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Honey bees for enhancing vegetable seed production

Bees are a gift from nature to farmers because they play a crucial role in the development of sustainable agriculture and horticulture. They aid in cross-pollination of crops, increase yield with high-quality crop production, and produce superior seeds in horticultural crops, particularly in vegetables. In addition to increasing vegetable output, honey bees also help to increase seed production. In radish, the seed production increases 22-100% by bee pollination whereas in cabbage and cucumber the value ranges from 100-300 and 21.1-411%, respectively. Furthermore, honey bee pollination boosts cauliflower, radish, lettuce, and mustard seed weight and pod setting. In addition to pollination by bees (*Apis mellifera*), honey and its other by-products, including bee pollen, bee wax, propolis, royal jelly, and bee venom, provide income for Indian farmers.

HONEY bees are considered as one of the most evolved social insects with excellent colony organisation. Bees exclusively depend on flowering plants to meet their nutritional needs, and in exchange, they provide pollination services for the plants. They have co-evolved with angiosperm plants during the evolutionary process for mutual benefit. A plants' ability to reproduce in the natural world depends on how well it is pollinated. The scientific management and maintenance of honeybees is called 'beekeeping' or 'apiculture' and the place where bees are kept is called an 'apiary'. The species of honey bees namely Rock or Giant bee (*Apis dorsata*), Little bee (*A. florea*), Indian bee (*A. cerana indica*) and European bee (*A. mellifera*) are widely available in India. Among these, *A. cerana indica* and *A. mellifera* is easily amenable. However, from economic point view, in India *A. mellifera* is widely used for commercial beekeeping. Apart from pollination, honey bees also provide many important products like bee pollen, bee wax, propolis, royal jelly, and bee venom widely used for various nutritional, medicinal and cosmetic purposes.

Pollination in cucurbits through honey bees

Apis mellifera colony

Current scenario of apiculture in India

In India, 160 million ha of land is under agriculture, out of which 55 million ha is used for agricultural purposes. Presently the number of bee colonies in the country is about 16 crores. To increase the food production to meet out the demand of increasing population, there is a need to expand the area under beekeeping so that the required targets can be met. According to an estimate, there is a scope of 20 crore bee colonies in the country. In India, Punjab, Uttar Pradesh, Madhya Pradesh, Bihar, Assam, Odisha, Kerala, Karnataka and Tamil Nadu are the leading beekeeping states. The Eastern Ghats and Western

Table 1. Increase in seed production of vegetable crops by bee pollination

Vegetable crop	Percentage increase in yield	Vegetable crop	Percentage increase in yield
Radish	22-100	Climbing beans	20.6-1,100
Cabbage	100-300	Cucumber	21.1-411
Turnip	100-125	Dolichos beans	6.8-90.1
Carrot	9.1-135.4	French beans	500-600
Onion	353.55-9,878	Bakla or Broad bean	2.8-20.7
Eggplant	35-67		

Source: Saraswat (2017).

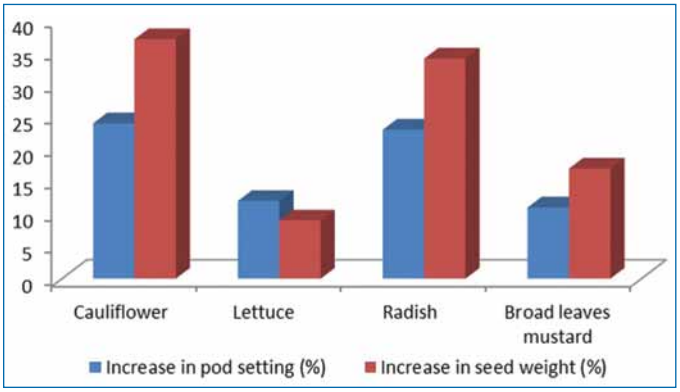
Ghats and the Himalayan North Eastern region are also favourable for beekeeping. The number of bee colonies required per hectare depends on the crop. Generally, 3-9 bee colonies of good strength are required for one hectare of vegetable crops.

Vegetables that benefit from honey bees by pollination

To gather pollen and nectar, honey bee workers forage from flower to flower and fly great distances. Their foraging activity ensures that the subsequent plants are pollinated, which enhances fruit yield, speeds up maturity, and creates a more symmetrical fruit shape. Honey bee pollination benefits a variety of vegetables, including carrot, cucumber, pumpkin, sponge and ridge gourd, squash, radish, okra, turnip, canola, peas, beans, Brussels sprouts, cabbage, cauliflower, Chinese cabbage, onion, coriander, etc.

Importance of honey bees for higher yield and quality seed production in vegetables

One of the most crucial elements determining the yield of crop seeds is honey bee pollination. Both crop productivity and seed quality are increased. Insufficient pollination lowers yields and degrades seed quality. Even if some of these plant species have pollinators that are insects other than honey bees, these plants nevertheless rely on or benefit to some level from bee pollination. Managed honey bees improve the seed weight and germination rate. For example, although cotton is self-pollinated, but honey bee pollination increased cotton production, seed germination, and oil content. Due to the pollination process of bees, the seed production of many vegetable crops increases by 1.25 to 1.5 times. Due to the unisexuality of cucurbits class of vegetables or the separation of male and female flowers in the same plant on different flowers, the pollination by bees is helpful in the aggregation process of 30 to 100% of the fruits. In vegetables like brinjal, honey bees contribute to the 25–150% increase in fruit output.



Effect of honey bee (*Apis cerana*) pollination on different parameters of seed production in vegetables (Source: Pratap 1992, Verma 1994)

Honey bees promote the production of seeds in several vegetables in addition to fruits. While the numbers are 100-300% in cabbage and 100-125% in turnip, the seed production increased by 22-100 and 9.1-135.4% in radish and carrot, respectively. Table 1 shows increased seed yields for several vegetables.

Contribution of apiculture towards biodiversity conservation, food security and rural livelihood

Crop pollination, crop production, crop productivity,

Table 2. Income received annually from 50 colonies of *Apis mellifera*

Description / colony /year	Yield (50 colony)	Rate/kg (₹)	Total income (₹)
Honey 30 kg	1,500 kg	175	2,62,500
Beeswax 4 kg	200 kg	250	50,000
Pollen 20 kg	1000 kg	500	5,00,000
Propolis 1 kg	50 kg	700	35,000
Royal Jelly 0.5 kg	25 kg	1200	30,000
Total income			8,77,500
Total expenditure for rearing of 50 colonies of honey bees			6,54,900
Net income (Total income – Total expenditure)			2,22,600

Source: Tripathi (2021).

soil conservation and fertility, environment preservation and biodiversity maintenance, income generation and food security, and rural people's way of life all are impacted by beekeeping. Beekeeping significantly increases the amount of food that is produced by pollinating more food crops. Beekeeping also helps to protect forests and promotes environmentally friendly activities.

In terms of apiculture, the least visible livelihood outcome is the pollination of both wild and cultivated crops. According to a 2016 international study by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, the annual value of the world's food production that directly depends on pollination ranges from $235 to $577 billion. India is currently the fifth-largest producer of honey. The Punjab state alone supplies more than 39% of the nation's total honey production. In general, a colony/hive produces 20-50 kg of honey annually. There is also potential for a 35% increase in honey production per colony.

In almost all societies, honey is also used as food or traditional medicine. Beekeepers and other residents of rural areas utilise honey and beeswax to produce candles, which they sell to earn a higher profit. Bee venom is used as medicine for treatment of arthritis. Additionally, bees produce pollen, propolis, and royal jelly, which in some cases can be harvested, sold, and transformed into secondary goods to improve people's livelihoods.

Economic analysis of beekeeping

In view of the increasing demand of honey in the international world market, the possibilities of beekeeping are limitless, so that by creating employment opportunities for the people in rural areas, along with increasing the income of the farmers, problems like malnutrition can be solved by this venture up to some extent. Apart from the pollination by the honey bees, other economic return and their analysis from this beneficial fauna are enumerated below. One hive will produce around 30 kg of honey each year; therefore, 50 colonies will produce 1,500 kg of honey. Table 2 provides the economic information

(income-expenditure) for 50 colonies of apiaries where it is evident that from 50 colonies of honey bees approximate INR.2,22,600/- may be earned annually.

CONCLUSION

Beekeeping is a successful venture with a proven technique that only requires a minimum initial investment. Beekeeping may be an important economic activity for the growth of vegetable output and the rural economy. Furthermore, adequate pollination might be ensured using apiculture to increase vegetable productivity and generation of its priceless seed. Therefore, it is imperative to provide farmers and other stakeholders with the required training to raise awareness of the need for proper crop pollination, with special focus on the development of the beekeeping based enterprises.

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