

# Building expertise and capacity for accurate Integrated Fruit Production models in the Network for Environment and Weather Applications (NEWA)

Juliet Carroll, Deborah Breth, Art Agnello, Kerik Cox, and Terence Robinson

**Final Report, June 30, 2016**

## **Summary**

The Network for Environment and Weather Applications has a proven track record for providing grower benefits and outcomes that include improved IPM practice, reduced environmental impact, and improved crop yield and quality. Grower expertise in weather station maintenance and troubleshooting was improved via hands on workshops, written educational materials, and web-based educational resources. Weather stations on apple farms were visited and tips for their improved maintenance and operation provided to the owners. The apple insect tools on NEWA now deliver degree day predictions, based on weather forecasts, allowing end users to know if IPM action thresholds for key insect pests are looming and to take steps to prepare for suggested management tactics. A degree day calculator is now available to allow apple growers to determine specific degree day accumulations between dates of their choosing. Apple disease model logic for apple scab ascospore release and fire blight epiphytic infection potential were developed for research testing to validate for 2017 implementation. Consensus on utilizing the apple chilling and heat unit models for all the apple tools was established along with basic model logic. When weather stations are properly maintained and deliver accurate data the weather-based phenology models are more accurate, thus enhancing their utility, ultimately contributing to the economic success and IPM practices of apple growers using NEWA's IPM forecast models.

## **Objectives**

The objectives of the work were to (1) improve the accuracy and reliability of the weather stations in NEWA and (2) improve the accuracy and user experience of the apple models.

## **Results**

*(1) Improve the accuracy and reliability of the weather stations in NEWA*

We exceeded our target of reaching 24 apple farmers in NY who own NEWA weather stations by 33%, performing field analyses at 32 sites. NEWA is a knowledge network that benefits all apple growers who are accessing NEWA and this project contributed significantly to the reliability and accuracy of the weather station data by building grower expertise.

A temporary technician, Stephen Valentino, conducted field visits at 32 of 38 Rainwise weather stations located on New York apple farms. The six that were not visited included two maintained by John Gibbons, recently retired NEWA technician, two on Long Island outside the reach of the project, one that had been disconnected and one that was being moved. Eighteen of the 32 instruments were not working correctly before the field visit, based on analysis of the data being reported on the NEWA website. Ten of these had RH sensor errors, 2 had rain gauge problems, and 11 were having data transmission outages. Nine stations were either fixed during the field visit or were fixed afterwards. Of the nine stations that still had problems, six needed the RH sensor replaced and three had data transmission problems. The RH sensors can be replaced on site and the owners have been notified. It is the owner's responsibility to buy the part and install it. Of the three that have transmission issues; one will be relocated because the property was sold, one will be sent in to RainWise because it has a short in the wiring, and one will need a new receiving base, but the owner is unresponsive.

Owners and farm managers learned about station maintenance and calibration methods during field visits. Follow up information was delivered via email. We wrote a Troubleshooting and Maintenance Guide, which was distributed during field visits and posted on the NEWA website,

under *About Weather Stations, Maintenance Guidelines* [newa.cornell.edu/index.php?page=maintenance-guidelines](http://newa.cornell.edu/index.php?page=maintenance-guidelines), and *Troubleshooting Guide* [newa.cornell.edu/index.php?page=weather-station-troubleshooting-guide](http://newa.cornell.edu/index.php?page=weather-station-troubleshooting-guide).

Automatic weather station outage messaging began in January 2014 and we have been pleased with the response from growers. Our weather station database has been updated with information gained from field visits. A global contact list for all the NEWA weather stations and collaborators was developed. A blog, *You're NEWA*, [blogs.cornell.edu/yourenewa/](http://blogs.cornell.edu/yourenewa/), was created and all NEWA contacts subscribed to it. Several blog posts have covered troubleshooting and maintenance. We also posted a blog for the workshops funded under this proposal, [blogs.cornell.edu/yourenewa/2015/02/11/weather-station-maintenance-workshops/](http://blogs.cornell.edu/yourenewa/2015/02/11/weather-station-maintenance-workshops/).

The workshops on weather station maintenance, troubleshooting and calibration techniques for weather station owners that were held in February 2015, *Improving the Reliability of your Weather Station*, in Geneva and Highland, NY included a weather instrument for hands-on use to learn about how to troubleshoot weather station issues. RainWise Inc. participated via Skype link during a Q&A segment. The full agenda is on the last page of this report.

### Workshop Evaluation results

Based on our Qualtrics survey evaluations, the workshops were successful in informing attendees about weather station maintenance and troubleshooting. Number attending in Geneva = 21, in Highland = 9; total 30. Eighteen people responded to the workshop evaluation, 60%. 11 (52%) from the Geneva workshop, 7 (78%) from the Highland workshop. We found there was considerable change in their knowledge as a result of the workshop (Fig 1) and attendees were

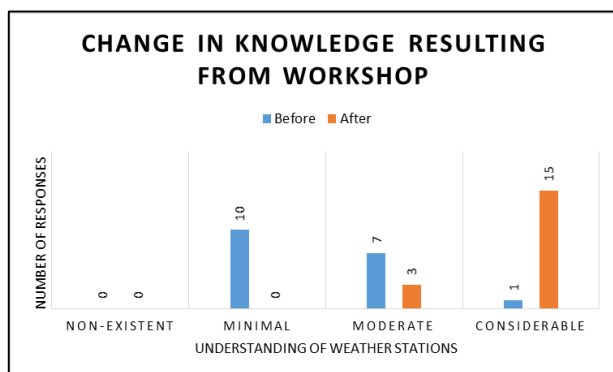


Figure 1. Knowledge change – before / after the workshop on weather station maintenance and troubleshooting.

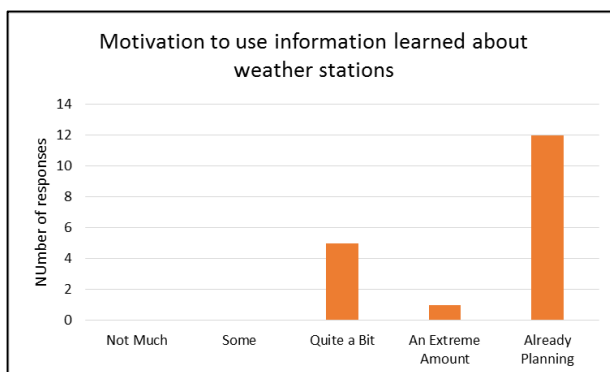


Figure 2. How motivated are you to use the information presented during the workshop about weather station?

highly motivated to utilize the information they had learned about weather stations (Fig 2). The workshop was effective in improving their understanding about the importance of routine maintenance, such that they would NOW DO DIFFERENTLY the following:

Responses	Change in behavior
15	Routinely, at least once per year, clean the rain gage, inspect all sensors and connections on the weather instrument and on the IP-100.
13	Periodically check the weather station battery voltage on RainwiseNet.
10	Check my weather data on RainwiseNet and NEWA for data gaps.
10	Have the weather station calibrated by Rainwise every two years.
8	Check my weather data on RainwiseNet and NEWA for errors in the data, such as in relative humidity, in order to know when to replace sensors.
0	None of the above, I already do these things.

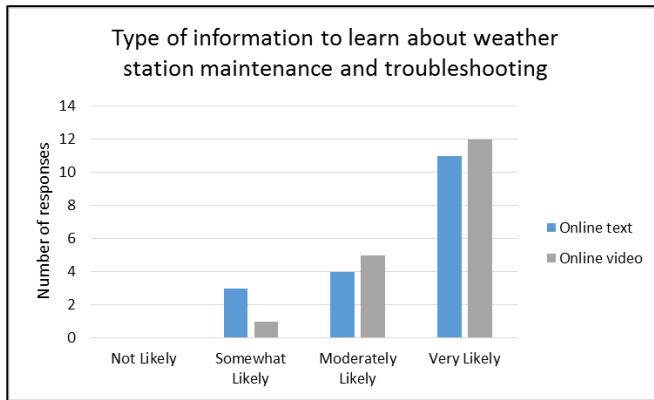
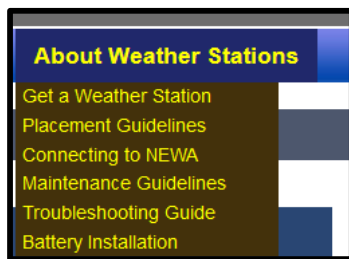


Figure 3. The likelihood of using online written or online video information to learn about weather station maintenance and

Because information delivery is primarily via the Internet, it was reassuring that those attending responded they would access information in this manner (Fig. 3).

Valued parts of the workshop were the Skype question and answer session with Rainwise Technical Support; the slide presentation about common maintenance issues, data transmission, and RainwiseNet settings; the demonstration of the weather station being taken apart; and the video of Rainwise Technical Support taking apart a weather station.

Other comments supported the need to conduct additional trainings on using NEWA tools. Therefore, two workshops were conducted on using NEWA tools for apple and for grape growers during the Hudson Valley Winter Fruit School and another will be done in the Lake Champlain region (it was cancelled due to the early spring in 2016).



The NEWA website ([newa.cornell.edu](http://newa.cornell.edu)) main menu under, *About Weather Stations*, now has links to the revised Maintenance Guidelines, the new Troubleshooting Guide and Battery Installation. See screen shot at left.

One person told Carroll the 2015 season had the best weather station performance in the Wayne County area they had seen.

*(2) Improve the accuracy and user experience of the apple models.*

We developed and prioritized a list of improvements to the apple tools on NEWA. Because of Robinson’s leave of absence, the apple phenology model using chilling and heat units to clock apple development was tabled until his return. Nonetheless, we did establish consensus on the base temperature to employ and to use this tool in all the crop management and IPM tools that require apple growth stage. Therefore, we are confident we will be able to develop the apple phenology tool in the future. Our top priority was to reinstate the degree day calculator, then to upgrade the six apple insect tools and build a new San Jose scale model, and finally to upgrade the apple disease tools. Improvements that were decided against included the upcoming pest events table for NEWA weather stations and the insect development graphs, which were overly complex, not only to develop but also to interpret by the end user. Carroll also investigated creating a web environment that can capture grower-entered information specific to their farm computer IP address, such as green tip date, first blossom open date, and petal fall date. Although feasible, this enhanced function of NEWA will require significant website revisions and will be incorporated into a system-wide upgrade.

The NEWA Degree Day Calculator was reinstated and provides an easy way to calculate the accumulated degree days for a desired date range for any base temperature used in NEWA tools. The results also show the degree day value for each day in the 5-day forecast window and a chart of degree day progression for the chosen date range, which includes the forecasted data. This new tool is now available at [newa.cornell.edu/index.php?page=degree-day-calculator](http://newa.cornell.edu/index.php?page=degree-day-calculator).

Because apple insects are the top priority of the ARDP we focused our efforts on the apple insect models in NEWA that inform IPM intervention for codling moth, oriental fruit moth, obliquebanded leafroller, plum curculio, spotted tentiform leafminer, and apple maggot, improving these with degree day forecasts for five days into the future and developing a new tool for San Jose scale. The insect tools now include a table of the insect developmental base temperature daily degree day accumulation forecast for five days into the future. Agnello revised the text for the insect tools to also cover the degree day forecasts that are now displayed. He also developed the NEWA tool for San Jose scale management. These insect tools include insect development status and pest management messages that change as the degree days accumulate from biofix. The improved and new apple insect tools are now available at [newa.cornell.edu/index.php?page=apple-insects](http://newa.cornell.edu/index.php?page=apple-insects) and are easily accessed from the NEWA main menu under Pest Forecasts, Apple Insects.

The apple scab, fire blight and sooty blotch and flyspeck tools are now showing the weather forecasts for wetting events including rain, humidity, and leaf wetness. Cox and Carroll investigated and developed logic for incorporating ascospore release and depletion predictions to enhance the apple scab tool. Cox investigated revisions to the sooty blotch and flyspeck model and has written improvements to the fire blight model, based on Alan Biggs' Maryblyt model to calculate epiphytic inoculum potential (EIP). These model improvements are slated for the near future and will be validated prior to full implementation in 2017.

### **Outcomes and Benefits**

The Network for Environment and Weather Applications, [newa.cornell.edu](http://newa.cornell.edu), has a proven track record for providing grower benefits and outcomes that include improved IPM practice, reduced environmental impact, and improved crop yield and quality. This is particularly true for apple production, as there are now 13 apple-specific IPM and crop production forecast models implemented in NEWA (apple scab infection events, apple scab ascospore maturity, fire blight, sooty blotch & flyspeck, obliquebanded leafroller, spotted tentiform leafminer, codling moth, plum curculio, oriental fruit moth, apple maggot, San Jose scale, apple irrigation, and apple carbohydrate thinning.)

What farmers say about NEWA: “The orchard was largely scab-free for the first time in several years. The orchard manager depended heavily on NEWA and could see significant differences between the on-site station and the one we had been using” and “I use the NEWA site almost every day early in the season.” In a survey on the economic impact of NEWA, conducted in 2007, we found that an average grower can save \$19,500 per year in spray costs and prevent \$264,000 per year in crop loss as a direct result of using the NEWA IPM forecast models. 99.2% of NEWA users would recommend NEWA to farmers.

### **Conclusions**

This project built grower expertise in weather station maintenance within the NEWA system and achieved improvements to the apple insect, disease and degree day tools on NEWA. We also developed a detailed plan for additional improvements to the apple scab, fire blight and sooty blotch and flyspeck tools. While we were unable to implement the apple phenology chilling and heat unit tools, we have established consensus on how to proceed with these models in the future. These outcomes will ultimately contribute to the economic success and IPM practices of apple growers using the NEWA IPM forecast models.