

A. Grant Data

- Category: *Northeast Regional IPM Competitive Grants Program (RIPM)*
- Title: Promoting Apple IPM Implementation in Eastern New York Orchards by Expansion of the Northeast Weather Association System
- Project Director: Juliet E. Carroll, Senior Extension Associate, Cornell University, NYS IPM Program, 630 W. North St., Geneva, NY 14456-0462, 315-787-2430, 315-787-2360, jec3@cornell.edu
- Team members:

Michael J. Fargione, Senior Resource Educator, Hudson Valley Fruit Program, Cornell University

Kevin A. Iungerman, Extension Associate, NE NY Fruit Program, Cornell University

Cheryl TenEyck, Programmer/Analyst, NYS IPM Program, Cornell University

John Gibbons, Extension Community Educator, Ontario County Cornell Cooperative Extension, Cornell University

Derrick Doubrava, Apple Grower, Minard Farms

David Fraleigh, Apple Grower, Fraleigh's Rose Hill Farm

Donald Green III, Apple Grower, Chazy Orchards, Inc.

Kevin Bowman, Apple Grower, Bowman Orchards

Jim Abbruzzese, Apple Grower, Altamont Orchards

William Truncali, Apple Grower, Truncali Farms

Will Gunnison, Apple Grower, Gunnison's Orchard

David Sullivan, Apple Grower, Sullivan's Orchard

Fred Sherrington, Apple Grower, Smith Farms, LLC

- State(s) involved: New York
- Grant #: 2004-41530-01856
- Year the grant was awarded: 2004
- Length of grant (note any extensions): 2 years and 1 year extension
- Funding amount: \$15,000

B. Nontechnical Summary. To conduct integrated pest management (IPM) for eight major pests, apple growers must use weather-based pest forecast models. The NYS IPM Program's Network for Environment and Weather Awareness (NEWA) provides pest forecast models for free, fostering IPM implementation, environmental conservation, and land stewardship. To expand NEWA into Eastern NY, four growers purchased weather stations, connected to NEWA, and served as grower educators to promote IPM implementation and the sustainability of apple production in their region. In this critical steps project cooperating growers learned about NEWA and pest forecast models to improve their IPM practices. The outreach plan targeted all other apple growers in Eastern NY who can benefit from the expansion of NEWA into their region. The NEWA system was upgraded to deploy the oriental fruit moth model and to use a weather database to improve data collection and web delivery. The project was evaluated through feedback during the growing season and grower satisfaction with the NEWA system. Because current apple IPM practices require the use of pest forecast models and not every grower has a weather station, the advantages of the NEWA system's instantaneous outreach potential to all growers in Eastern NY are considerable.

C. Introduction. The importance of the apple crop to New York agriculture is significant. New York is the second largest producer of apples in the USA, having a market value of \$170 million in 2005. On Eastern NY's 175 fruit farms, 13,000 acres of apples are grown. This project partnered with four of these Eastern NY farms with 795 acres of apples to expand NEWA into the region where it was previously unavailable. This expansion was crucial because, to conduct IPM for eight major direct and indirect pests, apple growers must use weather-based pest forecast models. NEWA provides pest forecast models for free, fostering IPM implementation, environmental conservation, and land stewardship.

The insects and diseases of apples for which NEWA provides forecast models include codling moth, obliquebanded leafroller, oriental fruit moth, plum curculio, San Jose scale, spotted tentiform leafminer, fire blight, and apple scab, all of which can be delivered via NEWA to growers and their advisors. Apple pesticide programs are targeted specifically to manage these pests and implementing NEWA pest forecast models enhances IPM practices to minimize pesticide inputs.

The project also received support from a Northeast SARE Partnership grant, allowing five additional apple growers with 1200 acres to connect weather stations to NEWA and deploy apple IPM pest forecast models. The commitment of two Commercial Tree Fruit Extension Educators and these initial five growers laid the foundation for the growers funded under this grant. The project was undertaken to enhance the ability of apple growers to conduct IPM and for Cooperative Extension Educators and Faculty to deliver timely IPM pest forecast information to growers in the region since the weather information collected via NEWA is freely shared via the Internet.

Beyond benefitting the local apple industry, NEWA weather data and pest forecast models benefit other commodities being grown in the regions that NEWA covers. The Eastern NY NEWA weather data and pest forecast models are available via the Internet to all growers throughout Eastern NY and the adjacent areas of VT, MA, CT and Quebec. NEWA pest forecasts exist for grapes, onions, potatoes, tomatoes, and sweet corn, in addition to apples. Weather data is utilized to calculate growing degree days, evapotranspiration, and drought index. Winter temperatures are tracked by NEWA to address chilling requirements and cold hardiness concerns in perennial crops such as tree fruit and grapes. NEWA weather data has high utility for agriculture in New York.

To maximize the utility of the collected weather data, this project allowed us to modernize and update the NEWA system, including sourcing a new weather station manufacturer, upgrading to database format, improving web pages and creating a new web-based apple insect pest forecast model.

D. Objectives. Restate your project objectives. After each objective, provide a brief (1-3 sentence) narrative about whether you've achieved it; if it was modified, mention how.

1. Expand NEWA with at least four, grower-owned, weather stations located in Eastern NY apple orchards to collect weather data and disseminate IPM pest forecast model information via NEWA to the apple industry in Eastern NY.

Four growers were set up with weather stations. Two have connections established with NEWA and the other two will connect their weather stations at the end of the apple growing season. The data from the weather stations is run through all the pest forecast models and posted on the NEWA website. We have successfully expanded NEWA into Eastern NY.

- Educate apple growers on using NEWA, weather stations, sourcing weather data, and integrating weather data with scouting and monitoring to improve IPM practices.

Growers were supplied with insect pheromone traps and information about collecting insect and tree phenology information for pest forecast model biofix dates. Biofix dates provide the starting point for most pest forecast models. Talks were presented at winter fruit schools and newsletter articles were written by Carroll, Extension Educators and Faculty covering NEWA pest forecast models that sourced the weather data from the Eastern NY NEWA locations.

- Upgrade NEWA to a database system to enhance web output and flexibility in deploying pest models and deploy the oriental fruit moth degree-day model developed by Dr. Larry Hull, Department of Entomology, Pennsylvania State University.

NEWA data was compiled into a database maintained by Robert Seem’s Plant Pathology research program. The oriental fruit moth degree-day model output was incorporated into a novel apple insect pest forecast utility called the Apple Pest Degree Day Calculator. This calculator greatly enhances insect pest forecast model outputs for apple growers, Extension educators and faculty. Apple disease forecast model web pages were also improved.

E. Approach.

Under Objective 1 – Our approach was to install a weather station on each apple growers’ farm and connect it to the NEWA system. The weather stations record hourly data on precipitation (inches), temperature (F), dew point temperature (F), relative humidity (%), leaf wetness (minutes wet), solar radiation (J/m²), and wind speed (mph). The data is collected by NEWA via modem or FTP transfer one to four times per day and uploaded to weather charts and pest forecast models on the NEWA website, <http://newa.nysaes.cornell.edu>.

NEWA pest forecast models and weather data became available in Eastern NY in 2005. The number of locations with NEWA weather stations continued to increase in 2006 and 2007. In year one and two, with funding from a grant from NE SARE, five weather stations were connected to NEWA (Table 1).

Table 1. Apple growers participating in the NE SARE Partnership grant, their location and the NEWA webpage for their weather station.

Apple Grower	Farm Name	NY Location	NEWA Web Page
Jim Abbruzzese	Altamont Orchards	Guilderland	http://newa.nysaes.cornell.edu/guilder.htm
Kevin Bowman	Bowman Orchards	Clifton Park	http://newa.nysaes.cornell.edu/clifton.htm
Derrick Doubrava	Minard Farms	Clintondale	http://newa.nysaes.cornell.edu/clinton.htm
David Fraleigh	Rose Hill Farm	Red Hook	http://newa.nysaes.cornell.edu/redhook.htm
Donald Green III	Chazy Orchards, Inc.	Chazy	http://newa.nysaes.cornell.edu/chazy.htm

In years two and three of the project, four growers purchased weather stations and two are now connected to NEWA (Table 2).

Table 2. Apple growers participating in the NE RIPM Critical Steps grant, their location and the NEWA webpage for their weather station.

Apple Grower	Farm Name	NY Location	NEWA Web Page
Will Gunnison	Gunnison’s Orchards	Crown Point	To be connected this fall
Fred Sherrington	Smith Farms	Hudson	http://newa.nysaes.cornell.edu/hudson.htm
David Sullivan	Sullivan’s Orchards	Peru	To be connected this fall
William Truncali	Truncali Farms	Marlboro	http://newa.nysaes.cornell.edu/marlboro.htm

Progress on this objective proved slow due to the phase out of Sensor/Sensatronics weather stations with which the NEWA network was built. We had to source another supplier of weather stations, compatible with agricultural applications and of low cost. RainWise Inc., weather station manufacturer, developed a consumer line of weather stations for the NEWA system that include a leaf wetness sensor and compatible software. Growers were trained in the use and application of the NEWA weather network to apple IPM.

In April 2007, Wayne Burnett, RainWise Inc., toured all the RainWise weather station installations and potential sites. During this tour, station siting and data transmission issues were resolved. RainWise weather stations are now interfacing with NEWA with little to no interruptions.

Under Objective 2 – Fargione, Iungerman, and Carroll gave talks about NEWA at winter fruit schools, summer field, and grower advisory meetings. NEWA information was used by faculty in entomology and plant pathology and by Extension educators for newsletter articles.

The weather station data was utilized to drive pest forecast models for apples (and for other crops). Cooperating apple growers were provided with insect traps and lures to collect biofix dates for codling moth, oriental fruit moth, spotted tentiform leafminer, and obliquebanded leafroller. Growers were also instructed on the collection of apple growth stages for setting biofix dates, including 50% green tip, first blossom open, and petal fall. Biofix dates mark the date to begin the pest forecast models.

Growers, Extension educators and faculty, and consultants sent biofix dates to Carroll for posting online in the Apple Pest Biofix Table at http://nysipm.cornell.edu/fruits/apple_biofix/default.asp. Growers could also refer to the historical biofix information online (Table 3) or in the Cornell Pest Management Guidelines for Tree Fruit Production.

Table 3. Historical approximate biofix dates for New York based on over 20 years of observations at the NYSAES, Cornell University, Geneva.

Pest	Biofix Date	Biofix
Codling Moth	May 19	First sustained trap catch of 1 st generation
Oriental Fruit Moth	May 2	First sustained trap catch of 1 st generation
Obliquebanded Leafroller	June 10	First sustained trap catch of 1 st summer generation
Plum Curculio	May 18	Petal fall (McIntosh)
San Jose Scale	March 1	March 1 st
Spotted Tentiform Leafminer	June 15	First sustained trap catch of 2 nd generation
Apple Maggot	January 1	January 1 st

Under Objective 3 – To upgrade the NEWA system, we continued to use a weather database created with NEWA weather data by Robert Seem’s Lab, Department of Plant Pathology, Cornell University. Two programmers were engaged to create three NEWA weather data utilities using this database, a Spectrum Data Conversion utility, the Degree Day Calculator, and the Apple Pest Degree Day Calculator.

SpecWare software runs several apple pest forecast models, but requires a specific data format. The Specware Compatible Data utility converts NEWA data into a format compatible to run on the user’s computer in their SpecWare software. It is online at <http://www.nysaes.cornell.edu/ipm/specware/nysaesQuery.html>.

The Degree Day Calculator calculates accumulated degree days for base 32, 40, 41, 43, 45, 48, 50, and 55 degrees Fahrenheit for any location in the NEWA network and any year. A table lists the locations and the dates of operation. Missing data, if any, is noted in the Calculator results (Fig 1). It is online at <http://www.nysaes.cornell.edu/ipm/specware/newa/>. Information from this Calculator is routinely included in the Scaffolds newsletter published by Arthur Agnello, Department of Entomology.

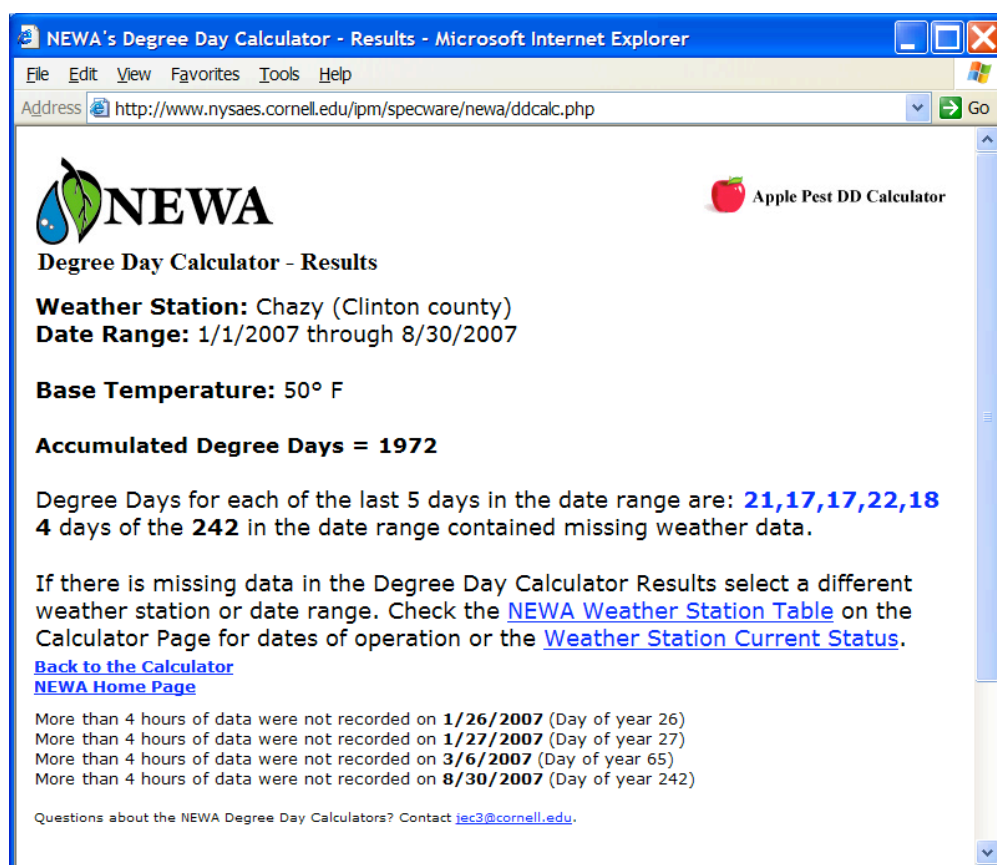


Figure 1. Output from the NEWA Degree Day Calculator for accumulated growing degree days (base 50 F) for Chazy, NY from January 1 to August 30, 2007.

The Apple Pest Degree Day Calculator performs similar to a mini-expert system and was created with Arthur Agnello and Harvey Reissig, Department of Entomology. This approach was taken

because essentially all the insect pest decision support models are based on the accumulation of degree days. In this Calculator users choose the insect pest (codling moth, oriental fruit moth, obliquebanded leafroller, plum curculio, San Jose scale, spotted tentiform leafminer, or apple maggot) and confirm the biofix date (default is the historical biofix, that listed on the apple pest biofix table, or their own) and then calculate. The Apple Pest Calculator returns an IPM message for the degree days accumulation to the current day (Fig 2).

NEWA
Apple Pest Degree Day Calculator - Results

Weather Station: Chazy (Clinton county)
Date Range: 1/1/2007 through 08/30/2007

Base Temperature: 50° F
Apple Maggot
Threshold is 890

Accumulated Degree Days = 1972
Degree Days for each of the last 5 days in the date range are: **21,17,17,22,18**
4 days of the **242** in the date range contained missing weather data.

If there is missing data in the Apple Pest DD Calculator Results select a different weather station. Check the [NEWA Weather Station Table](#) for dates of operation or the [Weather Station Current Status](#).

Threshold reached: Threshold of 890 DD50 has been reached. Apple maggot adults should be monitored with red sphere traps as described on the [Apple Maggot Monitoring Form](#). Continue monitoring until the last opportunity for a protective spray has passed, according to the appropriate PHI.

REFERENCES:
Reissig, W. H., J. Barnard, R. W. Weires, E. H. Glass, and R. W. Dean. 1979. Prediction of apple maggot fly emergence from thermal unit accumulation. Environ. Entomol. 8: 51-54.

[Back to the Apple DD Calculator](#)
[NEWA Apple Home Page](#)

More than 4 hours of data were not recorded on **1/26/2007** (Day of year 26)
More than 4 hours of data were not recorded on **1/27/2007** (Day of year 27)
More than 4 hours of data were not recorded on **3/6/2007** (Day of year 65)
More than 4 hours of data were not recorded on **8/30/2007** (Day of year 242)

Questions about the NEWA Degree Day Calculators? Contact jec3@cornell.edu.

Figure 2. Output from the NEWA Apple Pest Degree Day Calculator for apple maggot for Chazy, NY queried on August 30, 2007.

Links to this Calculator are routinely included in the Scaffolds newsletter that Arthur Agnello

publishes weekly during the growing season. The Apple Pest Calculator goes dormant on November 1 and resumes on March 1, each year.

Given the delicacy of a database transition, we contracted with Spider Graphics Corp., Ithaca, NY to develop a detailed conceptual plan for the complex NEWA data and web content. Carroll created a 19-member committee of farmers, consultants, food industry personnel, Extension educators and faculty that worked on the plan with Spider Graphics over a series of four, half-day meetings. This 30-page plan was shared with the leadership of the NYS IPM Program and NEWA committee members (Fig 3).

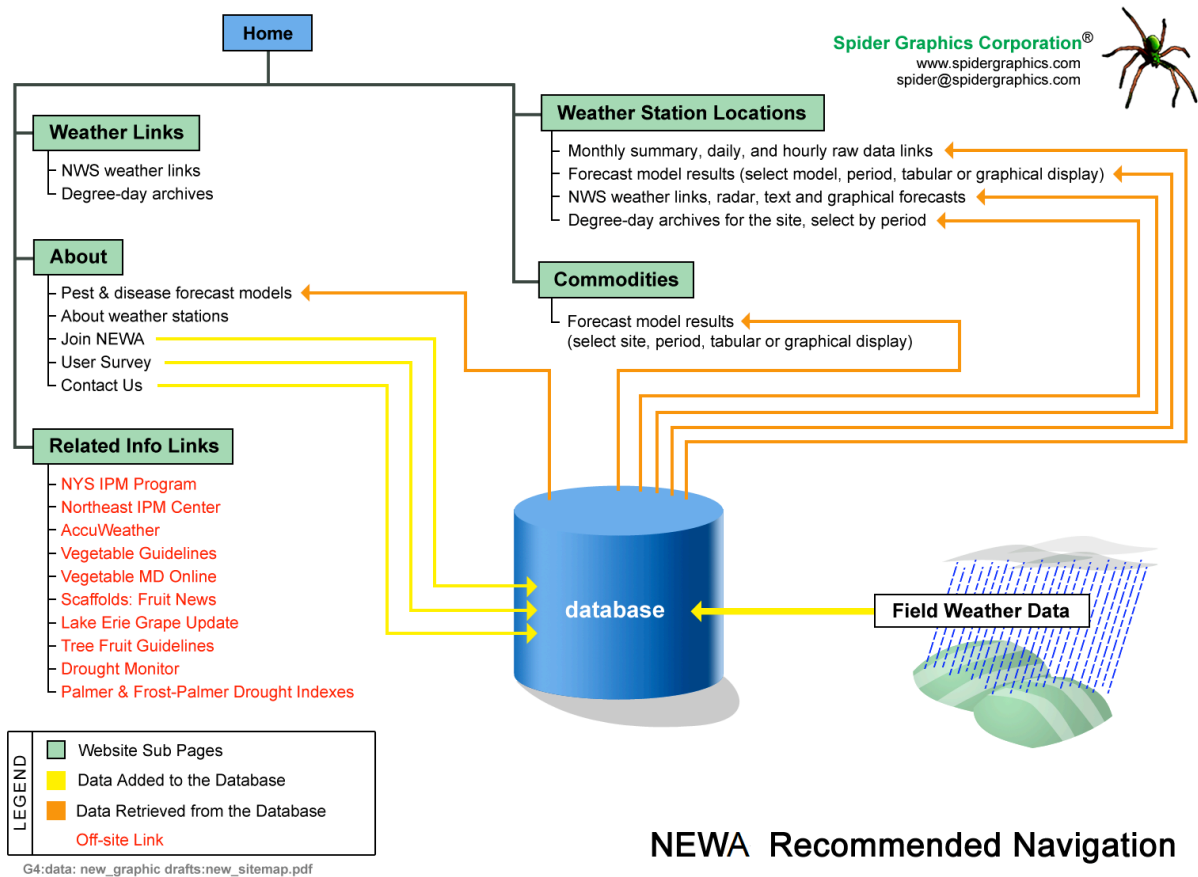


Figure 3. Spider Graphics recommended navigation plan for NEWA web site.

F. Progress. See under Results; this is a final report.

G. Results. Provide a brief explanation of your results *in 1-2 paragraphs*. Include a discussion of any unexpected events that seem noteworthy.

We successfully expanded NEWA into Eastern NY with nine new stations in seven counties and demonstrated that it is possible to rely on farmers to operate and maintain the weather stations and associated software with “distance” support. The support of RainWise staff in assisting

NEWA during the difficult “hardware transition” phase was invaluable. NEWA can now offer two weather station options at reasonable prices to farmers and the agricultural industry. FTP data delivery software was developed and perfected so that NEWA will be capable of downloading weather data in nearly real time from weather stations hundreds of miles away.

Apple growers learned about pest forecast models, pest biofix data collection, and improved their knowledge of computer and web-based technology. Of greatest utility in Eastern NY were forecast models for obliquebanded leafroller, apple maggot, and fire blight. Constant vigilance for apple scab infection periods continued to be high on the list. The most popular innovations in NEWA pest forecast models were the two degree day calculators. Spider Graphics engaged the NEWA Committee and leadership in discussions of a ground-breaking nature that have paved the way for continued expansion and improvement of the network and its web-based IPM pest forecast models.

Did this grant serve as seed money for obtaining additional, related grants? If so, please describe.

Yes.

The following grants were secured:

Impact of the NYS IPM Program’s Network for Environment and Weather Awareness (NEWA) on Agricultural Production. NYS IPM Program, Special Project. Carroll, J.E. \$ 12,000.
Northeast Regional Climate Center weather database collaboration with the NYS IPM Program Network for Environment & Weather Awareness. NYS IPM Program, Special Project. Carroll, J.E., Gibbons, J., TenEyck, C., Petzoldt, C., Weigle, T. \$3,000.

The following grants have been submitted:

Pesticide Management for High Value Crops. NRCS, Conservation Innovation Grants. Winnett, R.G. \$41,000.
Improved Late Blight Forecasting – The Roles of Weather, Inoculum, Host Resistance, and Fungicide. HATCH. Fry, W.E. \$60,000.
Development of Enhanced, Web-Based Cornell Tree Fruit Pest Management Guidelines. NYFVI, Extension Innovations. Reissig, W.H., Agnello, A., Carroll, J., and Cox, K. \$211,281.

H. Impacts. Describe and assess the impacts of your work. This section of your report will help the Northeastern IPM Center highlight the value of IPM research and education and the real-world impacts of funded projects. We will use the information in news articles and reports to showcase the worthiness of projects that our program supports. Below are some questions that will guide you in assessing the impacts of your project. The relevance of each question may vary depending on whether yours is a research or extension project. Please answer as many as you can to the best of your ability, and feel free to discuss any impacts not mentioned below.

1. Safeguarding human health and the environment:

- a. Are there new IPM practices that have been or could be adopted as a direct result of your project? What is the total number of acres (or homes, schools, greenhouses, nurseries) on which these practices could be implemented?
- b. Has the project reduced risk (or could it potentially do so) by changing the use of pesticides on farms, or in homes, schools, etc.? For example, could it result in fewer

sprays per season or a switch to lower-risk pesticides? (Since there is no unanimous definition of *high* and *low risk*, investigators selecting this indicator are asked to categorize the pesticides they are reporting on as *high* or *low risk* according to the particular situation [e.g., lower risk to natural enemies]).

Yes, by changing the use of pesticides on farms. Use of NEWA pest forecast models can save growers, on average, one spray per season. In some seasons more, in some less. In all instances NEWA pest forecast models improve the timing of pesticide applications and therefore the economy of their use.

c. Are there any other impacts on human health or the environment as a result of your project?

2. *Economic benefits:*

a. What is (or could be) the economic benefit (e.g., dollars saved) for clientele who adopt IPM strategies and systems you studied? Do you envision potential commercialization or mass production of these systems?

Pest forecast models and weather stations are already commercialized, but their adoption by growers has been poor due to high cost and steep learning curve.

A recent survey on NEWA was conducted. On average, apple growers using NEWA save up to \$19,500 per year on their spray bill. Through the use of NEWA pest forecast models, apple growers prevent, on average, up to \$250,000 in crop loss per year. The apple industry makes up the largest group of farmers, consultants, and Extension personnel who are actively using NEWA.

b. How many IPM personnel might be employed as a result of your work? (e.g., private consulting services, nursery operators, food service growers)

c. How many clients are satisfied with IPM results (such as improved yield, quality of yield, reduced pest populations, more effective pest control, greater preservation of nonpest species)?

Overall, all the growers participating on this project were satisfied with the results.

Weather stations did pose hardware and software problems and caused period of frustration for collaborators.

d. Are there other financial benefits that might be realized as a result of your project? Growers with weather stations better qualify for market certification protocols such as EcoApple, Eurpegap, IPM, etc.

3. *Implementation of IPM:*

a. How many IPM strategies and systems have been validated through this project (e.g., through on-farm trials, large plot tests, and other methods used to confirm efficacy)?

b. How many educational materials were delivered? To whom?

Information on hanging insect pheromone traps, traps, and lures were delivered yearly to participating growers.

c. What is the number of growers/personnel trained?

10 one-on-one

600 during presentations.

d. For a website, what volume of traffic and type of use has the site experienced? (For example, # visitors per day/month; # page views; # of unique user sessions; change in volume during growing season; average viewing time)

See NEWA Annual Report appendices. This data has not been split out for individual apple pest forecast pages. NEWA website use has about doubled from 2004 (66,139 hits) to 2006 (119,666 hits).

- e. How many more people adopted IPM practices as a direct result of your project, or how many people adopted new IPM practices?
- f. Are there other ways in which your work will result in improved use or increased implementation of IPM strategies in your region or across the Northeast?

4. Has your project or study enhanced collaboration among stakeholders interested in the development and implementation of improved IPM strategies and systems? (For example, number of growers or other types of stakeholders that have participated in advisory committees, surveys)

I. Appendices. Please attach to your report any of the following that will enhance our understanding of your project and its impacts:

See attached materials.

Web pages and url's:

Title	url
NEWA Home Page	http://newa.nysaes.cornell.edu/default.htm
Apple Home Page	http://newa.nysaes.cornell.edu/apple_home.htm
Degree Day Calculator	http://www.nysaes.cornell.edu/ipm/specware/newa/index.html
Apple Pest Degree Day Calculator	http://www.nysaes.cornell.edu/ipm/specware/newa/appledd.php
SpecWare data conversion tool	http://www.nysaes.cornell.edu/ipm/specware/nysaesQuery.html
Apple Leaf Wetness Periods	http://newa.nysaes.cornell.edu/apples/applefor.htm
NYS IPM Program NEWA page	http://nysipm.cornell.edu/newa/default.asp
Apple Pest Biofix Table	http://nysipm.cornell.edu/fruits/apple_biofix/default.asp

Presentations:

- IPM for Tree Fruit Using Predictive Models & the NEWA Weather Reporting System, Hudson Valley Fruit School, Kingston, NY, February, 2004.
- NEWA Weather & Apple Forecasting Project, Petal Fall Meeting, Clifton Park, NY, May, 2004.
- Apple forecasts on NEWA, Petal Fall Meeting, Appleton, NY, May, 2004.
- NEWA-IPM's Network of Weather Stations, National Association of County Agricultural Agents, Geneva, NY (NYSAES), July 2005.
- NEWA – New York's Network for Environment & Weather Awareness, Weather & IPM Conference, East Lansing, MI, October 2005.
- Utilizing NEWA Information to Inform IPM Intervention, Hudson Valley Fruit School, Kingston, NY, February 2006.
- Utilizing NEWA Information for Informed IPM Intervention, NE NY Fruit School, Lake George, NY, March 2006.
- Utilizing NEWA Weather Information for Informed IPM Intervention, New England, New York & Canada Fruit Pest Management Meeting, Burlington, VT, October, 2006
- Weather Stations for NEWA, 2007 Fruit Field Day, NYSAES, Cornell University, Geneva, NY, July 2007.

Publications:

- Gibbons, J., Carroll, J., TenEyck, C., Petzoldt, C. and Weigle, T. 2007. NEWA (Network for Environment and Weather Awareness) 2006: A Year in Review. 2006 NYS Fruit Project Reports, Cornell, NYS IPM Program, pp 118-123.
- Carroll, J., Fargione, M. and Iungerman, K. 2006. Delivering weather-related information to apple growers via the NYS IPM Program's NEWA system. 5th National Integrated Pest Management Symposium, St. Louis, MO.
<http://www.ipmcenters.org/IPMsymposiumV/posters/006.pdf>.
- Gibbons, J., Carroll, J., TenEyck, C., Petzoldt, C.P. and Weigle, T. 2006. NEWA (Network for Environment and Weather Awareness) 2005: A Year in Review. In: Annual Report 2005-2006, New York State Integrated Pest Management Program, Agriculture and Community IPM, Cornell University. NYS IPM Publication No. 503: 136-140.
- Gibbons, J., Carroll, J., TenEyck, C., Petzoldt, C.P. and Weigle, T. 2005. NEWA (Northeast Weather Association) 2004: A Year in Review. In: Annual Report 2004-2005, The New York State Integrated Pest Management Program, Agriculture and Community IPM, Cornell University. 6 pp. http://nysipm.cornell.edu/reports/ann_rpt/AR05/projects/gibbons.pdf.