Are GMOs and pesticides threatening bees?

First introduced in 1995, neonicotinoids are a class of insecticides popular in the US, Australia, Europe and elsewhere to control insect infestations of corn, soy, cotton and canola (aka oilseed rape). They also are widely used to combat pest devastation of vegetable crops, rice, cotton, melons, grapes and berries, and orchard crops, and are considered critical in combating the lethal 'citrus greening' disease spreading from already-devastated Florida to Texas and California. Seed coatings for row crops account for the largest volume of neonic usage by far.

Scientists and farmers applauded their developmentas neonics proved effective against common plant pests but were seen as relatively harmless to many beneficial insects, because of their systemic action: the insecticide is taken up into plant tissue where it consequently controls only the pests that actually feed on the crop. Applied to the soil, sprayed on the crop or, most commonly, used as a seed treatment, neonics reach the insect pests that feed by chewing or sucking crop plants. Seed coatings for row crops account for the largest volume of neonic usage by far. Seed treatments also lower the amount of the *pre-neonic, older, more toxic, spray-applied pesticides* that previously were sprayed 10 to 20 fold, decreasing the need for open spraying of the plant, a major sustainability benefit.

The mode of action of neonics is different from the sprays they replaced: Organophosphate pesticides, which are known to kill bees and wildlife (and have been linked to health problems in agricultural workers); and a class of natural insecticides known as pyrethrins, and their synthetic analogs, pyrethroids, which are deadly to bees and many beneficial insects, and known to kill mammals, including dogs and cats. By contrast, neonicotinoids are benign to mammalian physiology; they are a key ingredient in several long-lasting flea and tick remedies for dogs and cats that owners apply monthly directly to their pets' skin without any harmful effect.

The CCD crisis in 2006 fueled public concern about neonics and honeybees, and attracted the attention of anti-biotechnology and environmental activists. The public fervor escalated, as symbolized by the 2013 Time Magazine cover, "A World Without Bees," and persists today, embracing concerns about other types of bees, beneficial insects and even birds. The situation was dire, they environmental advocacy groups

an important pollinator, responsible for "one in every three bites of food we eat cientists as exaggerated).

Although the problems facing honeybees moderated, overwinter losses remained above historical norms for the next several years. Activists and some scientists blamed neonics for these declines, although there were no clear links. The assertions were mostly buttressed by a slew of worrisome laboratory studies, some funded by environmental groups. The studies were covered intensively by the media, often framed in apocalyptic terms, stirring public and political debates. In 2013, in response to escalating advocacy campaigns and media stories, and fueled by findings in lab studies, the EU placed a moratorium on three most widely-used neonicotinoids, forbidding their use on bee-attractive flowering crops, and made the ban permanent in 2018. France and Canada enacted restrictions on certain uses of these insecticides in 2018 and 2019.

What evidence supports claims that these pollinators are threatened? Numerous laboratory, or "caged bee," studies have shown that neonics can impact bee health. These studies suggest that "sublethal" exposure to neonics weakened the bees' immune systems and interfered with their foraging behavior, boosting their vulnerability to deadly infections and sabotaging their ability to feed themselves. The European Food Safety Authority (EFSA) concluded in a February 2018 report surveying some 1500 studies that some honeybees and managed bumblebees faced "high risk" from three neonicotinoid insecticides, although the EFSA's interpretations of the studies were challenged by numerous scientists skeptical of the conclusion. Many scientists noted that many of these lab studies share a problem: Exposing bees to neonics in a closed environment does not replicate what happens in real life; it doesn't tell us much about how neonic seed treatments affect bee colonies in their natural environment. The vast majority of the laboratory research are so-called "caged bee" studies: Experiments in which individual bees are exposed to some level of neonic pesticides and then examined for an adverse effect. Some such studies, for instance, have shown that "sublethal" exposure to neonics can weaken honeybees' immune systems and/or interfere with their foraging behavior, boosting their vulnerability to deadly infections and sabotaging their ability to feed themselves.

The problem with these laboratory 'caged bee' studies is that they invariably over-dose the bees — even when low, purportedly 'field realistic' doses are applied. Lab studies also don't evaluate bees in the context of their community. The beehive constitutes what amounts to a super-organism. Through the collective action of its tens of thousands of specialized members, it is capable of achieving things like significant detoxification of the hive and, hence, protection of its members that no individual bee could ever do alone, whether in a laboratory or in nature.

In contrast, the clearest, most accurate and most reliable picture of neonics' effects on honeybees is obtained from large-scale field studies under conditions approximating as closely as possible the real-world conditions under which colonies live, forage, reproduce, store food and over-winter. They are, consequently, very costly — tens or hundreds of times more expensive than laboratory 'caged bee' studies — and so there there far fewer of them. 13 such studies published in the last decade have examined how honeybees or bumble bees foraging in neonic-treated crops fared. All concluded that there was no observable adverse effect on bees at the colony level from field-realistic exposure to neonicotinoid-treated crops. In other words, because of the detoxifying and new brood producing capabilities in bee hives that overpower potential negative impacts on individual insects, low-level neonic exposure of individual bees is unlikely to have a serious deleterious effect on overall colony health.

Some environmentalists have also proposed that the herbicide glyphosate (Monsanto's Roundup now made by Bayer) kills bees or threatens their ability to collect the necessary resources to maintain healthy hives. The problem was amplified after the introduction of herbicide-resistant GMO seeds in 1996, activists claimed, because farmers could spray their fields without harming their crops, dramatically increasing glyphosate use.

For example, ciiting a 2013 study which showed that caged bees fed glyphosate experienced reduced sensitivity to nectar reward and impaired associative learning, the anti-GMO website Natural News claimed : "[A] groundbreaking study shows that Roundup causes honeybees to starve." That was an overstatement, however. The study authors qualified their findings, noting that "….no effect on foraging-related behavior was found."

There are numerous issues with these claimed findings. Critics of the study have pointed out that bees don't consume large doses of glyphosate on agricultural fields, a fact that severely limits the significance of the research.

Glyphosate is also sometimes paired with a pre-emergent (before seeds germinate), before insects present in the fields. In a 2014 study, scientists exposed honeybees to glyphosate "at realistic worst-case exposure rates" and found:

> ….[T]here were no significant effects from glyphosate observed in brood survival, development, and mean pupal weight. Additionally, there were no biologically significant levels of adult mortality observed in any glyphosate treatment group.

USDA researchers conducted a field study in 2015 to see how honeybees reacted to 40 pesticides commonly used in agriculture. Of the chemicals tested, glyphosate was the least toxic, with the researchers concluding that it is "…relatively safe to foraging bees because [it] may kill less [than] 1% [of] bees at the field use rate."

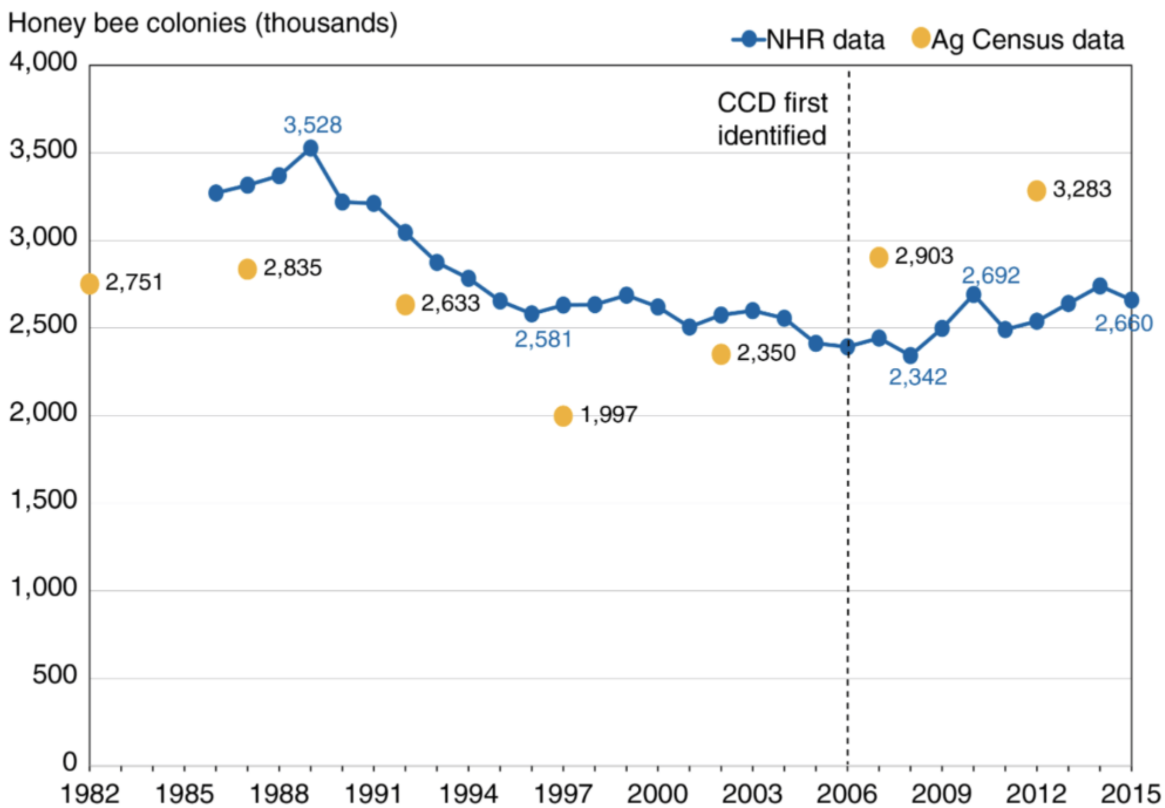
The glyphosate-bee death hypothesis got a boost in September 2018, when a study in the Proceedings of the National Academy of Sciences asserted that glyphosate exposure harmed the gut health of honeybees and increased their "susceptibility to infection by opportunistic pathogens." Environmental websites promoted the findings with headlines such as: "Glyphosate could be factor in bee decline, study warns."

Experts noted this study suffered from some serious limitations. The researchers found that the health of bees was worse when they were exposed to lower doses of the herbicide. Such a result violates the bedrock principle of toxicology that a chemical can be harmless or even beneficial at low concentrations but poisonous at higher ones; the dose makes the poison. Other flaws in the study were serious enough for researchers to doubt its validity, pending further research.

The overwhelming preponderance of honeybees are not 'wild' but are raised by beekeepers, rather like 'livestock'. Consequently, their population numbers aren't purely at the mercy of environmental factors like parasites, diseases, temperature, rainfall, weather, pesticides or other contaminants that bees may encounter. Colony numbers, although affected by these factors, are essentially determined by how many colonies beekeepers, in the aggregate, determine is profitable to cultivate and maintain.

The data clearly shows bees are in no danger of facing a catastrophic die-off — the common meme over the past decade. October 2018 statistics from the United States Department of Agriculture (USDA) show that honeybee populations are stable and may even be growing. The 1988 ‘highpoint’ of this graph follows closely the 1987 arrival of the *Varroa destructor* parasite in the United States from the Far East — an event that promptly produced precipitous decline in US honeybee colonies until beekeepers developed management techniques to stabilize the situation over the ensuing decade. After the CCD outbreak in 2006, between 2007 and 2013, winter colony loss rates averaged 30 percent, which is approximately double the loss rate previously thought to be normal. Elevated winter colony losses, however, have not resulted in enduring declines in colony numbers. Instead, the number of honey bee colonies is either stable or growing depending on the dataset being considered.

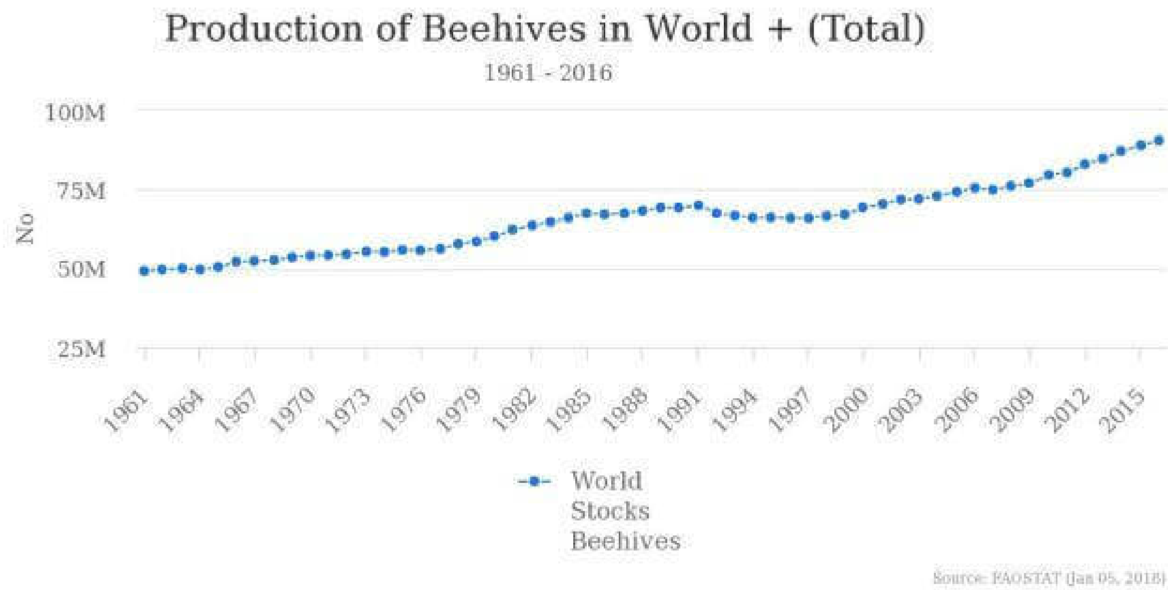
Honey bee colony levels have remained stable despite elevated loss rates



Notes: CCD = Colony Collapse Disorder. NHR = National Honey Report.
Source: USDA, Economic Research Service using data from USDA, National Agricultural Statistics Service Agriculture Census data and USDA, Agricultural Marketing Service National Honey Report data.

The USDA data confirmed research that showed that honeybee populations in the US, Canada and Europe have remained stable or increased since neonics were introduced in in the mid-1990s. In western

Canada, colonies are thriving while foraging on 21-million-acres, almost 100% neonic-treated, pollen- and nectar-rich canola crop. Populations in Australia, where neonics are heavily used and there are no *Varroa* mites, haven't experienced declines over the same time period. As the Washington Post reported in 2015 in "Call Off the Bee-pocalypse: U.S. Honeybee Colonies Hit a 20-Year High" and "Believe It or Not, the Bees Are Doing Just Fine", global honeybee hive numbers have risen to record levels.



It is normal for beekeepers to lose a percentage of their hives every year, especially in the winter, due to weather, disease or the exhaustion of stored food supplies. It is also normal for the number of hives to fluctuate annually for market reasons. However, misrepresentations of *overwinter* bee losses, or the adding together of winter and summer loss numbers, makes it seem as if the mid-2000s CCD event is ongoing, when it is not.

None of this is to suggest that bee health problems are not real. Honeybees and perhaps bumble bees, mostly wild native bees, face health threats that are cause for worry, imposing significant cost and labor burdens on beekeepers, and they need to be addressed. Most scientists cite multiple factors involved in bee health problems. Most scientists acknowledge that current bee health problems are multi-factorial although, according to the USDA, by far the number one problem is the *Varroa destructor* mite, which the agency calls:

> … [T]he single most detrimental pest of honey bees. Since the 1980s, honey bees and beekeepers have had to deal with a host of new pathogens from deformed wing virus to nosema fungi, new parasites such as Varroa mites, pests like small hive beetles, nutrition problems from lack of diversity or availability in pollen and nectar sources, and possible sublethal effects of pesticides. These problems, many of which honey bees might be able to survive if each were the only one, are often hitting in a wide variety of combinations, and weakening and killing honey bee colonies. CCD may even be a result of acombination of two or more of these factors and not necessarily the same factors in the same order inevery instance.

The parasite poses unique challenges to beekeepers and scientists. It sucks the bees' hemolymph' (blood-equivalent), compromises the immune system, vectors viruses into bee colonies and attacks the honeybee's fat body, a structure that plays a vital role in its ability to metabolize food, causing the bee to be chronically undernourished until it dies. Worse, *Varroa* mites rapidly develop resistance to different treatments, making control difficult.