



## Colony collapse disorder- The ecological clandestine of the missing bees

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### Abstract

Honey producing bees are important in many aspects including pollination and production of products like wax and royal jelly. Bees are important in building and increasing the total income obtains from agriculture. There are many problems faced by bee keepers like natural enemies like murder hornets, yellow jacket wasps, different birds like *Merops* spp. And many others attacking on bees and honey. There are several diseases attacking on bee colonies like brood diseases, nosema etc. colony collapse disorder is a major disease for disappearance of most of the population of bees. There are several factors can be considered as responsible for disappearing of bees.

**Keywords:** CCD, apiculture, apiary, diseases of bees, pollination

### Introduction

There are a lot of animals in the environment but only those who are really of very high economic importance have been given the major concern. In many ways Order Hymenoptera under class Insecta has very economic importance including parasitoids, predators, pests such as mustard sawfly, leaf cutter ants and beneficial insects such as honey bees. Honey bees are a major group of beneficial insects and are very important economically by producing many useful products such as honey, wax, royal jelly, and bee venom. Besides that, they are major pollinators in the whole cross, and often cross-pollinated crops. Bees are popular pollinators for increasing yields in many crops. We rely on honey bees for nearly 1/3<sup>rd</sup> of our entire food supply. A world without bees affects every aspect of the way we live. Bees are most widely recognized types of pollinators, and include many honey-producing and non-honey producing species like bumble bee and many others. There are so many species of bees in the world where some are economically important, namely *Apis cerana indica*, *Apis mellifera* and *Apis florea*, and are domesticated in all parts of the world for the production of honey, wax, royal jelly and bee venoms. Besides this, *Apis dorsata* is also a bee producing honey but has not been domesticated because of its ferocious nature. Given the projections of human population growth to about 9 billion by 2050 (UN, 2004) and the corresponding increasing conversion of landscapes to agricultural use (Tilman *et al.*, 2001) [28], the importance of bees for human survival and the preservation of a large part of terrestrial biodiversity can only increase in the coming years. Although honeybees are one of the ecosystem's most essential pollinators, the tremendous drop in the number of honeybees is a serious concern. The decline in bee species has been documented worldwide, despite stronger historical records for wild bee species in some nations. Comparing data from these records with more recent data in European

countries that have good historical records for wild bees has shown clear evidence of decline in bee species richness (number of species), frequency (abundance of species), and distribution (range). In a large-scale study, species richness or the number of bee species had decreased by 40% in the UK and 60% in the Netherlands (Brunet, 2019). Honey bee colonies have experienced a 2.96 million decline over the years in the US. Over the 2019 winter, backyard beekeepers lost 39.8 per cent of their colonies and 9.2 per cent of Europe's bee species are near extinction. The loss of bees worldwide to a mysterious condition is called colony collapse disorder (CCD).

CCD is a disease / phenomenon in which bees simply do not return to hive after foraging. Honey bees are best known for their host loyalty, and consider collecting pollen from a single type of flowers until it exhausts. In the same instances, host allocation memory in bees only lasts for one day. Scout bees have to allocate the same host locality again the very next day in order to start collecting pollen from the same host until the host used is available. In CCD, bees were observed to simply lose their ability to localize memories, where the hive is located, and they simply went away and died. This phenomenon is more common in introduced bee *Apis mellifera*, where bees were first observed and saw that they simply disappeared from colonies even when there were plenty of hosts and the weather was good for foraging. CCD only affects the castes of the worker and leaves a lot of honey, drone, queen and broods in the colony and has gone away (Engelsdorp, 2009) [30]. CCD's first official account was reported in 2006 when Beekeepers began to notice a drastic increase in the disappearance of colonies of honey bees in North America (with about 25-30 per cent of colonies dying each year). In earlier days, people named it with many other names, such as disappearing disease, spring dwindle, May disease, fall dwindle disease and autumn collapse. All the names indicate

its phenomenon of worker castes disappearing. This phenomenon was later named colony collapse disorder in 2006, and is now a well-known apiculture problem. From 2013 to 2019, more than 10 million bee colonies worldwide were lost due to CCD in the last seven years.

Bees are naturally afflicted by abiotic stressors like pesticides, climate change, electromagnetic radiation, poor nutrition and habitat change, biotic stressors like parasites, pathogens, pests that functions singly or synergistically. The following are the biotic and abiotic stressors associated with loss of bee population globally:



**Fig 1:** Bee on Plume Thistle Flower



**Fig 2:** Bee With pollen Load

## Abiotic Stressors

### Pesticides

Pesticides are believed to be among the major contributing factors to the current decline in bee populations. Due to its extensive use in crop protection, the neonicotinoid insecticide group has been singled out in particular. It is the most reported group of insecticides for CCD because of its ability to attack the nervous system, interfere with the production of honey, its ability to navigate and fly, and its reproductive capacity, resulting in insect paralysis and eventually death. Many other scientists have suggested that even fungicides can be related to CCD and they have shown that some fungicides can have sub lethal effects on bees, not killing them outright but altering their behaviour and colony collapse disorder is simply a phenomenon that occurs through altered behaviour. In pesticides, many studies find that imidacloprid, clothianidin, and thiamethoxam are associated with colony collapse disorder. In comparison with other pesticides, pesticides that have a longer residue period have a more significant effect on bees. Both the lethal and sublethal pesticides have been found to be

successful in altering the foraging behaviour of honey bees in many laboratory studies so that the pesticides can be considered a cause of CCD. In a 2010 survey about 98 pesticides and metabolites detected in aggregate concentration up to 214 ppm in the pollen of bees were reported. It was suggested that while exposing too many of the neurotoxicants causes acute and sub lethal reductions in the fitness of honey bees, the effect of these materials in combinations and their direct association with CCD or decreasing health of bees remains to be determined. Evaluating effect of pesticides over CCD is quite hard because in different areas it was reported to be caused by different pesticides and it is not possible to test efficacy of all the pesticides in altering bee behaviour.

### Neonicotinoid insecticides

Neonicotinoid insecticides were synthesized based on the molecular structure of the tobacco toxin called 'nicotine'. There are seven insecticides in this group which have been permitted in India and abroad. The nitro-substituted compounds (clothianidin, dinotefuran, imidacloprid and its metabolites, thiamethoxam, nitenpyram) appear the most toxic to bees. The cyano-substituted neonicotinoids seem to exhibit a much lower toxicity (acetamiprid and thiacloprid) (Decourtye & Devillers, 2010) [4]. Globally seed dressing constitutes 60% of neonicotinoid usage. Honey bees can be found to be affected by these chemicals when they are used as seed treatment because they know to work their way through the plant up to the flowers and leave residues in nectar. Foliar sprays are also very common on many fruit trees, crops and vegetables. Neonicotinoids are commonly used on oilseed rape, cotton, sunflower and maize in seed treatment, and foliar sprays. Honey bees and many other pollinators are attracted to these crops. Estimates show that between 700 and 1000 tonnes of Imidacloprid and between 200 and 300 tonnes of Thiamethoxam are used annually in India. Of this it is estimated that 168 metric tonnes of imidacloprid are used annually in India alone for cotton seed dressing. Imidacloprid treatment reduced short-term learning by 87 percent and memory retention by 85 percent compared to control bees, such learning should improve bee survival (Zhang & Nieh, 2015) [31]. These huge amounts of neonicotinoid application most certainly will have an adverse impact on bee health and survival.

### Conventional insecticides

A wide range of 'Organo-phosphate' and 'Carbamate' insecticide molecules are known to have broad spectrum toxicity to several insects including the bees (Kolankaya *et al.*, 2002) [14]. These insecticides had contact toxicity ranging from 18 nano grams per bee to 31200 nano grams per bee. Dimethoate, commonly used worldwide in pest management for several decades, was found to be responsible for several cases of bee poisoning in the UK and many parts of the world. Some of the most frequently found chemicals in pollen and/or wax samples were the miticides coumaphos and fluvalinate (applied by beekeepers to control *Varroa* infestation) and a fungicide, chlorothalonil. Each of these 3 commonly found chemicals have been shown to sub lethal effects on larval bees and certain combinations result in synergistic toxicity (Zhu *et al.*, 2014) [32]. Pyrethrin's are insecticides derived from flowers made from chrysanthemum. These are highly toxic to bees of between 50 and 210 nano grams per bee. Honeybee

locomotion, grooming, and wing fanning behaviour were affected by synthetic pyrethroids (cyfluthrin, tau-fluvalinate, allethrin and permethrin) (Oliver *et al.*, 2015) [22]. These accumulate over a period of time in the cells and have strong effects on mortality, especially for the young larvae. Permethrin and cypermethrin have been demonstrated as contact repellents for honey bees (Reith & Levin, 1988) [26]. Fipronil is yet another systemic insecticide that is highly toxic to honey bees at 4 nano grams. High levels of 1-4 nano grams of fipronil per gram of pollen have been reported. It is quite probable that pollen, nectar and wax in the urchins may be contaminated with a variety of insecticide combinations over a period of time that can have strong toxic effects on brood, queen and worker bees (Kranthi, 2013) [15].

### Heavy Metals

Metal and metalloid exposure in polluted areas may impair bee behaviour, reducing species fitness, population numbers and diversity of species (Mogren and Trumble 2010). Some common heavy metal pollutants that are toxic to honey bees are heavy metals such as Arsenic (As), Cadmium (Cd), Lead (Pb), Mercury (Hg), and Selenium (Se) (Gupta *et al.*, 2015; Gizaw *et al.*, 2020). Heavy metals are not only used as sprays in agriculture but are also industrial pollutants. These contaminants can be absorbed into pollen, nectar and gutting fluids via roots and leaves. Lead arsenate kills foraging bees when sprayed at recommended doses in orchards that generally exceed 400 micrograms of exposure per bee. Arsenate is causing severe oxidative stress in bees by interfering with cellular metabolic processes at doses lower than this. Even at low concentrations, muscle movement is impaired by cadmium poisoning, thus reducing flight capacity. Reports indicate that a 1 milli gm per liter of selenium as an oral toxicant causes mortality of at least 50 per cent of a normal bee population. Honey bees are subjected to heavy metal copper (Cu), chromium (Cr) and tin (Sn) toxicity which is used in hives as wood preservatives (Kranthi, 2013) [15].

### Climate Change

Climate change is emphasized as one of the causes of the collapse disorder. Understanding the bees' response to the new scenario of climate change is essential to tackle this challenge. Worker bees not only track and store pollen in hives but they also protect the queen bee and the larvae that they produce. This includes maintaining a specific temperature inside the hive, which is crucial to the queen's health and her eggs. When the cold weather strikes, keeping up with this duty becomes difficult. Eggs, the hive's future, die of exposure to cold weather and worker bees die of exhaustion from the heat-producing effort. When the few bees are available to collect pollen and produce food in the following flowering season, the network is significantly debilitated, leaving the queen and hive vulnerable. This eventually results in Colony Collapse Disorder (CCD).

Climate change is causing shifts in temperature that leave bees unable to pollinate in time. Bees are severely vulnerable to extreme weather, and earlier flowers have arisen and bloomed due to climate change. Because bees are unable to adapt to the changing climate, they are unable to pollinate flowers and therefore do not obtain nectar for use during the harsh winter months for their hives. Between 2006-2011, 2012-2013, about 32% and 31% of hives

respectively, continued to die each year in the United States due to unsuccessful wintering (Potts *et al.*, 2010) [25]. Changing temperatures have also reduced the size of their wild range by about five miles each year, rather than shifting it north to cooler temperatures like many other animals, causing bees to miss out on pollination further. Many of these factors have combined to stimulate the spread of CCD, a phenomenon in which a colony's many worker bees disappear. Research from the Agency for the Protection of the Environment shows that CCD is linked to changes in bee habitats and malnutrition, both indirectly caused by climate change. Furthermore, climate change allows invasive species to take over bee hive, spoil stored food and interfere with many processes within these hives, resulting in a further decline in bee populations.

Increasing carbon dioxide levels are also wreaking havoc among bee populations. Studies have revealed a correlation between atmospheric concentrations of carbon dioxide and the amount of protein found in pollen. High amounts of carbon dioxide are causing the protein found in pollen to dilute and become unhealthy for bees. This abundance of carbon dioxide plays a crucial role in the bee population's decline in quantity and health. Carbon dioxide causes various problems among bees which contribute to population decline.

IPCC estimates indicate that average global surface temperatures will continue to rise in the 21st century between 1.1°C (low emission scenario) and 6.4°C (high emission scenario) and higher temperature rises (IPCC, 2007). The biological impacts of rising temperatures depend on the organisms' physiological sensitivity to changes in temperature. Deutsch *et al.*, (2008) [5] found that an expected future tropical temperature rise, although relatively small in magnitude, is likely to have more deleterious effects than changes in higher latitudes (Figure 3). The reason for this is that tropical insects are relatively sensitive to changes in temperature (with a narrow span of suitable temperature) and live in an environment very close to their optimum temperature at present. In contrast, he pointed out that insect species at higher latitudes – where temperature rises are expected to be higher – have wider thermal tolerance and live in cooler climates than their physiological optimum. Warming can in fact improve the performance of insects living in these latitudes. Thus, tropical agro-ecosystems are likely to suffer from a greater decrease in population and extinction of native pollinators than agro ecosystems at higher latitudes (Deutsch *et al.*, 2008) [5].

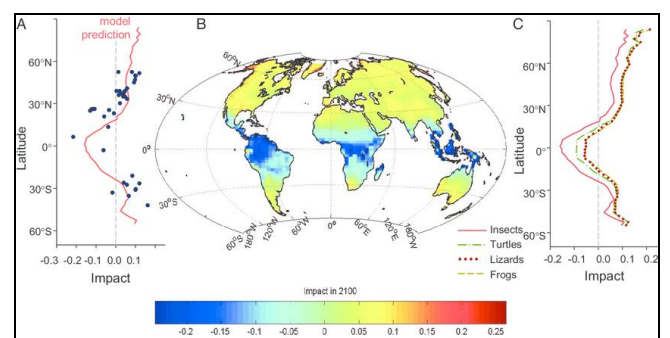


Fig 3: Climate Summarization Under Different Climates

### Electromagnetic Radiation

A recent study reveals that the enormous increase in electromagnetic radiation is another potential cause of

"Colony Collapse Disorder." The sudden growth in the telecommunications sector leads to a multitude of mobile phone increases and exponential installation of cell towers across nations. Although the cellular service providers and governing bodies confirm that there are no side effects due to radiation from the cell tower and cell phones, both the mobile towers and mobile phones emit electromagnetic radiation that affects the bees and their colonies (Kaur *et al.*, 2016) [13]. Honeybee uses the Earth's natural magnetic radiation to locate the way to its hives, but due to the emission of electromagnetic radiation from the mobile towers and mobile phones, magnetic radiation is high in frequency compared to earth (Paramanik and Paramanik, 2016) [23]. This causes confusion for the bees, and they fail to detect their hive location, which can cause honeybees to disappear or die (Sharma and Kumar, 2010) [27].

Some of the researchers revealed that standard evidence exists that the radiation from the EMF causes damage in honey bees. Over the last two decades a large number of studies have been conducted to evaluate whether cell towers and mobile phones pose a potential health risk or not. The first criteria are well explored, and because of mobile handsets, the studies confirmed the radiation effects for CCD are possible. Due to radiation emission from mobile phones, the wagging dance, foraging and navigation behaviour of honey bees is destroyed. The honey boxes with and without mobile phones experimented with exposure to the radiation. During experimentation the health condition and behavioral changes in honey bees are predicted. The study showed that the honey bees were hesitating to enter the hive where the inside mobile handset is placed. The bee was feeling discomfort and sounding alert about the indication of danger. The number of bees entered in another entrance (without mobile handset) is comparatively high and there has been no recorded behavioral change (Cammaerts, 2017).

#### **Bt. proteins in GM crops**

Ingestion of a novel protein expressed in pollen or occurring in a GM plant's nectar, resin, or honeydew can potentially affect bee behaviour, development, or survival or it may have no effect. Nectar is an unlikely source of novel proteins, as it is not a tissue but a plant secretion, and has no cellular content. Most nectar does not contain protein, which is composed mainly of sugars and sometimes free amino acids.

Many experiments have been conducted in which bees were fed with purified novel proteins at concentrations estimated to approximate or to exceed likely pollen expression levels. For example: Presence of high concentrations of Serine protease inhibitors *i.e.*, Bowman-Birk trypsin inhibitor (BI), Potato proteinase inhibitor 1 (POT-1), Potato proteinase inhibitor 2 (POT-2), Cowpea trypsin inhibitor (CpTI), Kunitz soybean trypsin inhibitor (SBTI) and Oryzacystatin (OCI) in GM plants reduce survival of worker bees for few days, whereas low concentrations have no effect (Louise, 2004). Though Cry toxins such as Cry1Ac, Cry1Ab or Cry2Ab expressed in GM crops are unlikely to have significant toxic effects on honey bees when present in pollen, a study conducted in 2008 by Ramirez-Romero's group showed that 'bees fed sugar syrup containing 5,000 ppb Cry1Ab, approximately 50 times the concentrations likely to be encountered in pollen, did consume less food and showed learning effects, as measured by the proboscis

extension response assay'.

#### **Poor Nutrition and Habitat Change**

Honey bees' natural diet comes primarily from nectar and pollen gathered from a wide variety of flowers. Insufficient or incomplete nutrition has come to be recognized as an essential factor that weakens the honey bee's immune systems and is likely to make bees more susceptible to all of the other problems troubling them today.

As demand for pollination services increases, bee colonies are often kept in a mono-crop environment for more time on sites before being moved directly to the next mono-crop zone. As more and more lands are lost to urbanisation and suburbanization, a loss of habitat with a diverse mix of nutritious bee forage plants is also involved. Moreover, both times when nectar supplies can be scarce for bees, beekeepers often provide an artificial diet when it comes to helping bee colonies survive the winter and droughts. Scientists are still trying to perfectly replicate the natural pollen / nectar diet of a bee during those times of the year when there is no good forage available.

#### **Biotic Stressors**

##### ***Varroa* spp**

The ectoparasitic mite, *Varroa* spp. (Mesostigmata: Varroidae) have caused irreparable damage to the beekeeping industry with destruction of numerous bee-hives each year. They feed directly on bee hemolymph providing an opening in the cuticle for viruses to enter. Most virus infections rarely cause infection when ingested orally, but only a few virus particles are necessary to cause infection when injected directly into the hemolymph. *Varroa* is a vector of various viruses such as: Deformed winged virus, acute bee paralysis virus, Israeli acute paralysis virus, Kashmir bee virus and sac brood virus. Although there is less evidence that *Varroa destructor* plays a role in sac brood virus transmission, correlative studies have found sac brood virus to be positively associated with *V. destructor*-infested honeybee colonies (Mondet *et al.*, 2014) [19].

If untreated, high levels of infestation can cause colonies to collapse, characterized by sudden disappearance of bees from the hive, leaving the queen and a small worker bee population behind. The *Varroa*-associated diseased pupae show uncapped or perforated cappings from which the adults emerge with heavily deformed wings and may act as an activator of in apparent viral infections. *Varroa* association with honey bee viruses is called 'bee parasitic mite syndrome,' also referred to as 'varroosis' (Moritz *et al.*, 2010) [20]. Chemical acaricides against the mites often lead to considerable bee loss from the hive.

##### ***Nosema***

It has been proposed that *Nosema cerana* is a relatively new parasite of *A. mellifera* that jumped from the Asian honey bee, *Apis cerana*, to European honey bees, and has recently dispersed (Gómez *et al.*, 2015) [8]. Today, we know that *N. ceranae* infects *A. mellifera* worldwide. Severe *N. ceranae* infections can cause bee mortality and have been correlated with colony losses (Higes *et al.*, 2008) [11]. It is also linked to morbid physiological impairments including suppressed immune function, foraging behaviour, production of pheromones and hormones, and lipid synthesis. *Nosema* invades the digestive system by taking inoculated food by mouth. These pathogens infect the mid

intestinal epithelial cells, which are constantly replaced and protected by membranes and filters confining the pathogen to gut tissues. Parasites that infect gut tissue like *Nosema apis* and *N. ceranae* can create lesions in the epithelium that allow a virus like Black Queen Cell Virus (BQCV) to pass into the hemolymph and infect other cells in the body. Infection normally does not pass directly from infected bees into the next adult generation. Young bees instead become infected by ingesting spores as they clean contaminated combs. During the summer months most colonies of honey bees carry a few infected bees with little or no apparent colony effect. Spores on the combs, too, may persist. As the weather changes in the autumn, these spores could initiate a *Nosema* outbreak. Losses of bees can be very serious at this time of year.

### Other pests

The *Galleria melonella* or greater wax moth, characterized by a long, grey-brown body, the female moth lays eggs in the cracks and crevices of a hive. Once eggs hatch the larvae burrow into brood comb cells, feed on bee larvae and pollen shed exoskeletons and hide from the worker bees. Some larvae can travel in close proximity to the hives, and also infect them. The silk trails are left behind on the comb as the larvae tunnel (Kwadha *et al.*, 2017) <sup>[16]</sup>. When they're ready to pupate, larvae attach to hive boards and spin into a cocoon. They have been found able to wipe out a whole hive in a single season, especially if the hive is left untended. The damage caused by *G. mellonella* larvae is severe in tropical and sub-tropical regions and is believed to be one of the contributing factors to the decline in both feral and wild honeybee populations. *Aethina tumida*, the small hive beetle, adversely affects all aspects of beekeeping; including the rearing of queens, the production and processing of honey, and pollination operations. They feed on pollen, honey and occasionally brood in honey bee colonies. The damage associated with an *A. tumida* infestation is caused by the beetle larval stage; in addition to distracting worker bees from their normal hive duties, adults have little negative impact on a colony (Ellis *et al.*, 2010) <sup>[6]</sup>.

### Immunodeficiency Theories

There are many possibilities and theories that suggest a correlation between the different pests and the bees that disappear. Diseases in this group are major diseases in the contagious category and can be correlated with them as a way to protect colonies from infection. Bees somehow avoid contact with queen and colony after infecting with such diseases in order to save their hive. They may be defined as immunosuppression, which is a reduction in immune system activation or efficacy. Some parts of the immune system itself have immunosuppressive effects on other parts of the immune system, and immunosuppression can occur as an adverse reaction to other congenital conditions. Specifically, research at the Pennsylvania State University in 2007 suggests that the magnitude of detected infectious agents in adult bees suggests some type of immunosuppression. Initially, these researchers suggested a link between *Varroa destructor* mite infestation and CCD, suggesting that a combination of these bee mites, deformed wing virus (which the mites transmit) and bacteria work together to suppress immunity, and may be one cause of CCD. Effect of Colony Collapse Disorder on the Ecosystem If all the bees on earth died off, major rippling effects would occur throughout the

ecosystems. A number of plants are pollinated exclusively by specific bees, such as many of the bee orchids, and they would die off without human intervention. This would alter their habitat composition and affect the food webs of which they are part, and would likely trigger additional extinctions or declines of dependent organisms. Other plants may use a variety of pollinators but many are pollinated most successfully by bees. They would set fewer seeds without bees, and would have less reproductive success. This would change ecosystems too. Beyond plants, many animals, such as the beautiful bee-eater birds, would lose their prey in the event of a die-off, and this would also impact natural systems and food webs.

### Cumulative Effects: Action of Biotic and Abiotic Stressors

Concerning the causes of the death of bee colonies, opinions are most often polarized, claiming that the main, if not the sole, cause of the phenomenon is one or another individual stress factor. Recently it has become increasingly accepted that the combined action of two or more different adverse factors increases the risk of collapse. It has been hypothesized that the poor health status of bees is the result of individual or combined action of different factors such as stress due to poor nutrition, fasting and "monocultural" diet, abrupt meteorological changes, reduced genetic diversity in honey bee populations, etc. Too little is known on individual and colony-level immune response in bees. As social insects, however, bees can count on a collective immune response to protect the colony as a whole. Recently it has been found that balanced feeding of pollen and propolis can activate detoxifying enzymes in the individual bee. It is also considered that in actual field experiments experimental data about the effects on an individual's protective capabilities cannot be extrapolated automatically to the entire colony. Recent studies have shown that interactions between pesticides and pathogens cause the health status of bee colonies to deteriorate. Exposure to neonicotinoid pesticides surges the sensitivity of bees to the intestinal parasite *N. ceranae*. Imidacloprid is able to synergistically increase the level of infection with *Nosema* spp. as well as mortality, when both stressors are present concurrently in the hive (Pettis *et al.*, 2012) <sup>[24]</sup>. Similarly, Aufauvre *et al.*, (2012) <sup>[2]</sup> found higher mortality from fipronil intoxication and infection with *N. ceranae* combined than when the two agents acted in isolation.

Individual factors which have a negative bee health effect do not act in isolation. Obviously, all types of bees are subjected simultaneously to different stress factors with an accumulating effect over time. In doing so, each individual factor reduces bees' ability to overcome the negative impacts of other stressors' action. Mortality of bees and bee colonies is likely to be lower if the hive infested with parasites is not exposed to sub-lethal doses of toxic substances, including. Antibiotics used in beekeeping, and acaricides. In addition, the pesticides in agriculture and/or bees are not starved or subjected to a monotonous diet, often due to adverse weather conditions, such as prolonged drought or low temperatures (Goulson *et al.*, 2015) <sup>[9]</sup>.

### The Economics of Decline

The economic cost is immense for these vanishing bees. As well as being a keystone species, bees alone contribute an estimated \$15-30 billion in annual agricultural productivity. Pollination is integral to the production of at least 90 commercial crops in North America, accounting for 15-30

per cent of the typical American diet (Amelia, 2016) [1]. The cost for beekeeping here arises in the agricultural market. Commercial farmers often hire beekeepers to have their land pollinated. And bees are the only available pollinator for certain crops, such as tomatoes. The California almond industry, for example, requires the annual services of roughly 1.4 million beehives, and is responsible for 80% of global almond production, amounting to a total value in excess of 4.8 billion dollars — and that's just one crop (Amelia, 2016) [1]. The overreliance of the agricultural industry on this disappearing resource means that the full impact of this pandemic will be realised not only by industry participants such as beekeepers, farmers and members of the secondary markets such as honey and wax, but also by consumers of the final products. California beekeepers charged \$51.99 per hive for the almond farmers in 2003. That price had more than tripled by 2009 (Amelia, 2016) [1]. As the costs of domestic nuts, fruits and vegetables inevitably rise, they will ultimately be reflected in the grocery store and not just in the production section. Further, India's domestic honey consumption is huge and the country exports honey worth 300 to 400 crores every year. Apart from thus the domestic honey production supports the livelihood of thousands of entrepreneurs.

### Remedial actions

As 2/3rd of the world's crop species for the pollination process depend on honeybees, which accounts for 30–35 percent of the food we eat. Therefore, some remedial measures should be taken to save the lives of natural pollinators in order to maintain the ecosystem balance. It can be done by raising awareness amongst people about the sustainable use and conservation of pollinators. In addition, some guidelines for increasing the implementation of bee conservation should be provided. Some to consider are the following:

1. At the global level, to preserve our bees we have to improve the environments in which they collect food. Planting flowering crops in the borders with bee-friendly flowers in agricultural lands, gardens, road side etc. can provide food for both wild and domestic bees.
2. Reduce or eliminate the use of herbicides or pesticides. For example, in many parts of Australia bees can access pesticide-free bushland (although unlike Europe, Australia has not yet banned use of neonicotinoids in agriculture).
3. Programs to reduce pesticide misuse, such as better regulations regarding warnings on labels of chemicals toxic to bees, and other educational efforts aimed at farmers and pesticide applicators.
4. Organic farming might be expected to benefit bees, first due to reduced insecticide use, and second because reduced herbicide use can lead to a greater abundance and diversity of floral resources.
5. Installation of a native bee hive or insect hotels.
6. Local and landscape scale features of urban gardens and nurseries distributed across an urbanization gradient in could shape wild bee communities.
7. Determining the impact of invasive plants, animals, parasites and pathogens.
8. Integrating this information to understand the potential impact of climate change on current bee diversity.

### Conclusion

Due to urbanization and industrialization the pollinators are in a disturbing stage. Normal pollinators are in danger, since we know the significance of pollinators in upgrading creation in the agricultural area, it is imperative that they be preserved to save the lives of our future generations. Pollinators are essential for the number of yields worldwide and they play a key role in maintaining healthy ecosystems and abundant food by allowing the plant flowers to reproduce. In some regions, recent concerns over an increase in colony losses have prompted investment in more coordinated bee monitoring and research into how pests and diseases, bee diversity, beekeeping practices and their foraging environment affect bee vitality. The global picture shows that parasitic *Varroa* mite populations of regions with established honey bee have consistently higher colony loss. The active role as a vector of bee viruses is emerging as a significant factor in globally viewed losses of honey bee colonies. Moreover, land management and environmental conditions affect the availability and quality of food sources and also affect hive conditions, and effective management of bee colonies under changing situations depends on beekeeping practices and bee selection / breeding.

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