V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Global Food Security and Hunger - Plant and Integrated Pest Management Systems

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
202	Plant Genetic Resources			20%	
205	Plant Management Systems			25%	
211	Insects, Mites, and Other Arthropods Affecting Plants			15%	
216	Integrated Pest Management Systems			40%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	13.0	0.0
Actual Paid Professional	0.0	0.0	18.2	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	561458	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	2802269	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	746503	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

The main research objectives for this program are to develop methods of pest control that require less chemicals and to develop and evaluate plant cultivars that are resistant to insect and plant pathogens and provide high yield. Important advances were made on these objectives during the reporting period. Several expected outputs (i.e., activities, services, events, and new crops that reach people) were designed to assist a broad, diverse group of stakeholders by providing products and information that will be used by growers and the general public to solve problems. We anticipate that some of these advancements will eventually benefit food production internationally. All activities of this planned research program will ensure that people have equality of service and access to research findings. Direct contacts were tabulated from persons served or those in attendance at meetings, workshops, etc. Numbers of indirect contacts with youth were obtained from teachers receiving CAES assistance and informative new findings in science curricula. The following activities were planned: (1) CAES scientists partnered with stakeholders and participated in their organizations as members or officers, (2) CAES scientists conducted workshops or special meetings for stakeholders, (3) experiments were performed on growers' properties as well as on CAES research farms, (4) 55 cultivars, representing 6 different crops, are currently under evaluation, and new cultivars of vegetables (e.g., broccoli) and fruits (e.g., peppers) will be tested, (5) Methods of controlling powdery mildew and crown gall continue to be developed, including dinofuran (Safari) testing as a trunk spray for insect pests of trees, (6) diagnostic services were provided to stakeholders, (7) training on IPM practices and other methodologies was provided to stakeholders, (8) staff members disseminated written information on research findings by presenting scientific displays at agricultural fairs and giving talks and interviews to civic groups, (9) staff members worked with the media and provide information on scientific discoveries, and (10) staff members educated teachers and thereby, indirectly reach youth. Public service is an important component for all output measures. For example, all state residents were allowed to request direct assistance on diagnosing insect or plant disease problems. About 20,118 stakeholders directly received assistance from these activities in this reporting period. CAES scientists are members or officers in at least 158 stakeholder or professional groups. This provides direct opportunities for stakeholder input on the research programs and facilitates reporting of research results. The non-traditional stakeholders were reached at agricultural fairs when they visited or inquired about CAES displays or through newspaper, radio, and TV reports. Based on media statistics for viewers or readers, one can estimate indirect contacts with adults and youth who hear or read about new scientific advances made at CAES and reported by the media. One open house was held on CAES property to allow the public to hear oral presentations on research results and to offer comments. About 700 talks and interviews were given to civic groups and the media to convey research results and to receive direct public input. Research experiments solved problems or provided information on new crops. Whenever possible, these experiments were conducted on farms or other private properties to encourage stakeholder engagement in the research. Results of these output activities led to specific outcomes, such as reducing pesticide use, controlling insects or plant disease pathogens, development of resistant cultivars, the introduction of new specialty crops, and increased farm income. Scientific publications in peer-reviewed journals or articles written for the general public reached traditional and non-traditional groups of stakeholders.

2. Brief description of the target audience

Diverse target audiences include under-served and under-represented stakeholders. CAES does not receive extension funds but, nonetheless, serves a variety of farmers and other stakeholders that grow vegetables, fruits, nursery stock, cattle/livestock, and flowers. CAES scientists worked with the University of Connecticut extension specialists in planning growers' meetings. Progress was made in reporting new findings to the national extension service (www.extension.org) to reach stakeholders nationally. Several scientists at CAES are participating as members of communities of practice. The broad goals of the CAES

research programs also include work on forestry and environmental problems. Accordingly, target audiences include landscapers, landscape architects, conservation officers, foresters, arborists, beekeepers, maple syrup producers, seed companies, and persons in the wood-products industry. Efforts were also made to reach government and water company officials, horticulturalists, groundskeepers, pest control operators, pesticide manufacturers and retailers, environmental regulators, extension specialists, and municipal officials. Scientists and government officials are also important target audiences for new experimental results. This research program is mainly designed to reach the general public, which includes non-traditional stakeholder groups. Homeowners with interests in agriculture and forestry have access to laboratories and scientific results, as well as equality of service. Women, members of minority organizations, and children are examples of under-represented and under-served groups that are important target audiences. Efforts will be made to reach Brazilian, Hispanic, Asian American, African American, and Native American populations as well as elementary and high school students. New scientific information will be transferred to teachers to develop educational curricula, and, thereby, indirectly reach youth.

3. How was eXtension used?

Although The Connecticut Agricultural Experiment Station does not receive extension funding and is not an official institution with eXtension, several CAES staff members in this program are registered with eXtension with the consumer horticulture, youth, pesticide environmental stewardship, bee health, grape, eOrganic, and urban IPM communities of practice. New findings, fact sheets, links to Station material, and answers to questions have occasionally been provided to the national eXtension service (www.extension.org).

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	18168	28462	1622	7718

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2013

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	0	22	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Total research papers

Year	Actual
2013	76

Output #2

Output Measure

- # of site visits to conduct research and solve problems

Year	Actual
2013	344

Output #3

Output Measure

- # of talks and interviews given to stakeholders

Year	Actual
2013	344

Output #4

Output Measure

- # of responses to stakeholders' inquiries

Year	Actual
2013	14968

Output #5

Output Measure

- # of diagnostic tests performed

Year	Actual
2013	2288

Output #6

Output Measure

- # of new IPM intervention strategies judged to be effective
  Not reporting on this Output for this Annual Report

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	# of homeowners and growers gaining knowledge on insect pests and plant pathogens
2	# of homeowners and growers learning practices to control plant and household pests
3	# of media reporters gaining knowledge on research results
4	# of students learning agricultural skills by attending talks, courses, or training sessions
5	# growers adopting IPM practices
6	# of cultivars introduced into farming operations

Outcome #1

1. Outcome Measures

# of homeowners and growers gaining knowledge on insect pests and plant pathogens

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	10793

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
American foulbrood (AFB) is a highly infectious disease of honey bees (Apis mellifera) caused by the endospore-forming bacterium Paenibacillus larvae, and is a regulated reportable disease in many countries. Not only is AFB devastating to colony health, but this disease has the capability to cause complete loss of an infected colony and render equipment unusable. A three year AFB survey in Connecticut has shown that 46.4% of the apiaries examined contain P. larvae spores. Most U.S. states mandate that bee hives with clinical symptoms of AFB be destroyed. Replacement cost to a beekeeper is approximately $300 for a single deep hive box plus bees. Connecticut has, on a yearly average, approximately 2800 registered bee hives.

What has been done
The main activity for the program consists of site visits to CT apiaries to meet with beekeepers and collected samples for analysis of AFB and Nosema infestations.

Results
Results are disseminated through bulletins and talks given to industry groups, citizens and other interested organizations. In addition, a database of registered beekeepers in Connecticut has been established for the years 2007-2011. New apiary registrations for 2012 are being added to the database. Staff scientists also maintain active membership in professional and amateur beekeeping societies and conduct work in collaboration with Ted Jones (president CT Beekeepers Association) at the Massaro Community Farm apiary in Woodbridge CT.

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants

Outcome #2

1. Outcome Measures

# of homeowners and growers learning practices to control plant and household pests

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1916

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Materials at the nanoscale or nanoparticles (NP) possess unique chemical and physical properties not observed in their equivalent bulk materials. The literature clearly demonstrates enhanced availability and transport of NP in plants, but information is scarce. There is no information on how NP micronutrients might uniquely affect root pathogens. The mechanisms of NP absorption in plant leaves and roots could significantly impact crop yield and plant disease management. More importantly the effect of NP on soil borne disease has not been studied.

What has been done
Six greenhouse trials and one field study were conducted with tomatoes and eggplants to determine the effect of applying NP of Al, Cu, Fe, Mn, Ni, or Zn to plant leaves and roots and to determine whether these compounds are actively translocated within the plant. Roots and leaves were assayed for these elements by ICP mass spectrometry.

Results
We found that Cu and Mn NP were the most effective element in conferring resistance to soil-borne pathogens. Aluminum, Fe, Ni, and Zn were not as effective and often were damaging to the plant. The NP was always superior to the bulked oxide in increasing plant size and eggplant yield and there was significantly more downward translocation to the root when the NP form was used when compared to the bulked form. These findings, thus far, suggest NP may be useful in disease management.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
216	Integrated Pest Management Systems

Outcome #3

1. Outcome Measures

# of media reporters gaining knowledge on research results

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	153

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Stakeholders requested new knowledge on how to grow specialty crops with little or no pesticides. Farmers wanted to reduce pesticide costs and worker exposure to these chemicals and desired to have marketable crops that are in public demand. Media reporters recognized the public's interest in having a cleaner environment and, likewise, sought new knowledge on managing crop and soil systems so that this information can be transferred to a diverse group of stakeholders.

What has been done
Reporters interviewed scientists, saw laboratories, and visited field research plots. There were at least 24 newspaper articles or other news stories on plants and IPM systems covering a wide range of topics, such as specialty crops, honey bee pollination, insect pests, trees, gardening, and homeowner plantings. Station scientists gave over 1000 talks and interviews, with at least 200 having participation of the press. At the summer Plant Science Day event, public television (CTN) recorded talks given by scientists on plant systems and pests and telecasted the presentations to state residents via a cable network.

Results
Reporters learned about the detection of the emerald ash borer in CT, effects of changing climate on plant health, effects of neonicotinoid pesticides on honey bees, role of nanoparticles in agriculture, plant damage caused by deer, and the introduction of new specialty crops. For example, one 30 minute radio interview conducted on Texas Public Radio's "Science Studio" focused on nanotechnology in agriculture and reached an audience measuring in the tens of thousands.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
216	Integrated Pest Management Systems

Outcome #4

1. Outcome Measures

# of students learning agricultural skills by attending talks, courses, or training sessions

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	591

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Students are tomorrows scientists and educating youth, an under-served group, is a major outreach initiative. By interacting with students, CAES scientists promote greater interest in science, and provide opportunities for students to learn more about biology and chemistry.

What has been done
A CAES scientist mentored seven high school students for research projects, which gave them hands-on opportunities to assist with laboratory and greenhouse studies, data collection, and data entry. The projects the students have worked on have been salt marsh dieback, earthworms and biochar, biochar and plant disease, and salt tolerance among salt marsh fungi.

Results
Research projects geared to the individual interests of each student were designed and developed, with the option of using the project for state-wide science fair competitions. Students received hands-on experience setting up experiments, collecting and analyzing data, and presenting their findings. Over half of the students involved in this program presented their projects and one student was awarded first place in a CT science fair for high school students. Teachers reported that students developed an increased interest in science. The long-term benefits are nurturing students with greater understanding and interest in science and possible careers in science.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
216	Integrated Pest Management Systems

Outcome #5

1. Outcome Measures

growers adopting IPM practices

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In October 2011, boxwood blight, a new fungal disease for North America was identified in Connecticut and North Carolina. This disease is now found in 12 U. S. states and three provinces in Canada. Boxwood blight is a devastating disease that can cause plant death, often hastened by secondary invaders. Boxwood is not only an important landscape plant in Connecticut and the U.S., it is also a significant part of the wholesale and retail nursery industry in Connecticut. The current annual wholesale market value for boxwood nursery production is estimated at $103 million (USDA-NASS, Census of Horticulture, 2010). Losses attributed to boxwood blight in CT alone have been estimated at $5.5 million since 2011.

What has been done
Plant pathologists at the Experiment Station drafted best management practices (BMPs) for boxwood blight in response to the initial U.S. outbreaks, but these were largely based on research performed in Europe. Although significant gaps in science-based information on many features of disease development and mitigation were evident, particularly under U. S. conditions, this prompted an unprecedented level of collaboration among federal, state, and university researchers with industry support. As a founding participant of this research consortium, CAES researchers have taken the lead in developing molecular detection assays, identifying effective products for sanitizing tools and equipment, and identifying effective fungicides.

Results

A sensitive and specific molecular detection assay has been developed to improve early, pre-symptom diagnosis, and work is underway to apply this assay to understand sources of the pathogen in potting media, soil, and water. Research has also successfully identified effective products (e.g., bleach, Lysol, Oxidate, ZeroTol, and X3) for sanitizing tools and equipment needed to refine current BMPs and minimize new infections and carry-over from infected plants, thereby reducing economic loss. Effective systemic and protectant fungicides (e.g., propiconazole, myclobutanil, thiophanate-methyl, fludioxonil, pyraclostrobin, kresoxim-methyl, and chlorothalonil) have also been identified from laboratory, greenhouse, and container nursery studies. New information was communicated to green industry professionals through presentations and posters at meetings, through fact sheets, and was incorporated into revised versions of BMPs. Prompt action by Station researchers, in concert with decisive regulatory actions, continue to minimize the economic impact of boxwood blight on the Connecticut nursery industry. Growers and landscape professionals incorporated this new information and updated BMPs into their practices. Although significant losses were realized after the initial outbreak, CAES actions helped to maintain boxwood as a viable and important component of the Connecticut landscape and nursery industry.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
211	Insects, Mites, and Other Arthropods Affecting Plants
216	Integrated Pest Management Systems

Outcome #6

1. Outcome Measures

# of cultivars introduced into farming operations

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Today, about 11,000 acres on 733 farms in Connecticut are devoted to vegetable production with a cash value of $30.2 million. Vegetable growers responding to a state survey requested that field trials be conducted on specialty pumpkins.

What has been done
Field tests revealed that the cultivar Apprentice yielded almost 15,000 more pumpkins per acre than the cultivar Minitreat.

Results
At a retail price of $2.00 per fruit, a grower can potentially gross nearly $30,000 more per acre with Apprentice than growing another popular cultivar Minitreat. Twenty-five vegetable growers are including this crop in their farming operations. The long-term benefits of growing specialty pumpkins include an additional product and revenue for growers who attend farmers markers or have their own roadside stands.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Competing Public priorities
- Competing Programmatic Challenges
- Other (Staff changes, media influences)

Brief Explanation

As reported previously, the loss scientific staff in this program has adversely affected outcomes. However, recent improvement in the state funding situation has allowed the hiring of 3 scientists, although the search process has just begun and will not likely be complete until late 2014. It is likely that significant portions of the research programs of these new staff will fall under this program and increased progress and outcomes are anticipated in the future.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Planned evaluation studies were conducted during this reporting period. "After only" evaluations verified that there were knowledge changes in reporters. "During program" evaluations showed that there were knowledge changes in 591 students, whereas "before and after" program on-site evaluations and observations indicated that there were positive outcomes in more effective control of various plant pests. Moreover, after requested field trials on specialty pumpkins, 25 growers included the selected cultivar in subsequent farming operations.

Key Items of Evaluation

The Science Citation Index and Google Scholar verified recognition of published articles on plant systems written by more than a dozen scientists. There were 1215 citations for this entire planned program during 2013. Several published news articles showed that substantial knowledge changes had occurred in reporters. Likewise, feedback from nearly 50 teachers verified knowledge changes in youth. On-site observations, site visits, and evaluations verified success in improved pest control methods, as well as IPM monitoring.