An Area-Wide Pest Management Program to Improve Honey Bee Health in Blueberry and Cranberry Pollination Services

Progress report for LNE18-364

Project Type: Research and Education
Funds awarded in 2018: $199,975.00
Projected End Date: 10/31/2021
Grant Recipient: Rutgers University
Region: Northeast
State: New Jersey
Project Leader:

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Rutgers University

Project Information

Performance Target:

1. Twenty fruit growers, producing fruit on 3,000 acres, will reduce applications of bee toxic insecticides, and replace with alternatives that result in decreased pesticide residues in hives.
2. Three beekeepers, with improved colony management plus lower hive residues will see a 30% increase of brood growth from overwintered levels, as measured by percent brood coverage in monitored hives, and compared to baseline data gathered prior to the start of this project.

Introduction:

Problem and justification- New Jersey a leading blueberry and cranberry production states. National highbush blueberry and cranberry production is over $1 billion (USDAAPHIS, 2017). Honey bees pollinate the $90-$100 million NJ blueberry and cranberry crops, where during the last 5-6 years beekeepers have seen a decrease in hive strength, reduced brood, and queenless and dead colonies. One NJ beekeeper stated that 90% of his Florida colonies used for NJ pollination were dead by February, while colonies kept in Florida had about 20% mortality (Ham, pers com. 2017). Both crops have required a high degree of pesticide use, which beekeepers attribute as the major cause of colony decline. As colony losses increase, pollination fees increase and the quality of pollinating hives goes down. In 2012 blueberry pollination fees were $60 per hive, and by 2017 fees were $90 per hive. Costs for cranberry pollination were over $100/hive. Blueberry requirements average of 2 hives per acre but often 3-4 hives per acre for pollination, as is the case for cranberries. Total hive requirements exceed 18,000 hives from NJ based and other migratory commercial beekeepers. Because of the cost and need for

bees, both commercial fruit growers and beekeepers have a vested interest in the continued health of honey bees.

Solution and approach – This project will focus on examining pesticide residues in pollinating hives, correlating residues with colony health measurements, and standard beekeeper practices; and changing fruit grower pest management practices that can reduce residues, thereby improving colony health. It has evolved from meetings that beekeepers organized with fruit growers and extension/researchers. Three grower clientele groups have funded pilot investigations – blueberry growers, cranberry growers, and beekeepers. We will use Rutgers managed hives and commercial hives. Colonies will be measured for brood growth, queen presence, diseases, parasitism, and pesticide residues. Bee Informed Partnership (BIP) measurement protocols will be used for measuring hive health, along with BIP management recommendations. Parasitism and disease diagnostics will be submitted to the UMD/USDA APHIS through BIP. Fruit growers will adhere to known bee safety and pesticide use recommendations, and supply pesticide records. Resulting data will form the basis for changes in pesticide use, while other analyses of hive health may lead to changes in colony management. For example, frequency of varroa or disease treatments or other management practices close to pollination periods.

Cooperators

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Research

Hypothesis:

1) Pesticides used close to or during bloom negatively affect brood growth, survival, and queen longevity, and often in combination with other stress factors.

2) Hives used for pollination services on small isolated farms, often have fewer and lower pesticide residue levels compared to those found in large diverse cropping areas.

3) Changes in pest management practices can reduce the number of pesticide residues present in honey bee colonies.

4) Fruit growers and beekeepers can together reduce pesticide and other stress factors, resulting in improve colony health.

Materials and methods:

Methods

There were 4 treatments: 1) blueberry pollination only on large farms (>200 acres), 2) blueberry pollination only on small farms (< 100 acres) surrounded by woods, 3) blueberry pollination on large farms followed by cranberry pollination, and 4) No pollination services, staying at the Rutgers Agricultural Research & Extension Center (RAREC). Each treatment had three replications and three hives per replication – total 9 hives per treatment. Hives were transported on small trailers and remained undisturbed, except for taking data. On April 23rd 2018 a commercial beekeeper delivered 36 strong honey bee hives. Each hive was weighed and inspected for queen rightness, hive strength, and good health. Hives were attained from a commercial beekeeper on April 27, 2018, and assessed, weighed and numbers on April 28 prior to initial placement in commercial pollination treatments April 28-30. Data collection occurred on May 10-12, June 5-6, July 5-6 and August 24-25, 2018. Data included determination of queen rightness, presence of eggs and larvae, brood growth (numbering three brood frames that are checked monthly for brood health and percent coverage), and hive weight. Each time the hives were inspected, commercial hives adjacent to treatment hives were inspected for comparison. Hives were returned to the Rutgers bee yard at the end of blueberry pollination (approximately five weeks later), weighed and inspected. On June 6th 2018 the hives used for cranberry pollination treatment were laced in cranberry fields. All hives, including those remaining at RAREC, were inspected on July 5th 2018. Upon completing cranberry pollination (approximately 5 weeks later) all treatments were returned to RAREC and inspected on August 25th 2018.

Brood coverage is determined by estimating the percent of brood covering the same three frames (front and back) located within each hives brood box. Three frames in each hive were numbered at the beginning of the season so that brood coverage could be determined using the same 108 (36 hives x 3 frames in each hive) throughout the experiment.

Queen rightness is determined by the presence the eggs within a hive. If a hive has no eggs, then it is considered a dead hive. If a hive was determined to be dead, then a new queen was introduced to the hive to be able to continue experiment.

All samples were collected following USDA AHPIS National Honey Bee guidelines.

To further inspections, a European Foul Brood test kit was applied to one sickly larva within in each hive on July 30th 2018.

Pollen samples were collected near the end of each pollination period along with 1 aggregate bee comb sample from each treatment for pesticide residue samples. Aggregate samples for each treatment were also taken for virus screening and sent to the University of Maryland Honey Bee laboratory/ Bee Informed Partnership for a 99 chemical analysis. All pollen was collected using pollen traps, a trap was place below the bottom box of one hive in each treatment, this process redirects the hive entrance so that pollen being brought into the hive on that day is separate from pollen collected at another date. The aggregate bee comb (wax) sample was collected from a new frame which was placed into the hive right before pollination services occurred, this ensured that the wax sample would not possess any chemicals which may have been applied at an earlier date.

Samples for Nosema and aggregate Varroa testing were collected on July 19th 2018 and analyzed by the NJDA Honey Bee Lab; 1/4 cup of live bees were collected from the entrance of each hive and transferred immediately into a specimen container with 50mL of a 70% alcohol solution to kill and preserve samples. Each sample consisted of bees from each of the three hives in that specific treatment (ie 1 sample represented each trailer consisting of 3 hives) totaling in 900 bees. (1/4 cup = 300 bees).

Sampling for virus testing was collected on July 24th 2018 and analyzed by Bee Informed Partnership at the University of MD. Sampling consisted of 2/3 cups of live bees were collected from frames of uncapped brood in each treatment and placed in BIP provided vented shipping box with enough food and water to sustain the bee until processed by lab. Each sample consisted of bees from each of the three hives in that specific treatment (ie 1 sample represented each trailer consisting of 3 hives) totaling in 2400 bees (1/3 cups = 400 bees). Live bees were tested for viral loads from 7 prevalent viruses (KBV, ABPV, IAPV, DWV, LSV-2, CBPV and BQCV).

For 2019 we carried out a similar set of field monitoring procedures with some changes. Hives were weighed once per week, or during each inspection. Varroa sampling was done every 4 weeks, and Varroa treatments rotated throughout the growing season. Brood coverage was measured in the same manner as was done in 2018. Virus testing was not done during 2019, since all samples had virus titers during 2018, and there was no difference between treatments. Pollen and aggregate samples were collected in the same manner as completed in 2018.

January 2021: Field work during and after the blueberry and cranberry pollination periods, continued during 2020 as was done in 2019, but with a few changes. We evaluated hives weights weekly and varroa populations every 4 weeks. Since during the previous year virus presence was widespread, and there were no differences between treatments, viral analyses was discontinued in 2020. Hive health measurement parameters were expanded to include a mathematical model for establishing a hive health index, with the intention of correlating with treatment conditions and fungicide use.

Research results and discussion:

Hive Weight and Brood Growth – Hive weights, which are a generally a measure of brood and food accumulation, generally increased throughout the season. The increase was numerically less on large farms, and decreased after hives were placed in cranberries. The decrease in hive weight after cranberry pollination suggests the poorer food sources and nutrition available in cranberry bogs as

compared to blueberry fields and more diverse settings. Brood growth varied by pollination treatment. When measured from May to July, brood increased in the non-pollination control and the large farm treatments, but decreased in hives placed on small farms and in blueberries followed by cranberries. The decrease was significant in the blueberry to cranberry treatment, reflecting the similar results seen in weight loss. (Figure 1) During 2019, with weights taken on a weekly basis, a trend was seen where hives placed on both small isolated farms and large blueberry farms, initially showed a rapid weight gain, but for 4 weeks after bees were removed, the hives that had been placed on small farms were heavier. This indicated more food stores and stronger brood. The data from internal colony measurements is still being analyzed in order to help explain weight differences. (Figure 2)

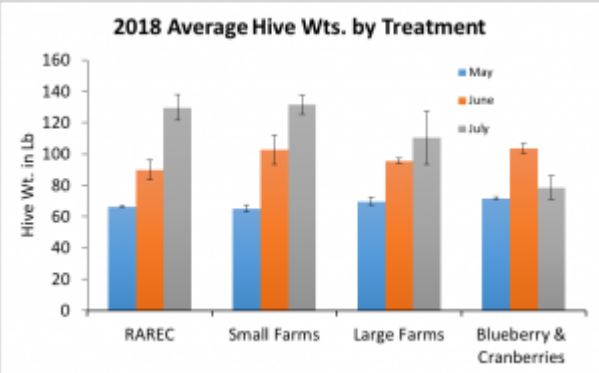

Figure 1. Hive weights taken across treatments in 2018.

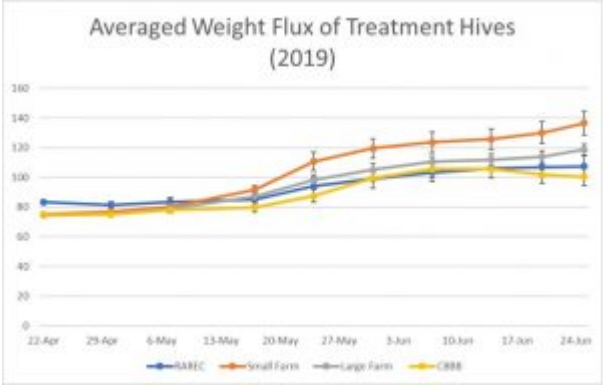

Figure 2. Weekly hives weights by treatment through June, 2019.

Varroa and Nosema Levels – Varroa as tested in July showed “0” samples infested with varroa mites. Dissection of bees showing Nosema spores showed varying levels that were not significantly different between treatments. Nosema infection was numerically lower on large farms.

Virus levels – Four different viruses were found throughout the treatments, with no significant differences in the levels found between treatments. These included Deformed Wing Virus (DFWV), Israeli Acute Paralysis Virus (IAPV), Lake Sinai Virus (LSV), and Varroa Destructor Virus (VDV). Two of these, DFWV and VDV are closely associated with Varroa mite infestation (2018).

Pesticide Residues – In 2018 pollen samples showed that up to 45 various pesticide residues were present in the colonies. These included several herbicides, 15 fungicides and 17 insecticide/miticides. Five of the insecticide/miticides were directly attributable to beekeeper use in varroa management. In the 2019 pollen samples we found residues from 17 insecticide/miticides, 12 fungicides, and 6 herbicides. Similar residues were found in wax & bee bread matrix samples, but at different concentrations.

January 2021: Pollen was collected as during previous years, and is presently stored and waiting analyses for pesticide residues. We decided that given the vegetation that surrounded our research farm sites, diet may be an important factor in colony health during the pollination period. Therefore, the identification of pollen to plant family was started. Since this was a late /additional objective, the identification of samples may be completed after the grant period is done. Similarly, given the many

fungicide residues being found, and the conditions of the colonies in high spray areas, it is appropriate to look at the effects of some of these materials on honey bee larval development.

Research conclusions:

January 2021: Highlights from the project so far show the following:

1. Colonies exposed to double pollination, or blueberry pollination for 4 weeks, followed by 1 week rest, then cranberry pollination, experienced poor brood growth. In fact, colonies in this treatment suffered from a decrease in hive health as measured by total brood coverage and hive weights.
2. Colonies used for blueberry pollination on large acreage blueberry farms and areas surrounded by blueberry farms, experienced an initial growth during the pollination period, but then went backwards shortly after pollination in terms of brood coverage and hive weights.
3. Colonies placed on small isolated blueberry farms showed an increase in hive weights and brood coverage throughout the season.
4. Colonies not placed in pollination service but remaining at a research farm (a sprayed area), showed variable results from year to year. Due to the COVID pandemic in 2020 there were few pesticide sprays applied that year. Colonies that gained the most weight and increase in brood coverage were from this “non pollination” treatment in 2020 (see Figure 2-21).

Figure 2-21. Hive weight record from 2020.

Participation Summary

13 Farmers participating in research

Education

Educational approach:

During the first year the educational approach involves a combination of formal annual grower and beekeeper meetings, in-season twilight update meetings, small group 'advisory discussions', newsletter articles, and formal classes and seminars with students.

Two formal classes were held, one titled “Blueberry Pollination and Honey Bees” on 11/12/18, and the second “Colony Collapse Issues with NJ Blueberry Pollination –

What's at stake besides $millions?" on 12/7/18. One blueberry grower meeting was held on April 26, 2018 with 83 blueberry growers. A beekeeper meeting was held July 11 to discuss preliminary results and approaches to use to mitigate colony decline during pollination services. This followed with a joint beekeeper, blueberry/cranberry grower/extension meeting held on September 5 to 1) summarize preliminary results from season 1, and to discuss approaches to be taken to reduce colony decline associated with pollination services.

During 2019 and early 2020 the following classes and talks were presented:

To Blueberry Growers:

2/7/19 A pollinator, practice and knowledge survey was filled out at the Atlantic City meeting - 61 growers.

2/19/19 Project results at the Annual Blueberry Open House - 92 growers.

4/23/19 Care of honey bees during pollination, Twilight Update Meeting - 86 growers.

2/5/20 Update on Honey Bee Health and Blueberry Pollination Services, Atlantic City Meeting - 98 growers.

To Beekeepers:

1/19/19 Project Update on Honey Bee Health During Blueberry Pollination, Jersey Cape Beekeepers Assc. - 42 beekeepers.

2/16/19 Pesticides and Honey Bee health, NJ Beekeepers Annual Winter Meeting - 250 beekeepers.

1/15/20 Research & Education to Reduce Honey Bee Losses During Blueberry Pollination, Delaware Beekeepers Association, DE Ag Week - 112 beekeepers and growers.

2/1/20 Project Update on Honey Bee Health in Blueberry Pollination,NJ Beekeepers Annual Winter Meeting - 165 beekeepers.

Education (Continued in late 2019 – 2020

Over the last year we reached just over 824 fruit growers and beekeepers through 8 annual and twilight update meetings throughout New Jersey and Delaware. We also gave presentations from this work at 3 professional meetings with audiences composed of graduate students, other entomologists and fruit scientists reaching over 1,100 people. Meeting held on February 1 and 4, and March 26 were in person. Meetings held on April 15, 28, June 10, November 15, 16 and December 3, 4 and 6 were all online in webinar format.

January 2021: Planned Meetings

New Jersey Agricultural Convention, Blueberry Section (Virtual), February 23, 2021.

Annual Blueberry Open House (Virtual) March 18, 2021

Commercial Beekeeper Project Update (Virtual) TBA late March early April

Blueberry Twilight Update Meeting, (Virtual), April 22, 2021

Milestones

Milestone #1

What beneficiaries do and learn:

1. During 2018, 100 fruit growers will participate in a knowledge survey about the

use of pesticides close to and during bloom periods. The survey will focus on fruit grower pest management practices used just prior to, during and shortly after bloom. Survey results will form a baseline for grower perception and understanding of pesticides and issues encountered by beekeepers, and later compared to a similar survey completed during the fall and early winter of 2020 (see milestone 9). Completion date 12/31/2018

Proposed number of farmer beneficiaries who will participate:

100

Proposed Completion Date:

December 31, 2018

Status:

In Progress

Accomplishments:

January 2021: The follow-up in person survey could not be administered due to the pandemic. Two webinar based meetings presented information about honey bee health and precautions to use during pollination. Therefore this is still in progress.

Milestone #2

What beneficiaries do and learn:

2. Forty blueberry growers and 10 cranberry growers will be surveyed for pesticide use data for the year preceding the project. These data will provide baseline information about actual grower pesticide use as it relates to pollination issues. Completion date 12/31/2018

Proposed number of farmer beneficiaries who will participate:

45

Actual number of farmer beneficiaries who participated:

40

Proposed Completion Date:

December 31, 2018

Status:

In Progress

Accomplishments:

Forty grower pesticide records were collected at the end of 2018 and 2019 and are being analyzed for pesticide used just before, during, and just after bloom. Actual pesticide use is being compared to pesticide residues found in the pollen sampled from hives during pollination.

January 2021: Forty blueberry grower pesticide records were also collected for the 2020 growing season and are being analyzed. A subset of pesticide use records was collected and analyzed for 1995, 2000, 2005, 2010 and 2015. This showed the change in fungicide use over time. Beekeeper observations about colony

decline during pollination seem to coincide with this change in fungicide use. See Figure 1-21

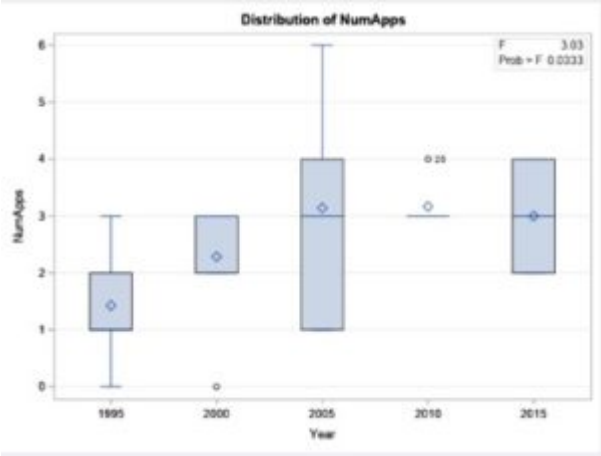

Figure 1-21. Historical blueberry fungicide use over time, showing an increase in the number of applications.

Milestone #3

What beneficiaries do and learn:

3. During 2018, 100 NJ beekeepers, consisting of commercial, sideline and hobbyist levels will participate in a similar baseline survey as given to fruit growers. However, the survey will focus on annual management practices for parasite and disease control, comb and queen renewal, as well as existing beekeeper practices when hives are placed in or near agricultural areas. Completion date 12/31/2018

Proposed number of farmer beneficiaries who will participate:

100

Actual number of farmer beneficiaries who participated:

150

Proposed Completion Date:

December 31, 2018

Status:

In Progress

Accomplishments:

Over 150 beekeepers have been surveyed for their use of varroa mite management practices, and their understanding on the effects of pesticides on honey bees.

January 2021: During the annual winter meeting of the NJ Beekeepers Association a survey was administered as a pre vs post test knowledge evaluation to 104 people about the effects of fungicides and other pesticides on honey bee health.

Milestone #4

What beneficiaries do and learn:

4. A 5-member fruit grower-beekeeper pollination advisory board (PAB) will create a dialogue between commercial beekeepers and blueberry/cranberry growers. The board will consist of 2 beekeepers, 1 primarily blueberry grower, 1 dual blueberry and cranberry grower, and 1 person representing the cranberry industry. Completion date 12/31/2018

Proposed number of farmer beneficiaries who will participate:

5

Proposed number of agriculture service provider beneficiaries who will participate:

1

Actual number of farmer beneficiaries who participated:

5

Proposed Completion Date:

December 31, 2018

Status:

In Progress

Accomplishments:

Beekeeper and grower groups have formally met in late 2018 to discuss pesticide use practices and how they affect honey bee health. As a result, growers who manage about 1,900 acres committed to adopting practices that showed promise in reducing negative impact of pesticide use on honey bees during bloom. These practices included the use of ground applications (compared to air), and making applications at night while bees are inactive.

January 2021: There were no in-person meetings this past year due to the pandemic.

Milestone #5

What beneficiaries do and learn:

5. Seventy-five blueberry growers and 20 cranberry growers will each attend 1 meeting per year in 2018, 2019 and 2020, where they will gain knowledge about beekeeper issues and honey bee biology, and learn about pesticide impacts on honey bees, partially based on the data collected from this project. Completion date 12/31/2020

Proposed number of farmer beneficiaries who will participate:

95

Proposed number of agriculture service provider beneficiaries who will participate:

3

Actual number of farmer beneficiaries who participated:

93

Actual number of agriculture service provider beneficiaries who participated:

3

Proposed Completion Date:

December 31, 2020

Status:

In Progress

Accomplishments:

Presentations were made regarding honey bee health, the data gathered and the progress made on this project to fruit growers at 3 meetings in 2018 and 2 meetings in 2019.

January 2021: The New Jersey Agricultural Convention, blueberry session, was done on February 6, 2019. This is usually attended by 75-90 blueberry and blueberry/cranberry growers. The Blueberry Open House, attendance = 96, 2019 and 93 in 2020) was done on February 19, 2019 and March 9 2020 . Presentations on first and second year field work were presented at both meetings, and a survey done during the 2019 meeting. The initial program plans about pollinator health during blueberry pollination were presented during a spring, 2018 blueberry grower twilight meeting with 84 growers attending.

Milestone #6

What beneficiaries do and learn:

6. By December 2020, a minimum of 40 blueberry and 5 cranberry growers will have participated in IPM programming and have consulted with project team members by phone, email, web blog and in person about pesticide use during and near bloom periods for the 3 years of the project, creating over 2,160 audience contacts during the life of the project. Completion date 12/31/2020

Proposed number of farmer beneficiaries who will participate:

45

Actual number of farmer beneficiaries who participated:

50

Proposed Completion Date:

December 31, 2020

Status:

In Progress

Accomplishments:

January 2021: Forty blueberry growers participated in a delivery IPM program during 2019 and 2020. Three of these growers are also cranberry producers. Additional cranberry producers received IPM information from project leaders, used for their IPM practices. A subset of 6 blueberry growers participated with honey bee pollination plots, and collaboratively managed their fungicide use to help with the research component of this project. Two of these growers also

produced cranberries, where hives were placed, in addition to one cranberry grower without blueberry fields, for a total of 7 grower collaborators.

Milestone #7

What beneficiaries do and learn:

7. Three major beekeepers who provide commercial pollination services for blueberries and cranberries will participate in small meetings and on-farm workshops during years 2019 and 2020. Discussions will cover varroa mite management, means of reducing pesticide contamination, and possible relation to bee diseases and other stress factors. Completion date 12/31/2020

Proposed number of farmer beneficiaries who will participate:

3

Proposed Completion Date:

December 31, 2020

Status:

In Progress

Accomplishments:

Five commercial beekeepers met during September of 2018, and informally in 2019 to discuss progress in this project. One commercial beekeeper independently met with 5 colleagues to discuss colony management and reducing pesticide impacts on honey bees. This meeting led to additional funding to help with the project.

January 2021: Informal meetings and phone conversations were held with major commercial beekeepers at the start of and during the blueberry pollination period throughout late April and May. In addition to data gathered from research hives, several beekeepers made their hives available to sampling.

Milestone #8

What beneficiaries do and learn:

8. Forty blueberry and 10 cranberry growers will be surveyed for pesticide use practices during each of the 3 years of the project to examine reductions in bee toxic products and the use of alternative practices. Pesticide surveys and analyses of practices will be done during the fall and winters of 2018, ’19, and ’20. Amounts of active ingredient used during each phenological fruit stage and cover sprays will be quantified and compared to pesticide residues found in pollen samples and in hives. Completion date 12/31/2020

Proposed number of farmer beneficiaries who will participate:

50

Actual number of farmer beneficiaries who participated:

50

Proposed Completion Date:

December 31, 2020

Status:

In Progress

Accomplishments:

As of February 2020, we have collected 80 grower pesticide use records that are currently being summarized.

January 2021: This work is ongoing and continues with the collection and analyses of pesticide use records. Pesticide use is being compared to pesticide residues found in hives.

Milestone #9

What beneficiaries do and learn:

9. During the late fall and early winter of 2020 a “post project” knowledge survey about pesticide use and pest management practices used during and near bloom periods will be given to 100 combined blueberry and cranberry growers as a follow-up from milestone 1. Completion date 12/31/2020

Proposed number of farmer beneficiaries who will participate:

100

Proposed Completion Date:

December 31, 2020

Status:

In Progress

Accomplishments:

January 2021: In Progress, delayed because of lack of in-person interaction due to COVID pandemic.

Milestone #10

What beneficiaries do and learn:

10. The 100 beekeepers listed in (3 above) will attend winter meetings in 2019 and 2020 where project results are presented, and follow-up surveys completed about annual management and pollination practices. Completion date 4/30/2018

Proposed number of farmer beneficiaries who will participate:

100

Actual number of farmer beneficiaries who participated:

569

Proposed Completion Date:

April 30, 2018

Status:

In Progress

Accomplishments:

As of February 2020, 569 beekeepers have participated in meetings and surveys as part of this project.

January 2021: Project results and interim recommendations were presented to 104 beekeepers at the annual winter meeting of the NJ Beekeepers Association February 1, 2020.