V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Local and Global Food Supply and Security - 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: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	13.0	0.0
Actual Paid	0.0	0.0	17.4	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	656463	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	2760810	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	894033	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

This program's objectives are to develop pest control methods requiring decreased pesticides, as well as to isolate high yield crop cultivars that are inherently resistant to insect and plant pathogens. Significant progress was made on these objectives during the reporting period. Outputs such as activities/events, services, and new crops assisted a diverse group of stakeholders both domestically and potentially internationally by providing products and information that will be used by growers and the general public to solve problems. All activities are designed to ensure that stakeholders have equality of service and access to research findings. Direct contacts are derived from persons served or those in attendance at meetings, as well as those directly requesting service in our inquiry offices. Indirect contacts with youth were obtained from educators receiving CAES assistance and information that could be incorporated into science curricula. Activities included: (1) CAES scientists conducted workshops or special meetings for stakeholders, (2) CAES scientists partnered with stakeholders and participated as members or officers in over 180 organizations and societies (3) experiments were performed on both CAES research farms and growers' properties, (4) cultivar trials on peppers, sweet corn, broccoli, melons, and hops were completed, (5) composting strategies using oak and maple leaves were investigated, (6) pathogens of tree species were invested, (7) stakeholders received information and training on IPM strategies, (8) written information on research findings was disseminated by scientific displays at agricultural fairs and giving talks and interviews to civic groups, (9) staff members utilized traditional and social media to provide information on scientific discoveries, (10) staff members educated teachers and thereby, indirectly reach youth, and (11) diagnostic services were provided to stakeholders. Field experiments solved problems or provided information on new crops, and where possible, were conducted on stakeholder properties. Collectively, these output activities led to specific outcomes, including reduced pesticide use, greater control of insect or plant disease pathogens, development of resistant cultivars, the introduction of new specialty crops, and increased farm income. Public service is an important component for all output measures. For example, CAES staff directly addressed 19,189 citizens' inquiries and conducted 20,185 diagnostic tests during the current reporting period. CAES staff serve as members or officers in at least 187 stakeholder or professional organizations, which enables stakeholder to directly comment on research and findings. Non-traditional stakeholders were reached at agricultural fairs when they visited or inquired about CAES displays, as well as through traditional and social media. Our annual open house event allowed over 1,130 stakeholders, including nearly 150 children, to hear oral presentations on research results and to offer comments. Approximately 780 talks, including 154 involving the media, were given to stakeholder or professional groups to convey research findings and to receive direct public feedback. Scientific publications in peer-reviewed journals (56) or articles written for the general public (37) 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 does serve a variety of stakeholders that grow vegetables, fruits, nursery stock, cattle/livestock, and flowers. CAES scientists worked with the UConn 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 CAES scientists are participating as members of communities of practice. Several broad goals of the CAES research programs include work on forestry and environmental problems. Accordingly, target audiences include landscapers, landscape architects, conservation officers, foresters, arborists, beekeepers, seed companies, and those 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. However, this research program is

mainly designed to reach the general public, including non-traditional stakeholder groups. Homeowners with interests in agriculture and forestry have access to research findings and have 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 are made to reach Brazilian, Hispanic, Asian American, African American, and Native American populations, among others, as well as elementary and high school students. New scientific information conveyed to educators will indirectly reach youth.

3. How was eXtension used?

CAES does not receive extension funding and is not an official institution with eXtension. However, several CAES staff members are registered with eXtension with 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

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	22863	9511	938	1902

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

Patent Applications Submitted

Year:	2014
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	19	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Total research papers

Year	Actual
2014	50

Output #2

Output Measure

- # of site visits to conduct research and solve problems

Year	Actual
2014	1392

Output #3

Output Measure

- # of talks and interviews given to stakeholders

Year	Actual
2014	530

Output #4

Output Measure

- # of responses to stakeholders' inquiries

Year	Actual
2014	8282

Output #5

Output Measure

- # of diagnostic tests performed

Year	Actual
2014	2856

Output #6

Output Measure

- # of new IPM intervention strategies judged to be effective

Year	Actual
2014	3

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	Number 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
2014	8487

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Phytophthora root rot is a devastating soil-borne disease of Christmas trees. Early and accurate diagnosis of the disease can reduce economic losses by harvesting marketable trees before they completely lose their market value.

What has been done
Researchers at CAES initiated a project to determine if there was a relationship between visible, aboveground symptoms and Phytophthora infection of roots. Ninety fir trees (5-6 years old) from five Christmas tree farms in Connecticut were examined for Phytophthora root rot in 2014. Sampled trees were assessed for symptoms (e.g., flagging/browning of lower branches, stunted growth) in the field and samples of basal bark tissues and roots were brought to the laboratory for testing. These tissues were analyzed using a serology-based method to confirm the presence or absence of Phytophthora in the tree.

Results
We found that trees with symptomatic (flagged) lower branches and stunted new growth were closely associated with the positive confirmations of Phytophthora in the roots. These results led us to develop a simple method to identify Phytophthora-infected Christmas trees without destructive sampling of the trees. This method was communicated to growers to assist them with making decisions to selectively harvest still-marketable trees with early-stage Phytophthora infections as pre-cut Christmas trees rather than leaving them in the field for later harvest. This effectively reduced economic losses caused by this important disease.

4. Associated Knowledge Areas

KA Code	Knowledge Area

205	Plant Management Systems
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
2014	981

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Grape growers in Connecticut experienced 40-60% bud kill during the winter of 2013-2014, which was characterized by large swings in temperature before protective snow cover. Temperatures varied from 60 F maximum to -5 F minimum in less than 10 days in December 2013 and again in January 2014. This resulted in considerable loss in fruit yield.

What has been done
To compensate for the winter kill, we modified our pruning techniques in experimental plots by leaving twice as many buds (10 per linear foot of cordon instead of 5).

Results
After bud burst but before flowering (mid-May to mid-June), a second pruning was executed to bring the cordons to the target 5 buds per linear foot. For cane pruned vines (mainly vinifera), there were not enough live buds per linear foot and yield was reduced by 30-50% over previous years. However, for spur pruned cultivars (hybrids) this strategy was successful and fruit yields were maintained in spite of harsh climatic conditions.

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
2014	154

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Stakeholders, including the press, continue to request new knowledge and techniques on how to grow crops with little or no pesticides. Growers want to reduce pesticide costs and worker exposure to these chemicals and seek marketable crops that are in public demand. Both traditional and social media can be used to address the publics interest in having a cleaner and more sustainable environment.

What has been done
Reporters and other stakeholders interviewed scientists, saw laboratories, attended open house events and visited field research plots. Within this program, there were at least 18 interviews and a total of 154 events involving the press. Station scientists gave 782 talks, including 530 within this program. At the August 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 weather on plant health, effects of neonicotinoid pesticides on honey bees, plant damage caused by deer, and the introduction of new specialty crops. Nearly all reporters accurately transferred new findings in written form to stakeholders. For example, a newspaper reporter learned that the mild winter advanced crop growth by about 3 weeks and that strawberries would be available for harvest ahead of normal schedule. Advanced harvesting was also likely to occur for many other crops.

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
2014	938

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Educating youth, an under-served group, is a major program initiative. The goal is to promote science and increase student interest in biology, chemistry, and agriculture. CAES scientists participated as judges in science fairs, showed exhibits and gave demonstrations at agricultural fairs and at our annual open house (Plant Science Day). Staff members organized tours of laboratories and experimental plots. Science teachers requested assistance in promoting interests in biology and chemistry and needed material for curricula.

What has been done
Scientists hosted tours of CAES laboratories and provide discussion of Departmental programs to a number of student groups, including the Sound School in New Haven. During this reporting period, scientists also served as judges in science fairs, displayed exhibits at public events where youth of varied backgrounds attended, and gave presentations that involved direct contact with 938 students. Students toured laboratories and saw demonstrations on the use of analytical equipment. Students from the Sound School learned how to grow crops at our Experimental Farm. At our annual open house, a hands-on science display had scientific staff interacting directly with nearly 150 students.

Results
Students of varied backgrounds from urban areas saw experimental field plots, experienced

science in action, learned how to grow crops and control pests by a range of strategies. Students saw live honey bees in a demonstration case and learned about the biology and importance of honey bees. High school students learned about research on testing different crop cultivars and about chemical analyses used to ensure food safety. These efforts to change knowledge in students about agriculture had impact. Students learned about food banks and donated surplus produce. Based on feedback from teachers, there was increased interest among students in science. New knowledge on agriculture and science was incorporated into science programs and helped to reach other students (e.g., indirect contacts with youth). The expected long-term benefits are a better educated youth population and increased interests 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
2014	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Micronutrients are critical in the defense against crop disease. Many host defense products are synthesized by enzymes that are often activated by micronutrients. One problem is that low element availability in soil often restricts a sufficient supply of micronutrients like Cu, Mn, or Zn. The application of micronutrients to shoot tissues is ineffective since most are not basipetally translocated. The use of nanoscale micronutrients (<100 nanometers) as part of an integrated approach to suppress crop disease and subsequently enhance growth and yield is a novel idea, but large knowledge gaps still exist. Consequently, the use of nanoparticles (NP) of metal oxides Cu, Mn, and Zn as micronutrient formulations may offer a highly effective novel platform for crop

disease suppression. Nanotechnology has the potential to play a critical role in global food production.

What has been done
Research at CAES was initiated to explore the role of NP metal oxides Cu, Mn, and Zn for suppression of Verticillium wilt of eggplant caused by Verticillium dahliae. Three to 4 wk.-old eggplant transplants were foliarly treated once with the NP formulations and compared to the bulked equivalent of each metal oxide along with untreated controls. Both greenhouse and field experiments were conducted with eggplant transplants in soil naturally infested with the Verticillium wilt pathogen, Verticillium dahliae, in 2013 and 2014.

Results
Cu oxide nanoparticles increased eggplant growth and yield when compared to controls. In both 2013 and 2014, a 43% and 58% increase in yield, respectively, was observed when compared to the untreated control, and a 17% and 31% increase in yield, respectively, was observed over the bulked equivalent of the micronutrient. These findings suggest the unique size of NP may favor their entry and transport in plants and may have a role in disease management. We estimate that one treatment of NP with CuO would cost less than $45.00, but could potentially increase eggplant yield in infested soil by more than 50 percent.

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 #6

1. Outcome Measures

Number 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
2014	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Today, about 10,000 acres on 952 farms in Connecticut are devoted to vegetable production with a cash value of $36.4 million. Vegetable growers responding to a state survey requested that field trials be conducted on specialty melons, broccoli, and edamame. These crops are currently being grown by at least 14, 31, and 23 growers, respectively.

What has been done
At our two experimental farms, we have conducted field trials on 11 cultivars each of specialty melons and broccoli, and 12 cultivars of edamame.

Results
Our research has shown that cultivar selection can dramatically increase yields and profits for the grower. For honeydew melons, by growing the cultivar Early Dew instead of Honey Brew, the grower can produce 19,054 more pounds per acre or 7,841 more melons per acre. At a retail price of $2.50 per melon, the grower could potentially gross almost $20,000 more per acre by growing Early Dew instead of Honey Brew. By growing Gypsy broccoli instead of Blue Wind, the grower can produce over 11,400 more pounds per acre or gross about $23,000 more per acre at $1.99 per pound. By growing the edamame cultivar Sunrise instead of the cultivar Beer Friend, the grower can potentially produce almost 13,000 more pounds per acre or gross almost $32,000 more per acre at $2.49 per pound.

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

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

Staff losses in IPM and related programs mentioned in previous annual reports remain unfilled. In addition, a weed scientist position is now open due to a recent staff departure and efforts are underway to refill this weed scientist vacancy. However, additional staff

scientists have IPM and related investigations as part of their research and all goals laid out under this planned program were met. In addition, 2 of the 5 new scientists hired this last reporting period (before re-instatement of the hiring freeze) are plant pathologists that will establish lines of research directly under this planned program. As such, meeting and/or exceeding future targeted outcomes is anticipated.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Evaluation studies were conducted during this reporting period. "After only" evaluations verified that there were knowledge changes in media and other stakeholders. "During program" evaluations showed that there were knowledge changes in students/children, whereas "before and after" program on-site evaluations and observations indicated that there were positive outcomes in more effective control of tree and other plant pests. Moreover, 212 farm visits enable direct evaluation of acceptance of new crop cultivars, IPM strategies, and cultivation practices.

Key Items of Evaluation

Google Scholar verified recognition of published articles within this program written by CAES staff. There were 1111 citations for this planned program during the current reporting period. Direct contacts within the program approached 24,000, including nearly 1000 with youth. Indirect contacts exceeded 11,000, including 1,900 youth. On-site observations and evaluations verified success in increased use of IPM and new cultivars, as well as control methods.