

# Bee pollination:

From an ecological and economical perspective

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*About 70% of our food crops depend on the pollination service provided by different insect pollinators amongst which wild and hive bees are the key pollinators. Insect pollination accounts for over 153 billion euro to agricultural production annually. Pollination also improves yield and market value of the food commodity. A section of people from our society depend on the activities related to bee pollination service to earn a livelihood. Bee pollination and beekeeping are significant contributors to a country's GDP. It also conserves several wild flowers by helping them in reproduction. However, due to the action of various stressors such as chemical advancement in agricultural production, the diversity of different bees is in a threatening position. Though technological advancement brings some alternatives of bee pollination, but that can't meet the requirements up to a satisfactory level. With the decline in bee diversity our food production is also in an alarming stage. Keeping this in view, everyone needs to come forward to protect the pollinators for a promising future.*

**Keywords:** Bee pollination, Crop production, Decline, Economy

**I**N the last year, global population has crossed the milestone of 8 billion people. As population growth is directly related to our food security. It is the need of our society to create such an environment that will protect our future generation from an acute food shortage. In this respect, pollination is a service that can ensure our food security. Different insect pollinators play a significant role in this aspect by pollinating ~70% of our food crops. Among different insects Hymenopteran bees are pre-eminent in this role. Bees unintentionally pollinate the flowers while collecting pollen and nectar from them. Pollen provides all the essential nutrients to the bees, whereas the nectar is converted into honey as a future reserve. In return, bees pollinate the flowers, helping them in their reproduction and maintain their diversity. Besides, bee pollination also improves quality and quantity of the produce of ~85% cultivated crops which allow the farmer to earn

an additional income. Even 78–94% of wild flowers also depend on insect pollination for reproduction. In the present situation of employment generation, commercial beekeeping is an excellent alternative and also a significant contributor to the socio-economic condition of the rural people. Thus, beekeeping creates a mutualistic environment between the beekeeper and the farmer.



Working with *Apis cerana* (honey bee) colony  
Source: Apiary unit of Uttar Banga Krishi Vishwavidyalaya (UBKV), Cooch Behar, West Bengal

## Impact of bee pollination on economy

Bee pollination and beekeeping assist directly and indirectly in the country's economic growth. California almond is the most prominent example that gets benefitted from bee pollination service. In the USA, there are approximately 2.7 million honeybee colonies. To pollinate the almond blooms, every year around 60% (1.5 million) of that commercially managed beehives have been migrated to the Central Valley of California. So, it is fair to say, each almond that they eat is the result of pollination service provided by the honeybees. This almond crop has a net value of 2.2 billion USD and it contributes approximately 21.5 billion USD to the economy of California. Besides, pollination service also provides employment to about 104,000 people performing in different sectors from production to marketing.

Countries that grow cash crops such as cocoa, coffee, almonds, and

soybeans highly rely on pollination on a substantial scale. Scientists used a variety of methods to figure out the annual benefit of certain ecological costs incurred by native insects. In the USA, annual benefit was found to be over USD 57 billion, of which USD 3 billion was contributed by bee pollinators. Pollination services provided by non-*Apis* pollinators were valued at USD 3.44 billion in 2009, whereas only honey bees contributed approximately USD 11.68 billion in the USA. Over 100 commercial crops in North America are fertilized by honey bees. Bees are economically important for sunflower seed production, which is a thriving sector worth about USD 10.4 million per year. In 2016, the annual value of pollination services provided by bees in Brazil's protected areas was estimated to be around USD 564,000 in the north and USD 246,000 in the southern part, respectively and the total value of pollination services was USD 983.2 million, accounting for 33% of total crop production value. The annual production value of wild pollinators for economically important crops in the USA exceeds USD 1.5 billion. The estimated economic value of honey bees in the production of apple, watermelon, blueberry, sweet cherry, art cherry, and pumpkin crops is approximately USD 6.4 billion.

#### Influence on quality and quantity of produce

Pollination is an essential phenomenon to improve food production in both qualitative and quantitative aspects. Bee pollination increases cotton yield to 62% in sub-Saharan Africa, which is considered as the key producer of cotton, compared to an estimated 37% without pollinators. In Western Ghats of South India, only the *Apis* bees pollinate about 18% of trees and 22% of shrubs. In India, employing honey bees as pollinators improves firmness of guava as well as the fruit size of citrus and coconut when compared to controls. It has also been demonstrated in kiwi fruit that buzz pollination by bumble bees under Indian context results

in larger, heavier, longer, and healthier fruits, which has a direct relationship with economic value. In Indian context, the role of bees in economy is exclusively oriented around honey production (Table 1).

#### Bee decline

Standing on the present scenario of agricultural intensification we are moving towards a situation of acute pollinator decline. According to ecologists, the world has reached the summit of a pollination crisis. However, the declining trend in bee population is more pronounced than the declining trend in overall insect population which is a major concern. A number of strong evidences from the last few decades indicate a significant downward trend in the local and regional diversity of bees and raise a serious question about the potential consequences of this bee decline in the ecosystem.

**Global scenario:** About 25% loss in bee colonies was recorded from Central Europe from 1985–2005. Besides, 37–65% of bee species in Europe come under serious conservation concern. Even different bee species became extinct from the face of the Earth. In between 1947–2005, 59% decline in bee colonies was noticed in the USA. *Bombus terricola* and *Bombus occidentalis* used to be very abundant bee species in North America formerly, but after 1990's there was severe decline in their population that now occupied only a small fraction of their previous foraging range. During the 2021–22 season, American beekeepers faced

about 39% loss of their managed honey bee colonies. Even in India, in the last 25 years about 40% of honey bees have disappeared. A decline in bee diversity also leads to the decline in the economic activity that is based on bees and beekeeping.

**Influencing factors:** There are many factors that are responsible for an unwanted decline in bee population. In this aspect non-judicious application of different chemical pesticides occupies the foremost position and leads to the phenomenon like colony collapse disorder (CCD). To tackle the insect pest problem on crops, people indiscriminately use different chemical insecticides (particularly, neonicotinoids) that showed a negative impact on the physiology of bees and ultimately caused bee mortality. Studies revealed that when bumble bees were exposed to imidacloprid, then it slowed down their colony growth and caused around 85% reduction in production of queen bees. On the other hand, bees are highly dependent on wild flora for food and nutrition. However to reduce the crop-weed competition, a heavy amount of herbicides has been used and it reduced the weed diversity by 50% in 70 years. These wild flora served as a vital source of raw materials for bees and decline in wild floral diversity strongly related with the decline bee diversity. For e.g. in the United Kingdom during the 20<sup>th</sup> century, 97% flowering grassland has been lost. This massive loss in habitat forced the bees close to extinction.

**Table 1.** Impact of honey bee pollination on quality and productivity of crop in India

| Crop      | Honey bee pollinator                                          | Key impact                                                                                                                                                                                      |
|-----------|---------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mango     | <i>Apis cerana</i>                                            | Fruit setting was 42.29%, while for open pollination 33.36%.                                                                                                                                    |
| Guava     | <i>A. mellifera</i>                                           | Improved fruit set, fruit length and girth.                                                                                                                                                     |
| Cumin     | <i>A. florea</i> ,<br><i>A. mellifera</i> , <i>A. dorsata</i> | Bee pollination increased productivity by 40.03% when compared to no insect pollination (control).                                                                                              |
| Coriander | <i>A. cerana</i>                                              | The yield in bee pollination was 14.57 q/ha while 11.66 q/ha in the control group. The seed set was significantly higher in the experimental group (69.51%) than in the control group (54.89%). |
| Mustard   | <i>A. cerana</i>                                              | Increased siliqua/panicle by 20.8%, seeds/siliqua by 9.4%, and seed yield by 17.1%.                                                                                                             |
|           | <i>A. mellifera</i>                                           | Augmented fruit set, seed yield, viability and oil nutrient contents in the seed.                                                                                                               |



Mass of dead bees lying on beehive (Left) and field (Right) caused by pesticide poisoning  
Source: Apiary unit of UBKV, West Bengal

Besides this reason, there is a nexus of various stressors that are responsible for bee decline. This nexus makes the anticipation difficult due to the complex relation of the stressors. The other stressors include, infestation of parasitic mites (varroa mite, brood mite, tracheal mite etc.) and diseases (foul brood, stone brood, chalk brood, sac brood etc.) to the bee colonies, incidence of various insect pests (wax moths, ants etc.) and natural enemies (wasps, hornets, predatory birds, etc.) of bees, loss of floral resources to bees, adoption of mono-cropping practice, occurrence of unfavourable weather conditions, invasion of exotic bee species that enforce the native bees towards extinction and

finally the global climate change.

**Threats and future scope:** Based on the changing scenario, approximately 5 billion people may lose food grain production due to lack of pollination especially in South Asia and Africa. Even in Western countries where crop production is highly dependent on honey bee pollination service, bee decline can cause 40–50% yield loss. Without pollinators 3–8% of the world's food production may disappear. In this aspect, global production of edible oil crops, fruits, nuts and vegetables will suffer more.

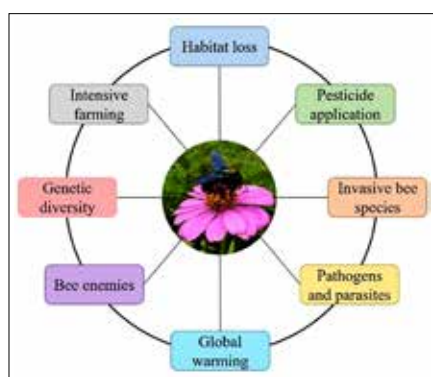
Assuming the downward trend in the bee population, roboticist from many laboratories around the world are manufacturing robotic bees. Still a robot can never be able to replace nature's beautiful creation, i.e. bees in terms of both efficiency and monetary value. A dramatic scene has taken place in China where the farmers from the Marxian County of Southwestern China have started to employ human pollinators to pollinate their apple plants. The main reason behind this was the unavailability of natural pollinators and 100% of their apple blooms were hand pollinated. Now, it is the need of the society to think beyond

the sole aim of food production and find the best routes of creating eco-friendly strategies to maintain food production in connection with societal benefits. So, we need to rebuild the habitats for the bees and minimize the use of various chemical pesticides to protect their diversity. In this aspect, organic farming could be an excellent alternative. Studies suggest that, if organic cropping increases from 5–20%, then it can improve the diversity of bumble bees by 150% and wild solitary bees by 60%.

## SUMMARY

From the above perspective, it is obvious that without bees our food production is a big question. They not only feed our overgrowing population, but also contribute to the economic growth of the country. Even both quantity and quality parameters of food depend on the pollination service provided by bees. However, in the present scenario of agricultural intensification, decline in bee diversity is a major concern. Both natural and man-made factors are responsible for this situation. It threatens the human society with an acute food shortage. Nothing can substitute the essentiality of pollinators in food production. No matter how much progress we can make in technology, still we need to conserve each and every gift of nature to protect ourselves. People need to be aware and should come forward to protect the bees for building a sustainable future. Different government and non-profit organizations, scientists, entomologists and social activists from all over the world are taking initiatives to address this serious issue as Sir Albert Einstein once said, "If the bee disappeared off the face of the Earth, man would only have four years left to live".

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Various stressors responsible for bee decline

Earth provides enough to satisfy every man's needs, but not every man's greed.

—Mahatma Gandhi