Northern NY Agricultural Development Program
2016 Project Report

Improving Beekeeper Management Practices to Increase Pollinator Health and Honey Production in Northern New York

Project Leader(s):

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Cooperating Producers:

60 beekeepers in New York State; see Appendix 1, Table 1.

Background:

Pollinators are an integral part of New York State (NYS) food production and pollinator services contribute $500 million annually to the state's agricultural economy. Honey bees are used to pollinate a variety of fruits and vegetables in NYS, including apples, blueberries, cranberries, peaches, pumpkins, and beans, to name a few. In addition, 3.6 million pounds of honey (a specialty crop) was produced by NYS beekeepers in 2015, bringing NYS from 13th in rank to 10th for honey production in the U.S. and the top producer in the Northeast.

Despite the increasing demand for crop pollination and growing consumer preference toward local honey, NYS beekeepers are experiencing excessive and unsustainable colony losses. These losses totaled 54% in 2014 alone, exceeding what beekeepers consider economically sustainable (15-20% losses) and the national average (42%). The cost of one package of bees to replace a dead colony in NYS is between $100-200. Beekeepers can instead replace their dead colonies by splitting strong colonies into multiple smaller ones, likely at the expense of a reduced honey crop.

There are several stressors predicted to impair honey bee health within the U.S. and elsewhere, and considerable evidence shows parasites and pathogens are among the

leading factors. Honey bees in NYS are susceptible to a variety of parasites and pathogens. Of these, the *Varroa* mite is the most detrimental and widespread. In addition to killing bees directly by sucking their blood, this parasite also vectors and transmits several viruses. A recent large-scale study conducted in southern Ontario, Canada, found levels of *Varroa* mites in the fall were the leading predictor of colony mortality compared to other parasites, small population size, and low food reserves.

The most effective way for beekeepers to reduce mites and viruses is to regularly monitor and treat colonies; however, preliminary survey data collected throughout the US shows that the majority of beekeepers do not monitor or control for *Varroa*. The most effective approach to control *Varroa* is by using Integrated Pest Management (IPM). This approach relies on a combination of methods (genetic, cultural, and chemical) to reduce pests. At the center of this approach is the practice of only using chemical treatments once pest levels exceed a specific threshold.

In addition to the *Varroa* mites, *Nosema ceranae* is another parasite that is found in the honey bee digestive tract and is present in NYS.The presence of *Varroa*, *Nosema*, and viruses in colonies, as well as beekeepers' management practices to control them, are currently unknown for NYS. These parasites and pathogens have negative implications on NYS agriculture. Slow colony growth and death from these issues translate into decreased honey production, a reduction in the stability of pollination services to NYS's most important crops, and pose a considerable detriment to beekeepers' businesses.

Research into the factors impacting bee health provide insight used to inform beekeeper management decisions. Evidenced-based extension of this nature is critical to mitigating colony losses and returning to a period of sustainable beekeeping. If beekeepers are better able to manage the leading parasites and pathogens that cause colony death, their colony loss rates should improve, which in turn can improve the profitability of the state's beekeeping industry.

This Northern New York Agricultural Development Program-funded project investigated the prevalence of honey bee parasites and pathogens, as well as beekeeper management practices across NYS, with an emphasis on the Northern New York counties of Jefferson, Lewis, and St. Lawrence. This project documents, for the first time, the levels of parasites and viruses in hobbyists, sideliners (managing 50-499 colonies), and commercial beekeepers' beekeeping colonies in New York State, and reports current management practices. All beekeepers in NYS will benefit from the results of this project, and the efforts of Cornell's Honey Bee Research and Extension Program to target all beekeepers throughout NYS with a variety of extension program and resources.

Methods:

Contacting Beekeepers

All known beekeeping clubs in northern New York were contacted to identify beekeepers that would be interested in participating in the project. An additional 120 beekeepers whose contact information had been collected at Cornell University were called or emailed to participate in the study. Through these avenues, 60 beekeepers agreed to take part in the study.

Sampling Honey Bee Colonies
In September 2016, we sampled 309 honey bee colonies distributed across 70 apiaries that belonged to the 60 beekeepers (Appendix 1, Figure 1). Thirty of the 60 beekeepers (50%) kept their colonies in Northern New York (4 beekeepers in Lewis County, 12 in St. Lawrence County, and 14 in Jefferson County). Of the 60 beekeepers, 31 were hobbyists (149 colonies), 13 were sideliners (50-499 colonies), and 16 were commercial beekeepers (500 or more colonies). Of the Northern New York beekeepers, 26 were hobbyists, 4 were commercial, and one was a sideliner. These colonies were sampled for *Varroa* mites, *Nosema*, and 8 viruses.

Determining Parasite and Pathogen Levels per Colony
Approximately 350 bees from the brood nest of each colony were collected and shipped to the USDA Beltsville Bee Lab in Maryland. At the lab, *Varroa* and *Nosema* spores were counted and the viral loads for Deformed Wing Virus (DWV), Acute Bee Paralysis Virus (ABPV), Black Queen Cell Virus, (BQCV) Chronic Bee Paralysis Virus (CBPV), Israeli Acute Paralysis Virus (IAPV), Lake Sinai Virus 2 (LSV), Kashmir Bee Virus (KBV), and Slow Bee Paralysis Virus (SBPV) were all quantified.

Beekeeper Surveys
The survey included questions on operation demographics, beekeeping experience, parasite monitoring behavior, parasite treatment history, and colony health concerns. This survey was approved by the Cornell Institutional Review Board, and was mailed out to each of the participating beekeepers in August 2016.

RESULTS:

Colony Losses
The 60 beekeepers' annual colony loss, including winter and summer loss, in 2016 averaged 34%. Hobbyists lost 42% of their colonies, sideliners lost 29%, and commercial beekeepers lost 30% between October 2015 and September 2016.

Across NYS, the average winter colony loss was 28% and the average summer loss was 7%. Northern New York's colony losses were lower than the state average; NNY beekeepers reported 21.23% loss in winter and 6.17% loss in summer.

Parasite Levels in NYS Colonies
***Varroa* Mite Prevalence:** *Varroa* mites were very common in honey bee colonies in NYS in 2016. Of the 309 colonies sampled, 277 (90%) contained *Varroa* mites, and 192 (62%) were above the economic threshold. Out of 70 apiaries visited, all except one (99%) had at least one colony with *Varroa* mites. Fifty of the 60 beekeepers had an average *Varroa* mite level above the economic threshold (Figure 2).

Varroa mites were significantly higher in hobbyists' colonies compared to sideliners' colonies ($p=0.04$), but there were no significant differences in mite levels between either group and commercial colonies.

Varroa mites were significantly higher in colonies in Northern New York ($p=0.040$) and Western New York ($p=0.010$) compared to Central New York.

***Nosema* Prevalence:**
Nosema spores were present in 185 out of 309 colonies (60%), but were above the economic threshold in only 22 colonies (7%) (Figure 3). The majority of instances of *Nosema* infections above the economic threshold occurred in commercial operations (19 cases) compared to sideliners (1 case) and hobbyists (1 case); however, there were no significant differences in average *Nosema* infection rates among the three operation sizes (p=0.514).

Nosema levels were significantly lower in colonies in Northern New York compared to colonies in Central New York (p=0.002), while *Nosema* levels in the Western Region were not significantly different from the other two.

Pathogen (Virus) Levels in NYS Colonies
Viruses were quite prevalent in the honey bee colonies sampled in 2016. At least one virus was present in every colony, and it was more common to have multiple viruses present at the same time. Seven percent of colonies had 1 virus, 34% had 2 viruses, 44% had 3 viruses, 13% had 4 viruses and 2% had 5 viruses.

Overall, commercial and sideliner colonies harbored more viruses (4.2 and 3.9 per colony, respectively) than hobby colonies (2.4 per colony).

There were no significant differences in virus levels across regions in NYS, with the exception of Acute Bee Paralysis Virus (ABPV). This one virus was significantly higher in colonies in Central New York (389 billion viral colonies per mL average) compared to Northern New York with an average of 31.2 billion viral colonies per mL ($p<0.05$).

There was no relationship between beekeeping operation type and virus levels for ABPV (P = 0.79), CBPV (P = 0.31), DWV (P = 0.81), KBV (P = 0.65) or LSV2 (P = 0.07). The levels of BQCV differed between operation types ($P = 0.019$, Tukey's significant difference test): sideliner levels were greater than hobbyists, as did the levels of IAPV ($P = 0.016$, Tukey's): commercial levels were greater than hobbyists.

There was a strong positive relationship between *Varroa* mite levels and DWV levels ($R^2 = 0.15$, $P < 0.001$; Figure 4). Deformed Wing Virus is the main virus that is transmitted by the mite. Average parasite and pathogen levels across the three operation types are summarized in Figure 5.

Management Practices
Recordkeeping
Only 30 (53%) beekeepers reported keeping records of their observations and practices while working their honey bee colonies. An additional 16 (28%) beekeepers reported they 'sometimes' keep records, and 11 (19%) reported they do not keep any records of their honey bee colonies.

***Varroa* Mite Monitoring and Treatment**
The majority of beekeepers (64%) who participated in the project do not monitor for *Varroa* mites to determine their colonies' infestation levels. Twenty (36%) beekeepers reported they do. Commercial beekeepers were more likely to monitor than hobbyists.

Overall, 35 (62%) beekeepers reported that they treat *Varroa* mites in their colonies, while 21 (38%) beekeepers report that they do not treat.

Treating was more common among commercial beekeepers compared to hobby beekeepers. Eighty three percent of commercial beekeepers treated, 69% of sideliners treated, and only 52% of hobbyists treated their colonies. The majority of beekeepers who treat their colonies do not follow an IPM approach: 66.7% treat on a schedule regardless of first knowing their mite levels, while only 11.1% only treat when their mite levels exceed the economic threshold. The remaining beekeepers follow a combination approach.

Honey Production

The average honey harvest by the beekeepers in our project was 64 pounds per hive, and this volume was similar across all operation types. Hobbyists extracted an average of 67 lbs/hive, sideliners extracted 60 lbs/hive, and commercial beekeepers extracted 65 lbs/hive. There were no significant differences in honey production among the three operation sizes. This production is similar to the average lbs/hive reported in National Agricultural Statistics Service for NYS in 2015 (62 lbs/hive) and higher than the reports in NYS for 2014 (55 lbs/hive).

The average honey harvest for beekeepers in Northern NY was 46 lbs/hive. Regional variations in honey production are largely influenced by soil type. A map of the major honey producing counties in New York can be found at https://pollinator.cals.cornell.edu/sites/pollinator.cals.cornell.edu/files/shared/documents/morse-dyce-beekeeping-in-NY.pdf.

Conclusions/Outcomes/Impacts:

This project has identified opportunities for Cornell's Honey Bee Research and Extension Program to work with NYS beekeepers to improve their colony health. Beekeepers continued to experience unsustainable colony losses in 2016, losing an average of one third of their operation.

Northern New York's colony losses were lower than the state average; NNY beekeepers reported 21.23% loss in winter and 6.17% loss in summer. We do not yet know why this is the case. In 2017, we are following up on the colonies that were sampled to determine which ones died over winter to help determine the main predictors, e.g., Varroa, Nosema, viruses, or specific management practices, for colony loss in the state..

Varroa mites are one of the leading contributors of colony death. *Varroa* mites were the most prevalent parasite in honey bee colonies in NYS AND were significantly higher in colonies in Northern New York ($p=0.040$) and Western New York ($p=0.010$) compared to Central New York.

83% of beekeepers statewide had an average mite level that exceeded the economic threshold for September (3 mites/100 bees). If colonies at or above this threshold are not effectively treated, the colony is predicted to die within one to two years. There were no significant differences in mite levels between hobby colonies and commercial colonies, showing that this parasite is an issue for the entire beekeeping industry.

Viruses that are transmitted by *Varroa* mites were also very common in the sampled colonies. Every colony had at least one virus, and it was most common for colonies to be infected with three different viruses at the same time. The most common virus that was detected was Deformed Wing Virus, which also happens to be the most virulent of those transmitted by *Varroa* mites. Of the colonies sampled, 96% tested positive for this virus.

There are no treatment options for honey bee viruses; the only management practice is to keep *Varroa* mite levels below the economic threshold consistently throughout the active beekeeping season. Despite a variety of monitoring methods and treatment options for beekeepers to use to reduce varroa mite risks, only 36% of beekeepers (30 % of NNY beekeepers) monitor for mites to determine their presence and levels in their colonies.

More beekeepers treat for *Varroa* mites (62%), but it is evident that further education is needed to effectively control this pest. Although treatment frequency was higher among commercial beekeepers, they experience similar mite pressures to hobbyist colonies. Introducing an IPM approach may help improve the efficacy of their control methods. The Honey Bee Research and Extension program at Cornell will be actively pursuing opportunities to educate beekeepers on *Varroa* mite best management practices.

Nosema was common in honey bee colonies, but levels were low in the majority and only exceeded the economic threshold in 7%. *Nosema* levels were significantly lower in colonies in Northern New York (NNY mean : 8 billion colonies/mL; CNY mean: 43 billion colonies/mL; WNY mean: 22 billion colonies/mL) compared to colonies in Central New York ($p=0.002$) The one treatment option available that controls *Nosema* with low to moderate efficacy has been communicated to beekeepers in the study that inquired about managing this particular parasite.

Another management practice underutilized by beekeepers in our study is keeping colony records. Keeping records of colony inspection observations and management practices is an easy way for beekeepers to track colony growth, productivity, and the health of their bees, yet only 53% of beekeepers (73% of NNY beekeepers) in the project keep such records.

Record keeping allows beekeepers to track mite levels and other diseases, and to learn which treatments are most effective for their colonies. When colonies die, reviewing records can provide an indication for the cause of death. These results have motivated our lab to create example record keeping sheets that will be made available to beekeepers in two of our extension avenues: students in the Cornell Master Beekeeping program and enrollees in the NYS Beekeeper Tech Team.

Outreach:

The beekeepers in this project received their parasite and pathogen results, and 30 (4 from NNY) have enrolled in the NYS Beekeeper Tech Team program to meet regularly with extension personnel and receive recommendations for improving their colony health. We have provided information on how to effectively monitor and control *Varroa* mites to the Tech Team participants, as well as on the Cornell Pollinator Website: www.pollinator.cals.cornell.edu and the online Cornell Master Beekeeper Program.

To enhance communication among beekeepers in NNY, a publicly-available beekeeping directory was created that includes 42 NNY beekeepers' contact information (Figure 6). The results of this project also were communicated at several events (Table 2).

A workshop titled 'Parasites and Pathogens of Honey Bees' was held at Cornell Cooperative Extension Jefferson County with 10 participants on November 21, 2016, to educate beekeepers in parasite monitoring and control. The expected attendance was higher, but the first snowstorm of the season occurred on that night and prevented several attendees from coming. The workshop consisted of three lectures (slides: Appendix 2) and one activity to equip beekeepers with the tools and resources to improve colony management in their own operations. All participants received a manual on parasites and pathogens of honey bees, a disease identification test kit, an informative poster on diagnosing honey bee disease, a *Varroa* mite monitoring record sheet, and a frame of drone comb foundation to use in their own colonies to control for *Varroa* mites. Nine participants filled out a workshop evaluation, and all nine (100%) reported the workshop was applicable to their beekeeping operation.

We recommend beekeepers apply the results of this project by actively working to decrease their *Varroa* mite and virus levels. They can accomplish this in three ways:

1) monitoring their colonies using a method that quantifies mite levels,
2) treating colonies using an IPM approach when mites exceed economic threshold, and
3) keeping records of treatments and management practices to track colony health in the long term.

Next Steps:

The research team will follow up with 30 (8 in NNY) of the beekeepers in spring and fall 2017, with a survey and colony sampling, to assess whether recommendations were implemented. Due to additional funding from the New York State Pollinator Protection Plan, we will continue to conduct analyses to determine whether parasite and pathogen levels impact honey production. We will also analyze pesticide residue levels (herbicides, insecticides, fungicides, and miticides) in colonies to determine how this can impact overall colony health.

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For More Information:

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