset is crucial for maintaining momentum and continuing to push forward, even when the odds seem stacked against them.

Innovation and Creativity: Achievement-motivated individuals are naturally inclined toward innovation. They are not satisfied with the status quo and continuously seek better ways to solve problems, improve products or deliver services. This drive for improvement and innovation is essential in entrepreneurship, where staying ahead of competitors often requires creative thinking and the ability to adapt for changing market conditions.

Risk-Taking: Entrepreneurship inherently involves risk, whether it is financial, reputational or personal. Achievement-motivated entrepreneurs are more willing to take calculated risks because they are driven by the potential rewards of success. They carefully evaluate the risks and benefits, make informed decisions and are prepared to take bold steps to achieve their goals.

Self-Efficacy and Confidence: Achievement motivation enhances an entrepreneur's self-efficacy or belief in their ability to achieve their goals. This confidence is crucial in entrepreneurship, where doubt and uncertainty are common. A strong sense of self-efficacy enables entrepreneurs to take initiative, influence outcomes, and inspire confidence in others, including investors, employees and customers. People with high achievement motivation are goal-oriented, self-disciplined, and focused on improving their skills and performance.

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Focus on Growth and Learning: Achievement-motivated entrepreneurs are committed to personal and professional growth. They seek out opportunities to learn, develop new skills, and increase their knowledge. This continuous improvement is vital for adapting to changes in the market, staying competitive and scaling their business/enterprise.

The key components of achievement motivation are essential elements that drive individuals to pursue and attain their goals. These components are central to understanding how and why people strive for success, especially in challenging situations. Here are the primary components:

1. Goal Orientation

Goal orientation refers to the direction and focus of an individual's efforts towards achieving specific outcomes. People with high achievement motivation set clear, challenging and attainable goals.

Importance: This focus on goal setting ensures that individuals are purposeful in their actions, directing their energy towards meaningful objectives that align with their personal or professional aspirations.

2. Persistence

Persistence is the ability to maintain efforts and motivation over time, especially when facing hurdles or setbacks. It reflects a commitment to long-term goals and a refusal to give up easily.

Importance: Persistence is crucial for overcoming challenges and continuing to work towards goals, even when progress is slow or difficult. It ensures that individuals remain dedicated to their objectives despite potential difficulties.

3. Self-Regulation

Self-regulation involves the ability to monitor and control one's behavior, emotions and thoughts in the pursuit of long-term goals. It includes self-discipline, time management and the ability to stay focused.

Importance: Effective self-regulation helps individuals stay on track towards their goals, manage distractions and make necessary adjustments to their strategies. It also enables them to maintain motivation over time.

4. Intrinsic Motivation

Intrinsic motivation is the drive to engage in activities for their own sake, deriving satisfaction from the process rather than external rewards. It is fueled by personal interest, curiosity and a desire for mastery.

Importance: Intrinsic motivation is a powerful force that sustains long-term engagement and commitment. Individuals motivated intrinsically are more likely to continue in challenging tasks because they find the work itself rewarding.

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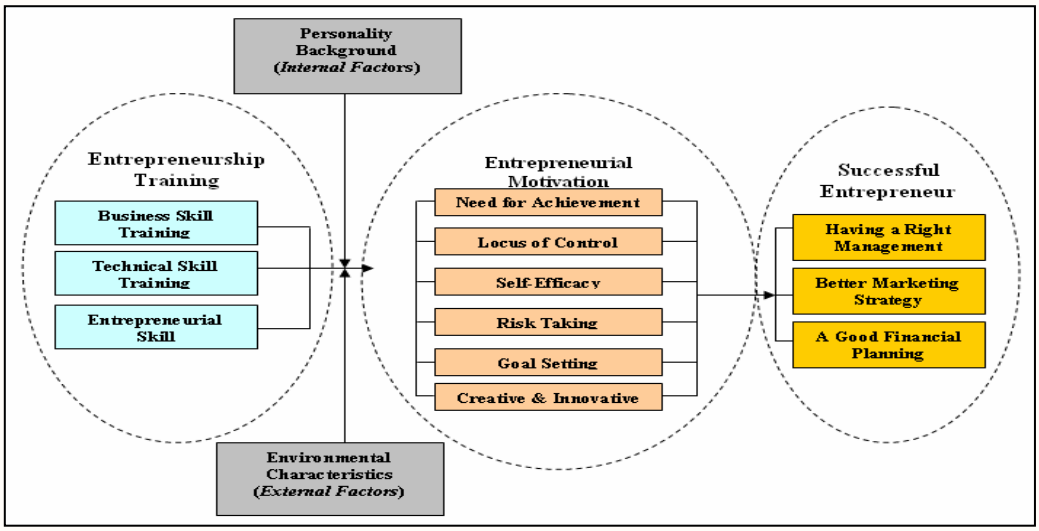

Essentials for Entrepreneurial Motivation

Understanding the Beekeeping Business

Before diving into entrepreneurial skills, it is essential to understand the beekeeping business landscape.

Market Analysis: Survey the demand for honey and other bee products in your region. Identify target markets, such as local consumers, health food stores or specialty markets.

Competitive Analysis: Study your competitors to understand their offerings, pricing and marketing strategies.

Value Proposition: Define what makes your beekeeping business unique. This could be the quality of your honey, sustainable practices or a specific product line.

Core Entrepreneurial Skills for Beekeepers

1. Market Understanding and Product Development

Market Research: Conduct thorough market research to identify consumer preferences, trends and untapped opportunities.

Product Diversification: Explore products beyond honey such as beeswax candles, propolis, royal jelly and pollen. Consider creating value-added products like honey-infused skincare or gourmet food items.

Branding: Develop a strong brand identity that resonates with your target market. Create a compelling brand story and visual elements.

Packaging: Invest in attractive and functional packaging that enhances your product's

2. Financial Management

Budgeting: Create a detailed budget to cover beekeeping expenses, including equipments, supplies, labour and marketing.

Pricing Strategy: Determine competitive and profitable pricing for your products. Consider factors like production costs, market demand and value perception.

Cash Flow Management: Monitor your cash flow closely to ensure you have sufficient funds to meet operational needs.

Financial Recordkeeping: Maintain accurate financial records for tax purposes and business planning.

3. Marketing and Sales

Digital Marketing: Leverage online platforms like social media, email marketing and your website to reach a wider audience/people.

Content Marketing: Create valuable content such as blog posts, videos or recipes to attract and engage customers.

Public Relations: Build relationships with media outlets to generate positive press coverage.

Sales Channels: Explore various sales channels, including direct-to-consumer, farmers' markets, online stores and wholesale partnerships.

Customer Relationship Management (CRM): Implement a CRM system to manage customer interactions and build loyalty.

4. Risk Management

Business Insurance: Protect your business with appropriate insurance coverage such as liability insurance and property insurance.

Disaster Preparedness: Develop contingency plans for potential challenges like bee colony collapse, natural disasters or economic downturns.

Quality Control: Implement strict quality control measures to ensure the purity and safety of your products.

5. Business Planning and Strategy

SWOT Analysis: Conduct a SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) to assess your business's internal and external factors.

Goal Setting: Define clear and measurable business goals.

Strategic Planning: Develop a comprehensive business plan outlining your vision, mission, objectives and strategies.

Adaptability: Be prepared to adapt your business plan as per market conditions and customer preferences change.

Chapter - 12

A Journey with Honey Bees

K. Indira Reddy, President
Managing Director, Rutika Innovations Private Limited, Hyderabad

K. Indira Reddy is an accomplished professional with a diverse educational background, holding degrees in B.Ed, MBA and LLM. After spending four years working abroad, she returned to India to support her mother and establish a school. She is currently the Principal of St. Joseph's Grammar High School. In addition to her educational role, Indira began beekeeping as a hobby, which has since grown into a significant initiative.

In the serene melody of the apiary, amidst the graceful choreography of honey bees, K. Indira Reddy discovers solace and enlightenment. To her, beekeeping transcends mere livelihood; it represents a transformative journey of self-exploration, education and unyielding dedication. Her journey in the realm of beekeeping is a testament to passion, perseverance and purpose.

Born amidst the lush landscapes of Telangana, Indira's affinity for nature and fascination with bees ignited at an early age, inspired by the buzzing symphony of life that surrounded her. Armed with a vision to empower rural communities and conserve biodiversity, Indira embarked on her voyage into beekeeping with unwavering determination.

The Importance of Honey Bees in the Ecosystem and Agriculture

Honey bees are crucial to the ecosystem and agriculture. As pollinators, they facilitate the reproduction of many flowering plants, contributing significantly to biodiversity and food production. In Telangana, where agriculture is a cornerstone of the economy, the role of honey bees becomes even more vital. Their pollination directly impacts the yields of key crops, helping to sustain the livelihoods of farmers across the region.

My Journey into Beekeeping

My journey into beekeeping began with a profound interest in sustainable farming practices. Witnessing the declining bee populations and understanding their significance in natural farming, I decided to delve into beekeeping. This not only allowed me to contribute to preserving these essential insects but also provided me with a deeper connection to nature and sustainable agriculture. Initially, there was a belief in Telangana that bees could not thrive in the region. However, through persistent efforts and the support of initiatives like the State Level Steering Committee (SLSC) and horticulture department, this perception has changed. Today, Telangana is home to a growing number of beekeepers who are reaping the benefits of this practice.

Getting Started with Scientific Beekeeping

Starting a journey in beekeeping requires hands-on experience. Beginners should seek out mentorship programs, workshops, and practical training sessions to familiarize themselves with hive management, bee behavior and best practices in beekeeping. Emphasizing the importance of a scientific approach, they should learn about hive dynamics, disease management, queen rearing techniques and honey extraction methods based on evidence-based practices.

Exploring Bio-Products in Beekeeping

Bio-products derived from beekeeping such as honey, beeswax, royal jelly, propolis and bee pollen offer diverse commercial opportunities. Beekeepers should delve into the production, processing and marketing aspects of these bio-products to maximize their potential earnings. Through value addition processes like organic certification, packaging innovation and product diversification, beekeepers can enhance the marketability and profitability of their bio-products.

Hands-on Field Work and Practical Experience

Beyond theoretical knowledge, practical experience in the field is invaluable for beekeepers. Engaging in hive inspections, swarm management, queen rearing and hive manipulation under the guidance of experienced beekeepers provides essential learning. Establishing networks within the beekeeping community and seeking guidance from agricultural extension officers, research institutions and beekeeping associations can offer valuable support for navigating challenges in the field.

Integrating with all Line Departments

To enhance the impact of beekeeping, integrating efforts with various departments such as horticulture, agriculture, forestry, tribal welfare, MANAGE, NiMSME, NIRD, Horticulture University and urban development is essential. In Telangana, where diverse ecosystems and farming practices coexist, this integration can promote the planting of bee-friendly crops and plants. By collaborating with these sectors, we can create a more supportive environment for bees, improving crop yields and biodiversity across the state. Focused efforts on planting suitable crops that require minimal pesticides and fertilizers will further benefit the environment and reduce costs for the farmers.

Benefits to Farmers and Communities

Incorporating bee-friendly practices into agriculture can significantly reduce the use of harmful pesticides and fertilizers. This not only lowers farming costs but also enhances crop yields and quality. For farmers in Telangana, where agriculture is a primary livelihood, these approaches can effectively double their income. Moreover, beekeeping offers substantial opportunities for employment generation, particularly in rural areas. The increased demand for honey bee products coupled with higher agricultural productivity, can create new jobs and support the economic well-being of farming communities.

Building Ecosystems and Biodiversity in Telangana

Beekeeping plays a crucial role in building robust ecosystems and enhancing biodiversity, especially in regions like Telangana, where diverse flora and fauna are vital to ecological balance. By supporting plant reproduction, bees help to maintain a variety of plant species, which in turn support a wide range of wildlife. This biodiversity is essential for resilient ecosystems that can withstand environmental changes and stressors.

Impact on FPOs and SHGs

5 FPOs Benefited: Highlight how five Farmer Producer Organizations have seen significant benefits from beekeeping, including better market access and increased income.

10 SHGs Benefited: Discuss the positive impact on ten Self-Help Groups, emphasizing the role of beekeeping in improving their economic standing and creating sustainable livelihoods.

Market Potential for Honey

Current Consumption Statistics: Mention that currently, only 0.8% of the potential honey market is being consumed domestically, which has increased to 0.26%.

Growth Opportunity: Emphasize the huge market potential that remains untapped, making honey production a highly lucrative opportunity for farmers.

Role of Honey Bees in Natural Farming

Pollination Impact: Explain how deploying beehives in natural farming environments enhances pollination. This not only supports wild bee populations but also helps in the growth of weeds, which are beneficial for bees and other pollinators.

Ecosystem Support: Highlight the symbiotic relationship between bees and their environment, showing how beekeeping supports overall biodiversity and contributes to a healthier ecosystem. These points will strengthen your message, showing the multifaceted benefits of beekeeping, from economic growth to environmental sustainability.

Creating Awareness and Developing Bee Parks

Promoting the planting of bee-friendly plants and developing bee parks in Telangana are vital steps in supporting bee populations and raising awareness. Bee parks can serve as educational centers, helping the community understand and appreciate the vital role of bees in our ecosystem. Through these initiatives, we can inspire more people to participate in beekeeping and contribute to preserving the environment for future generations.

Establishing a Training Institution

With over four years of experience in beekeeping and exposure to various regions, K. Indira Reddy is well-positioned to establish her own training institution. This institution can offer structured courses, workshops, and practical demonstrations to aspiring beekeepers, farmers, and agricultural enthusiasts.

Chapter - 13

Programs/Schemes for Promoting Scientific Beekeeping

Neetu Singh, Coordinator
ACES, Amity University Uttar Pradesh, Noida

Introduction

Apiculture or Beekeeping has emerged as a vital supplementary activity in agriculture that contributes to environmental sustainability, biodiversity and economic development due to symbiotic relationship between bees and environment. As pollinators, their pollination services are essential for the crop production. Beekeeping can provide additional income source to the rural youth and entrepreneurs reducing dependence on single crops for economic gain. Recognizing its potential, the Government of India and various international organizations have launched several schemes and programs for promoting scientific beekeeping. These initiatives are taken with the objectives to equip beekeepers with the necessary knowledge, skills and resources to adopt modern practices for mobilizing the beekeepers and farmers. In this chapter, various schemes and programs that have been implemented at both the national and international levels for promoting scientific beekeeping are discussed.

National Programs and Schemes (India)

The Indian government has launched several schemes and programs /missions to promote scientific beekeeping at national level.

a) Mission for Integrated Development of Horticulture (MIDH)

The Mission for Integrated Development of Horticulture (MIDH) was launched in 2014 centrally sponsored scheme under Ministry of Agriculture & Farmers Welfare, Govt. of India became operational on April 1, 2014. The Mission for Integrated Development of Horticulture (MIDH) aims to promote the holistic growth of the horticulture sector including beekeeping to enhance agricultural productivity and farmers income. Financial support is provided for establishing apiaries including the purchase of bee colonies, hives and necessary equipments. MIDH organizes training programs to educate beekeepers on scientific practices. It includes courses on hive management, disease control and honey processing.

Impact

Enhanced Productivity: Beekeepers under the MIDH program have reported higher honey yields and improved colony health.

Economic Upliftment: Financial assistance and trainings have empowered beekeepers leading to increased income and better living standards.

b) National Beekeeping and Honey Mission (NBHM)

In view of the importance of beekeeping and to achieve the goal of 'Sweet Revolution', the need for holistic development of beekeeping was emphasized. Accordingly, a new Central Sector Scheme 'National Beekeeping and Honey Mission (NBHM)' for overall promotion and development of scientific beekeeping, production of quality honey and other beehive products was launched in 2020 as part of the *Atma Nirbhar Bharat* package which aims to promote and develop scientific beekeeping practices. The scheme is being implemented through National Bee Board as a Central Sector Scheme (100% funded by Central Government). The NBHM is implemented by the National Bee Board (NBB) in India, promotes beekeeping as part of the National Horticulture Mission. The National Bee Board (NBB) was reconstituted in June, 2006. The main objective of the National Bee Board (NBB) is overall development of Beekeeping by promoting Scientific Beekeeping in India to increase the productivity of crops through pollination and increase the honey production for increasing the income of the beekeepers/ farmers as part of the National Horticulture Mission.

The NBHM have following sub-schemes/ three Mini Missions**:**

(a) Mini Mission-I: Under this Mission, thrust is given on production and productivity improvement of various crops through pollination assisted by adoption of scientific beekeeping;

(b) Mini Mission-II: This Mission is concentrated on post-harvest management of beekeeping/ beehive products including collection, processing, storage, marketing, value addition etc. with a thrust to develop requisite infrastructural facilities for these activities; and

(c) Mini Mission-III: This Mission is concentrated on research and technology generation for different regions/ states/ agro-climatic and socio-economic conditions.

Scheme Objectives: Foster the holistic growth of the beekeeping industry for income and employment generation for farm/non-farm households and to augment horticulture/agriculture production. Empowering women via beekeeping is emphasized. Create and enable honey corridors in potential areas are also one of the objectives. Another objective is to encourage agri-entrepreneurs for agri-startups in beekeeping/honey production.

Components

Promoting Good Beekeeping Practices (GBP): Capacity-building/training programs are organized to educate beekeepers on modern techniques and best practices. It includes hive management, pest and disease management and scientific beekeeping practices.

Research and Technology: The mission also supports research and development activities in order to improve beekeeping practices which includes studies on bee behaviour, disease resistance and the development of new technologies to enhance productivity.

Development of Infrastructure for Post-Harvest Management: The NBHM supports the establishment of processing units of honey and other bee products. It includes facilities for extraction, processing and packaging to ensure the quality and marketability of honey products.

National Bee Board (NBB) Initiatives

Objective: The National Bee Board (NBB) aims to promote scientific beekeeping for increasing honey production and pollination services.

Activities

Certification of Quality Bee Colonies and Hives: The NBB certifies high-quality bee colonies and hives to ensure that beekeepers have access to healthy and productive bees.

Technical Training and Workshops: Regular training and workshops are conducted to educate beekeepers on advanced beekeeping practices, disease management and honey quality control.

Research and Development: The NBB supports research in bee disease management, genetics and the development of new technologies to improve beekeeping efficiency.

Impact

Improved Honey Quality: Certified colonies and advanced training have led to higher quality honey production.

Sustainable Beekeeping: Research and development efforts have contributed to sustainable beekeeping practices and ensuring long-term viability.

c) Khadi and Village Industries Commission (KVIC)

KVIC was established by the Government of India in 1956.

Objective: The main aim of KVIC is to promote and develop khadi and village industries in the country. It supports the creation of employment opportunities in rural areas and aims to improve the economic status of the rural population.

Scientific Beekeeping Initiatives

Scientific beekeeping involves the use of modern techniques and equipments to enhance honey production and ensure better management of bee colonies. The KVIC has recognized the potential of beekeeping as a viable livelihood option for rural population and has been involved in promoting it through various programs:

Training and Support: KVIC provides training and technical support to farmers and rural entrepreneurs on scientific beekeeping methods. This includes education on hive management, disease control and honey extraction processes.

Subsidies and Financial Assistance: The commission offers financial assistance and subsidies to individuals and groups who want to start or improve beekeeping operations. This support often includes funding for purchasing modern beekeeping equipments and hives.

Promotional Activities: KVIC conducts awareness campaigns and workshops to promote the benefits of beekeeping. This includes demonstrating the economic advantages of honey production and its potential for improving rural incomes.

KVIC's involvement in scientific beekeeping is part of its broader mission to enhance rural development and support village industries. By promoting modern beekeeping practices, KVIC helps to improve the livelihoods of rural communities and contributes to the overall agricultural economy.

Krishi Vigyan Kendra (KVKs)

KVKs are giving focus on organizing capacity building programs and creating beekeeping units at the centre and also at the farmers' fields. These centres are playing a greater role in making convergence among different beekeeping related schemes and programs for creating more awareness about apiary. Entrepreneurship development is being created in the field of beekeeping and its related aspects including value chain management.

International Programs and Schemes

a. Food and Agriculture Organization (FAO)

Objective: The FAO supports sustainable beekeeping practices globally to enhance food security, biodiversity and rural livelihoods.

Activities

Technical Assistance and Capacity Building: The FAO provides technical assistance and training programs to improve beekeeping practices in developing countries.

Promoting Best Practices for Bee Health Management: Guidelines and resources are provided to help beekeepers manage bee health and prevent diseases.

Facilitating International Collaboration: The FAO fosters collaboration between countries to share knowledge and best practices in beekeeping.

Impact

Global Knowledge Exchange: International collaboration has led to the sharing of innovative beekeeping techniques and technologies.

Improved Bee Health: Beekeepers have adopted better health management practices, leading to healthier bee colonies.

b. United States Department of Agriculture (USDA) Programs

Objective: The USDA supports initiatives to enhance honey bee health and support the beekeeping industry in the United States.

Components

Research on Bee Diseases and Pests: The USDA funds research projects focused on understanding and controlling bee diseases and pests.

Funding for Beekeeping Research and Extension Services: Grants and financial support are provided for research institutions and extension services to promote scientific beekeeping.

Guidelines for Best Beekeeping Practices: The USDA publishes guidelines and resources to help beekeepers adopt best practices in hive management and disease control.

Impact

Enhanced Bee Health: Research and guidelines have led to improved bee health and reduced colony losses.

Increased Productivity: Beekeepers have reported higher honey yields and better colony management due to USDA-supported programs.

c. European Union (EU) Beekeeping Programs

Objective: The EU supports sustainable beekeeping within its member states to enhance agricultural productivity and biodiversity.

Activities

Financial Assistance for Beekeeping Operations: Grants and subsidies are provided to support beekeeping activities, including the purchase of equipment and establishment of apiaries.

Research and Development on Bee Health and Biodiversity: The EU funds research projects focused on improving bee health, understanding pollinator dynamics and enhancing biodiversity.

Promoting Organic and Sustainable Beekeeping Practices: The EU encourages beekeepers to adopt organic and sustainable practices to ensure environmental sustainability.

Impact

Sustainable Practices: Beekeepers have adopted more sustainable and environmentally friendly practices, contributing to biodiversity conservation.

Economic Benefits: Financial support has enabled beekeepers to expand their operations and increase productivity.

Non-Governmental Organizations (NGOs) and Private Sector Initiatives

a. Project Apis.

Objective: Project Apis m. aims to enhance honey bee health and crop production through research and practical solutions.

Activities

Funding for Bee Health Research Projects: Grants are provided for research projects focused on improving bee health, understanding diseases, and developing new treatments.

Technical Support to Beekeepers: Practical support and resources are offered to beekeepers to help them adopt best practices in hive management and disease control.

Promoting Habitat Improvement for Bees: Initiatives are launched to improve bee habitats, including planting pollinator-friendly crops and creating safe foraging environments.

Impact

Improved Bee Health: Research and technical support have led to better disease management and healthier bee colonies.

Enhanced Crop Production: Improved pollination services have resulted in higher crop yields for farmers.

b. Heifer International

Objective: Heifer International uses beekeeping as a tool for poverty alleviation and environmental sustainability.

Activities

Distributing Bee Colonies and Equipment: Bee colonies, hives and necessary equipment are provided to small-scale farmers to start beekeeping operations.

Training in Sustainable Beekeeping Practices: Training programs are organized to educate farmers on sustainable beekeeping techniques, hive management and honey production.

Supporting Community-Based Beekeeping Projects: Community beekeeping projects are supported to enhance collaboration and shared learning among beekeepers.

Impact

Poverty Alleviation: Beekeeping has provided an additional source of income for small-scale farmers and helping to alleviate poverty.

Environmental Sustainability: Sustainable beekeeping practices have contributed to environmental conservation and biodiversity.

Key Components of Scientific Beekeeping Programs

a. Training and Capacity Building

Training and capacity-building programs are essential components of scientific beekeeping initiatives. These programs educate beekeepers on modern techniques, disease management and best practices.

Activities

Workshops and Seminars: Regular workshops and seminars are organized to provide hands-on training and theoretical knowledge to beekeepers.

Field Demonstrations: Demonstration plots and apiaries are established to showcase modern beekeeping techniques.

Online Resources and Courses: Online platforms offer courses, videos and resources to educate beekeepers on scientific practices.

Impact

Knowledge Transfer: Beekeepers gain valuable knowledge and skills, enabling them to adopt scientific practices effectively.

Increased Adoption: Training programs have led to the widespread adoption of improved beekeeping techniques.

b. Research and Development

Research and development activities are crucial for advancing scientific beekeeping practices. These efforts focus on improving bee health, productivity and sustainability.

Activities

Studies on Bee Behavior and Genetics: Research is conducted to understand bee behavior, genetics and breeding for disease resistance.

Development of New Technologies: Innovative technologies and tools are developed to enhance hive management, disease control, and honey extraction.

Collaboration with Research Institutions: Partnerships with universities and research institutions foster collaborative research and knowledge sharing.

Impact

Improved Practices: Research findings have led to the development of better beekeeping practices and technologies.

Enhanced Productivity: New technologies and disease-resistant bee strains have contributed to higher honey yields.

c. Infrastructure Development

Developing infrastructure for beekeeping is essential for post-harvest management, processing, and marketing of bee products.

Activities

Establishment of Processing Units: Facilities for honey extraction, processing, and packaging are set up to ensure quality control and marketability.

Storage Facilities: Proper storage facilities are provided to maintain the quality and shelf life of honey and other bee products.

Market Linkages: Efforts are made to connect beekeepers with markets and buyers, ensuring better prices for their products.

Impact

Quality Improvement: Processing units and storage facilities have led to better quality honey products.

Market Access: Improved market linkages have enabled beekeepers to reach wider markets and achieve better prices.

d. Financial Assistance

Financial assistance is provided to beekeepers in the form of subsidies, loans, and grants to support the establishment and expansion of beekeeping operations.

Activities

Subsidies for Equipment and Inputs: Subsidies are offered for the purchase of bee colonies, hives and necessary equipments.

Low-Interest Loans: Low-interest loans are provided to beekeepers to support their operations and expansion plans.

Grants for Community Projects: Grants are given to support community-based beekeeping projects and initiatives.

Impact

Financial Support: Financial assistance has enabled beekeepers to invest in their operations and improve productivity.

Economic Upliftment: Increased income from beekeeping has contributed to the economic upliftment of rural communities.

e. Awareness Campaigns

Awareness campaigns are conducted to raise awareness about the importance of bees for biodiversity, agriculture and environmental sustainability.

Activities:

Public Awareness Programs: Public awareness programs and campaigns are organized to educate the general public about the benefits of beekeeping and the importance of bees.

Educational Materials: Educational materials, such as brochures, posters and videos are distributed to inform people about beekeeping practices and bee conservation.

Media Campaigns: Media campaigns, including social media, television and radioare used to reach a wider audience and promote beekeeping.

Impact

Increased Awareness: Awareness campaigns have increased public understanding of the importance of bees and beekeeping.

Support for Beekeeping: Greater public awareness has led to increased support for beekeeping initiatives and policies.

Conclusion

Promoting scientific beekeeping through various programs and schemes is crucial for enhancing honey production, ensuring sustainable agriculture and supporting rural livelihoods. National initiatives, such as the National Beekeeping and Honey Mission (NBHM) and the National Bee Board (NBB) programs have significantly contributed to the growth of the beekeeping industry in India. International organizations like the FAO, USDA and EU have also played a vital role in promoting sustainable beekeeping practices globally. Additionally, NGOs and private sector initiatives have provided valuable support in terms of funding, research and capacity building. Key components of successful scientific beekeeping programs include training and capacity building, research and development, infrastructure development, financial assistance and awareness campaigns. Collaboration between government bodies, NGOs and international organizations is essential for the successful implementation of these initiatives. By adopting scientific beekeeping practices, beekeepers can achieve higher productivity, better quality honey and sustainable operations, ultimately contributing to environmental conservation and economic development.

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Chapter - 14

Mobile Apps and Portal for Beekeeping

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Introduction

This document provides a detailed overview of various mobile apps and portals available on Google Play Store that promote beekeeping in India. These platforms offer resources, trainings, market access, community support for beekeepers, making them valuable tools for both beginners and experienced practitioners.

1. Madhumakhi Palan App

Developer: National Bee Board (NBB), Ministry of Agriculture & Farmers Welfare, Government of India.

Purpose and Overview: The Madhumakhi Palan App is a specialized tool developed to assist beekeepers across India. The app focuses on promoting scientific beekeeping practices, providing resources and guidelines, and ensuring that beekeepers have access to government support and market linkages. It aims to increase awareness and adoption of beekeeping, particularly among rural and small-scale farmers.

Key Features

Step-by-Step Tutorials: The app provides detailed tutorials on beekeeping practices. This includes instructions on how to start beekeeping, manage bee colonies and harvest honey. The tutorials are easy to follow, making them accessible even for beginners. It covers topics like setting up bee boxes, identifying different honeybee species and the seasonal management of bee colonies.

Information on Honeybee Species: Detailed information is available on various honeybee species found in India. This includes *Apis cerana indica* (Indian honeybee), *Apis dorsata* (Rock bee), and *Apis mellifera* (European honeybee). The app guides users on how to choose the right species based on their geographic location and climatic conditions.

Government Subsidies and Schemes: One of the standout features of the Madhumakhi Palan App is its integration with government schemes. It provides information on various subsidies and financial assistance programs available for beekeepers. Users can learn how to apply for these schemes and receive updates on new initiatives launched by the government to support beekeeping.

Disease and Pest Management: The app offers comprehensive guidelines on identifying and managing common diseases and pests that affect honeybees. This includes Varroa mites, foulbrood and wax moth infestations. Preventative measures, as well as treatment options are detailed, helping beekeepers maintain healthy colonies.

Training and Workshops: The app provides information on training programs and workshops organized by the National Bee Board and other government agencies. These programs are essential for beekeepers who want to enhance their skills and learn about the latest advancements in beekeeping technology.

Availability: Free on Google Play Store
Download Link: https://play.google.com/store/apps/details?id=com.madhumakh.palan

2. BeeSure App

Developer: ICAR-Central Bee Research & Training Institute (CBRTI)

Purpose and Overview: The BeeSure App is designed to provide comprehensive support for both novice and experienced beekeepers. Developed by the ICAR-Central Bee Research & Training Institute, the app focuses on scientific beekeeping practices, disease management, honey processing, and market access. The primary goal is to help beekeepers increase productivity, maintain healthy bee colonies, and ensure the quality of honey and other bee products.

Key Features

Training Modules and Tutorials: The app offers a wide range of training materials tailored to different levels of experience. Beginners can start with basic beekeeping practices, while more experienced beekeepers can explore advanced techniques. Video tutorials provide visual guidance on setting up beehives, managing bee colonies and harvesting honey. These tutorials are structured in a way that makes complex concepts easy to understand.

Disease Management: BeeSure provides in-depth information on the common diseases and pests that affect honeybee colonies, such as Varroa mites, foulbrood and Nosema disease.

Market Linkages and Selling Platforms: The app helps beekeepers connect with buyers and markets for honey and other bee products. This is particularly useful for small-scale farmers who may struggle to find reliable buyers. Information on current market prices and demand trends is also provided, helping beekeepers make informed decisions about when and where to sell their products.

The app offers practical advice on how to identify symptoms, implement preventive measures, and apply treatments to control these issues. This is essential for ensuring the health and longevity of bee colonies.

Honey Processing and Quality Control: The app includes detailed guides on honey extraction, processing and packaging. It emphasizes maintaining high-quality standards to ensure that the honey produced is pure and meets market requirements. Information on best practices for hygiene, equipment handling, and storage is also provided, helping beekeepers maintain the quality of their honey.

Market Access and Price Information: BeeSure offers real-time updates on honey prices and demand trends in various markets. This helps beekeepers make informed decisions about when and where to sell their products. The app also provides information on marketing strategies and how to connect with buyers, including wholesalers, retailers and online platforms.

Scientific Beekeeping Practices: The app promotes scientific methods of beekeeping, which include proper hive management, feeding, breeding and seasonal care. It encourages beekeepers to adopt these practices to improve productivity and sustainability. The focus on science-based techniques helps beekeepers maximize their yield while minimizing losses due to diseases or poor management practices.

Government Schemes and Subsidies: The app provides information on various government schemes and subsidies available for beekeepers. This includes details on how to apply for financial assistance, grants and training programs. Updates on new policies and initiatives by the government to support beekeeping are regularly provided through the app.

Resource Library: The app includes a comprehensive library of resources, including articles, research papers and publications on beekeeping. This allows users to deepen their knowledge and stay informed about the latest developments in the field. Topics covered range from basic beekeeping practices to advanced techniques and innovations in beekeeping technology.

The app is available in multiple languages, catering to beekeepers from different regions of India.

Availability

Availability: Free on Google Play Store

Download Link: https://play.google.com/store/apps/details?id=com.beesure.app

The Madhukranti Portal

The Madhukranti Portal is an initiative launched by the National Bee Board (NBB) under the Ministry of Agriculture and Farmers Welfare, Government of India. This portal is part of the National Beekeeping and Honey Mission (NBHM) and aims to digitize the beekeeping sector in India, bringing transparency and efficiency to the honey trade.

Key Features and Objectives

Digital Traceability: The Madhukranti Portal provides a digital traceability system for honey and other beekeeping products. It helps in tracking the source of honey from beekeepers to consumers, ensuring the quality and authenticity of the products.

Real-time Data: The portal collects and disseminates real-time data on honey production, beekeepers, and other stakeholders in the beekeeping industry. This data is crucial for planning, monitoring and policy making.

Registration of Stakeholders: Beekeepers, honey processors and other stakeholders involved in the honey production value chain can register on the portal. This registration helps in creating a comprehensive database of all the participants in the industry.

Market Linkages: By connecting beekeepers directly with buyers and processors, the portal helps in establishing better market linkages, which can lead to fair prices for honey producers and improved market access.

Quality Assurance: The portal is integrated with honey testing laboratories, ensuring that the honey being marketed meets the quality standards. This integration helps in curbing the sale of adulterated or substandard honey.

Support for Beekeepers: The portal provides information on various government schemes, technical guidance and other resources that can help beekeepers improve their practices and increase their income.

Benefits of Madhukranti Portal

For Beekeepers: Access to a larger market, better prices and support from government schemes.

For Consumers: Assurance of quality and authenticity of honey products.

For Exporters: Enhanced traceability and certification, which are crucial for international trade.

For Policymakers: Real-time data and analytics to support decision-making and policy formulation.

How to Access the Madhukranti Portal

The portal can be accessed online, where stakeholders can register and log in to avail of the various services provided. The registration process typically involves providing details like the type of stakeholder, location and business specifics.

4. iHive App

Developer: ICAR (Indian Council of Agricultural Research)

Purpose and Overview: The iHive App is a specialized tool developed by ICAR to assist beekeepers with real-time information on various aspects of beekeeping. It is designed to help beekeepers improve the health of their colonies, optimize honey production, and connect with the beekeeping community. The app emphasizes the use of modern technology in managing beehives and provides resources for both beginner and experienced beekeepers.

Key Features

Real-Time Weather Updates: The iHive App provides real-time weather updates, which are crucial for beekeeping activities. Weather conditions significantly affect bee behavior, nectar flow, and hive management.

The app includes localized weather forecasts, helping beekeepers plan their activities, such as hive inspections, feeding and honey harvesting, based on current and predicted weather conditions.

Pest and Disease Management: The iHive offers comprehensive guidance on identifying and managing pests and diseases that commonly affect honeybee colonies. This includes information on Varroa mites, American and European foulbrood, Nosema, and other threats. The app provides detailed instructions on how to implement preventive measures and apply treatments to control these issues, thereby reducing colony losses and maintaining hive health.

Honey Production Optimization: The app includes tools and resources to help beekeepers optimize honey production. It offers tips on managing bee colonies during different seasons, selecting the right locations for hives, and maximizing nectar collection. iHive also provides insights into the best practices for honey extraction and processing, ensuring that the honey produced is of high quality and ready for market.

Community Networking and Support: iHive features a community forum where beekeepers can connect with each other, share experiences, ask questions, and provide support. This platform fosters collaboration and knowledge-sharing among beekeepers across India. The app also allows users to connect with experts and trainers, offering access to professional advice and assistance.

Educational Resources and Training: The app provides access to a variety of educational materials, including articles, videos, and tutorials on beekeeping practices. These resources cover topics ranging from basic beekeeping techniques to advanced hive management strategies. iHive also offers information on upcoming training programs and workshops organized by ICAR and other agricultural institutions, allowing beekeepers to enhance their skills and knowledge.

Equipment and Technology Guidance: The iHive provides information on modern beekeeping equipment and technology, helping beekeepers make informed decisions about the tools they use. This includes guidance on selecting hive types, protective gear, and honey extraction equipment.

Market Information and Access: The app includes features that provide market information, such as honey prices and demand trends. This helps beekeepers make informed decisions about when and where to sell their honey and other bee products.

Customized Alerts and Notifications: Users receive customized alerts and notifications based on their location and specific needs. These notifications can include reminders for hive inspections, disease control measures and updates on market prices.

Target Audience: The iHive App is designed for a broad audience, including:

Beginners: Those new to beekeeping can benefit from the basic tutorials and weather updates that help them get started and manage their hives effectively.

Experienced Beekeepers: More experienced users can explore advanced features such as pest management, honey production optimization and market information.

Commercial Beekeepers: Larger operations can use the app to connect with markets, manage multiple hives efficiently, and stay informed about the latest beekeeping technologies and practices.

Availability: Free on Google Play Store

Download Link: https://play.google.com/store/apps/details?id=com.icar.ihive

5. Honey Testing Labs

The **Honey Testing Laboratories App** developed by the **National Bee Board (NBB)** is a digital tool designed to facilitate access to information regarding honey testing facilities across India. The app aims to assist beekeepers, honey producers, traders, and consumers in locating and utilizing honey testing labs to ensure the quality and safety of honey.

Key Features

Lab Locator:

Geographical Search: The app allows users to search for honey testing laboratories based on their geographical location. Users can enter their location or use the app's GPS feature to find the nearest labs. The app also provides a state and district-wise listing of honey testing labs, making it easier for users to find labs in their specific region.

Detailed Lab Information:

Contact Details: Each lab listed in the app includes detailed contact information, such as the lab's address, phone number and email. This makes it easy for users to get in touch with the lab for inquiries or to schedule testing services.

Testing Services Offered: The app provides information on the specific tests offered by each lab, such as purity tests, pesticide residue analysis, moisture content and more. This helps users choose the right lab based on their testing needs.

Accreditation and Certification: Information about the accreditation and certification status of each lab is available in the app, helping users identify labs that meet national and international standards.

Online Booking and Scheduling

Test Booking: The app allows users to book testing services online. Users can select the desired tests, choose a lab, and schedule an appointment through the app.

Sample Submission Guidelines: The app provides detailed guidelines on how to collect and submit honey samples for testing. This ensures that samples are handled correctly, which is crucial for accurate test results.

Test Results and Reports

Digital Reports: Once the testing is completed, users can access their test results through the app. The app provides a secure platform for viewing and downloading digital reports.

Result Interpretation: The app includes tools and resources to help users interpret their test results. This includes explanations of the various parameters tested, what the results mean, and how they relate to honey quality.

Quality Assurance and Standards

FSSAI Compliance: The app ensures that all listed labs comply with the standards set by the Food Safety and Standards Authority of India (FSSAI). Users can check whether the lab adheres to FSSAI guidelines for honey testing.

International Standards: The app also provides information on labs that meet international standards, such as those set by the European Union (EU) and Codex Alimentarius, which is particularly useful for exporters.

Educational Resources

Testing Protocols: The app offers educational resources on various honey testing protocols. This helps beekeepers and producers understand the importance of different tests and how they contribute to honey quality.

Guidelines on Adulteration: The app provides detailed guidelines on how to detect and prevent honey adulteration, including information on common adulterants and testing methods to identify them.

Government Schemes and Support

Subsidies and Financial Assistance: The app includes information on government schemes that offer subsidies and financial assistance for honey testing. This is particularly beneficial for small-scale beekeepers and honey producers.

Training Programs: The app also provides details on training programs and workshops organized by the National Bee Board and other related organizations.

User-Friendly Interface

Intuitive Design: The app is designed with a user-friendly interface, making it easy for beekeepers, producers, and consumers to navigate and use the various features.

Multilingual Support: The app is available in multiple languages, catering to users across different regions of India, ensuring that language is not a barrier to accessing honey testing services.

Availability

Availability: Free on Google Play Store

Download Link: https://play.google.com/store/apps/details?id=com.honeylabs.finder

e-NAM (Electronic National Agriculture Market)

Developer: Small Farmers Agribusiness Consortium (SFAC)

e-NAM was launched in April 2016 by the Ministry of Agriculture and Farmers' Welfare. The **Electronic National Agriculture Market (eNAM)** is an innovative online trading platform developed by the Government of India to create a unified national market for agricultural commodities. Though e-NAM was originally conceived to streamline the marketing of traditional crops, it has expanded to include other agricultural products, including honey. For beekeepers and honey producers, e-NAM offers several benefits and opportunities, enhancing the market access and efficiency of their operations.

e-NAM for Beekeeping: Beekeeping, though traditionally managed outside the APMC framework, has seen integration into e-NAM due to its growing economic significance and the increasing demand for honey and other bee products. Here's how e-NAM benefits beekeepers:

Market Access and Expansion:

- **Nationwide Reach**: e-NAM allows beekeepers to access markets across the country, breaking the geographical barriers that traditionally limited their sales to local markets.
- **Diverse Buyer Base**: By listing their products on e-NAM, beekeepers can connect with a broader base of buyers, including large traders, exporters, and food processing companies, who are willing to pay competitive prices.

Transparent Price Discovery

- **Real-Time Bidding:** Beekeepers can benefit from real-time online bidding on e-NAM, which ensures that they receive the best possible price for their honey and other products. The transparent bidding process reduces the influence of middlemen and allows for fair price discovery.
- **Market Price Information:** e-NAM provides real-time market price information for honey and related products, helping beekeepers make informed decisions about when and where to sell their products.

Direct Payment and Reduced Transaction Costs

- **Secure Payments**: Payments are made directly to the beekeepers' bank accounts, ensuring timely and secure transactions. This eliminates the risk of delayed payments often encountered in traditional markets.
- **Lower Costs**: By reducing the need for intermediaries, e-NAM lowers the transaction costs associated with selling honey, resulting in better profit margins for beekeepers.

Availability: Free on Google Play Store

Download Link: https://play.google.com/store/apps/details?id=com.enam.app

PROMOTING SCIENTIFIC BEEKEEPING FOR LIVELIHOOD SECURITY

Dr. Lakhan Singh, Dr. Shahaji Phand, Dr. Sushrirekha Das, Dr. Sunil Kumar

This e-book is a compilation of resource text obtained from various subject Experts for the Collaborative Online Training program of Amity Centre for Extension Services, Amity University, Noida, Uttar Pradesh & MANAGE, Hyderabad, Telangana on "Promoting Scientific Beekeeping for Livelihood Security". This e-book is designed to educate extension workers, students, research scholars and academicians related to beekeeping about various technologies in bee management.

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