

# 2011 Connecticut Agricultural Experiment Station - Research Annual Report of Accomplishments and Results

Status: Accepted

Date Accepted: 04/18/2012

## I. Report Overview

### 1. Executive Summary

Scientific advances have been made at The Connecticut Agricultural Experiment Station (CAES) in meeting the research and outreach objectives set forth in all 4 planned programs: Global Food Security and Hunger - Plant and Integrated Pest Management (IPM) Systems; Food Safety; Human and Animal Health; and Soil and Water Quality. Cooperation with extension personnel at UConn, Cornell, and other land-grant universities has helped to transfer new scientific information to a broad base of stakeholders. Collaborations exist with scientists in at least 40 states and 12 countries.

There are current restrictions on hiring new employees on state funds because of budget deficits. We were, however, able to hire Postdoctoral Research Scientists on federal grants, and two Technicians were promoted in a previous reporting period to Assistant Scientist I. Moreover, we shifted some scientist year (SY) commitments from state-funded positions to Hatch projects. These steps increased SY times beyond those listed in the Plan of Work. We expect shifts in scientist years back onto state projects in the future when research program goals are reevaluated. Although most scientists and other staff members conduct research and outreach activities, we are unable, however, to accurately separate costs for these major initiatives.

Research on plants and IPM systems has led to improved crops, such as the development of a strawberry cultivar (called Rubicon) that is resistant to black vine weevil and a fungus that causes root rot. A patent application has been filed. Of the 93 cultivars, representing 8 different crops, currently under evaluation, 6 are ready for commercial farming. In addition to Rubicon, two cultivars of pak choi, which grow well in Connecticut (CT) and are high-yielding, have been released to help satisfy the demands of a rising Asian population in Connecticut. Three cultivars of vegetable amaranth have been released for commercial farming. Based on a 5-year study, chardonnay budwood grafted onto selected rootstock consistently reduced grapevine losses due to crown gall (a bacterial infection). Grape growers have gained knowledge of this advance. Their use of high-grafted vines is saving about \$2,070 plus labor costs per acre. Moreover, eco-friendly methods of controlling powdery mildew have been developed.

In the Food Safety Program, CAES scientists continue to assist CT state agencies and the US Food and Drug Administration (FDA) in developing more efficient assay methods to detect toxic chemicals. Decisions on violations are based on tolerance levels established by the US Environmental Protection Agency or the US Food and Drug Administration. During this reporting period, there were joint pilot programs, conducted by the CAES and the CT Department of Public Health, to test foods for unwanted chemicals and microbials. Kale was contaminated with *Listeria monocytogenes*, and there was chemical contamination of domestic watermelon, alfalfa, and kale with excessive residues of acephate, atrazine, and linuron, respectively. The kale was recalled nationally.

Progress has been made in the Human and Animal Health Research Programs, and positive outcomes have resulted in changes in behavior. Laboratory tests of 115,725 mosquitoes, collected at 91 trap sites in CT, revealed widespread presence of the West Nile and Jamestown Canyon viruses. Press releases on isolation results warned citizens. Based on a survey of 52 state residents, 24 (46%) indicated that they protected themselves by using repellents or by going indoors when mosquitoes were biting. Genetic analyses for *Culex pipiens*, found to be an important carrier of the West Nile encephalitis virus, revealed that there is a complex of closely related subspecies. Moreover, field tests of biological controls (*Bacillus* species) effectively reduced larval *Culex pipiens* populations in catch basins. Public health sanitarians in some towns relied on this knowledge and have switched from chemical larvicides to biological controls. Efforts to control *Ixodes scapularis* nymphal ticks in selected sites were successful. A

lignon formulation of nootkatone provided 100% control in experimental plots 6 weeks after application. There is promise for nootkatone treatments as an alternative option in tick-management programs.

In the Soil and Water Quality Program, molecular markers were developed to distinguish variable leaf water milfoil (*Myriophyllum heterophyllum*) from other closely related invasive aquatic plants, such as *M. hippuroides*. Conventional morphological methods were insufficient for accurate identification. Based on chloroplast and ribosomal DNA sequences and evaluation of amplified fragment length polymorphisms, a strong phylogeographic break distinguished populations located on the Atlantic Coastal Plain versus other "Continental" portions of the native range. It was concluded that the introduced ranges of variable leaf watermilfoil (northeastern and western US) resulted from multiple independent introductions from several sources.

Outreach programs have been active. There have been 22,725 direct and 98,595 indirect contacts with adults in CT, respectively. Less frequent direct (3,041) contact and indirect (20,180) contacts were noted for youth. Staff members gave 1,266 talks and interviews, made 248 farm visits to solve specific problems, and answered more than 18,000 citizens' inquiries, including 13,436 diagnostic tests. Stakeholders have access to 50 new published peer-reviewed scientific articles and 82 non-peer reviewed fact sheets, CAES Bulletins, newsletter articles, book chapters, and symposia proceedings. Assistance was given to 107 reporters, representing newspapers, television, and radio. An upgraded CAES website continued to be a powerful method of transferring new information to the public. There were 2,686,464 page views, including 4,986 visits for publications and 4,564 visits to the CAES Plant Pest Handbook. The average user time per visit was about 14 minutes. A 30-second video on CAES programs was produced for public information and posted on the Station's website.

**Total Actual Amount of professional FTEs/SYs for this State**

Year: 2011	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	30.0	0.0
Actual	0.0	0.0	30.3	0.0

**II. Merit Review Process**

**1. The Merit Review Process that was Employed for this year**

- Expert Peer Review
- Other (Internal administrative and scientific review )

**2. Brief Explanation**

The review process described in the updated Plan of Work was followed during this reporting period. To evaluate project outlines for Hatch grants, external reviews were received. All scientific proposals submitted to USDA-CSREES or other federal agencies likewise received merit and external peer-review to determine if the planned research had relevance to stakeholders' needs, met program goals, and had sufficient technical structure and resources to conduct the studies. In addition to critiques given by scientists in the discipline, Department Heads, the Vice-Director and the Director were involved in the internal review process. The Director gave final approval of all research proposals and manuscripts. In addition to meeting residents' needs, the likelihood of success and originality of the studies received careful consideration. During 2011, there were 5 Hatch and McIntire Stennis project outlines reviewed and submitted to USDA/CSREES to address state and national needs and to accomplish planned research goals in the following programs; Global Food Security and Hunger: Plant and Integrated Pest Management

Systems (n = 3), Human and Animal Health (n = 1), and Soil and Water Quality (n = 1). The approved project outlines covered work on *Neonectria* genetics, invasive plants, native bees and pollination, Brown Marmorated stink bug (NE-580), and removal of Japanese barberry for tick control. Additional expert peer-review was also received on the quality of research results when manuscripts were examined by journal editorial boards and reviewers and when grant proposals submitted for competitive funds were critiqued by scientific review panels.

### III. Stakeholder Input

#### 1. Actions taken to seek stakeholder input that encouraged their participation

- Use of media to announce public meetings and listening sessions
- Targeted invitation to traditional stakeholder groups
- Targeted invitation to traditional stakeholder individuals
- Targeted invitation to non-traditional stakeholder individuals
- Survey of traditional stakeholder groups
- Survey of traditional stakeholder individuals
- Survey of the general public
- Survey specifically with non-traditional groups
- Survey specifically with non-traditional individuals
- Survey of selected individuals from the general public
- Other (Targeted invitations to legislators and their staff members)

#### Brief explanation.

Stakeholders participated in CAES research programs and public events. Special conferences and workshops were held on pests of fruit trees and vegetables (58 attendees), bed bugs (229 attendees), and controlling Christmas tree pests (20 attendees). Information was disseminated to state residents living in widely separated towns and cities in the state. Press releases promoted 2 Open Houses in the spring and summer (Plant Science Day). For the latter, a one-page promotional flyer was delivered to at least 92,000 households in an edition of the New Haven Register preceding Plant Science Day. This all day event, held at Lockwood Farm (Hamden, CT) each year on the first Wednesday of August, is open to the public. It would be of great benefit for NIFA and NPL's to see the exhibits, hear the talks, and see stakeholder interactions. Attendance at the April event (75 persons in the main auditorium) and at the August Plant Science Day at Lockwood Farm (687 adults, 192 youths) was excellent. Connecticut Network (CT-N), a public TV station, taped the main speaker's talk and scientists' presentations at Plant Science Day for statewide telecasting. Extensive media assistance targeted the non-traditional stakeholder groups and individuals. Notices of these public events were mailed or e-mailed to 195 press contacts and 5,600 state residents on the Station's contact list to cover traditional stakeholder groups and individuals. Station displays of research, presented at 6 regional or state fairs, and invitations for high school students to tour Station laboratories, provided further opportunities to reach traditional and non-traditional stakeholders. For example, the Norwalk Tree Festival provides stakeholders an opportunity to meet Experiment Station staff; 1,300 people saw Station displays. An additional 145 students toured laboratories at the Station's main campus in New Haven or heard oral presentations. Survey forms were distributed at both open houses plus at selected exhibits in statewide agricultural trade shows to seek written public comment on research programs and to encourage stakeholder participation. Thousands of citizens saw Station exhibits on agricultural, forestry, and public health topics and had opportunities to bring insect, plant, and soil samples for diagnostic testing. To determine if state residents were pleased with talks given at a spring Open

House event, forms were distributed at the end of the event to receive input. All 38 residents who responded were pleased with the program. The stakeholders lived in at least 22 towns or cities in Connecticut. Survey forms completed by 44 attendees of Plant Science Day indicated that residents came from at least 30 towns and cities of a total of 169 municipalities. In addition, survey forms returned by 54 participants of 2 invasive aquatic plant workshops indicated that the programs were informative. These persons lived in 31 towns or cities. Meetings for bedding plant growers, organized by Station scientists and UConn extension specialists, were attended by 47 persons. All individuals rated the programs as useful. The majority indicated that they would benefit economically based on what they learned. Station staff members served on advisory boards and committees of at least 143 agricultural and environmental civic groups. Invasive aquatic plant problems were identified at meetings of traditional and non-traditional groups and individuals. Moreover, staff members made 248 visits to farms and other properties where pest problems occurred. In many cases, growers participated in research to find solutions for controlling insect pests and plant diseases. Finally, 2 state representatives, 2 state senators, staff in the Governor's Office of Policy and Management and State Office of Fiscal Analysis, and in two congressional offices requested and received information following newspaper articles, other media coverage, or constituent requests.

**2(A). A brief statement of the process that was used by the recipient institution to identify individuals and groups stakeholders and to collect input from them**

**1. Method to identify individuals and groups**

- Use Advisory Committees
- Open Listening Sessions
- Needs Assessments
- Use Surveys
- Other (Public access to diagnostic laboratories)

**Brief explanation.**

Collecting input from stakeholders helps to realign research programs. There are several mechanisms in place to identify individuals and groups of stakeholders and to collect input from them. Evaluation forms, distributed to open house, meeting, and workshop attendees, were relied on heavily for stakeholder input. Special e-mail messages and letters, written by state residents, are forwarded by Station staff members to Department Heads and the Director and are then addressed after review. Citizens received responses. A complaint requires a response and follow-up contacts by administrators. Active participation of Station staff members on 143 advisory boards of civic groups, representing different agricultural, forestry, environmental or public health interests, is an excellent way to identify users of Station research findings, receive stakeholder input, identify problems that need to be addressed, and to find solutions. A research project on the Brown Marmorated stink bug (*Halyomorpha halys*) was requested by state residents. Current research on detecting pesticides and pathogens in honey bees started as a result of requests from beekeepers and fruit growers who are concerned about rising honey bee mortality. Work on removing invasive plants from lakes was initiated when Station scientists attended lake association meetings. Field research on specialty crops was increased at the requests of Hispanic and Asian residents. New cultivars of chestnut trees and grapes are being evaluated at growers' requests. Greenhouse growers requested research on ebb and flow irrigation systems. Station staff members, who were officers of civic groups, recognized the needs of the public and were able to respond. The two annual Open House events of the Station and frequent use of displays at public meetings, trade shows, and science fairs provided opportunities to meet stakeholders who are interested in science issues, and to hear about the problems that need attention. Written survey responses obtained at special listening sessions held by CAES scientists during evenings for growers were especially

useful in documenting public input. About 1,266 talks and interviews were given to civic groups and the media. Discussion during question and answer periods following the talks was an effective process in collecting input and in performing needs assessments. Major concerns are conveyed to the Director in writing. Research priorities on food safety, solving crop pest problems, providing new niche crops, and mosquitoes and ticks as transmitters of disease organisms were set as a result of public input. Phone inquiries from the public and stakeholder access to diagnostic services also revealed important problems that needed attention. For example, pest control operators have indicated that controlling bed bugs continues to be very difficult. Further, frequent attendance at agricultural groups' meetings was very helpful in collecting stakeholder input. An open listening session was held in collaboration with the Connecticut Urban Forest Council meeting for 168 attendees. Pest problems, difficulties in receiving permits for plant shipments and pesticide treatment, and interpreting federal and state plant regulations remain common concerns expressed by meeting participants. Finally, the Science Citation Index was used to identify scientists in other institutions who were recognizing the Station's published works and using new knowledge.

**2(B). A brief statement of the process that was used by the recipient institution to identify individuals and groups who are stakeholders and to collect input from them**

**1. Methods for collecting Stakeholder Input**

- Meeting with traditional Stakeholder groups
- Survey of traditional Stakeholder groups
- Meeting with traditional Stakeholder individuals
- Survey of traditional Stakeholder individuals
- Meeting with the general public (open meeting advertised to all)
- Survey of the general public
- Survey specifically with non-traditional groups
- Meeting specifically with non-traditional individuals
- Survey specifically with non-traditional individuals
- Meeting with invited selected individuals from the general public
- Survey of selected individuals from the general public

**Brief explanation.**

Written stakeholder input was received during this reporting period. The correspondence and completed surveys, which were well designed to ask specific questions, were very effective processes in collecting public input on research and outreach programs. Emphasis is being placed on obtaining more written input so that additional in-depth evaluations of program effectiveness can be made and that objectives can be prioritized. Giving research reports, providing displays, and attending meetings of traditional stakeholder groups, such as the Connecticut (CT) Tree Protective Association, CT Nursery and Landscape Association, CT Pomological Society, CT Forest and Park Association, Federated Garden Clubs, CT Pest Control Association, CT Academy of Science and Engineering, Christmas Tree Growers, CT Greenhouse Growers' Association, CT Urban Forest Council, Northeast Organic Farmers Association, CT Beekeeper Association, Backyard Beekeeper Association, and the Experiment Station Associates, were effective in collecting direct stakeholder input. Meetings for the CT Greenhouse Growers' Association were co-organized by a Station scientist and personnel in the UConn extension system. When scientists met with the general public at two Open Houses (advertised to all) and at organized events where exhibits were displayed, input was received from traditional and non-traditional stakeholders. Survey or evaluation forms, which provided for more formal written comments, were forwarded to Department Heads and the Director. All CAES staff members have been instructed to allow sufficient time following invited talks for

attendees to ask questions. This process allowed traditional and non-traditional individuals to provide additional input. Inviting high school students and teachers to see CAES laboratories and hear brief presentations on research resulted in collecting written stakeholder input from teachers (mostly non-traditional individuals). The 13,436 diagnostic tests performed for traditional and non-traditional individuals also resulted in stakeholder input. Finally, meeting with specific traditional and non-traditional individuals, such as state or federal legislative leaders or staff, was another effective method of collecting stakeholder input on research results and budgetary matters. A new, formal system of evaluating the effectiveness of Station research and outreach programs has been implemented by Connecticut's General Assembly. The Appropriations Committee requires all state agencies to report on performance measures and accomplishments as a part of their Results-Based Accountability (RBA) program. The Station's outreach activities and stakeholder input processes are components of the RBA evaluation requirement.

### **3. A statement of how the input will be considered**

- In the Budget Process
- To Identify Emerging Issues
- Redirect Research Programs
- In the Staff Hiring Process
- In the Action Plans
- To Set Priorities

#### **Brief explanation.**

Stakeholder input was considered by Station scientists, and in many cases, written comments were read by the Department Heads and the Director. All written comments received in e-mail messages, letters, or survey forms were reviewed by Station staff members and considered by the appropriate Department Head in re-establishing research priorities or initiating new studies. At the requests of stakeholders, 5,788 inquiries were answered in the Department of Plant Pathology and Ecology. Fungal and bacterial infections of crops and other plants have economic impact and reporting information to the National Plant Diagnostic Network (NPDN) has relevance to other states. However, many other inquiries answered in other departments, such as Entomology and Environmental Science, are not reported to the NPDN. Chrysanthemum white rust was once again detected. Growers requested guidance in disposing of federally regulated plant waste. Despite severe budget cuts, stakeholders want the high quality diagnostic and research services continued at the present level. Growers requested information on rapeseed cultivars for control of plant-parasitic nematodes. Pest control operators notified CAES scientists that chemical control of bed bugs was ineffective. Research on insecticide resistance is in progress. Health officials asked for research on Powassan virus in ticks. Beekeepers and fruit growers expressed concern about declining honey bee populations and requested that analyses be conducted for possible pesticide contamination. Hispanics and Asians requested assistance on introducing new specialty crops. Accordingly, experiments were conducted on 93 cultivars of 8 specialty crops. At the request of stakeholders, training was given on IPM practices. In nurseries, insect infestations of Christmas trees and other economically important crops are having detrimental effects on plant vigor and quality. Field tests were continued in response to stakeholder requests. In other cases, stakeholders were concerned about the following: chemical contamination of foods, forest health, ticks, mosquitoes and viruses, possible health problems associated with invasive plants, mold in buildings, and insect pests of grass turf. Based on written stakeholder responses, research priorities were re-assessed to address current and relevant problems. All written comments received by the Director were discussed with appropriate Department Heads, and in some cases, specific

objectives were included in the managers' annual performance goal programs.

**Brief Explanation of what you learned from your Stakeholders**

Stakeholders have extensive knowledge and experience, which can aid research programs. Potential environmental, economic, or health impacts became apparent. Damage to fruits and vegetables, caused by spotted wing drosophila (*Drosophila suzukii*) was reported to our entomologists. We were informed that golden bamboo might be another invasive plant. Station scientists and administrators learned that bed bugs are resistant to pyrethroid insecticides and that infestations in buildings are getting worse. Members of lake associations revealed invasive plant infestations and provided feedback on effectiveness of control methods, such as the use of herbicides and lakewater draw-down programs. Nursery growers enlightened Station scientists about new insect damage of Christmas trees and about the increasing problem of insect resistance to certain pesticides. The general public expressed their concerns over product and food safety. We learned that people do not have confidence in the quality of imported foods. Increased surveillance for unwanted chemicals and microbials in foods was requested by the public and the Station responded accordingly. A pilot program was established with the CT Department of Public Health to test foods for toxic chemicals and microbials. Physicians have alerted CAES scientists about the increase in numbers of ticks which transmit disease organism that cause Lyme disease, granulocytic anaplasmosis, and human babesiosis. These people described the impact that these diseases had on their lives and the need to develop tick control programs for homeowner properties. We were informed by local health officials that our new methods of controlling mosquitoes in catch basins are working. We learned from foresters that the Asian longhorned beetle and Emerald ash borer is spreading in Massachusetts and New York State, respectively. We learned from grape growers that fungal infections are a difficult problem to control. Fruit growers have informed CAES scientists that there are bacterial infections on peaches. Finally, CAES scientists learned that biochar might be an ideal soil amendment. Moreover, positive stakeholder input was received from growers and ethnic groups (Hispanic, Brazillian, and Asian) praising the Station's continued efforts to provide information on cultivars of specialty crops, such as jilo, calabaza, edamame, garlic, pak choi, daikon radish, vegetable amaranth, and Chinese cabbage. We learned that crops evaluated by Station scientists were grown commercially and sold in farmers' markets.

IV. Expenditure Summary

<b>1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)</b>			
<b>Extension</b>		<b>Research</b>	
<b>Smith-Lever 3b &amp; 3c</b>	<b>1890 Extension</b>	<b>Hatch</b>	<b>Evans-Allen</b>
0	0	965663	0

<b>2. Totaled Actual dollars from Planned Programs Inputs</b>				
<b>Extension</b>			<b>Research</b>	
	<b>Smith-Lever 3b &amp; 3c</b>	<b>1890 Extension</b>	<b>Hatch</b>	<b>Evans-Allen</b>
<b>Actual Formula</b>	0	0	965663	0
<b>Actual Matching</b>	0	0	4671285	0
<b>Actual All Other</b>	0	0	1752883	0
<b>Total Actual Expended</b>	0	0	7389831	0

<b>3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous</b>				
<b>Carryover</b>	0	0	0	0



**V. Planned Program Table of Content**

<b>S. No.</b>	<b>PROGRAM NAME</b>
1	Global Food Security and Hunger - Plant and Integrated Pest Management Systems
2	Food Safety
3	Human and Animal Health
4	Soil and Water Quality

**V(A). Planned Program (Summary)**

**Program # 1**

**1. Name of the Planned Program**

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

**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%	
	<b>Total</b>			100%	

**V(C). Planned Program (Inputs)**

1. Actual amount of FTE/SYs expended this Program

Year: 2011	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	14.4	0.0
Actual Paid Professional	0.0	0.0	12.9	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	510531	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	2367633	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	255184	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 are high yielding. New 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 expect that some of the new advances 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, who receive CAES assistance and informative new findings in science curricula. The following activities were planned: (1) CAES scientists will partner with stakeholders and participate in their organizations as members or officers, (2) CAES scientists will conduct workshops or special meetings for stakeholders, (3) experiments will be performed on growers' properties as well as on CAES research farms, (4) 93 cultivars, representing 8 different crops, are currently under evaluation, new cultivars of vegetables (e.g., pak choi) and fruits (e.g., strawberry) will be tested, (5) Methods of controlling powdery mildew and crown gall will be developed, dinofuran (Safari) will be tested as a trunk spray for insect pests of trees, (6) diagnostic services will be provided to stakeholders (7) training on IPM practices and other methodologies will be provided to stakeholders, (8) staff members will disseminate written information on research findings by presenting scientific displays at agricultural fairs and giving talks and interviews to civic groups, (9) staff members will work with the media and provide information on scientific discoveries, and (10) staff members will educate 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 18,700 stakeholders directly received assistance from these activities in this reporting period. CAES scientists are members or officers in at least 143 stakeholder 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 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. Two open houses were held on CAES properties to allow the public to hear oral presentations on research results and to offer comments. About 100 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 who grow vegetables, fruits, nursery stock, cattle, 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](http://www.extension.org)) to reach stakeholders nationally. Five 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, who have 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, 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, five staff 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](http://www.extension.org)).

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

2011	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
<b>Actual</b>	17187	47998	2364	9599

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

**Patent Applications Submitted**

Year: 2011  
 Actual: 1

**Patents listed**

Strawberry cultivar Rubicon

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

2011	Extension	Research	Total
<b>Actual</b>	0	22	22

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Total research papers

<b>Year</b>	<b>Actual</b>
2011	95

**Output #2**

**Output Measure**

- # of site visits to conduct research and solve problems

<b>Year</b>	<b>Actual</b>
2011	248

**Output #3**

**Output Measure**

- # of talks and interviews given to stakeholders

<b>Year</b>	<b>Actual</b>
2011	773

**Output #4**

**Output Measure**

- # of responses to stakeholders' inquiries

<b>Year</b>	<b>Actual</b>
2011	18700

**Output #5**

**Output Measure**

- # of diagnostic tests performed

<b>Year</b>	<b>Actual</b>
2011	5872

**Output #6**

**Output Measure**

- # of new IPM intervention strategies judged to be effective

<b>Year</b>	<b>Actual</b>
2011	6



**V(G). State Defined Outcomes**

**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	# of homeowners gaining knowledge on insect pests and plant pathogens
2	# of homeowners 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 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**

<b>Year</b>	<b>Actual</b>
2011	14168

### **3c. Qualitative Outcome or Impact Statement**

#### **Issue (Who cares and Why)**

Many ornamental plants commonly used in landscapes around Connecticut homes are important food sources for honey bees. Pollination by these insects accounts for about one-third of our food supply. Ornamental plants are subject to powdery mildew infections. This disease is caused by a fungus that grows on the surface of plant tissue giving the foliage a white powdery appearance. In addition to being unsightly, repeated infections by the fungus can also weaken plants by feeding on the sugar the plant produces and by blocking sunlight, which limits the ability of the plant to produce more sugar. Heavy infections reduce the vigor and longevity of a landscape planting. Although effective conventional chemical controls are available, many homeowners have concerns about using these products around the home because of issues with the safety and environmental impact of these compounds. Efforts were needed to develop an eco-friendly compound to control powdery mildew.

#### **What has been done**

With the goal of evaluating environmentally-friendly (biorational) compounds for disease management, a plot of woody and herbaceous plants susceptible to powdery mildew was established in the fall of 2008. This landscape planting consisted of woody ornamentals (lilac and deciduous azalea); perennials (bee balm, peony, and phlox); and annuals (zinnia and black-eyed Susan; that would commonly be found in a home planting. Eco-friendly foliar sprays of milk (25% - 33% in water), potassium bicarbonate (1% in water) and light horticultural oil (1% in water) were applied bi-weekly starting in early May and compared to conventional chemical fungicides in their ability to control powdery mildew.

#### **Results**

All three of the biorational foliar sprays significantly delayed the onset of disease by 2 to 5 weeks, depending on the host plant and year. Disease control was better for plants in full sun when compared to plants with morning shade. After 3 years of biorational treatments, the vigor of the



plants substantially improved over the unsprayed controls. In the short term, these biorational products were able to control disease and maintain the appearance of the planting through August, when infection pressure exceeded their ability to control the mildew. These findings had immediate impact. Homeowners, who have been notified of these test results, have begun using one or more of the eco-friendly foliar sprays. These results meet the needs of Connecticut homeowners, who seek environmentally-friendly, non-toxic alternatives to conventional fungicides for home use for disease control. Healthy ornamental plants support local honey bee populations, which are important pollinators for home gardens and commercial vegetable and fruit production.

#### 4. Associated Knowledge Areas

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

#### Outcome #2

##### 1. Outcome Measures

# of homeowners 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
2011	1908

##### 3c. Qualitative Outcome or Impact Statement

###### **Issue (Who cares and Why)**

Homeowners (including farmers) sought information on how to control plant and household pests. Problems that occur on private and commercial properties can sometimes be solved by using biological controls, grafting techniques, insecticidal soap, horticultural oil, or crop rotation. When these alternatives are not available, the least toxic chemicals are used. People want healthy plants, a clean and comfortable indoor or outdoor environment free of pests and chemical pesticides, and high-yielding, quality crops. Crown gall, caused by a bacterium, was identified by homeowners and commercial growers as an important problem of grape vines. Diseased plants often require replacement when physical wounds result from freeze damage or other causes. Connecticut's vineyard industry is thriving with 40 farms on about 320 acres. Wine production is at least 300,000 gallons per year with a value of nearly \$10 million. There was an immediate need to solve the crown gall problem.

**What has been done**

In commercial grape operations, scientists conducted experiments on stakeholders' properties. Experiments were continued with chardonnay (clone 96) budwood grafted onto rootstock (33096) to determine if grafting the vines at different heights could consistently reduce crop losses due to crown gall. Stakeholders assisted in the experimental design and allowed use of their own equipment and materials.

**Results**

Based on findings obtained over 5 years, high-grafted vines consistently reduced vine losses. The short-term benefits include a savings of about \$2,070 plus labor per acre in replacement costs for vines and increased grape production in CT. These advances not only support the grape-growing industry in CT, but also have potential to reduce crown gall damage in other states and countries. The long-term benefits include a profitable and growing fruit, juice, and wine-producing industry and preservation of agricultural lands at home and abroad.

**4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
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**

<b>Year</b>	<b>Actual</b>
2011	55

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Growers and homeowners 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 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 14 newspaper articles or other news releases on plants and IPM systems covering a wide range of topics, such as specialty crops, honey bee pollination, trees, gardening, and homeowner plantings. Station scientists gave 773 talks and interviews. At the summer Plant Science Day event, public television (CTN) taped talks given by scientists on plant systems and pests and telecasted the presentations to state residents via a cable network.

### **Results**

Reporters learned about a new strawberry cultivar (called Rubicon), potential problems with the Asian longhorned beetle and Emerald ash borer, 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 (86%) reporters accurately transferred new findings in written form to stakeholders. For example, a newspaper reporter learned that vegetable amaranth, an annual native to central Mexico, grows well in CT. This plant, high in calcium, magnesium, iron, protein, and vitamins A, B, and C, is used in soups. "All Red", "Red Stripe Leaf", and "Ground Round Leaf" have good yields (3.2 to 3.5 lbs/plant), and at \$0.99 per pound, there is a potential crop value of \$33,541/acre. There are very few pest problems associated with this plant. These results had impact because some growers are including this crop in their farm operations. A grower in Bloomfield, CT is supplying a local school system with this crop. The long-term benefits will include greater profits for growers, less pesticide use on farms, farmland preservation, and a source of locally grown, nutritious food for consumers. Science citations = 10 for the specialty crops program.

## **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
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**

<b>Year</b>	<b>Actual</b>
2011	510

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Educating youth, an under-served group, is a major outreach initiative. CAES scientists participated as judges in science fairs, showed exhibits and gave demonstrations at agricultural fairs and Plant Science Day. Staff members organized tours of laboratories and experimental plots. Parents want their children to learn about science, including skills of growing crops. Science teachers requested assistance in promoting interests in biology and chemistry and needed material for curricula.

**What has been done**

Scientists contacted career specialists in high schools in Bloomfield, New Haven, and Waterbury and invited students to see CAES facilities. During this reporting period, scientists also served as judges in science fairs, displayed exhibits at public events where youth of mixed racial and ethnic backgrounds attended, and gave at least 25 presentations to 374 elementary and high school students and 30 teachers. Students toured laboratories and saw demonstrations on the use of analytical equipment. Students from the Sound School in New Haven and from Waterbury, Connecticut learned how to grow vegetables in community gardens. They grew vegetables for their own use at the research farm and were taught good farming practices.

**Results**

Students of mixed racial/gender makeup and living in two cities, saw experimental field plots and learned how to grow vegetables, to control plant pests by using mulching practices, and how to fertilize and rotate crops. Elementary and high school 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 cultivars and about chemical analyses used to ensure food safety. These efforts to change knowledge in students about agriculture had impact. The students, who learned how to grow vegetables, shared their knowledge with family members and neighbors, who were participating in urban community garden programs. 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 gardening was incorporated in science programs in elementary schools 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**

<b>KA Code</b>	<b>Knowledge Area</b>
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**

<b>Year</b>	<b>Actual</b>
2011	10

### **3c. Qualitative Outcome or Impact Statement**

#### **Issue (Who cares and Why)**

Excessive use of pesticides on farms increases costs and environmental contamination. These chemicals can cause toxic effects on users, consumers and beneficial insects, and can pollute soil and surface and ground water. Christmas tree growers requested assistance on how to reduce amounts of pesticides used and exposure to chemicals. The adoption of IPM practices benefits farmers, consumers, golf course managers, landscapers, and the environment. Annual gross revenue for 440,000 harvested Christmas trees, representing 6% of the total 7.7 million trees in Connecticut, is valued at about \$9 million. Most growers include food crops on their farms to diversify operations and ensure sufficient income to keep the entire farm financially solvent. Christmas trees are normally grown relatively close together on 6,000 acres in CT. Under these conditions, insect pest problems can emerge and cause immediate economic losses. On Hemlock trees, earlier work revealed that systemic applications of pesticides might be more effective than the use of foliar sprays.

#### **What has been done**

Experiments were conducted with the insecticide dinotefuran (Safari) as a basal trunk spray of Christmas trees of 6 feet or less to control scale insects, adelgids, and other sucking insects.

#### **Results**

Field tests revealed that dinotefuran effectively suppressed armored scales and adelgids without negatively impacting biological control. Properly timed treatments avoided losses ranging from \$20,000 to \$50,000 per acre. These results had several impacts because growers in Connecticut, Pennsylvania, and Rhode Island have adopted the use of dinotefuran as a trunk spray in IPM programs, and the increased profits from Christmas tree sales helped support the production of fruits and vegetables on these farms. Moreover, Valent Biosciences Corporation, the producer of Safari, has obtained US EPA registration approval of basal bark spray use. The New York State Department of Environmental Conservation approved the use of Safari as a basal trunk spray for

eastern hemlocks.

#### 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
2011	6

##### 3c. Qualitative Outcome or Impact Statement

###### **Issue (Who cares and Why)**

The Asian population has increased in Connecticut during the past 20 years. Consequently, there is public demand for certain specialty crops. Moreover, growers seek special niche crops that can increase revenue.

###### **What has been done**

Experiments were conducted on several cultivars of pak choi to determine if this crop can be grown in Connecticut and if there is potential revenue for farmers.

###### **Results**

Cultivars "Joi Choi" (27.8 tons/acre) and "Canton Long" (17.6 tons/acre) had the greatest yields. At a retail price of \$0.99 lb., there is a potential crop value of \$55,044/acre. These findings had immediate impact because based on a recent survey of 220 farmers, 77 (35%) are now including pak choi in their farm operations and are selling their produce at farmers' markets. In addition to increased revenue for farmers, other benefits include providing a nutritious food for consumers and preservation of farmland.

#### 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

#### 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 (Media influences)

##### Brief Explanation

The loss of an IPM specialist in a prior reporting period and recent resignation of a scientist hired about 3 years ago, adversely affected outcomes because the new knowledge could not be effectively transferred to more growers. This vacancy will not be refilled because of a large state budget deficit and hiring freeze. Nonetheless, the actual quantitative target outcome of 6 growers adopting IPM practices was met because other scientists are working to develop IPM programs in commercial nurseries, orchards, and vegetable fields.

#### 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 374 students, whereas "before and after" program on-site evaluations and observations indicated that there were positive outcomes in more effective control of Christmas tree pests. Moreover, a survey of 220 farmers revealed that 77 were growing cultivars of Pak Choi that had been field tested at Experiment Station research farms.

##### Key Items of Evaluation

The Science Citation Index verified recognition of published articles on plant systems written by 28 scientists. There were 534 citations for this entire planned program during this reporting period. Twelve of 14 published news articles showed that substantial knowledge changes had occurred in reporters. The remaining 2 news articles had minor misquotes of information. Likewise, feedback from 6 teachers verified knowledge changes in youth. On-site observations and evaluations verified success in improved IPM monitoring and control methods.

**V(A). Planned Program (Summary)**

**Program # 2**

**1. Name of the Planned Program**

Food Safety

**V(B). Program Knowledge Area(s)**

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources			100%	
	<b>Total</b>			100%	

**V(C). Planned Program (Inputs)**

1. Actual amount of FTE/SYs expended this Program

Year: 2011	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	2.5	0.0
Actual Paid Professional	0.0	0.0	2.5	0.0
Actual Volunteer	0.0	0.0	1.2	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	46240	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	280754	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	0	0

**V(D). Planned Program (Activity)**

1. Brief description of the Activity

The main research activities are to develop more efficient analytical methods to detect toxic chemicals in food and other consumer products, to determine if consumer products are safe, and to



determine if pesticides are causing honey bee mortality. A pilot program was established in collaboration with the CT Department of Public Health to test foods for unwanted chemicals and microbials. Decisions on whether or not foods are "safe" depends on tolerance levels established for chemicals by the US Environmental Protection Agency (EPA) or the Food and Drug Administration (FDA). Good progress was made on all objectives. The activities, services, and events that reach people are designed to assist a broad, diverse group of stakeholders by mainly disseminating scientific information to the public through the media, publications, and exhibits. People will have equality of service, ease of access to scientific results, and the ability to see laboratories and field plots. The state-generated outputs include numbers of food samples tested, scientific publications, and talks and interviews. The following activities were planned: (1) new analytical chemistry procedures will be developed, (2) staff members will disseminate new information on analytical test results to visitors at open house events and in scientific displays at agricultural fairs, (3) oral presentations will be given to civic groups, and (4) laboratories will be opened to allow adults and youth to meet staff members and see analytical equipment. Direct interactions with a broad base of stakeholders provide a mechanism for public input on the research program. Non-traditional stakeholders are reached at agricultural fairs when they visit Station displays. Two open house events are scheduled annually on Station properties to allow the public to hear oral presentations on research results and to offer comments. Results of these activities will lead to specific outcomes, such as removing tainted or adulterated food items from the markets and greater public awareness of research on food safety.

**2. Brief description of the target audience**

A diverse group of targeted audiences includes: state and federal public health officials and regulators, state and federal legislators and their staff members, food producers and importers, managers of supermarkets, educators, extension specialists, researchers in the food sciences, and the general public. Women, members of minority organizations, and children are examples of under-represented and under-served groups who are expected to receive benefits.

**3. How was eXtension used?**

eXtension was not used in this program

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

2011	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
<b>Actual</b>	1311	13332	356	2128

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

**Patent Applications Submitted**

Year: 2011

Actual: 0

**Patents listed**

### 3. Publications (Standard General Output Measure)

#### Number of Peer Reviewed Publications

2011	Extension	Research	Total
Actual	0	1	1

#### V(F). State Defined Outputs

##### Output Target

##### Output #1

###### Output Measure

- Total research papers

Year	Actual
2011	5

##### Output #2

###### Output Measure

- # of talks and interviews

Year	Actual
2011	45

##### Output #3

###### Output Measure

- # of tests performed

Year	Actual
2011	744

**V(G). State Defined Outcomes**

**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	# of stakeholders gaining knowledge of food safety
2	# state regulatory agencies applying decisions on testing results

## **Outcome #1**

### **1. Outcome Measures**

# of stakeholders gaining knowledge of food safety

### **2. Associated Institution Types**

- 1862 Research

### **3a. Outcome Type:**

Change in Knowledge Outcome Measure

### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2011	1035

### **3c. Qualitative Outcome or Impact Statement**

#### **Issue (Who cares and Why)**

There have been several instances when foods were contaminated with toxic chemicals or microorganisms. Food producers, retail operators, and consumers want safe foods. Federal and state regulators request analyses of foods and enforce laws by recalling contaminated products from commerce. These programs include livestock feed, such as alfalfa.

#### **What has been done**

Inspectors from the CT Department of Consumer Protection collected foods from farms and wholesale and retail establishments and requested analyses for pesticides, toxins, and specified poisons. In a pilot program with the CT Department of Public Health (DPH) 52 separate samples, included in chemical analyses, were also screened for *Escherichia coli* (O157:H7), *Salmonella* species, and *Listeria monocytogenes*. Chemical analyses were performed at CAES and tests for microbials were done at DPH.

#### **Results**

Of the 52 products tested, 3 (6%) were violative for pesticide residues. Based on US EPA standards, domestic watermelon, alfalfa, and kale contained excessive residues of acephate, atrazine, and linuron, respectively. Kale samples also contained *Listeria monocytogenes*. The latter results had immediate impact because the US Food and Drug Administration performed a trace back on the product and ultimately ordered a national recall. In addition, the collaboration of state and federal agencies in testing food samples for chemicals and microbials will be continued. Other benefits include safer products for consumers and the prevention of human illnesses.

### **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from

Agricultural and Other Sources

**Outcome #2**

**1. Outcome Measures**

# state regulatory agencies applying decisions on testing results

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

Year	Actual
2011	5

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Foods and beverages are tested for unwanted chemicals and to determine if products are in compliance with labels. Consumers are concerned about potentially contaminated products. State and federal regulatory officials are mandated to enforce consumer protection laws.

**What has been done**

Research was conducted to determine if nanoparticles of specified materials might contaminate agricultural crops destined for human consumption. Nanoparticles have at least one dimension less than 100 nanometers. The focus was on the use of pesticides and fertilizers applied directly to food crops. From a regulatory perspective, nanomaterials are considered to have the same risk and toxicity profile as equivalent bulk material.

**Results**

In preliminary hydroponic experiments, results indicate that potential toxicity of a given nanoparticle may be significantly greater than that of the corresponding bulk material. The risk and toxicity profile for certain pesticides are not necessarily equivalent to corresponding bulk materials. These findings had immediate impact because health risks of nanomaterials are now being viewed more carefully. A new USDA grant has been awarded to CAES to define the impact of certain nanomaterials on food crops as they relate to the food chain. Corn, soybean, spinach, lettuce, and tomatoes will be studied. Long-term benefits include safe and healthy foods for consumers.

**4. Associated Knowledge Areas**

KA Code	Knowledge Area
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from

## Agricultural and Other Sources

### **V(H). Planned Program (External Factors)**

#### **External factors which affected outcomes**

- Appropriations changes
- Competing Programmatic Challenges
- Other (Staff changes)

#### **Brief Explanation**

One scientist retired on August 1, 2008, and with the current hiring freeze in place and continued budget cuts, this vacancy was not filled. This is a critical position because the discipline requires the testing of toxic heavy metals (e.g., lead, arsenic, cadmium, and mercury). However, a Postdoctoral Research Scientist has been hired on a federal grant and other scientists, who were working entirely on state projects with state funds, have been reassigned in either part or full-time status on Hatch-funded programs. Work continues in the Department of Analytical Chemistry and planned program objectives were met. Grant-funded positions are now a critical component for food safety programs.

### **V(I). Planned Program (Evaluation Studies)**

#### **Evaluation Results**

Information on research and service results was obtained "during the program" written evaluations and oral comments received at public meetings (1 Open House), civic groups' meetings, and at Station exhibits. Positive feedback was received from stakeholders. Observations made during interviews with stakeholders revealed positive stakeholder sentiment about program effectiveness and value.

#### **Key Items of Evaluation**

The key items of evaluation and data collection were as follows: stakeholders' written responses concerning food analyses; constructive written feedback from grant peer-reviewers for a competitive USDA grant (the grant on nanoparticles was awarded); and responses and corrective actions by the US FDA to recall contaminated kale from commerce. The Citation Index indicated that articles written in previous years by 3 scientists were recognized and cited by scientists in this field (total citations = 26 during the reporting period).

**V(A). Planned Program (Summary)**

**Program # 3**

**1. Name of the Planned Program**

Human and Animal Health

**V(B). Program Knowledge Area(s)**

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
722	Zoonotic Diseases and Parasites Affecting Humans			85%	
723	Hazards to Human Health and Safety			15%	
	<b>Total</b>			100%	

**V(C). Planned Program (Inputs)**

1. Actual amount of FTE/SYs expended this Program

Year: 2011	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	9.9	0.0
Actual Paid Professional	0.0	0.0	9.6	0.0
Actual Volunteer	0.0	0.0	11.4	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	227776	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	1529922	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	1002988	0

**V(D). Planned Program (Activity)**

1. Brief description of the Activity

The main research objectives are to determine the chief mosquito vectors of encephalitis viruses, the sources of blood meals in engorged mosquitoes, if biological control agents can control mosquitoes and

ticks, and to determine which vertebrate hosts are reservoirs for arthropod-transmitted pathogens. Major advancements continue to be made on all objectives. The expected outputs are designed to benefit federal, state, and local public health officials, physicians, veterinarians, and the general public. State-generated outputs mainly include scientific publications, talks and interviews, identifying and testing ticks for the Lyme disease agent, and numbers of state residents served directly by answering inquiries. For activities, staff members will (1) conduct research on tick and mosquito control and disseminate information on research findings by giving talks and media interviews, (2) analyze ticks and mosquitoes for disease agents, (3) answer public inquiries, and (4) inform public health officials on control methods. All activities strongly emphasize public service and include traditional and non-traditional stakeholders. Two open house events are planned annually on Station properties to allow the public to hear oral presentations on research findings and to offer comments. Results of these activities will lead to specific outcomes, such as more efficient or environmentally sound methods of tick and mosquito control and prevention of human illnesses.

**2. Brief description of the target audience**

Research on human and animal health benefits a broad range of stakeholders. Research findings were directly transferred to scientists via peer-reviewed journals and conferences. The general public was reached and participated in events by means of agricultural fairs, open houses, TV, radio, and newspaper articles. Media reporters frequently requested information for stories. Oral presentations were given to public health officials in meetings and, as requested, to civic groups. Also, state residents were allowed to submit ticks through local health departments for identification and analysis for the Lyme disease agent. Results were reported to public health officials who then informed the residents. General information on tick-related research was also provided. Fact sheets and other information were posted on the CAES website and made available to everyone. Although these communication venues allowed for extensive contacts with the public, special efforts were made to reach underserved and under-represented groups. Information on ticks and mosquitoes was printed in Spanish. A fact sheet on bed bugs was printed in Spanish, Chinese, and French. Displays at agricultural fairs and open houses were designed to interest children as well as adults. There has been ongoing cooperation with the Yale Peabody Museum to provide new information on mosquitoes and ticks to develop science curricula for middle and high school students. The Yale program, funded by a \$1.3 million Science Education Partnership Award and supported by the National Institutes of Health, is expected to impact 18,000 students and hundreds of teachers by 2016. Public participation in agricultural fairs was particularly effective in reaching non-traditional stakeholder groups.

**3. How was eXtension used?**

eXtension was not used in this program

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

2011	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
<b>Actual</b>	2952	34890	111	6978

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



Year: 2011  
 Actual: 0

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

2011	Extension	Research	Total
Actual	0	20	20

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Total research papers

Year	Actual
2011	23

**Output #2**

**Output Measure**

- # of talks and interviews

Year	Actual
2011	169

**Output #3**

**Output Measure**

- # of responses to stakeholders' inquiries

Year	Actual
2011	5275

**Output #4**

**Output Measure**

- # of ticks identified or tested

Year	Actual
2011	2593

**Output #5**

**Output Measure**

- # mosquitoes identified and/or tested

<b>Year</b>	<b>Actual</b>
2011	115725

**V(G). State Defined Outcomes**

**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	# of residents gaining knowledge of ticks, mosquitoes, and mold
2	# of media reporters gaining knowledge of ticks, mosquitoes, and mold

**Outcome #1**

**1. Outcome Measures**

# of residents gaining knowledge of ticks, mosquitoes, and mold

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

Year	Actual
2011	4207

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Prevalence of Lyme disease, human granulocytic anaplasmosis (HGA), and human babesiosis cases continue to increase in the United States. There were 30,169 confirmed and probable cases of Lyme disease reported to the Centers for Disease Control and Prevention in 2010. Without antibiotic treatment, persons can suffer from dermatologic, joint, cardiac, or neurological disorders. The mean cost per Lyme disease patient is about \$1,965 (in year 2000 dollars). Pathogens for HGA and babesiosis attack white and red blood cells, respectively. The application of pesticides remains one of the primary methods for tick control in the residential landscape, and there is growing interest in biological, natural, and cultural methods to reduce the risk of tick bite and disease. Only 22% of residents in one knowledge, attitudes and behavior Lyme disease survey indicated that they would use or consider using synthetic pesticides.

**What has been done**

Field research was conducted over several years to determine if nootkatone, a compound of the essential oil from the heartwood of Alaska yellow cedar and an extract from grapefruit, could control Ixodes scapularis nymphs. This tick is the main vector for the Lyme disease, HGA, and human babesiosis agents. New formulations of nootkatone were developed in cooperation with the USDA-Agricultural Research Service.

**Results**

A lignin formulation of nootkatone provided 100% tick control for over 6 weeks in the study plots. Reduced abundance or activity of nymphal ticks is of paramount importance in reducing risk of human infections during May and June in CT. These results have impact because nootkatone, a natural product, may provide an alternative to conventional synthetic pesticides and be an additional tool in IPM programs to prevent human illnesses.

**4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
722	Zoonotic Diseases and Parasites Affecting Humans
723	Hazards to Human Health and Safety

## **Outcome #2**

### **1. Outcome Measures**

# of media reporters gaining knowledge of ticks, mosquitoes, and mold

### **2. Associated Institution Types**

- 1862 Research

### **3a. Outcome Type:**

Change in Knowledge Outcome Measure

### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2011	44

### **3c. Qualitative Outcome or Impact Statement**

#### **Issue (Who cares and Why)**

Reporters frequently sought information on mosquitoes, ticks, human pathogens, and associated diseases and were interested in new information gained from research on the spread of disease organisms in nature and the status of tick and mosquito population densities. West Nile and Eastern Equine Encephalitis (EEE) viruses constitute ongoing threats to human health by causing severe illness or death. Since its introduction into the United States in 1999, West Nile virus has sickened nearly 30,000 people resulting in over 1,500 deaths. During this reporting period, there were six human cases of West Nile virus in CT, but no deaths were reported. Public health officials have requested studies on the ecology of mosquitoes and viruses and biological control of mosquitoes.

#### **What has been done**

There were at least 34 reporters who sought information on mosquitoes and encephalitis viruses. More than 2 million mosquitoes were tested for viruses over 12 years. By interviewing scientists, who were conducting field and laboratory investigations, the reporters gained new knowledge of mosquitoes and the three main viruses (West Nile, Eastern Encephalitis, and Jamestown Canyon) that cause human illnesses. Viruses cultured from mosquitoes were identified by RNA analyses. Results were conveyed to the general public via press releases. Tens of thousands of stakeholders were kept informed of recent research findings and the significance of new scientific advances as they relate to the geographic areas they live in.

#### **Results**

There were 44 news stories on mosquitoes and viruses. Eight reporters wrote multiple articles. Articles written by 32 (94%) of 34 reporters accurately transferred results to stakeholders. Reporters and stakeholders learned that *Culex pipiens* is the main carrier of the West Nile virus and that this species is a complex of closely related subspecies of mosquitoes. Results of DNA-based single nucleotide polymorphism markers were published in the American Journal of Tropical Medicine and Hygiene. Stakeholders also learned that biological controls (*Bacillus thuringiensis*, *B. sphaericus*, and *spinosad*) effectively reduced *Cx. pipiens* larvae in catch basins (published in the Journal of the American Mosquito Control Association). In a survey of 52 state residents, 24 (46%) indicated that they took precautions in preventing mosquito bites. These results had impact because mosquito control programs targeted the most important mosquito species and state residents took precautions to avoid mosquito bites. The long-term benefit is healthy human and domestic animal populations. Science citations = 120 for the mosquito/encephalitis virus program.

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
722	Zoonotic Diseases and Parasites Affecting Humans
723	Hazards to Human Health and Safety

#### 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)

##### Brief Explanation

Grant funds were available to hire a Postdoctoral Research Scientist and there were shifts in scientists' work times from state projects to Hatch projects. Because of delays in re-hiring temporary workers on grant funds, it was difficult to collect mosquitoes from field sites. The traps used require technical expertise and the use of dry ice (carbon dioxide attracts mosquitoes). The public would not be able to assist on mosquito collections. There were no changes in public policy, competing priorities, or competing programmatic challenges. There continues to be a hiring freeze on state-supported positions.

#### V(I). Planned Program (Evaluation Studies)

##### Evaluation Results

"During program" and "after only" evaluations were conducted to assess program effectiveness. The treatment of catch basins in areas where West Nile virus is prevalent was successful in reducing *Culex pipiens*. Surveys of stakeholders revealed positive responses to news releases to warn the public about infected mosquitoes, at least 46 of 52 persons surveyed indicated that they closely followed advice to reduce exposure to mosquitoes.

### **Key Items of Evaluation**

Data were collected mainly by on-site evaluations conducted following talks to civic groups. A survey was conducted to assess changes in behavior regarding prevention of mosquito and tick bites, and there were face-to-face interactions with reporters and other stakeholders. During this reporting period, there were a total of 381 citations for scientific articles written by 9 scientists on ticks and mosquitoes for the entire planned program.

**V(A). Planned Program (Summary)**

**Program # 4**

**1. Name of the Planned Program**

Soil and Water Quality

**V(B). Program Knowledge Area(s)**

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
112	Watershed Protection and Management			30%	
133	Pollution Prevention and Mitigation			70%	
	<b>Total</b>			100%	

**V(C). Planned Program (Inputs)**

1. Actual amount of FTE/SYs expended this Program

Year: 2011	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	3.2	0.0
Actual Paid Professional	0.0	0.0	3.2	0.0
Actual Volunteer	0.0	0.0	4.8	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	181116	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	492976	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	494711	0

**V(D). Planned Program (Activity)**

1. Brief description of the Activity

The main research objectives are to develop chemical, biological and mechanical methods of controlling invasive plants, to use molecular methods to identify invasive plants, and to develop procedures to monitor herbicides in water. Good progress was been made on these objectives. The expected outputs



are new scientific findings; scientific publications, newsletters, and fact sheets; talks and interviews; and numbers of state residents served directly by analyzing soil samples, identifying invasive aquatic or terrestrial weeds, or controlling these pest plants. These activities, services, or events are designed to provide new information that will be used by the general public and to seek their input on the research program and findings. Participation by members of lake associations in group discussions and workshops are particularly important because these stakeholders must agree on how to remove aquatic weeds from lakes. Options are limited for herbicide treatment and mechanical methods, which can vary in effectiveness depending on the extent of invasive weed infestations. Diagnostic services are available to determine the extent of pollution problems and to determine the success of field experiments. Water quality standards for acceptable herbicide concentrations are those established by the CT Department of Energy and Environmental Protection. Information will also be made available to all stakeholders on the CAES website, in newsletters and fact sheets, and in displays at the open house events or at agricultural fairs. It is also expected that there will be interest from reporters to write articles on the research, thereby enhancing awareness of invasive plant infestations. Results of these output activities will lead to specific outcomes, such as removing pesticides from soil and water, clearing lakes and ponds of invasive aquatic plants, and preventing loss of water quality.

**2. Brief description of the target audience**

A broad base of stakeholders, including under-represented and under-served persons, is targeted. It is expected that the following stakeholder groups will directly benefit from the research: farmers, lake associations, boaters, homeowners, water company officials, environmentalists, extension specialists, corporate and municipal officials, and pesticide producers. Special efforts will be made to contact and include members of minority organizations, women, and children to provide information and to participate in open house events.

**3. How was eXtension used?**

eXtension was not used in this program

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

2011	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
<b>Actual</b>	1275	2375	195	1475

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

**Patent Applications Submitted**

Year: 2011

Actual: 0

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

2011	Extension	Research	Total
Actual	0	7	7

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Total research papers

Year	Actual
2011	9

**Output #2**

**Output Measure**

- # of talks and interviews given to stakeholders

Year	Actual
2011	165

**Output #3**

**Output Measure**

- # of diagnostic tests performed

Year	Actual
2011	10190

**V(G). State Defined Outcomes**

**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	# of homeowners gaining knowledge on pesticide pollution and invasive aquatic plants
2	# of homeowners gaining knowledge about watershed protection and soil and water quality
3	# of lakes and ponds surveyed and/or cleared of invasive aquatic plants

## **Outcome #1**

### **1. Outcome Measures**

# of homeowners gaining knowledge on pesticide pollution and invasive aquatic plants

### **2. Associated Institution Types**

- 1862 Research

### **3a. Outcome Type:**

Change in Knowledge Outcome Measure

### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2011	816

### **3c. Qualitative Outcome or Impact Statement**

#### **Issue (Who cares and Why)**

Extensive growths of invasive aquatic weeds, such as Eurasian water-milfoil (*Myriophyllum spicatum*) can significantly reduce water quality and alter wildlife habitats. Candlewood Lake, the largest body of fresh water in Connecticut, is infested with this invasive plant. First Light Hydro Generating Company requested assistance on surveying and controlling Eurasian water-milfoil. State residents who live near or use this lake are concerned about the rapid growth of the weed.

#### **What has been done**

Surveys were conducted over a 4-year period to record the locations of Eurasian water-milfoil populations in Candlewood Lake. Results were mapped. Research was conducted to eradicate the invasive plants. Water levels in the lake were dropped in varying amounts in an effort to reduce populations of the plants. The densities of Eurasian water-milfoil populations were re-examined the next summer following water drawdowns.

#### **Results**

Surveys revealed that Eurasian water-milfoil is a dominant plant in the lake and that this weed is rapidly replacing native aquatic plant species. A comparison of acres of infestation reduced following shallow versus deep water drawdowns of water revealed that deep drawdowns during winter months were more effective in controlling the weed. A 10-foot drawdown in water level significantly reduced the invasive plants, whereas a 3-foot drawdown in water level was ineffective. This new knowledge changed the strategy for controlling Eurasian water-milfoil. It was concluded that the timing of water drainage is crucial in maintaining sufficient water supply and controlling the invasive plant. The maximum depth of the water drawdown must be carefully timed with onset of shoreline water freezing. These results had an impact because new control methods have been developed to manage the invasive plant. Long-term benefits will be a clean water supply and a body of water which can be used for recreation.

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation

#### Outcome #2

##### 1. Outcome Measures

# of homeowners gaining knowledge about watershed protection and soil and water quality

##### 2. Associated Institution Types

- 1862 Research

##### 3a. Outcome Type:

Change in Knowledge Outcome Measure

##### 3b. Quantitative Outcome

Year	Actual
2011	3900

##### 3c. Qualitative Outcome or Impact Statement

###### **Issue (Who cares and Why)**

Homeowners, landscapers, golf course managers, and farmers frequently use fertilizers. In many cases, these chemicals are applied without knowledge of soil quality. This practice can lead to polluted surface and ground water and encourage rapid growth of algae and other invasive aquatic plants. People who own or rent lake-front properties have expressed concern over reduced water quality and the inability to navigate boats in areas where aquatic weed populations are dense.

###### **What has been done**

At the request of about 3,900 stakeholders, 4,090 soil tests were performed at our research laboratories in Windsor, CT to determine nitrogen and phosphorous concentrations, acidity, and amounts of organic matter present. Specific results were provided on soil quality, and, as a part of an educational program, written suggestions were made concerning the application of fertilizers and lime to improve soil quality, or a statement was provided that no fertilizers were needed.

###### **Results**

Analyses revealed that 941 (23% of 4,090 samples) were considered adequate for plant growth and did not require fertilizer applications. These stakeholders, mainly homeowners who submitted soil samples collected from their lawns or gardens, learned that they did not need to purchase fertilizers and, collectively saved about \$18,820. Another important short-term benefit is less fertilizer leaching into surface and ground water. The long-term benefit is a cleaner environment.

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation

#### Outcome #3

##### 1. Outcome Measures

# of lakes and ponds surveyed and/or cleared of invasive aquatic plants

##### 2. Associated Institution Types

- 1862 Research

##### 3a. Outcome Type:

Change in Action Outcome Measure

##### 3b. Quantitative Outcome

Year	Actual
2011	20

##### 3c. Qualitative Outcome or Impact Statement

###### **Issue (Who cares and Why)**

Invasive aquatic plants reduce public access to water, restrict boat navigation, decrease water quality by increasing sedimentation and eutrofication rates, and alter wildlife habitats. People who own or rent lake-front properties have requested assistance on the control of aquatic weeds, such as Eurasian water-milfoil, variable water-milfoil, curly leaf pondweed, fanwort, common water-hyacinth, yellow iris, and watercress. Based on earlier studies, it appears that conventional morphological methods of identifying variable leaf water milfoil (*Myriophyllum heterophyllum*) cannot reliably distinguish this plant from other *Myriophyllum* species. More precise taxonomic methods were needed to document variable leaf water milfoil invasions and to determine if invasions result from single introductions or multiple independent introductions from a variety of source populations.

###### **What has been done**

Research was conducted to assess genetic variation in *M. heterophyllum* in its native range and two disjunct introduced ranges in the US (eastern versus western US). Analyses were based on using chloroplasts and ribosomal DNA sequences, as well as amplified fragment length polymorphisms.

###### **Results**

The molecular markers used in identification were useful in reconstructing invasion history of *M. heterophyllum* and in distinguishing this plant from closely related species. A strong phylogeographic break distinguished populations located on the Atlantic Coastal Plain versus other "continental" portions of the native range. It was concluded that the introduced ranges of

variable leaf water milfoil (northeastern and western US) resulted from multiple independent introductions from several sources. Although *M. heterophyllum* is genetically distinct from *M. hippuroides*, there is some hybridization occurring between the two species. Results were published in the *Journal of Biological Invasions*. These findings have had impact because molecular markers are now available for further taxonomic and molecular studies. Scientific advances can make direct contributions to managing invasive plant species by identifying potential introduction pathways, potential biological agents, and by distinguishing between different introduced taxa or native species.

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation

#### V(H). Planned Program (External Factors)

##### External factors which affected outcomes

- Economy
- Appropriations changes
- Other (Staff changes)

##### Brief Explanation

Although there were no external factors that immediately affected outcomes during this reporting period, the current sluggish economy, changes in state or federal appropriations, and resulting staff changes remain the primary external factors that could affect outcomes.

#### V(I). Planned Program (Evaluation Studies)

##### Evaluation Results

"Before and after" and "during" evaluations were conducted to document increased knowledge of aquatic plants, whereas "during" evaluations were most helpful in assessing advanced knowledge of stakeholders on soil and water quality issues. More than 90 stakeholders participated in the aquatic weed abatement programs and in town meetings. They followed progress as treatments cleared the weeds from targeted areas and indicated in surveys that they learned new information on control of invasive aquatic plants.

##### Key Items of Evaluation

Written information on evaluation forms following two workshops, held in different towns, was an important information collection method for program assessments. During this reporting period, there were 398 citations for scientific articles written by 4 scientists for the entire planned program. These citations indicate that knowledge was gained by scientists and used in their studies.