Life Without Bees

Our Eco-sociotechnical Food System

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<u>Abstract</u>

While humans once considered war, disease, and poverty as the greatest threats to their ways of life, the past several decades have revealed that environmental upheaval has and will continue to alter the human existence. The most striking example of this revelation has come with the death of honeybees and the need to reimagine our system of food production in the last several decades. As people living in 2040 work to create a more sustainable food system in the absence of bees, it is critical to understand how we have contributed to this problem and how our actions have moved us towards this goal. Our construction of a timeline built around events related to policy, science, and cultural allows for an in depth understanding of how our relationship to the natural world has necessarily shifted over time.

Our analysis reveals the importance of unsustainable agriculture in aggravating the loss of bee populations. Before the federal interference from the United States Department of Agriculture and the creation of big agribusiness and harmful pesticides, farmers grew crops at smaller scales, relying on bees to pollinate these crops and provide affordable food for hungry Americans. As humans began to rely on the technological promises of exponential food production, the bee populations suffered. This instability in the system was largely ignored until the emergence of Colony Collapse Disorder in 2006 and the large-scale death of bee colonies.

Key to this discussion is our identification of consumer adaptation, influential policies, and scientific discovery in the time between this discovery and the establishment of the current system in 2040. With the decline of honeybee populations, the production of fruits, vegetables, legumes, meat, dairy, and cotton also declined, leading to the collapse of food industries and extreme price increases for consumers. Consumers responded by gravitating toward nutritional supplements, new fashion trends, and local foods. The latter was reinforced through policies that supported small-scale farming, the elimination of pesticides, and the development of pollinator habitats in urban areas. Scientists and engineers enabled the system through the creation of improved farming technologies and research to learn more about the bee death.

Despite these efforts, the momentum created over decades of unsustainable food production was too great to avert and honeybees were declared extinct in 2035. Five years later, we continue to adapt to this new reality. This means placing more responsibility on the consumer in the production of their own food, reintroduction of pollinator habitats, and attention to nutritional intake. The government policies established in previous years have eliminated practices that led to the death of the honeybees and have encouraged farming behaviors, such as crop rotation and lying land fallow that work with the nature's restorative capabilities.

While the system of food production has been changed through better farming management, consumer efforts, and widespread awareness of the importance of bees in food production, we still have a long way to go. Through the rescue of several bees and dedicated research efforts, we hope to one day reintroduce this species and establish a symbiotic relationship between humans and nature. The following analysis gives a detailed telling of this changing relationship from the year 1862 to present day 2040. This compilation was researched through reviews of scientific journals, news articles, archival videos and photographs, and the journals of today's citizens. We conclude that our relationship to bees and corresponding management of the food system has changed for the better and must continue to improve in the coming years if we are to establish a sustainable future for ourselves and for the bees.

Beyond Bees

Bees are an integral component of many agricultural and environmental systems all over the world. Throughout history, many institutions have been created both that help bees and indirectly damage them. By 2040, however, the damage to the pollinator bee population was, for all intents and purposes, irreparable.

The following is an excerpt from "A Brief History of Bees" by renowned agricultural archivist Megan Schmidt with help from Matthew Plitt, a President of the Engineering Studies Society of America and former apiarist:

In 1862, Abraham Lincoln created the U.S. Department of Agriculture to help farmers and protect consumers in the growing national market. With the establishment of the USDA, agricultural research and development grew to play a major role in the lives of Americans (Alston et al., 2009). As further technologies and acts to facilitate agriculture were introduced, the industry grew at a rapid pace. The 1922 Capper-Volstead Act further changed the shape of American agriculture as limited immunity against anti-trust laws were granted to farming cooperatives, encouraging the growth of large scale agribusinesses (Varney, p. 1, 2010). In 1962, Rachel Carson published her book Silent Spring, which raised awareness about the effects of pesticide use on natural systems and water supplies, ultimately encouraging more products without inorganic pesticides (Unsworth, 2010). As a result of this growing awareness of the harms of pesticides, more research was poured into developing new chemicals that would not have negative consequences for certain plants and animals. This research led to the development of neonicotinoids in the 1980s (Unsworth, 2010).

In 2006, beekeepers began noticing their bees dying off at increasingly alarming rates in a phenomenon that came to be known as Colony Collapse Disorder. While studies

eventually found several contributing factors, including neonicotinoids and other pesticides, various parasitic mites, and other bacteria and viruses, there was no clear, singular cause (Hagopian, 2016). The Farm Bill (passed June 10, 2013), which allocated \$956 billion dollars for various nutrition and agriculture programs, included less than \$2 million for honeybee assistance. In 2014, the EPA required that labels for neonicotinoid products that have use directions for outdoor foliar application include a "Pollinator Protection Information Box", as well as new pollinator language to be added to the "Directions for Use" section of each label (Buhler).

Why was the decline of bees so important? In 2016, the United States relied on honeybees for approximately one third of its food production (Shultz, 2007). One study indicated that 39 of the 57 leading crops were positively affected by pollinators, enhancing and enabling growth and quality of yields (Klein et al., 2007). This natural symbiosis between nutrition for bees and nutrition for humans and animals enabled agricultural systems. The nectar honeybees collect through their contact with flora supplies energy for life processes and colony activities. As the bees collect this honey, they also transfer pollen from the anthers of one flower to the ovules of another flower in a fertilization process known as pollination (National Honey Board).

However, the scientific community was aware of the unsustainable relationship of food production processes and bee health, as indicated by the increasing case studies of Colony Collapse Disorder. Projections of the exponential worldwide population growth sparked invested interest in pesticides and GMO technologies that stimulated the onset of disease, immune deficiencies, and nutritional stress. During this time, food prices remained relatively unaffected by Colony Collapse Disorder. Industrial production standards demanded efficient use of land and agricultural techniques, strengthening the human dependency on pesticides and removing land that bees had depended upon for sustenance. The growth of certain food markets led to justification for large-scale monoculture infrastructure and maintenance technologies which stripped bee habitats of nutritional diversity. Ironically, these industrial practices and human consumption habits, while detrimental to bees, also amplified the human dependency on bees as pollinators. Furthermore, bees also served as a vital organism in other human connections to food, providing crops essential for livestock and consequently the meat and dairy industries.

With the election of Donald J. Trump as president and the Republican House majority in 2016, environmental activists and scientists became increasingly motivated to pursue direct and immediate action, uniting many angry Americans to their cause. International pressures also served as powerful incentives for the government to fulfill the obligations set out in the Paris Climate Agreement. Under the banner of economic recovery and reclaiming international competitiveness, the Trump administration was able to re-prioritize agricultural research, instigating a revival in the prioritization of the USDA's budget. By the end of the Trump administration in 2020, the United States had developed a comprehensive research schedule focused on diagnosing the current state of pollinator health in the country and developing technologies to sustain agricultural yields in the face of the banning of pesticides and lack of natural pollination.

In 2020 bee population was cut by 50% and people start fearing the negative effects this would have on them economically. The United Nations reported at their annual conference on July 28th 2020, "The 100 crop species that provide 90 percent of the world's food supply, over 70 are pollinated by bees. According to the BBC, half of all the food in the grocery store would be gone if bees disappeared." They were talking about almonds, apples, avocados, cashews, blueberries, grapes, peaches, peppers, strawberries, tangerines, walnuts, watermelons, and probably worst of all, coffee. Prices soared to five times the prices in 2016. On top of all this the \$10 million dollar dairy industry took a big hit. All of these food industries were slowly going out of business, and the few who had survived started to raise their prices to a point not even the middle class could afford. Senator Stephanie Roman promoted a huge campaign in 2021 around college's providing education about bee keeping and human pollination as a government job. Her campaign was titled "Save the Bees, so we don't have to be the Bees". This campaign did not take off as planned, as the agriculture business did not have enough money to properly fund it. "People do not realize the hits that they are going to be taking on their health, and by the time they do it will be too late" Roman announced in her speech at a rally at the University of Connecticut. Roman was able to get 60% of colleges to either start beekeeping or to create a subsection major off of entomology to bring awareness to his campaign.

As perhaps the leading factor in the loss of bee populations, agricultural technologies have been the focus of worldwide research. As cases of Colony Collapse Disorder increased, farmers relied more heavily on fertilizers and pesticides to maintain crop yields, ultimately leading to a more severe decline of bee populations. Scientists worked to address this practice through educating farmers about organic farming techniques, spatial and temporal crop diversity, and crop rotation (Tilman et al., 2002) rather than attempting to impose alternative chemicals on production. A greater emphasis on monitoring soil health and increased research has also been made possible through government and nonprofit funding. In addition to agricultural reform, the scale of human pollination has been amplified through improved efficiency in technique and the creation of rigorous training programs. In late 2021, the USDA allocated 80% of its agricultural budget towards the study of sustainable agricultural practices. Never before had the United States witnessed such rapid development of solutions and long-term strategies as scientists released the Sustainable Farming Bill to the Senate in 2024, which outlined requirements for yearly crop rotations, fallow periods, and limitations on the size of a single bed of crops meant to address the monoculture practices of big agribusiness. Following a series of protest against the bill from industry leaders, the Senate passed the crop rotations and fallow period requirements and excluded the bed size requirements. However, in 2025, when President-elect Elizabeth Tanner came into office and the Democratic majority resurfaced in the House, the Sustainable Farming Bill was revisited with a new amendment in abolishing monocrop practices through severe restrictions on crop size. This Bill was further facilitated by the repeal of the Capper-Volstead Act, which led to the reemergence of small-scale farming. This Bill was accompanied by increased national budget allocations, drawn from the formerly prominent defense budget, to increase funds for Senator Roman's education initiative and for the increased accessibility of conferences for farmer training.

A lot happened in 2025, as the cotton industry and the dairy farmers became almost nonexistent, with the few remaining farms producing extremely exclusive products. The government passed a "Ration Bill" that choose the amount of fruits and vegetables that each town would receive and how they distributed them. With the Bill jobs and schools were required to hire personal doctors to monitor declining health. This also started the debate about mandated gardens, but it won't be until 5 years later that the Garden Bill would be put into effect. Beepollinated crops provide the majority of the lipids as well as a large portion of the minerals calcium, fluoride, and iron, vitamin A, C, and E. A key technology in surviving the extinction of bees has come in the form of nutritional supplements. Honeybees once enabled the mass production of numerous fruits, vegetables, legumes, and nuts, all containing vitamins and minerals that improve health and fight disease. As the honeybee population declined along with the flora they pollinated, humans began to experience vitamin deficiencies, declines in intestinal health, and increased rates of cancer, high cholesterol, diabetes, stroke and obesity (SFGate). In response, scientists have developed complex vitamin and injection-based diets that provide people with bee-related nutritional losses. The average person is recommended to take 10-15 vitamins per day in order to maintain energy and fight disease. Injections are made available through health providers for those seeking to further streamline their diets. Personal nutritional readers, similar to insulin-measuring devices, are marketed worldwide as a means for monitoring personal nutritional intake on a daily basis. Scientists have also provided additional sources of nutrition in the form of vitamin-rich tofu, made possible by the increased production of self-pollinating soy.

So, "VitamiX" stores were put up where the old Starbucks Coffee shops and Whole Foods markets used to be, as people were tested at work and school and prescribed the proper amount of vitamins. Luckily the Food Network was working with VitamiX to provide great recipes for all the different types of supplements people needed to survive. At the government, officials were still confident that the bees were going to be back and that the EPA would figure out a way to revive the bee population. People in the United States began to buy pet goats in order to further supplement their diets with the production of homemade cheeses and milks.

By 2029, cotton products were banned completely from Fashion Week. Dolce and Cabana's representative after their show on February 17th, 2029 stated, "Cotton is too expensive for our market." This statement was recorded after watching their models sport polyester suits costing \$5,599. New brands were featured at Fashion Week, including brands specifically focused on strictly man made materials. Macy's and Targets across the country started focusing on clothes that maximized the ability of vitamin D exposure. Fashion week in 2031 focused on clothes that worked with VitamiX to have patches of vitamins embedded in the clothes, they called it the "built in Vitacheck". Once the younger generations physically displayed the health concerns of malnutrition the government started giving out incentives to companies like Macy's and Target to make vitamins a cultural aspect through fashion.

In 2030, the Garden Bill was officially enacted and a large portion of government jobs began focusing on how to feasibly carry it out. The Bill stated that all city roofs had to have gardens and all suburban communities had to have 48% of their laws be gardens. Education was a major key to this Bill's success, but people were not happy with the time management aspects of this new Bill. An amendment to the Bill was created only four months later stating that if you couldn't work the mandated time on the garden in your community, a fee would have to be paid by your household. To help with this community garden law many schools were creating clubs and programs to help out. With the Green Path Bill in 2031 came "pollinator paths," which are pathways that bees could take to ensure that they were functioning in an extremely bee-friendly environment. In 2033, the bee population was almost non-existent and the environmental protection agency was scrambling for a solution, so they made another amendment to the Garden Bill that banned all grass lawns without a municipal purpose. Parks, sports complexes and historic sites were deemed acceptable; all other grass lawns had to be remade so that they fit the parameters outlined in the Garden Bill.

Then, in 2035, a virus called the Varroa IV killed the entire remaining bee population on Earth, except for several hundred saved by the government for research and potential reintroduction. Varroa is a species of mite, which is natural pest native to South East Asia and was originally a contributing factor to Colony Collapse Disorder. The virus, which was named after the parasitic mite, traveled from Asia and first hit Europe before quickly settling upon the United States. New antibiotics and vitamin supplements designed to relieve nutritional stress and strengthen bee immune systems and introduced through genetically modified flora are in the early stages of development.

Many personal technologies have arisen as a result of bee loss and work towards creating a more viable relationship with pollinators. As noted earlier, urbanization and industrialization led to massive loss of pollinator habitats (Naug, 2009). In conjunction with the Garden Bill of 2030 and Lawn Amendment of 2033, scientists have facilitated individual and community pollinator gardens through improved green roof technology, instant window gardens, meadow starter packs, and pollinator networking systems. While urbanization continues, finding space for pollinator habitats has been primarily achieved through the integration of green roofs on all new and existing infrastructures. These gardens are accompanied by mechanized irrigation and drainage systems that increase the time available for organic pest control methods. Pollinator networking systems, facilitated through the Green Path Bill of 2033 have been installed in conjunction with urban planning initiatives in order to provide the nutritional connections necessary for pollinators to maintain energy over urban spaces (Naug, 2009). Supplementary pollination gardens are available in the form of self-sufficient, compact window boxes, ideal for those living in densely populated areas and incentivized through the government's Pollinator Habitat Subsidy Program (P.H.S.P.). For the few remaining rural and suburban areas, meadow starter packs serve as a viable alternative to increasing foraging resources. These "instant"

meadows are composed of species that can grow in difficult soil conditions and that are best suited for creating long-term habitats for butterflies, hummingbirds, bats, and other pollinators

In 2015, scientists discovered the method by which bees effectively "vaccinate" their young. Pollinator bees pick up pathogens while they are out collecting pollen to produce food for the hive. These pathogens then get mixed into the food supply and are digested by the queen bee. A protein called "vitellogenin" then picks up pieces of the bacteria and travels through the bloodstream until it reaches the developing eggs. Being exposed to these diseases early on provides the young bees with a boosted immune system. However, scientists were unable to figure out how to transform this form of vaccination into something that would be effective in protecting against viruses, specifically Varroa IV. Twenty-five years later, they were finally able to place a weakened form of the virus into weakened bacteria, which was spread over an artificial garden. Using the last vestiges of the bee population available for scientific problems, they experienced success. Despite this major breakthrough, they still have to develop protective measures for the maladies that led to the early stages of the bee extinction (Leander, 2015). This research is far from enabling the return of the honeybee as the world's leading pollinator, leading to increased stress upon more immediate adaptation technologies.

The following was compiled from the diaries of Caleb Rowe, a citizen who had kept bees as a hobby and who was profoundly affected by their extinction:

As one could guess from the various policies that have been implemented and the implications of the bee extinction, daily life is quite different. Everyone takes vitamin tablets every day and receives a supplemental nutritional injection once a month. Because of uniform

diets, many people have developed several food allergies, making it even more difficult for them to receive the proper amount of nutrients, even when certain vegetables and fruits are available. For many, the worst consequence of the bee extinction is the rarity of meat, particularly beef and chicken. Without the agriculture to support cow and chicken feed, prices have skyrocketed, reaching \$21 per pound (in 2016 dollars) of ground beef and \$15 per pound of boneless chicken breasts. Since most of the farms grow soybeans, tofu (both the regular and vitamin-infused variety) makes up a significant portion of many people's diets. Favorite childhood fruits and desserts have become expensive luxuries; families with the time to hand-pollinate have their government-mandated green roof covered with strawberry, raspberry, and blueberry plants. All of the hard work is worth it; both for the nutritional and monetary value. Neighbors, friends, and family who are too busy to plant their roof gardens with fruits will pay quite a high price to satisfy their nostalgia for the days before the extinction. Most consumers have made the switch from fashionable to practical clothing; Target, Macy's and other department stores carry affordable, vitamin-D absorbent clothing, while the VitamiX Corporation worked with several clothing companies to produce their "VitachecK" line of clothing. Embedded with a monitor that checks your nutrition levels in real time, 72% of all households in America own multiple articles of clothing from the VitachecK line.

Conclusion

As a society that has faced a great deal of environmental changes through colony collapse disorder, policy change has been imminent once the government realized the numerous ways bees impact the human population. When the bees went extinct in 2035, the policy that was in place only helped solve the initial problems that humans would face, such as nutrition. The bees ability to pollinate revealed why the food chain matters and how such a small insect can have such a tremendous control on such a variety of industries, such as dairy and fashion. The Varroa IV virus, which finished off the bee population (besides the few that the government saved for research) was the fulfillment of a prediction scientists had made back in 2030 based on statistical data that was revealed through certain food pricing markets. The varroa mite feeds off the hemolymph of the adult bees and developing eggs (Entomology 2016). The mites move from colony to colony by robbing bees. The mites were accidently introduced into the bee population in the United States in the mid-1980s; people have been attempting to control varroa mites for over 40 years with coumaphos, fluvalinate, two formulations of thymol and fenpyroximate (Entomology 2016). Over time the mite gained resistance to these drugs therefore the EPA asked beekeepers to rotate chemicals, delay treatments and only use cultural controls to continue managing the mites in a sustainable manner. In 2030 a lot of research went into the viruses that the varroa carried around when scientists realized that the drugs to keep them out were no longer getting rid of them. Unfortunately the virus mutated in the mite and with no drug to kill them off, it infested the bees and near-total extinction occurred by the end of 2035.

A sector of the government involved in colony collapse disorder had been preserving hives in a sterile area in a research center in Virginia starting in 2028 with the help from international zoos and nonprofit organizations. The Roman Grant made huge impacts on the funding process of this research and generations of Romans continue in the field. In 2040, five years after total collapse, the scientists working on the project were able to place the deactivated form of the virus into a weakened bacterium. The scientists were not sure of the outcome but 2 years later the bee population continued to grow as they slowly introduced the mites into an immune colony. The researchers are now working with the Engineering Studies Society of America (ESSA), composed of a diverse group of individuals who trying to set a path of introducing bees back into society. The scientists want to immediately reintroduce but the ESSA have been very tentative. A press conference held outside the research center by the ESSA stated

that "Colony Collapse is not a disorder we want future generations to have to deal with and we are taking many scientific, political, and societal factors into account before we can launch the bees back into the world. This collapse mediated nature and science's research to bring reconciliation between the humans, who have destroyed the bees, and the environment. The research is advancing into sustainable agricultural practices, creation of habitat, and more sustainable consumption habits.

Colony collapse media has centered on the idea of policy holding back technology and research. The hot new debate seems to be around the lack of technological fixes in the collapsed sector. More and more technology companies are competing with each other to develop an artificial bee. The ESSA has been trying to slow down the technical advances in this category because they believe funding should go into a long-term reintroduction solution rather than a project that is full of uncertainty and carries a danger of being hacked. The ESSA has been criticized because of their rejection of technology but with their new monthly magazine, their efficient and well thought-out methods have been explained and are slowly gaining praise. Colony Collapse Disorder has hit its low and is heading upwards to a more concise solution and brighter future.

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