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Scientific Beekeeping Technology for Sustainable Agriculture and Employment Generation

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Abstract

Beekeeping (or apiculture) is the maintenance of bee colonies, commonly in man-made hives, by humans. Beekeeping is an agro-based occupation that provides income and employment generation for rural and tribal families. It plays a vital role in the present context of the commercialization of agriculture and liberalization of the economy. It covers the entire scope of honeybee resources, bee-products, beekeeping practices, pollination services, and their interface with business systems and ecological integrity. Bees are a special gift to mankind due to their pollination services and valued products like honey, beeswax, propolis, bee venom, *etc*. Honey bee farming in India is also a good source of income for the farmers especially during the period when the growth of crop is still under process. After Indian independence, beekeeping was promoted through various rural developmental programs. Beekeeping has been included as an activity for promoting cross pollination of Horticultural Crops under National Horticulture Mission since May, 2005.

Introduction

The bees are classified into three castes queen, worker, and drone. Queen is the mother of all other bees in the colony which can be identified with its long abdomen and short wings and its duty is to lay eggs. The queen maintains the colony by its pheromones. Queen lives for up to three years or more and may be capable of laying half a million eggs or more in her lifetime. There are thousands of workers in a colony, and they perform all the duties including foraging, defending, and brood-rearing, and cleaning activities. They are smaller than the queen and drones. There are about 8,000-25,000 workers in the *A. florea* colony, 40,000-50,000 workers in *A. mellifera* colony, 20,000-40,000 workers in *A. cerana,* and 50,000-80,000 in the *A. dorsata* colony. Drones are stingless that are easily recognized by their dark colour and eyes touching at the top of their head and their only role is to fertilize the queen and enjoy the food in the hive. Seven species of Apis are known among those four species are in India, *A. cerana*, *A. mellifera*, *A. dorsata* and *A. Florea*. *A. mellifera* is an introduced species resistant to the Thai sacbrood virus (TSBV) and highly suitable for commercial beekeeping. Honey exports from India have risen from 29.6 to 51.5 thousand tonnes. The major markets for exporting Indian honey are Germany, USA, UK, Japan, France, Italy, and Spain.

Importance of Beekeeping as a Viable Diversification Enterprise for Sustainable Livelihood

Beekeeping is a very different profession as compared to various agro-based subsidiary occupations as it needs more art and skill and less physical labour. As an agro-

based enterprise, it does not require land ownership or rent, it can be started with equipment and tools sourced locally. It provides sustainable livelihood options for poor people and fits with small-scale farming systems. There is vast potential and scope from diversification in beekeeping *i.e.,* besides honey it offers scope for production and marketing of other bee products like pollen, propolis, royal jelly, bee wax, and bee venom. Technologies for the production of different products like royal jelly, beeswax, pollen, propolis, bee venom, queen bees, package bees, *etc*. are currently available in India.

Bee Venom

Bee venom is synthesized in the venom glands of worker bees (150-300 mg) and queen bees (700 mg), however, only the worker bees are exploited for venom production. It can be commercially obtained by stimulating a large number of bees by electric shock (8-12 volts). It has been used to cure polyarthritis, infectious-polyarthritis, neuralgia, rheumatism, certain eye diseases like iritis and iridocyclitis, skin diseases (tuberculosis of skin), inflammation of sciatic, facial and other nerves, hypertension, *etc*. It is also known to lower down the cholesterol level. Normal recovery of dry venom per bee is 0.5-0.1 mg. One million stings result in the production of 1 g dry venom (Abrol, 2007).

Queen Bees and Brood

Brood (larvae and pupae) of honey bees is very hygienic food for human beings and livestock. The bee larvae/ pupae provide 15.4 percent proteins and 3.7 percent fat, Vitamin A and B, *etc*. In many countries, bee brood is relished for human consumption and is also used as apitherapy. Mass queen rearing is another area for employment generation. A beekeeper can produce about 200 queens per colony per annum and sell them to the needy beekeepers for replacing their unproductive queen bees. A good quality/ pedigree queen bee can be sold for Rs. 150.00 to Rs. 200.00. Nucleus colonies with brood frames and package bees (bees by weight without brood and frames) can also be sold by the beekeepers to supplement their apicultural income. About 25 percent of the total colonies can be increased and sold.

Rent Out Bee Colonies for Pollination Service

Honey bees are excellent agents of crop pollination because they can be easily managed at any time and in any number. The body of honey bees is extremely hairy and thus they collect a higher amount of pollen which results in better pollination of crops. Moreover, pollen being the food of larvae and adult bees, the foragers purposely visit the flowers for pollen collection; and hence, prove to be efficient pollinators. Bees also have the behavior to constantly visit blossoms of a crop until it is exhausted of pollen/ nectar resources. In India, there is a demand for honey bee colonies for pollination of apple, other temperate fruit plants, and for hybrid seed production of various vegetable, oilseed, and other field crops. Thus, beekeepers can earn additional income by renting out their honey bee colonies to the farmers for pollination service to their crops. A colony (excluding beehive) with 4-frames bee strength, queen right, and with the optimum amount of brood, pollen, and nectar/ honey is generally sold @ Rs. 600.00 per colony (Aryal *et al*., 2015).

Fabrication and Manufacturing Activities

With the development of beekeeping, several subsidiary industries are developed which include fabrication of hives, nucleus hives, and other bee equipment like honey extractors, comb foundation mills, bee veils, smokers, queen excluder sheets, hive tools, iron stands, swarm catching nets, uncapping knives, queen cages and gates, uncapping trays, hand gloves, ant proof bowls (ant wells), pollen traps and other allied tools. All these equipment and tools are manufactured by rural artisans thus creating additional employment for them in carpentry, blacksmithy, and tailoring, *etc*. It also includes the manufacture of honey processing plants and containers for packing honey.

Indigenous Method of Beekeeping

The method of rearing honey bees for honey and wax is a purely natural type in which the combs cannot be removed or manipulated for management or harvesting without permanently damaging the comb. Almost any hollow structures are used for this purpose, such as a log gum, skep, or clay pot. Beekeeping using fixed comb hives is an essential part of the livelihoods of many communities in poor countries.

Modern Method of Beekeeping

Langstroth was the first person to design the successful top-opened with movable hive and frames. Other parts of the hive include the stand, bottom board, brood chamber, super, inner cover, and top cover. The size and number of frames are variable according to the need. The hole of the zinc sheet is only 0.375 cm but the thorax of a queen is 0.43 to 0.45 cm so the queen cannot pass through the pore. The stand is a basal part of the hive which is adjusted with the bottom board to make a slope so that rainwater comes down quickly. Bottom Board is situated above the stand and forms the proper base which has two gates one gate is for the entrance and the other is for the exit. The brood chamber is the most important part is provided with 5 to 10 frames in a vertical position where bees start making walls and cells. Super are boxes are placed on top of the brood boxes with a queen excluder during nectar or honey flow to provide additional space for expansion of the hive. The inner cover is

a wooden piece used for covering the super, has many holes for proper ventilation. The top cover is a plain and sloping zinc sheet that protects the colony from rain. Queen excluder consists of wire gauze, extras guards, and drone traps where workers can pass through it but a queen cannot. The honey extractor is mechanical device functions on the principle of centrifugal force which extracts the pure honey without any damage to the comb. Uncapping knife is used to uncap the honey-filled sealed combs by heating. Other equipments like protective garments, gloves, net veil, bee net, brush, *etc*. are required for easy and well-planned handling of bees. Most beekeepers extract honey 2-3 times per year. Honey is normally harvested between mid-Junes until mid-September. Poor weather conditions, disease, and pests infiltrating will affect the harvesting schedule (Das *et al*., 2021).

General Management and Rearing Methods of Honeybees

The important basics to start beekeeping are knowledge and training on beekeeping, local bee flora, sufficient local bee flora, and migratory beekeeping. The beehive is the home for honey bees and site requirements should bedry without dampness, nearby water source, shade structures, and sufficient bee forage cropsto collect pollen and nectar. Hive inspection for the presence of the queen, eggs, brood, honey, pollen storage, and bee enemies must be done twice a week. During the flow season of honey, a comb foundation sheet is placed in an empty frame of the super chamber for more honey storage. While during the dearth period sugar syrup with a sugar and water ratio of 1:1 dilution must be provided inside the hive. Supering or addition of frames must be done in the super chamber when all brood chamber frames are covered by comb. Swarming or natural method of colony multiplication occurs when a colony built a large strength or when the secretion of the queen's substance falls below a certain level. Swarm management is done by providing brood frames from strong colonies to weak ones, pinching off the queen cells, dividing strong colonies, and trapping and hiving the primary swarm. During severe summer season management of beehive are done by providing sufficient shade, wet gunny bag or rice straw putting on the hive to increase RH and reduce heat, increase ventilation by putting splinter between brood and super chamber, and providing sugar syrup, pollen supplement, and water. In the winter season management is done by maintaining strong and disease-free colonies and provides new queens to the hives. The management during the rainy season is done by keeping beehive dry, providing sugar syrup, avoiding dampness in the apiary site, and providing drainage. Honeybees are attacked by many pests, diseases, and viruses and they are strong enough to defend their colonies from various pests, but when they are weak, the beekeeper should assist the bees in defending the colony (Khan *et al*., 2018).

How to Harvest Honey

To harvest honey beekeeper should wear a protective cloth, take along a good knife, brush, and clean container for honey. Remove the combs one by one giving a puff of smoke before removing each one and look at them carefully. Empty combs, brood combs, and combs containing both brood and honey should leave it and only full combs of ripe honey should be taken from the hive. Brush the bees on the comb and uncap the comb witha knife upto 1 cm on the top bar to guide the bees to work the next honey. After removing honey, rearrange the frame in the same manner as before and close the hive carefully. Honey harvesting in daylight is a simple and effective system for controlling the brood nest with little or no danger, even during the hottest hours of the day foraging bees always return to the site, even if the hive is no longer there.

Economics of Honey Production

The beekeeping can be started with ten boxes/ hives, extractors, bee veils, gloves, decapping knife, hive tools, *etc*. initially 5 farmers will keep only one honey extractor. The bee farmer can start with 5-10 colonies which can sell 5-10 colonies each after proper division with retention of 5-10 colonies with them. Also, the farmers can produce 2-3 colonies each year from a single colony with modern scientific management.

Conclusion

Honey beekeeping is a very valuable occupation in rural areas of the world. It generates employment and provides income to people of rural areas that reduced poverty in the long run. Beekeeping provides nutritional and ecological security to the rural communities at the household level in the rural area. Honey beekeeping plays a key role in pollination that enhanced agriculture production. They provide a valued product like honey and their by-products to the community that has antimicrobial and medicinal properties. Beekeeping is a very easy occupation and investment in this profession is very little and everyone can start easily. Honey production was found more *Apis mellifera* than the other species. India ranked in 8th position in the world in terms of honey production 64.9 thousand tonnes in 2017-18 while china stood first with the production level of 551 thousand tonnes. The major constraints in beekeeping are the expensive inputs, pest attacks, lack of scientific production and rearing techniques, and training. To overcome this constraint a comprehensive program focusing on the provision of low-cost inputs, pesticides/ insecticides, scientific techniques and training, and value chain market facilities at the local and regional level. Construction of a training center for skill transformation is required at the local level for the solution of honey bee problems. Transportation and marketing facilities networks should be developed for enhancing bee

production. Credit facilities on low-interest rates should be provided to honey beekeepers for the development of honey bee production. Bee foraging crop should be multiplied for enhancement of honey business in the implemented area. Hence, beekeeping can be adopted as an enterprise by anyone after getting training on the subject.

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