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Pollinators Declining Drivers and Their Management

Mogili Ramaiah[1] and Archana Anokhe[2]
[1]Ph.D. Research Scholar, ICAR-Indian Agricultural Research Institute, New Delhi
[2]Scientist, ICAR-Directorate of Rapeseed and Mustard Research Institute, Bharatpur, Rajasthan

SUMMARY

Pollination improves the yield of most crop species and contributes to one-third of global crop production, but comprehensive benefits including crop quality are still unknown. Hence, pollination is underestimated by international policies, which is particularly alarming in times of agricultural intensification and diminishing pollination services. Agricultural production forms are one of the most important economic sectors. The quantity of most crop species is increased by pollination which is a highly important, but also seriously endangered ecosystem service. More than 75% of the 115 leading crop species worldwide are dependent on or at least benefit from animal pollination, whereas wind and self-pollination are sufficient for only 28 crop species. Thereby, animal pollination contributes to an estimated 35% of global crop production.

INTRODUCTION

One-third of the world's crops require pollination to set seeds and fruits among which the great majority of them are pollinated by bees. These pollinators also provide an important ecosystem service that is essential for sustaining wild floral biodiversity. Concern over the decline in pollinator population followed by sudden disappearance of honey bee colonies are well-documented in North America and Europe but have not yet been well-researched in other parts of the world including India. The dramatic decline in overall pollinator populations is a critical issue for agriculture production but it is not yet top prioritize researchable area for Indian scholar. We all agree with the fact that pollinator population dwindling worldwide but the question is how serious is this problem in India? Is it getting worst?

In India, bees are well known to the general public as honeybees which produces honey and other commercially important bee products but these honey are not well recognized for their contribution as pollinators. In-spite of several biodiversity hotspots very few studies has been performed on documentation of pollinator's species diversity and their behaviours. No correlation studies has been performed with respect to decline in bee population and its effects on agriculture productivity and sustainability. Due to several anthropogenic factors pollinators are getting exposed to numerous pressures in the modern world resulting decline in population.

Drivers Responsible for Declining of Wild Bee Species Diversity and Honey Bee Colony Losses:

Habitat Loss:

Decline in bee population have been attributed to many factors, some more plausible than others; however, the clear consensus is that loss of habitat which has been reported as long-term contributor of pollinator declining. Bees require appropriate floral resource during the adult flight season, which may be short for some solitary species or yearlong for social species in tropical environments. They also require undisturbed nest sites, with different species occupying diverse locations (e.g. cavities underground, hollow-stemmed twigs, burrows in the soil, even abandoned snail shells). The conversion of natural and semi-natural flower rich habitat to farmland has been a major driver of long-term declines in bees.

Parasites and Disease:

Bees naturally suffer from a broad range of parasites, parasitoids, predator and pathogens, the latter including protozoans, fungi, bacteria, and viruses. By far the majority of research has focused on those associated with honey bees and to a lesser extent with bumblebees; very little is known about the pathogens of other wild bee species. Some bee disease agents, such as deformed wing virus (DWV) and protozoan, *Nosema ceranae*, have broad host range and are able to infect both honey bees and bumblebees; others, such as *Crithidia bombior paenibacillus* larvae, seem to be more host specific.

Pesticides:

Pesticides are the most controversial and debated cause of bee declines. When appropriately used, pesticides provide a clear economic benefit, but they bring the welfare of bees into direct conflict with industrial agriculture. Herbicides are highly effective at minimizing weed problems in most cropping systems, enabling farmers to grow near-pure monocultures, but their use inevitably reduces the availability of flowers for pollinators and can contribute substantially to rendering farmland a makes environment inhospitable for bees. Neonicotinoid molecules are the newest of the main insecticide classes which 1st appeared in 1990s in the market as Imidachlorprid. Due to its quick mode of action it has occupied larger market share within few year of time span. Its market has grown from €155 million in 1990 to €957 million in 2008. Later several study has been published and it has been realised that this group of insecticides are majorly responsible for declining of bee population.

Monotonous Diets:

Intensively farmed areas provide few wild flowers but do provide spatially and temporally isolated gluts of flowers, in the form of mass-flowering crops such as sunflowers and canola. More generally, it seems that generally bees inhabiting intensive farmland have a more monotonous diet than they would have experienced in their evolutionary past, but how this might affect their fitness remains unclear. The pollen of different plant species varies greatly in protein content, amino acid composition, lipid, starch, and vitamin and mineral content. Nectar commonly contains varying and low concentrations of nutrients and other compounds of largely unknown importance.

Shipping Fever:

It seems reasonable to hypothesize that the long distance transport of bees, as routinely occurs in apiary management for commercial purpose which implicates stress on the colonies. Sometimes these movements lead to death of queen which results in complete disappearance of bee colony. For several days, they may be confined and subject to vibration, high temperatures, high levels of carbon dioxide, and irregular disturbance. It has long been known that such stress can activate bacterial and viral infections in vertebrate livestock, but this has not been investigated in bees, although Bakonyi *et al.* has reported that shipping stress may have contributed to honey bee colony losses in Hungary.

Competition:

The role of competition in determining the relative abundance of species is notoriously difficult to ascertain in mobile organisms such as bees, but it seems likely that competition for floral resources and perhaps also for nest sites does occur in natural communities, and that it can be exacerbated by the introduction of non-native species, particularly when the latter are present at high densities.

Climate Change:

It has been widely accepted that climate change poses one of the great threats to biodiversity worldwide, but likely impacts on pollinators and pollination are not well studied. One danger is that the phenology of pollinators may diverge from the plants they pollinate, with potentially disastrous consequences for both, but there is little evidence that this has happened so far. Advances in flowering and bee emergence are often broadly similar, and in any case few plants are dependent on a single pollinator, so that any mismatch with one pollinator is likely to be compensated by increased availability of another. Another potential affect of climate change is a driver of range shifts, leading to a spatial mismatch between plants and pollinators. Range shifts in response to climate have been demonstrated in butterflies and are to be expected in bees*; i.e* there is already evidence that the lower altitudinal limit of some mountain bumblebees has shifted uphill in Spain.

Microwave Radiation from Mobile Tower:

In one of the study on effect of microwave radiation on honey bee, six colonies of honeybees were selected and half of them served as the control group. The test colonies were provided with working mobile phones (frequency of 900MHz for 10 minutes each day, for ten days) and the others without mobile phones. Flight activity

and returning ability of honey bees were measured 20 before exposure, during exposure and after exposure. The study showed that after ten days the worker bees never returned to the hives with the working mobile phones. The behavior of the other bees remained unchanged. The mobile phone radiation was actually frying the navigational skills of the honey bees and preventing them from returning back to their hives.

Threat to Agriculture, nutritional security and Biodiversity:

One of every three bites of food eaten worldwide depends on pollinators, especially bees, for a successful harvest. Bees are particularly important pollinators for many agricultural crops and their absence often results in lower yields and less marketable products. In western countries, where they fully depend on managed honey bee colonies experiencing 40-50 % losses in yield. Economic vulnerability of each crop to the loss of pollinators was found to vary widely across crop categories. Globally, vulnerability was high for fruits (23%), vegetables (12%), nuts (31%), edible oil crops (16%) and stimulants (39%), lower for pulses (4%) and spices (3%) and 0% for cereals, roots and tubers and sugar crops (Gallai et al., 2009). Whereas staple crops, being primarily wind-pollinated, have low vulnerabilities, those crops providing much of the proteins, vitamins and minerals in human diets are more reliant on biotic pollination. Vulnerability values were heterogeneous across the globe, with some regions more at risk of pollinator loss than were others. There are lots of studies on pollination and pollinator composition of particular crop in India, but they are not adequate and reliable. There is still a lack of basic information about how species diversity, and the abundance and community composition of pollinating insects, contributes to seed and fruit yield and quality in most crops in India.

Management of Pollinators Decline:

Increasing Abundance, Diversity, and Continuity of Floral Resources:

Schemes such as the sowing of flower-rich field margins or hedgerows, or retaining patches of semi natural habitat among or near farmland, provide clear benefits to bee diversity and abundance. This in turn increases pollination to nearby crops and provides an economic incentive to farmers growing insect pollinated crops.

Reducing Exposure to Pesticides:

Bees are currently chronically exposed to a cocktail of pesticides, some of which act synergistically. Since the late 1990s, the cost of pesticides has fallen markedly relative to labor and fuel costs and the value of the crops. As a result, current levels of pesticide use are generally high and are not always justified by evidence that they are necessary to maintain yield. The widespread prophylactic use of systemic insecticides (such as neonicotinoids) as seed dressings exposes bees and other non-target wildlife, results in accumulation of pesticides in the environment, and places strong selection pressure on pests to evolve resistance. A return to the principles of integrated pest management (IPM), which depends on preventive methods and views the use of pesticides as a last resort in the battle against insect pests, could greatly reduce exposure of bees, benefit the environment, and improve farming profitability.

Providing Nest Sites:

Wild bees use a diversity of habitats for nesting, including burrowing into bare soil and using existing cavities underground, holes in wood, or hollow plant stems. Semi-natural habitats, hedgerows, and permanently uncropped field margins allow for many of these; hence, schemes to boost floral diversity are also likely to boost nesting opportunities. Additional nest sites can also be provided by providing bundles of hollow reeds or canes, or patches of bare soil

Preventing Further Introductions of Non-Native Bees, Parasites, and Pathogens:

The careless disregard with which we ship bees from country to country has resulted in the irreversible spread of many serious parasites and pathogens. Strict quarantine controls should be implemented on the movement of all commercial bees, and there is an urgent need to develop means of rearing commercial bumblebees that are free from disease. Deliberate introductions of non-native bee species (such as the recent

introduction of the European bee *B. terrestris* (Pl write full name) to South America) should of course be prevented. The companies that rear commercial bees should bear some responsibility here and should refuse to sell bees to regions where they are not native. There is clear hypocrisy in the policies of countries that prevent importation of non-native species but allow exportation of species to places where they do not naturally occur.

Global Pollinator Initiatives:

When Colony Collapse Disorder swept through American and European bee populations in 2007, the western world was alerted. These countries started several action plans to save bees, the initiatives include North American Pollinator Protection Campaign (NAPPC), Brazilian Pollinator Initiative (BPI), Canadian Pollinator Conservation 2013 and European Pollinator Initiative (EPI, 2000). Even developing countries like Africa (African Pollinator Initiative) and Sri Lanka (Pollinator Conservation Action Plan for Sri Lanka) have pollination conservation strategies, no such actions are taken to conserve pollinators in India. On a global level, the Convention on Biological Diversity has identified the importance of pollinators with the establishment of the International Initiative for the conservation and sustainable use of Pollinators (also known as the International Pollinators Initiative-IPI) in 2000, facilitated and coordinated by FAO. International Pollinators Initiative includes a project involving seven nations (including India) with the 23 aim of identifying practices and building capacity in the management of pollination services. In Indian condition research activities in India on bees or on other pollinators are in a state of neglect. Despite the global worry, no study had been done to assess directly the scale of the decline in natural pollinators.

CONCLUSION

The crucial role of bees as providers of pollination services in developing countries like India cannot be ignored, although this service is mainly feral here. Most of small-scale farmers are not aware of the value of pollination services on crops they grows. Farmers have very limited knowledge on pollination and pollinators; they often take pollinators for granted. In western countries, pollination has been industrialized; bee keepers ship their hives from one place to other to meet the needs of the fruit and vegetable demands. It was seen in some plantations farm in northern india where farmers have colonies of *Apis cerana* and *Apis mellifera* for pollination purposes and it is rarely seen in south India regions. In India at present, one hundred and fifty million colonies are needed to meet the pollination requirement for around 50-million-hectare bee dependent crops but there are only 1.2 million colonies present (TNAU agritech portal) are maintained. So it is need of hour that beekeeping in India can be promoted at larger scale and same time farmers and general public are made aware of other pollinators. For which active participation of researcher and extension specialist is needed to educate them about the benefits of pollinator, consequence of their decline and direct and indirect profitability generated from pollination.

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