



Why Honey Bee Population is Declining: Causes and Solutions

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Abstract

Honey bees play a crucial role in pollination, facilitating the sexual reproduction of numerous flowering plant and crop sciences, which enhance the world's agricultural productivity, the conservation of its biodiversity and global food security. Honey bees throughout the world have experienced severe population declines in recent years due to various factors including parasite infestation and disease, pesticide applied indiscriminately, land development and habitat loss and inadequate diets coupled with climate change. The reports in recent months of unprecedented honey bee losses have cast serious concern on the continuity of these services with important implications for food production and the environment. This article reviews the environmental and economic value of honey bees, outlines some of the causes behind the global honey bee crisis and outlines some of the colony losses that have occurred recently. In addition, this framework provides actionable and evidence-based solutions to honey bee conservation, including restoration of their habitat, prevention and management of bee diseases, use of climate-resilient farming practices, as well as public engagement. The sustainability of honey bee conservation requires collaboration among farmers, beekeepers, scientists, policymakers and the public in supporting sustainable farming, biodiversity and long-term food security.

Keywords: Food security, Honey bee decline, Pesticide impact, Sustainable agriculture

Introduction

Honey bees are vital allies for both agricultural and natural ecosystems. They serve as a required facilitator of agricultural and flowering plant reproduction through pollination services. By transferring pollen between flowers to facilitate fertilization, these services deliver tangible gains: improved fruit and seed quality, increased yields and optimized quality of agricultural produce. They aid in keeping the variety of flora and the equilibrium of the ecosystem. Nearly 75% of the world's primary food crops depend on animal pollination, with honey bees being among the most efficient and important pollinating insects.

Though these creatures play an important role economically as well as ecologically, they are facing significant decline in numbers in the past couple decades across most countries. There is growing evidence of weakened colonies, more colony mortality and less honey being production, indicating that pollinators are facing unprecedented challenges (Dicks

et al., 2021). In the case of honey bees faces combination of stresses that eventually affect their pollination activities. Such as urbanization, habitat loss and decline, farming practices, pesticides, parasites and diseases, poor quality flowers with low nutrient levels, climate change are all placing a strain on the colonies of honey bees and threatening their very existence (Nicholson and Egan, 2020; El-Seedi *et al.*, 2022).

The decline of the honey bee not only threatens the interest of beekeepers but also has serious consequences for nature and humans alike. The pollination of plants by honey bees and other pollinators not only has a great impact on the yield of agriculture, but also on the supply of healthy food for humans and on the ecological services in nature. Against the backdrop of continued global population growth, rising food demand and the compounding impacts of environmental change, pollinator protection has become a core challenge for sustainable agriculture and biodiversity conservation. So, there is a need that the researchers, bee keepers, scientists

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and consumers work collaboratively to advance four actions that are creating bee habitats, using pesticides responsibly, preventing and controlling bee diseases and promoting conservation agriculture, can this impasse be overcome.

Honey Bee Decline: The Indian Perspective

Colony Losses, a threat to honey bees of North America and Europe, is also threatening honey bees of India, where there are several native species of honey bees viz. *Apis cerana indica*, *Apis dorsata*, *Apis florea* and introduced species *Apis mellifera*. These species of honey bees are involved in pollination of various crops and also in honey production. Most of the species of honey bees are pollinating several crops like mustard, sunflower, apple, litchi, cucurbits, coriander, onion and many other vegetable seed crops of economic importance.

Although many species of bees are thriving in parts of the country, urbanization, pesticide use, habitat destruction, monoculture farming practices, climate change and new pests and diseases are threatening the pollinator. The increase in movement of managed bee colonies for commercial pollination services is also bringing diseases into colonies and placing additional stress on them. Formation of regional appropriate management strategies and practices for pollinators that encourage farmers education and use of pollinators in agricultural production systems, thereby can promote productivity of crops and biodiversity of agroecosystems.

Major Cause of Honey Bee Decline

1. Parasite, Pathogen and Disease

Honey bee populations are being threatened globally by external parasites, especially the mite, *Varroa destructor*. Varroa mite sucks the liquid from adult bee and brood (bee larvae). It weakens the bees severely and puts a lot of stress on them. Also, the mite transmits a lot of viruses within the bee colony, which makes the bees sick. If mite population are left unmanaged, the bees can become extremely weak, leading to the collapse of the entire colony before winter. Nosema disease, caused by the microsporidian parasites *Nosema apis* and *Nosema ceranae*, is the other major pest affecting honey bees worldwide. These parasites infect the epithelial cells of the honey bee midgut which unable the bees to digest the food and can cause them to die young. One of the most common viruses that affects honey bee is Deformed Wing Virus (DMV) that causes bees which are been emerged from the brood nest to have deformed wings. They are unable to fly and live for a short period of time. Other serious viruses affecting honey bees are Sacbrood Virus (SBV) and Chronic Bee Paralysis Virus (CBPV). These diseases can weaken the individual bees within a colony and when the bees in a colony are already weak due to other problems in the colony these viruses can kill them. Honey bees too are succumbing to bacterial diseases. The most serious disease in brood is American foulbrood (*Paenibacillus* larvae) which spreads very quickly within the apiary as well as between apiaries. It affects the 3rd and 4th instar larvae stage and kill the larvae within 3 to 4 days. It is so serious that all measures must be taken to try and prevent its spread.

European foulbrood (*Melissococcus plutonius*) is another serious disease that affects the young larvae which are in the feeding stage.

2. Pesticide Exposure

Pesticides, especially a group of insecticides called neonicotinoids, have become a serious threat to honey bees. Even at very low application rates, they can alter the honey bee's behavior in a negative way by affecting its nervous system. Honey bees exposed to neonicotinoids have extreme difficulty returning home with nectar and pollen. They are not as good in harvesting food. They get confused easily; unable to navigate back to honey bee colony (Siviter *et al.*, 2021). In a study it was seen that bees that get exposed to pesticides like thiamethoxam collected significantly less pollen than the unexposed bees. We know that honey bees and other insects are very essential for pollination (Singla *et al.*, 2021). Given that the honey bee colony is already suffering from other stressors (bees and pesticide poisoning), the added pressure from the pesticides may further weaken the healthy queen too and may lead to colony collapse disorder.

3. Habitat Loss and Nutritional Stress

Healthy bees require a constant supply of nectar and pollen from a diversity of flowers. The fast-paced urbanization, deforestation and moreover the intensification of farming with large fields of monocultures have massively reduced nectar and pollen relevant flowers for bees in agricultural landscapes. The few flowers with nectar and pollen for bees, which are available in most agricultural landscapes, are mostly restricted to a period of a few weeks a year. After this time, bees have nothing to eat any more. The lack of flowers with nectar and pollen for bees can cause severe problems for the bees. Malnourished bees are easy prey for diseases, for parasites as well as for pesticides (Dicks *et al.*, 2021).

4. Climate Change

Climate change is a growing concern for honey bees. While warmer temperatures bring earlier and extended flowering of many plant species, the nectar may be in shorter supply and have a lower nectar to pollen ratio than in the past. Flowers may come into bloom at the peak bee activity, but only remain in flower for a shorter period of time. The extreme weather events such as flooding, prolonged droughts and heat, can destroy forage and reduce the productivity and survival of the colony. Changes in flowering time can lead to mismatch between plant blooming and the peak foraging period of bees, thereby reducing their foraging efficiency. Drought reduces the amount of nectar available from flowers, while storms and extreme heat can destroy floral resources and bee habitats, increase physiological stress in bees and make them more vulnerable to threats that affect their survival (El-Seedi *et al.*, 2022).

Why Honey Bee Decline Matters?

For most people, honey bees mean honey. This is not to say that honey bees are the most effective pollinators on Earth only they can pollinate a large range of flowering plants and crops. Currently, at the orchards and farm we have honey

bee colonies which are placed here by local beekeepers who bring their bees out to pollinate crops like almonds, apples, berries, cucurbits (cucumber family), coffee and many more fruits and vegetables during spring bloom. The pollination of these crops by honey bees leads to increased numbers of fruits setting, better seed set, improved quality of produce and increased yields. As the Food and Agriculture Organization (FAO) reports, 75% of the world's leading food crops require to some extent animal pollination for effective reproduction. Thus, honey bees play a critical role in the world's food security.

Declines in honey bee colonies have far-reaching consequences extending beyond the beekeeping industry. This could lead to farmers being unable to grow certain crops that rely heavily on pollination by bees. In the most efficient pollination systems, losses in bee pollination can result in lower yields and reduced quality of produce for consumers.

Turning the Tide: Strategies to Protect Honey Bees

Scientists, farmers, beekeepers, environmental organizations and lawmakers have developed concrete actions that can keep our bees in good health and maintain the buzz of the pollinating world.

1. Reviving Pollinator Habitat

Helping honey bees, of course, is most effectively done by providing flowering plants throughout the year. A wildflower strip, a hedgerow left to grow, grassland protected from cattle grazing and not regularly mown along road verges and the field margins of arable farms could all help in this way. Then there are the flowering plants which can be grown as flowering cover crops on arable land and as native flowering plants in gardens and within orchards. These plants provide a constant supply of nectar and pollen to help sustain the honey bees throughout the year. Around the world, there are many different programs established for the conservation of pollinator habitats on environmentally sensitive lands. In the US for example, the USDA's Natural Resources Conservation Service has programs that support the planting of pollinator habitats within Conservation Reserve Program (CRP) lands. Take the European Union, for example. It requires natural habitat to be restored on farmland to attract pollinators and help to improve biodiversity.

2. Using Pesticides with Caution and Responsibly

The conservation of the honey bees, along with judicious use of right pesticides for pest control by farmers in integrated pest management (IPM) framework, is essential for sustainable agriculture. IPM consists of continuous monitoring and control by using biological methods, cultural methods and pesticides. A wide range of pesticides is available and the most suitable one can be chosen on a case-by-case basis. Pesticides must be used in the correct dosage. Most impact on bees is caused when they are active during the day. Pesticide should be applied early in the morning or late evening when the bee activity is minimal. Less toxic chemicals should be used when flower bloom. Restrictions are being considered for other pesticides as well.

3. Effective Management of Varroa Mites and Bee Diseases

Frequent check for mites and immediate control of pests is vital for the well-being of colonies. Beekeepers manage mites by combining biotechnical control methods with approved acaricides within integrated mite control. Also, the monitoring of the hives on regular basis should be done to ensure the sustainability of honeybee colonies for long-term. Looking for bees which exhibit natural mite resistance and excellent hygiene behavior should be incorporated in the colonies.

4. Strengthening Research and Support for Beekeepers

Monitoring honey bees will help us to monitor emerging threats to honey bees and measures to manage them. To understand causes of recent severe losses to honey bee colonies, scientists and beekeeping organizations have conducted rapid surveys of honey bee colonies and subsequent lab work to understand the causes of Colony Collapse during the 2024-2025 seasons. If we want to protect pollinators and make sure they keep doing their important work, we need to get serious about honey bee health research, improve how we spot and diagnose diseases and support beekeepers with the tools and money they need. Help from these kinds of programs lets beekeepers handle the threats that put their bees at risk and also reduces the damage those threats cause. This all does a great deal in keeping our pollinators healthy.

5. Building Climate-Resilient Agricultural Landscapes

Climate change is resulting in increase in events such as natural extreme weathers and flowering of the crops may not sync. To support bees in agricultural landscapes under change, it is necessary to create resilient landscapes that contain a wide variety of different flowers that are in season throughout the year. Similarly, the conservation of forests, wetlands and naturally grown vegetation will enhance the level of pollinating species habitat and its resistance to climate change (El-Seedi *et al.*, 2022).

6. Encouraging Public Participation

Honey bee conservation is beyond any particular beekeeper's problem. There is an interplay of support from farmers, gardeners, schools, communities and governments. All pollinators can be easily supported in our gardens by planting native flowers, not applying pesticides, providing places with clean water and protecting habitats. Activities leading to the awareness of the importance of bees for healthy food for human consumption culminate on 20 May every year on World Bee Day, with campaigns worldwide involving various community actions in the conservation of pollinators.

Conclusion

Honey bees not only produce honey, agricultural crops, biodiversity and food worldwide are pollinated by these very valuable insects. The death of honey bees is caused by a variety of interactions between factors such as pests and diseases, poisons, loss of habitat, a bad diet and climate change. The unprecedented honey bee colony losses within the last years are putting a great pressure on these pollinators, with far-reaching consequences for humans and the environment. There is hope for the decline of the honey

bee. A total of all sectors in implementing of pollinator-friendly farming, pest control, habitats, disease control, support for research as well as awareness among citizens will bring desired results. All the farmers, beekeepers, scientist, researchers, policy makers, citizens can help to save the bee populations. Save the bees; the honey bees are far more than just another species of insects which we need to save. Honey bee is necessary for maintaining the well being of ecosystem, for crops needed for our food consumption and securing food systems in all part of the world.

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