PROJECT SUMMARY

Instructions:
The summary is limited to 250 words. The names and affiliated organizations of all Project Directors/Principal Investigators (PD/PI) should be listed in addition to the title of the project. The summary should be a self-contained, specific description of the activity to be undertaken and should focus on: overall project goal(s) and supporting objectives; plans to accomplish project goal(s); and relevance of the project to the goals of the program. The importance of a concise, informative Project Summary cannot be overemphasized.

Title: Handheld Mobile Application Technology For Pest Identification And Scouting In Christmas Tree And Conifer Nursery Production

PD: Lamb, E.	**Institution:** Cornell University
CO-PD: Eshenaur, B.	**Institution:** Cornell University
CO-PD: PD/PI 3 Name (Last, First, MI)	**Institution:**
CO-PD: PD/PI 4 Name (Last, First, MI)	**Institution:**
CO-PD: PD/PI 5 Name (Last, First, MI)	**Institution:**
CO-PD: PD/PI 6 Name (Last, First, MI)	**Institution:**
CO-PD: PD/PI 7 Name (Last, First, MI)	**Institution:**

This project is an Extension project.

Pest identification and scouting are the backbone of good integrated pest management. Many conifer nursery and Christmas tree producers scout their crops, but availability of pest identification information, and tools for record keeping to measure the effects of control methods would help them reduce unnecessary pesticide applications. Providing these tools in a device they are already carrying into their fields, their phones, would encourage the use of pest id and scouting. In this project, we will create and demonstrate an application for mobile hand-held devices to assist growers in identification of insect, disease and weed pests of conifers, and in compiling and recording scouting data. Growers will participate in the development of the application as an advisory committee, evaluating the application on their farms. The application is designed to be useful for conifer producers throughout the NE region and participation by all states will be encouraged through training events held in conjunction with state Christmas tree and nursery organizations' education sessions. The project will evaluate the level of adoption of the application, increase in adoption of IPM, and the potential for use of the application to result in better pest management and economic benefits, through surveys at training events and after growers have had a chance to trial it, in order to measure knowledge and action impacts. Additional media outreach will extend the information to a national audience. The overall goal of the project is to reduce unnecessary pesticide applications, with the concurrent reduction in human health and environmental risks.

Handheld Mobile Application Technology for Pest Identification and Scouting in Christmas Tree and Conifer Nursery Production

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Definitions:

Conifers are defined by the USDA as cone-bearing trees and plants which retain their needle-like or scale-like leaves year-round, such as arborvitae, cedar, fir, pine, and spruce; including balled and burlapped Christmas trees. Christmas trees grown for cutting are not included in this category.

Mobile application or app is a program written for a handheld device such as a mobile phone or iPad that provides information in the form of text and photographs.

Problem statement:
Pest identification and scouting are the backbone of good integrated pest management. Many nursery and Christmas tree producers scout their crops, but availability of pest identification information and tools for record keeping to measure the effects of control methods would help them reduce unnecessary pesticide applications. Providing these tools in a device they are already carrying into their fields, their phones, would encourage the use of pest id and scouting.

The production of conifers in nurseries and on Christmas tree plantations has a significant economic value to the region. Available USDA statistics for the NE are provided in the following tables. Insects, diseases, and weeds cause significant losses in production and result in pesticides being a major production cost. (Crop profiles for Pennsylvania Christmas trees and New York Ornamental Plants http://www.northeastipm.org/ipm-planning/crop-profiles/crop-profiles-by-crop/)

2006 USDA Nursery Crops Summary (operations with $10,000 + in sales)

State	Nursery conifer sales ($1000)	Christmas tree sales ($1000)	Number of conifer producers	Christmas tree producers	Christmas tree production
CT	20,580	1,509	23	48	1,594 acres
NJ	34,670	544	101	50	1,042 acres
NY	12,129	2,532	65	107	5,431 acres
PA	34,054	17,290	105	241	17,443 acres

http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1115

Scouting is already a frequently used IPM tactic. In Pennsylvania, 95% of nursery and floriculture producers reported scouting for pests while performing routine tasks (http://www.nass.usda.gov/Surveys/Guide_to_NASS_Surveys/Chemical_Use/index.asp). In NY, 63% and 85% respectively reported scouting their crops (2007, http://www.nysipm.cornell.edu/grantspgm/projects/proj07/default.asp#orn). However, 19% of NY Christmas tree growers still reported using the calendar to time their insecticide applications and only 45% reported recording their scouting results. Twenty-four percent of NY nursery growers reported scouting only when they have a pest problem.

Background:
Nursery and Christmas tree producers in the northeastern US have identified pest identification and integrated pest management as needs in a variety of sources. From the 2007 NYS IPM surveys, "Disease/Insect and weed ID led the "What would you like to learn more about?" category with 58% followed by IPM (53%)." for Christmas tree growers (150 responses), while for nursery producers (147 responses) "With 51%, disease/insect and weed ID led the "What would you like to learn more about?" category followed by IPM (41%) and biological control (39%)."

The New York Farm Viability Institute surveys producers regularly on industry opportunities and barriers. The 2011green industry report listed "Reduction of chemical use through predators, IPM, new spraying techniques, etc." as a current funding priority based on grower comments (http://nyfvi.org/default.aspx?PageID=2342). Their list of research and education

needs in production management for the NY nursery industry included several that relate to IPM (numbers are ranks of the needs with 1 as the most highly ranked need, highest need received 274 votes) (http://nyfvi.org/default.aspx?PageID=2345).

- Weed control research in both field and pot situations (1)
- Research into IPM and alternatives to chemicals (2)
- Insect pest management research (3)
- Implementation, management, evaluation of effectiveness, and fine tuning of IPM (12)
- Employee training in IPM practices (18)

In addition, the attached letter of support from the Christmas Tree Farmers Association of NY states "Anything we can do to support NYS Integrated Pest Management in identifying a number of insects and diseases that can impact Christmas tree production in NYS is a benefit to our tree farmers. Many of our members have shown interest in using smart phones, iPads, iPods, and other electronic devices as part of their farm operation in one manner or another."

Ongoing work by the project directors relevant to this project includes development of a hand-held mobile application for biocontrol and scouting in greenhouses funded by USDA-NIFA and a Christmas tree IPM manual funded by NE-IPM. The USDA biocontrol grant gives us the background to work with the developers of the application to create a tool that is easy to understand and useful to growers. The NE-IPM manual provides pest identification information and scouting calendars as a basis for the information to include in the application.

Justification:

Relationship to priorities identified for the NE-RIPM grant funds:

1.Will reduce risks to the environment.

2. Will reduce risks to human health.

Conifer production in the northeastern US frequently necessitates the use of chemical pesticides. However, by assisting growers in correctly identifying insect, disease and weed pests so that the pesticides applied are the correct ones, and by encouraging scouting and record keeping by growers so they can improve the timing of their applications and determine if they are effective, there is the potential for reduction in the use of pesticides, with the concurrent reduction in environmental risk. As applications of chemical pesticides are reduced, there will also be less exposure of the applicators to pesticides. Also, there will be fewer pesticide residues on the plants when consumers plant them in their landscapes or bring them into their homes.

3. Has stakeholder support and the priority has been cited.

Information on grower needs and stakeholder support is detailed in the Background section above. A letter of support from the Christmas Tree Farmers Association of NY is included in the appendices.

4. Focuses on a pest, crop, or setting found in at least five states or cropping regions.

Christmas trees and conifers are produced in all the states in the Northeastern Region (see USDA statistics above for Connecticut, New Jersey, Pennsylvania and New York). Most states in the NE have state Christmas tree associations. It is a bit more difficult to specify the number of conifer nurseries as conifers are usually included as part of the mix of species grown.

5. Will fill a niche.
While the number of applications for hand-held mobile devices is increasing rapidly, we have not seen any for pest identification and scouting in conifer production yet.

6. Involves multiple states in an active partnership.
This project involves specific involvement from personnel in New York State and Connecticut. We also have unofficial interest from participants in Pennsylvania and New Hampshire. We will continue to look for collaborators in other states in the NE-IPM region as the project progresses.

7. Will advance IPM implementation in a few years.
Because this project involves the development of a tool that utilizes existing information, the impacts should occur relatively rapidly. Within the time frame of the project, we expect to see some growers using the application for pest identification and scouting (action change) beyond the level of knowledge change. We should also be able to document changes in pesticide use by at least some of the early adopters within that time period.

8. Is interdisciplinary.
The personnel involved in this project come from a variety of disciplines. Brian Eshenaur is a plant pathologist. Richard Cowles is an entomologist. Elizabeth Lamb is a horticulturalist with a background in plant protection.

10. Has significant economic implications.
Conifer production in the region is economically significant as indicated in the Problem section. Losses due to insects, diseases, and weeds, and expenditures on preventative measures, such as pesticides, are more difficult to quantify but anecdotal information suggests they can be a major cost of production because of the importance of appearance in determining value of ornamental crops. While improved pest identification and scouting/record keeping will not alleviate the need for pesticides, it should help reduce unnecessary applications and therefore the cost of pest management.

13. Is likely to be adopted by the target audience.
As part of biocontrol app grant, we have been presenting the concept of a mobile device based application for pest management and scouting to growers. The level of interest has been very high, with one grower suggesting it would be reason enough to purchase a 'smart phone'. Based on conversations with Christmas tree growers, conifer producers will also find this tool useful.

Rationale for development of a mobile application to deliver information
The Pew Internet and American Life Project (based on internet use tracking and phone interviews of adults in the US) calculated that 82% of adults have cell phones and 29% have downloaded an app to their cell phone (http://pewinternet.org/Reports/2010/The-Rise-of-Apps-Culture/Overview.aspx). And as more growers get smartphones, applications relating to agriculture are becoming more prevalent, including weather, pest identification, tank mix and other calculations, and links to research (http://www.thisweekinag.com/article/agriculture-answering-call-smartphones).

Objectives:
1) Create a mobile application (app) for handheld devices using two major mobile phone platforms (iPhone, Android) that provides real-time on-demand information and management tools for identification of the primary Christmas tree and conifer nursery pests and collects and compiles growers' scouting data.

2) Demonstrate the use of the application to an advisory committee of Christmas tree and conifer nursery growers in the Northeast as an information management system and means of providing technical assistance on pest management. Update the application based on grower comments.

3) Extend the application information to a wider audience of Christmas tree and conifer growers in the Northeast and nation-wide.

Impacts:
Implementation of IPM

- 500 conifer growers throughout the NE region will be trained in the use of pest identification and scouting and the use of the application.
- 250 conifer growers from the NE region will report knowledge change based on training in the use of the application
- 100 conifer growers from the NE region will download the application
- 25 conifer growers from the NE region will report action change in pest management based on use of application – including changes in pesticide use

Economic benefits

- 100 conifer growers in the NE region will be satisfied with IPM results and more effective pest management based on use of the application

Safeguarding human health and the environment

- Unnecessary or inappropriate pesticide use on Christmas tree farms and in conifer nurseries in the NE will be reduced by 2 fewer applications on average.
- Pesticide exposure to applicators and pesticide residues on plants sold will be reduced (measuring this impact is outside the specifications of this project).

Logic model – Impacts of introducing a hand-held mobile application for pest identification and scouting on pest management in conifer production

Inputs	**Audience activities**	**Knowledge Change Impacts**	**Action Change Impacts**	**Condition Change Impacts**
Technology developed for mobile application Personnel for information collection, technology development and extension of technology and evaluation Growers to serve as advisory committee Organizational (Christmas tree and Nursery organizations), NYS IPM and University framework for demonstration and education Funding	*Audience* - Producers of conifers as nursery stock or as Christmas trees *Activities* Evaluation of app with advisory committee throughout growing season Demonstration of application to audiences at Christmas tree and nursery meetings throughout the region Partnerships with industry organizations Print/electronic resources through NYS IPM website Media outreach and trade journal articles	*Implementation of IPM* Increase audience awareness of pest identification, scouting and record keeping as IPM tactics Increase audience awareness of the use of the app to aid in pest identification, scouting and record keeping *Economic benefits* Increase audience awareness of the use of IPM to reduce pest management costs and improve pest management *Safeguarding human health and the environment* Increase audience awareness of the use of IPM to reduce pesticide use	*Implementation of IPM* Determine number of people downloading application Survey program participants on use of application and effects on improved pest identification, scouting and record keeping. *Economic benefits* Survey on changes in pest management and pesticide use based on use of application. *Safeguarding human health and the environment* Survey on changes in pest management and pesticide use based on use of application.	*Economic benefits* Extrapolate from survey results to determine cost savings due to reduced pesticide use and increased quality due to improved pest management *Safeguarding human health and the environment* Extrapolate from survey results on action change to determine likely reduction in pesticide exposure to applicators and reduced pesticide residues on plants sold

Approach and Procedures:

1) Create a mobile application (app) for handheld devices using two major mobile phone platforms (iPhone, Android) that provides real-time on-demand information and management tools for identification of the primary Christmas tree and conifer nursery pests and collects and compiles growers' scouting data.

- Work with an application development company to design and create a mobile application that works on the Apple and Android platforms. The application will allow growers to find insect, disease, and weed identification information and scouting information based on tree species or type of pest (see Figure 1 for a proposed schematic of page and information flow). The application will also allow growers to identify locations for scouting, input scouting counts, input pest management measures such as cultural or chemical controls, and create reports of pest numbers.
- PDs and collaborators will provide the technical information for pest identification and scouting methods

2) Demonstrate the use of the application to an advisory committee of Christmas tree and conifer nursery growers in the Northeast as an information management system and means of providing technical assistance on pest management. Update the application based on grower comments.

- PDs and cooperators will select a group of growers in northeastern states to act as an advisory committee for beta testing of the application.
- These growers will use the application for pest identification and scouting throughout a growing season to evaluate its utility and ease of use
- Changes based on grower comments will be incorporated into the application

3) Extend the application information to a wider audience of Christmas tree and conifer growers in the Northeast and nation-wide.

- PDs and cooperators will run training programs on the application at annual state or regional nursery and Christmas tree meetings, such as the Christmas Tree Farmers of NY winter meeting and statewide nursery and landscape association meetings
- Participants will be surveyed at the time for knowledge change and intent to use the application
- A sample of those who download the application will be surveyed to determine action change.
- PDs will promote the application through media outreach, including trade journals, to extend the information to a wider audience

Priorities for Extension projects

Research base

The information on which the application is built comes from researchers in the NE region. This includes pest identification, cultural and other control options, and scouting calendars and other scouting information.

Alliances built with stakeholders

Stakeholders are integral to the success of this project. Specific growers from the NE region will participate as an advisory committee to evaluate the application through use on their

own farms. State Christmas tree and nursery organizations will provide opportunities for PDs to train growers at their annual education sessions. Some organizations may also have newsletters or other means of media outreach available to the PDs. Keeping these organizations appraised of the progress of the project will encourage them to participate in it.

Wide-scale implementation of IPM methods

While the mobile phone application will be developed with the assistance of growers and Extension personnel in the Northeastern region, their scouting needs are very similar to those of conifer growers around the country. Therefore, the mobile phone application will have utility for a much wider audience. Pest issues vary by region so additional identification information might be necessary to adapt that aspect of the application to a wider region.

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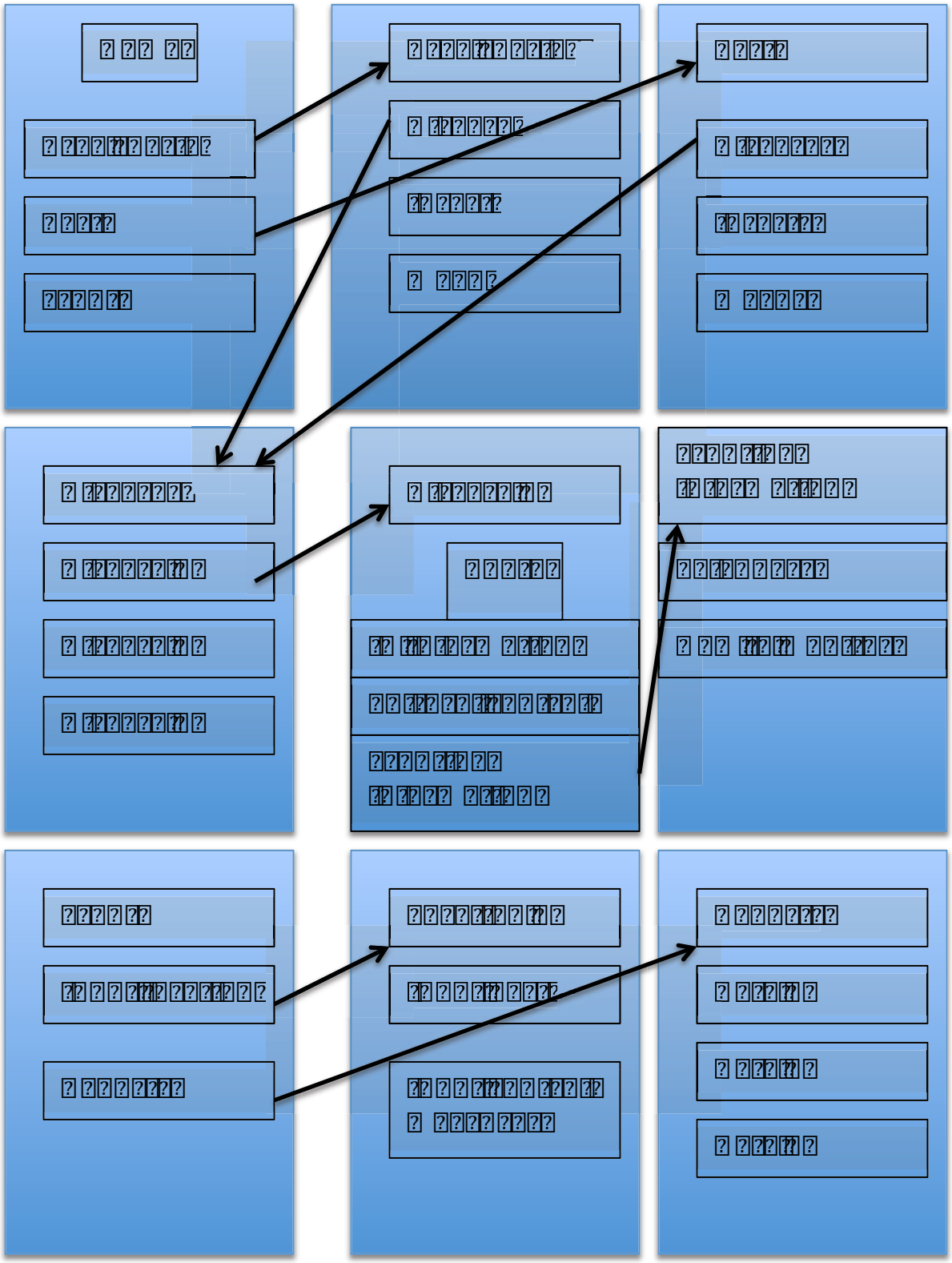

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Timetable – Objectives and activities for introducing a hand-held mobile application for pest identification and scouting on pest management in conifer production

Objective	Activity	Date completed	Responsible
1. Create app	Gather information to be included	October 2012-Jan 2013	Lamb, Eshenaur, Cowles
	Work with developer to create app	October 2012 – May 2103	Lamb, Eshenaur
2. Demonstrate and evaluate app	Identify growers to serve as advisory committee	October 2012 – Dec 2012	Lamb, Eshenaur, Cowles
	Beta test app with advisory committee through 2013 growing season	May 2013 – October 2013	Lamb, Eshenaur, Cowles
	Update app based on grower comments	October 2013 – December 2013	Lamb, Eshenaur
	Survey initial users on action change	January 2014 – May 2014	Lamb, Eshenaur
3. Extend the information on the app	Promote and demonstrate the app to growers in the NE at state and regional meetings	November 2013 – May 2014	Lamb, Eshenaur, Cowles
	Update app as needed based on additional comments	May 2014 – July 2014	Lamb, Eshenaur
	Promote app to growers within and beyond the NE through trade journals and meetings	November 2014 – January 2015	Lamb, Eshenaur
	Survey program participants and those who download app on action change	January 2015 – May 2015	Lamb, Eshenaur
	Present information at the 8th International IPM Symposium	March 2015	Lamb, Eshenaur
	Data analysis and report writing	May 2015 – September 2015	Lamb, Eshenaur

Evaluation Plans:

Evaluation of application by advisory committee
Methods for evaluation
Because the PDs will be working one-on-one with the growers in the advisory committee, information will be collected through direct survey. This approach allows for more open-ended questions and a greater depth of response.

Specific evaluation objectives
Ease of use of the application
Additional information or utilities to be included in application

Specific evaluation indicators
Level of positive reactions to the application and its use

Evaluation of number of growers trained and knowledge impact
Methods for evaluation
A written survey will be collected from all participants in training programs with a series of standard questions on knowledge gained due to the training. A few open-ended questions will be included as they often bring to light topics or responses not anticipated by the survey writers.

Specific evaluation objectives
Are growers participating in application training gaining knowledge on IPM tactics?
Are growers participating in application training gaining knowledge on use of the application for pest identification and scouting?
Do growers intend to apply the knowledge gained on IPM or use of the application in their own operations?
Are there changes that growers would suggest to improve the application?

Specific evaluation indicators
Numbers of growers indicating knowledge impacts
Specific responses leading to changes in the application

Evaluation of number of growers downloading application
Methods for evaluation
The application can collect information when it is downloaded. It can also provide the PDs with some information when it is used for compiling scouting information.

Specific evaluation objectives
How many people are downloading the application
Is it being used for scouting and record keeping?

Specific evaluation indicators
This information will be collected primarily as numbers. Other information may be available from the app.

Evaluation of action change in use of scouting, improved record keeping, and reduction in unnecessary pesticide use

Methods for evaluation

In order to evaluate action change, surveys of training participants and advisory committee members need to be conducted some time after direct contact with the PDs. Therefore, survey questions will be sent to growers by email or as a web-based survey. Phone follow-ups are sometimes necessary to get a good sample of responses. Because of the greater contact with advisory committee growers, PDs will create a more detailed survey for them, including more information on changes in pesticide use based on use of the application, and improvements in overall pest management.

Specific evaluation objectives

Did growers download and use the application for pest identification, scouting, and/or record keeping?
Were growers satisfied with the results based on IPM and use of the application?
Did growers reduce pesticide use based on use of the application and by how many pesticide applications?
Were there other changes in pest management that growers attribute to the use of the application?

Specific evaluation indicators

Number of growers using application and reporting changes in pest management due to it
Change in pesticide applications based on use of the application
Impact statements based on open-ended questions that may not fit into specific indicators

Survey expertise

The PDs have experience with one-on-one data collection surveys, survey instruments developed for use as part of training events, telephone surveys and web-based surveys. Cornell University also has assistance in developing survey instruments available through the Cornell Cooperative Extension office.

Associated costs

The evaluation procedures will primarily be conducted in person or as phone or web-based surveys for which there are few costs. Therefore, there are no costs associated with evaluation included in the budget.

Key Personnel

Lead institution:
Cornell University

Project Directors (Principal Investigators):

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The Project Directors are responsible for managing the project, ensuring that all activities are completed and impacts are documented, and fulfilling all reporting requirements.

Consultant:

Dr. Richard Cowles

The Connecticut Agricultural Experiment Station
123 Huntington Street
Box 1106
New Haven, CT 06504

The consultant will work with conifer producers in Connecticut. He will identify growers to serve as an advisory committee and to evaluate the mobile application. He will also promote the mobile application in the region and train growers in its use. Please see attached documentation for more information.