2003 Annual Report of Accomplishments and Results

The Connecticut Agricultural Experiment Station

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TABLE OF CONTENTS

Executive Summary (Overview)

The Connecticut Agricultural Experiment Station ("Station") continues to serve the needs of all citizens. Not being a university, no federal funds are received for education or extension, but federal formula and grant funds are received for research. Research findings are continuously reported to the public in different venues. Efforts are made to include growers and other stakeholders in the research planning process. Outreach programs continue to be expanded and modified to meet the needs of the under-served and under-represented. Collaborations continue between the institution's scientists and extension specialists at the University of Connecticut and other land-grant universities and, thereby, continue to disseminate new findings to a broader base of stakeholders. State appropriations continue to exceed amounts of federal Hatch funds, but the latter continue to play an important role in our ability to respond quickly to emerging problems, conduct relevant research, and to meet the needs of society.

As in the past three years, we are pleased to report progress that benefits stakeholders. In many instances, the results obtained over the past three years can now be more easily assessed regarding their immediate and long-range impacts on these people. Outcomes have resulted in economic, health, or environmental benefits or behavioral changes in stakeholders. The research accomplishments reported herein align with some focus areas of the CSREES budget: improved pest control, invasive species program, organic agriculture, the importance of small farms, sustainability of agriculture and forestry, food safety, and water quality. The research programs at The Connecticut Agricultural Experiment Station are strongly supported by stakeholders of different racial and ethnic backgrounds, who in some instances call problems to our attention. Stakeholders have access to Station programs and research information and are given opportunities to see laboratories and experimental plots, meet scientists, comment on research findings, and to request new research initiatives as the needs arise.

Research programs at The Connecticut Agricultural Experiment Station focus primarily on national priorities and federal (USDA) goals on improving the agricultural production system to be highly competitive in the global economy (goal #1). Food safety and environmental issues are also of concern to stakeholders, particularly with regard to potential terrorism activity. Accordingly, there are program activities associated with USDA national goals #2 and #4, respectively. Some research programs described herein also address goal #3 (" A healthy, well-nourished population") and goal #

5 (“Enhanced economic opportunity and quality of life for Americans”). Details on how all 5 national goals are being met are described in the *Planned Program* sections. As required, this Annual Report of Accomplishments and Results includes financial data for federal FY2003. The research results and impact statements are primarily linked to FY2003 activities, but collective results for this Plan of Work cycle are described to show short and long-term benefits to society.

To further promote the competitiveness of our agricultural system in an expanding global economy, many research initiatives are directed at adding value to new and old agricultural products, increasing profitability, encouraging energy efficiency, reducing the use of pesticides, and improving soil conditions, plant health, and agricultural production. Multistate and integrated activities increase efficiency and enable us to make progress on a wide range of problems. Stakeholders have requested assistance on identifying insects that attack crops, diagnosing plant diseases, treating diseased and infested plants with minimal amounts of pesticides or by cultural practices, and on growing vegetables organically. Integrated Pest Management (IPM) practices are being accepted by growers. It is important to develop new analytical methods and to refine older methods in our efforts to detect and quantitate pesticide residues and unwanted chemicals in soil, air, food, and drinking water. Finally, with increased amounts of imported goods, there is a need to survey our nurseries, orchards, vegetable crops, and forests for exotic, invasive insect and plant species and to take corrective action when problems arise.

Highlights of major accomplishments in Hatch/state-supported program **goal #1** are as follows:

1. Chiral gas chromatography with ion trap mass spectrometry detected chlordane residues in air over a 40-year old application site in Connecticut. Volatilization of chlordane residues occurred from the topmost centimeter of soil, but concentrations of pesticide residues decreased in ambient air with height. Chlordane residues were detected in zucchini plants grown on contaminated soil. Two major short-term benefits resulted from this work. First, the newly developed analytical procedures were found to be sensitive and specific in their detection of chlordane residues. Scientists in other institutions are now using these methods. Second, it is now known that chlordane residues persist for decades longer than originally thought and can enter edible crops. This information has impact because zucchini should not be grown in contaminated soils. Vegetable growers have responded by not planting zucchini in chlordane-contaminated soil.
2. A computer model developed to predict the effects of a pathogenic fungus, *Entomophaga*

maimaiga, was useful in predicting infections in gypsy moth caterpillars. It is now possible to use incidence of fungus infection of caterpillars to estimate survival rates of the pathogen. Stakeholders benefited by knowing that the fungus effectively controls gypsy moths and unnecessary preventive spraying of trees was avoided. Consequently, less pesticides were used in urban, suburban, and rural forested areas. The computer model is posted on the Station's website and is being used by other scientists for short-term and long-term benefits in predicting gypsy moth populations for improved natural resource management.

3. As a part of multistate, integrated activities to meet the long-term critical issues of fruitgrowers, a model has been further developed to estimate probability of apple scab infection in orchards. New information indicates that the pathogen may be able to spread by means of leaps between regions of host plants separated in space. Growers are now using IPM practices, such as monitoring for infections and mulch-mowing, for short-term benefits to reduce apple scab infections. With widespread acceptance by apple growers, nationally, these IPM practices could have the long-term benefit of saving $3.5 million in fungicide costs. Another expected long-term impact with less pesticide usage would be the preservation of the overall orchard environment by reducing run-off of pesticides into streams and ground water, less adverse impact on beneficial insects and mites, and less human exposure to pesticides.
4. Experiments were conducted to determine if coating chromate copper arsenate (CCA) preserved wood with paint or stain can form a barrier to leaching arsenic in soil. Significant reductions in arsenic leaching were observed when the wood was coated with acrylic and alkyd resins or with polyurethane. Stakeholders are now reducing arsenic leaching for short-term benefits in garden plots where CCA-treated wood is used as borders for raised beds containing edible plants. Long-term benefits are expected because alternative wood products, not CCA treated, are being considered by industry.
5. Field tests conducted in five nurseries revealed that the insecticide bifenthrin, applied to potting media in concentrations of two parts per million (ppm) protects plants from feeding damage caused by oriental and Japanese beetles. Nursery growers are now using less pesticides as a short-term benefit to obtain quality plants for wholesale and retail sales. Further reductions in amounts of pesticides used and lower costs of pest management are expected as long-term benefits. Reduced pesticide usage will decrease adverse impact on beneficial insects and non-target organisms in nurseries and will lessen human exposure to insecticides.

6. The insecticide bifenthrin, applied as a root dip at 600ppm, synergistically improved the infection of late-instar oriental beetle larvae with a pathogenic nematode, *Heterorhabditis bacteriophora.* These root dip treatments do not interfere with IPM practices. Growers benefited in the short term by having reduced costs for pesticide treatments. With less pesticides being used and more growers implementing IPM practices, long-term benefits for a cleaner environment are expected.
7. Digital photographs of arugula cultivars and pertinent information on yield, early harvest, leaf quality, and delayed molting have been submitted to the North Central Regional Introduction Station to be posted on the Germplasm Research Information Network. Plant breeders, growers, scientists in seed companies, and other stakeholders are accessing the new findings and are growing the most desirable cultivars. With further testing of selected cultivars, profits are expected as high quality plants are grown to meet market demands. These efforts will lead to expanding economic opportunities in rural America.
8. To assist fruitgrowers with pest management of apple tortrix infestations, biological studies were conducted to determine the life history of this insect and optimal times for insecticidal treatments with minimal impact on beneficial insects and mites in orchards. It was concluded that the pre-bloom sprays already applied in pest management programs were sufficient to control apple tortrix. Fruitgrowers benefited in the short-term by not having to add extra costs for insecticide treatments. There will be a cleaner environment and less human exposure to insecticides in the long-term by having fewer insecticides applied.
9. As a part of multistate, integrated activities, the use of Polynema marigold as a rotation crop in potato fields significantly reduced prevalence of *Pratylenchus penetrans,* a parasitic nematode. Use of a marigold rotation crop increased profits by about $500 per acre by reducing costs of pesticide applications used for a short-term benefit. Potato growers are now willing to try effective rotation crops and reduce nematicides for long-term benefits of a cleaner environment and less human exposure to pesticides.
10. The use of green manures in vegetable production (ie., eggplants, potatoes, and tomatoes) reduced verticillium wilt for at least one year after incorporation into the soil. This eliminated the need to apply fungicides, and growers saved about $250 per acre for short-term benefits. Growers now know that there are other alternatives to fungicide treatment of verticillium. These stakeholders are more willing to follow IPM methods, which offer long-term benefits for a cleaner environment.

11. A pumpkin grower, who lost his entire crop, and other stakeholders requested assistance on determining the cause of crop disease. Examination of seeds from infected pumpkins revealed the presence of a pathogen, *Fusarium solani*. For short-term benefits, growers now know the specific cause of pumpkin decline and how to recognize early stages of infection. A monitoring system has been established to detect this fungus, and control measures have been implemented to prevent further unexpected losses for long-term benefits.

Goal 1: Federal Hatch Funds ($437,495), State Funds ($2,177,548), Scientist Years (15.5)

Stakeholders are concerned about food safety issues and have requested analyses for pesticide and other chemical residues in the food supply. Annual marketbasket surveys and analyses of food items yielded results of public interest.

Highlights of major accomplishments in program **goal #2**, which had support from Hatch and state funds, are as follows:

1. In routine analyses of 270 produce samples for pesticides, most samples had no detectable amounts or concentrations well below tolerance limits established by U.S. EPA. However, a non-permitheol pesticide residue (iprodione) was detected in quince imported from Chile. In another case, permethrin was detected in canned mustard greens. Results had immediate impact nationally. There were voluntary recalls by food producers and destruction of contaminated food products for short-term benefits. On a long-term basis, stakeholders will be re-assured that canned and frozen vegetables are safe to consume and that a wide range of foods will continue to be tested.
2. In the analyses of 545 food samples, suspected by consumers as being contaminated or tampered with, three problems were identified. Fungal material was found in several bottles of apple juice, macaroon cookies were rancid, and organic syrup was found to contain 1.5% ethanol and yeast. For short-term benefits, national recalls of all products occurred after food producers and the U.S. FDA officials were notified. Also, stakeholders received prompt responses to their inquiries. The long-term benefits of food analyses programs and results ensure safe foods of high quality, enhance an expanding base of stakeholders receiving services, and provide a system for detecting bioterrorist acts of contaminating the nation’s food supply.

3. Cider producers requested assistance on evaluating ultrasonic cleansing methods for decontaminating *E. coli* in apple cider. Although there were no noticeable changes in physical properties of ultrasonic-treated, non-contaminated cider when blind tastes were conducted, high-energy sonication procedures were needed to decontaminate *E. coli* altered cider composition. Compared to flash pasteurization and ultraviolet pasteurization methods, stakeholders learned that ultrasonic technology was a non-viable alternative for sanitation. These findings had immediate regional impact. Cider producers in New England used this information in implementing more efficient sanitation programs to obtain quality products for short-term benefits. Consumers benefited by having safe cider available that was still nutritious. Flash and ultraviolet pasteurization methods decontaminate bacteria from cider without altering product quality and offer alternative cleaning procedures for other juices as a long-term benefit.

Goal 2: Federal Hatch Funds ($122,824), State Funds ($294,071), Scientist Years (2.9)

Research objectives in program **goal #4** are designed to address a variety of environmental problems and issues that are of interest to stakeholders. Arthropod-transmitted pathogens that cause Lyme disease, ehrlichiosis, babesiosis, or encephalitis affect humans and domesticated animals. Monitoring for changes in the natural occurrence of these infections and improving laboratory diagnosis meets the immediate critical needs of stakeholders. There continues to be grower interest in more efficient plant nutrient management in greenhouses, developing composting programs, and in implementing IPM programs. Deer populations continue to rise, and with damage to crops and motor vehicle accidents caused by these animals, research on reducing deer was initiated.

Highlights of major accomplishments in program **goal #4**, which had support of Hatch and state funds, are as follows:

1. In evaluations of greenhouse tomatoes, the cultivar “Quest” gave the highest marketable yield (10.4 pounds per plant) with minimal cracked skin defects. This cultivar grew well with reduced amounts of nitrogen and potassium nutrients. These results had impact. Some growers have added “Quest” to the selection of cultivars for greenhouse production as a short-term benefit. Consumers benefit by having nutritious, quality tomatoes available throughout the year. Reductions in the use of nitrogen and potassium as nutrients in greenhouses have expected long-

term benefits because there will be less contamination of streams and ground water due to reduced run-off.

2. In efforts to biodegrade polynuclear aromatic hydrocarbon (PAH) compounds from soil, experiments were conducted to investigate desorption with Alfonic 1412-7, a non-ionic alkyl ethoxylate surfactant. At high concentrations, this surfactant significantly enhanced the extent and rate of release of PAH compounds from the soil. These promising results show that desorption of PAH compounds from contaminated soil is possible as a short-term benefit. With further work, methods can be developed to remove contaminants from soil and have cleaner environments available for recreation or re-development of currently non-useable lands as long-term benefits.
3. The owners of a large mushroom farm in eastern Connecticut requested assistance on finding ways of recycling spent growing media. Other stakeholders requested assistance on determining the effects of mushroom wastes on the growth of ornamental plants in containers. In tests with two varieties of chrysanthemum, results showed the best growth for plants when mushroom waste compost was in lower percentages (less that 25%). Thus, this material is suitable as a soil amendment, and growers have begun to use the composted material as a short-term benefit. With increased usage of mushroom wastes by more growers, more efficient recycling of the wastes will be accomplished on a larger scale for a cleaner environment in the long term.
4. To answer immediate questions from stakeholders as a short-term benefit, composted leaves were analyzed for chlordane, a banned pesticide. There were concentrations of this insecticide ranging from 5 to 415 parts per billion. This finding had impact because efforts have led to the design of other experiments to determine if compost with chlordane can enter edible plants grown with this material. Stakeholders want to know if the use of compost is a safe farming or gardening procedure for long-term use.
5. Eastern equine encephalitis (EEE) and West Nile encephalitis (WNE) viruses persist in mosquito and bird populations in Connecticut, where human or equine infections have been reported. Analyses of 190,692 mosquitoes from 14,649 pools yielded 51 and 53 isolates of EEE and WNE viruses, respectively, most of which originated in areas of dense human populations. With public release of this information, stakeholders used repellants and changed their behavior to avoid mosquito bites during high risk periods. Knowing patterns of virus infections in mosquitoes and birds over several years will help provide long-term benefits by predicting viral outbreaks.

6. Newly developed enzyme-linked immunosorbent assays, containing purified recombinant antigens (i.e., fusion proteins) are being used experimentally to diagnose human granulocytic ehrlichiosis and Lyme disease in human beings and domesticated animals. These assays are highly sensitive and specific and have led to short-term benefits by determining whether or not 198 persons were exposed to tick-borne infectious agents. Technological information has been transferred to the private sector, and commercialization of these diagnostic methods is being pursued by a small biotechnology company. The new methods could also have application in diagnosing other infectious diseases. Early diagnosis would result in expected short-term benefits of effective treatment and long-term benefits of healthy human and domestic animal populations.
7. An entomogenous fungus, *Metarhizium anisophiae*, kills *Ixodes scapularis* ticks in natural settings and is a useful adjunct control method as a short-term benefit. More extensive use of this fungus for control will lead to less human exposure to chemical pesticides, less adverse impact on non-target organisms, and a cleaner environment in the long term.
8. Deer populations have risen sharply in many states. In a new initiative on developing methods to sterilize male deer, a sclerotizing agent was injected into the cauda epididymis. The compound caused a scar to develop within the epididymis and, thus, blocked the flow of sperm. The sterilization method was successful, and treated males continued to engage in normal mating and mate-guarding behavior. As a short-term benefit, scientists in other states can now apply the method in their experiments. Extensive application of these methods offer long-term benefits of reducing deer populations, reducing losses due to automobile accidents and crop damage, and improving natural resource management in forests.
9. Experiments revealed that a microsporidian parasite, *Hyalinocysta chapmani*, had a detrimental effect on a bird-feeding mosquito, *Culiseta melanura*, which harbors and transmits Eastern Equine Encephalitis viruses. These findings are important because the microsporidian has potential as a biological control agent. Scientists in other institutions have begun studies on this organism. With further work on formulating the biological control agent for commercial uses, long-term benefits of fewer chemical pesticides being used will lead to a cleaner environment, less adverse impact on non-target organisms, and reduced exposure of humans and domesticated animals to pesticides.

Goal 4: Federal Hatch Funds ($200,222), State Funds ($2,012,206), Scientist years (20.8)

There are new accomplishments during this reporting period that benefited a broad and diverse group of stakeholders by helping to solve immediate problems. Meaningful results were reported to clientele and stakeholders in meetings, via the media, in written reports, on the station's web site (http://www.caes.state.ct.us) or by other means described later. There was continued good balance in the scope of impact with a mixture of multistate and state-specific projects.

The USDA-approved multistate Hatch research projects (NE-009, NE-164, NE-171, NE-183, NE-187, NE-1005, S-301, and W-082) allow for extensive scientific collaborations during times when individual experiment stations have had to reduce resources due to budget cuts. The diverse backgrounds and expertise of these scientists enhanced research efforts. Other less formal multistate collaborations also exist and benefited the overall research effort. The interaction with extension specialists allows for greater dissemination of new information to broader audiences and provides research scientists with different perspectives on stakeholder needs and concerns. The Hatch funds were efficiently utilized and are acknowledged in peer-reviewed publications. Hard copies of stakeholders' letters are also available on request as examples to show citizens' gratitude and satisfaction for the services and research results they received. There is growing concern among stakeholders about what government officials are doing to protect the nation's food supply from bioterrorism. The networking of diagnostic laboratories to detect and report emerging plant and animal pathogens should include all partners of CSREES, including The Connecticut Agricultural Experiment Station, and should receive high priority.

Introduction

In accordance with the Agricultural Research, Extension, and Education Reform Act (AREERA) of 1998, this fourth Annual Report of Accomplishments and Results (with accompanying impact statements) included in the *Planned Programs* sections is submitted. The Connecticut Agricultural Experiment Station (referred to as the "Station" in this report) is unaffiliated with a university and does not receive federal funds for extension or education. Federal Hatch and McIntire-Stennis funds are received for research, however. Therefore, the accomplishments and impacts reported herein are based on the Station's research program, the main mission of the institution. Some research efforts, however, are linked to extension programs at universities. Accordingly, information on research findings was disseminated to extension personnel in accordance with the Station's approved Plan of Work. Improvements have been made in the multi-functional programs, including the integration of research and extension activities. Extension personnel at the University of Connecticut and other land-grant universities in northeastern United States heard oral presentations given by Station scientists and received written research findings that can be incorporated in educational programs directed at all five national USDA goals. Joint publications for scientists and other stakeholders have resulted. The main mission of CSREES to advance knowledge for agriculture, the environment, human health and well-being, and communities is consistent with that of the Station, as is the goal to enhance economic opportunities and quality of life among families and communities. Staff members at the Station develop creative research to provide the support that growers and other stakeholders need to succeed.

The Station's outreach program and engagement with stakeholders is extensive and mutually beneficial. We define stakeholders as those who are interested in and benefit directly or indirectly from agricultural research (including forestry). Stakeholders include scientists, legislators, business leaders, farmers, administrators, forestry officials, industry personnel, state and federal workers, and the general public. The Station receives assistance from stakeholders who testify at state appropriation hearings to support Station programs as new budgets are developed. Publishing scientific results in peer-reviewed journals is an important venue for reaching scientists in the nation, but other means of communication, such as giving oral presentations, disseminating written materials, and participation as officers in civic group organizations are other effective mechanisms for interacting with stakeholders. The multistate, multi-institutional, and multi-disciplinary approach

to research at the Station (1) addresses critical issues of strategic importance identified by stakeholders as described in the institution's approved Plan of Work; (2) addresses the needs and inputs of under-served and under-represented populations in the state; (3) meets the expected outcomes and impacts; and (4) results in improved program efficiency. As done in the first three annual reports, this accomplishment report provides new supportive information and documentation for the aforementioned statements. Accomplishments of multistate, multi-disciplinary, and integrated research for projects approved by a Regional Association and USDA/CSREES for The Connecticut Agricultural Experiment Station's participation will be further documented through annual northeast impact statements and the northeast results (SAES-422) reports. As stated in the Plan of Work, the research programs at the Station focus mainly on national priorities and federal (USDA) goals on improving the agricultural production system to be highly competitive in the global economy (goal #1), providing a safe and secure food and fiber system (goal #2), and on greater harmony between agriculture and the environment (goal #4). Results reported under these national goals, however, also apply in some instances to goal #3 (a healthy, well nourished population) and goal #5 (enhanced economic opportunity and quality of life for Americans). Details on which projects address one or more national goals are provided, as appropriate, in the *Planned Programs* sections of this document. A program review process (merit and peer review system) is being used to evaluate research projects for quality and relevance to national and state program goals and the needs of stakeholders.

Stakeholder Input Process

In accordance with Section 102 (c) of the Agricultural Research, Extension, and Education Reform Act of 1998, the Station reports on (1) actions taken to seek stakeholder input that encourages their participation, (2) the process used by the Station to identify individuals and groups who are stakeholders, and (3) how the collected input was considered in the Hatch and McIntire-Stennis research programs during fiscal year (FY) 2003. Station scientists, administrators, and other staff members continually seek stakeholder input to identify problems so that critical issues in Connecticut can be addressed. Oral and written stakeholder comments received during this reporting period were seriously considered by Station personnel. It is our policy to respond to all public inquiries and to be of service to all racial and ethnic groups. Examples of how the collected stakeholder input was considered in the design, execution, and changing of research goals of various

projects are given throughout this document. During this reporting period, we received input from the media, legislators, and members of organized groups (eg., Connecticut Pomological Society, Connecticut Nursery and Landscape Association, Connecticut Tree Protective Association, Federated Garden Clubs of Connecticut, etc.) in an open and fair process that encouraged participation of diverse groups. Notices were sent to members of 26 protected organizations (i.e., minority groups) announcing the institution's job vacancies and describing research programs. There were several mechanisms used to receive stakeholder input on their needs, opportunities for people to see research plots and experimental results, and to encourage more customer engagements. Station scientists participated in dozens of public meetings attended by stakeholders and university extension personnel, gave oral presentations to citizens' groups, gave interviews to the media, and served on advisory boards of stakeholder organizations. In addition, the Station held open houses and other public events and invited citizens' comments on research programs during all of these listening sessions.

Special listening sessions were held with four beekeeper organizations on October 17, 2002, November 3, 2002, January 25, 2003, and February 25, 2003. These people have a common interest in beekeeping but represent a broad base of occupations. The main purposes for these meetings were for the Station Director and Vice Director to describe services available and current research underway at the Station and to seek stakeholder input. In previous reporting periods, the Director and Vice Director received constructive comments from fruitgrowers in similar listening sessions. The decision was made to continue this process of meeting with groups of citizens.

In another initiative, stakeholders requested assistance on preparing a publication on native alternatives for invasive ornamental plant species and a turf manual for pest control. These publications, edited by a Station scientist, have been completed. Of the 12,000 printed copies on native alternatives, 11,955 were distributed to nursery growers, landscapers, and the general public. This project was a collaborative effort with the U.S. Fish and Wildlife Service and had the assistance of an extension specialist at the University of Connecticut. The publication had immediate impact because it informed the public that some plants are invasive and harmful to the environment and that other native, non-invasive plants could be used to provide attractive landscapes and gardens. Surveys will be conducted to determine if there have been changes in the behavior of stakeholders seeking to buy the native plants rather than the invasive plants. A turf manual, another joint publication with extension, was completed in the last reporting period. Of the 2,000 printed copies, 1,120 manuals

have been purchased by stakeholders, who are now relying on the information to identify and control pest problems.

During FY 2003, 845 talks and interviews were given by Station scientists in Connecticut. These presentations were in response to stakeholders' requests and occurred in urban, suburban, and rural areas. In many instances, extension personnel from universities heard these presentations and received the latest research results. In addition, Station scientists organized or attended stakeholder meetings in FY 2003. People in the numerous groups, organizations, or agencies listed in the following pages heard scientific presentations on Hatch or McIntire-Stennis research findings, received assistance from Station scientists, provided comments on the research results, and gave input for research programs during question and answer sessions. These persons were, therefore, considered direct beneficiaries of agricultural research in Connecticut and elsewhere. An asterisk marks stakeholder interactions in the McIntire-Stennis research programs.

*American Chestnut Foundation
American Phytopathological Society
American Rhododendron Society
American Society for Horticultural Science
Ansonia Garden Club
Backyard Beekeepers Association
Bartlett Arboretum
Bloomfield 4H Farm
Bristol Garden Club
Bristol-Myers Squib Pharmaceutical Research Institute
Centers for Disease Control and Prevention (Atlanta, GA and Fort Collins, CO)
Cheshire High School
Common Ground High School (New Haven)
Connecticut Academy of Science & Engineering
Connecticut Agricultural and Natural Resources Foundation
Connecticut Association of Wetland Scientists

Connecticut Audubon Society

Connecticut Beekeepers Assoc.

Connecticut Butterfly Association

*Connecticut Chapter of the American Chestnut Foundation

*Connecticut Chapter of the American Society of Foresters

*Connecticut Christmas Tree Growers' Association

Connecticut College

Connecticut Department of Agriculture

Connecticut Department of Consumer Protection

*Connecticut Department of Environmental Protection

Connecticut Department of Health

Connecticut Entomological Society

Connecticut Farm Bureau

Connecticut Farm Wine Council

Connecticut Federation of Lakes

Connecticut Federated Garden Club

*Connecticut Forest and Park Association

Connecticut Gardening School

Connecticut Gladiolus Society

Connecticut Greenhouse Growers Association

Connecticut Groundskeepers Association

Connecticut Horticultural Society

Connecticut Invasive Plant Working Group

Connecticut Maple Syrup Producers Association

Connecticut Master Gardeners

Connecticut Municipal Tree Wardens' Association

Connecticut NOFA (organic farmers)

*Connecticut Nursery & Landscape Association

Connecticut Nurserymen's Foundation

Connecticut Pomological Society

*Connecticut Tree Protective Association

*Connecticut Tree Warden School

*Connecticut Urban Forest Pest Council

Cornell University Cooperative Extension

Council for Agricultural Science & Technology

Doolittle School (Cheshire)

Dunland Woods Garden Club

Eastern Plant Board

East Haven Garden Club

East Windsor Garden Club

Enfield Garden Club

Entomological Society of America

Environmental Industry Council

Evergreen Garden Club

Experiment Station Associates

Fairfield Woods Middle School

Florida Nurserymen & Growers Association

Future Farmers of America

Gaylord Hospital

Governor's Council on Agriculture

Guilford Audubon Society

Guilford Conservation Commission

Hamden Grange

Hamden Hall Country Day School

Hill & Dale Garden Club

Holcomb Farm Learning Centers

Hortulus Garden Club in Greenwich

Invasive Non-Native Plant Working Group

Little Cherubs Christian Preschool

Long Hill Garden Club

Lyme Disease Foundation

Maine Entomological Society

Mansfield Middle School
Mary Wade Home (New Haven)
*Massachusetts Blueberry Growers' Association
Mount Holyoke College
National Plant Board
National Science Foundation
Natural Resources Council
Naugatuck Community College
Naugatuck Garden Club
Naugatuck Valley Audubon Society
*New England Christmas Tree Growers Assoc.
*New England Society of American Foresters
New England Vegetable and Berry Growers
New Haven Public Schools
Newington Garden Club
North End Club
Northeast Aquatic Plant Management Society
Northeast Integrated Pest Management Committee
*Northeast Forest Pest Council
Northeastern Mosquito Control Association
Northeast Organic Farming Association
Northeastern Weed Science Society
*Northern Nut Growers Assoc.

Ohio Agricultural Cooperative
Old Lyme Lyon's Club
Old Saybrook Lions Club
Orange Rotary Club
Pomperaug Garden Club
Prides Corner Farms
Quinnipiac Chapter of Sigma Xi

Quinnipiac University

Rutgers University

Sacred Heart University

Salem Country Gardens

Seth Haley Elementary School

*Society of American Foresters

Southern Connecticut State University

Southington Park & Recreation School

Stonington Grange

Thames River Garden Club

Thomas Edison Middle School

Uniroyal Research Station

Torrington Hospital

University of Connecticut (includes Cooperative Extension)

University of Massachusetts

University of Vermont

University of Wisconsin

*US Forest Service (Durham, NH; Hamden, CT)

*USDA/APHIS/PPQ

West Hartford Gladiolus Society

Western Beekeepers' Association

*Western Chestnut Growers Association

Western Massachusetts Gladiolus Society

Wethersfield Garden Club

Windsor High School

Working Lands Alliance

Worthington Hooker School

*Yale University (includes forestry and public health)

Yale Peabody Museum

Stakeholders rely on diagnostic services provided by the Station. Identification of insects and plant diseases and soil analyses provide specific information on a variety of problems, but the program is also useful in identifying emerging problems, such as the introduction of exotic pests. Our diagnostic services program coincides with a USDA management goal: agricultural communications, enhancing customer service/satisfaction information technologies. During state FY 2003, there were about 21,000 public inquires from stakeholders to all Station staff members. The problems varied. For example, scientists in the Department of Entomology answered 4,718 public inquiries. Of these, 1,212 (27%) were from persons who visited the department. Information obtained by growers and industry personnel enhanced their businesses. Questions on natural resources (65%) were most frequent followed by inquiries on pests of humans or persons' dwellings (32%) and on food crop insects (3%). Scientists at the Valley Laboratory in Windsor, Connecticut answered 9,212 inquiries from the public, including those from commercial growers and pest control operators. Questions about hemlock woolly adelgid, a serious forest-insect pest, and blue mold disease continued to be most frequent. Plant pathologists answered 7,145 inquiries. Scientists responded to special problems and visited commercial and private properties to diagnose more complex problems and to give stakeholders immediate assistance in solving problems. In addition, hundreds of soil tests were performed for homeowners, landscapers, and groundskeepers. There was daily contact between citizens and scientists, an exchange of scientific information, and public input into research programs and diagnostic services.

Members of the media frequently request information. In some instances, such as mosquito research and encephalitis virus outbreaks and the entry of a plant pathogen, *Ralstonia solanacearum* race 3 biovar 2, in the United States, there was national interest in research findings. West Nile encephalitis has spread to western United States. An ambitious field research program on mosquitoes was continued in response to stakeholders' concerns in Connecticut. Administrators in towns and cities were kept informed of weekly mosquito and bird surveillance test results. Information on the isolation of encephalitis viruses from mosquitoes collected in different towns had immediate impact on stakeholders' lives and resulted in their use of precautionary measures, such as application of repellents and avoiding mosquito bites during high risk periods. The notices of infected mosquitoes and information on precautionary measures had an impact. There were 12 locally acquired encephalitis virus infections in the state during calendar year 2003, but no fatalities occurred. Other experimental findings on ticks, three tick pathogens that cause human diseases, hemlock woolly

adelgids, the small Japanese cedar longhorned beetle, composting, pressure-treated wood, food safety issues, and a variety of plant diseases continue to be of high interest to reporters and other stakeholders nationally. The Director, Vice Director, and all Department Heads conduct research and report findings to the media and other stakeholders.

Public meetings and open houses, announced in newspapers and newsletters, were held at the Station to allow stakeholders to meet scientists, see experimental plots, visit research laboratories, and to review and discuss research findings. Stakeholders met with scientists and discussed research "face to face" or attended public talks and were able to address specific issues and concerns. Special contacts were made by phone or correspondence with members of organizations that serve protected individuals, trade groups, commodity associations, and with other state agencies to reach under-served populations.

During this reporting period, the Station held special public conferences and open houses. About 50 Christmas tree growers attended a meeting at the Valley Laboratory in Windsor, CT on July 8, 2003. They heard presentations on research and toured experimental plots. Also on this date, about 20 arborists were shown common insect problems of trees in a walking tour of a park in New Haven. Over 40 nursery and landscape professionals attended the annual tour of the Valley Laboratory on July 9, 2003. Attendees were shown research plots and educational gardens. In addition, attendees heard short talks by staff members on hemlock woolly adelgids, postproduction fertility management, and new findings on managing turf insects, parasitic nematodes, and weeds. Stakeholders also saw displays on identification of weeds and insect pests of woody ornamentals. After the outdoor program, attendees heard other research talks in the conference room on managing nematodes in the landscape, effects of endophytic turf on white grubs, plant disease problems, and updates on arthropods and pesticides. Discussions followed the talks. At a public meeting on April 22, 2003 (Plant Science Day In the Spring), scientists reported their findings on growing asparagus, lawn care, and issues impacting organic produce. Additional information was presented on detecting serum antibodies to the tick-transmitted agents that cause Lyme disease, ehrlichiosis (anaplasmosis), and babesiosis; diseases of flowers and herbs; vegetable transplants; chestnut cultivars and on testing of mosquitoes for encephalitis viruses as a part of laboratory tour program for stakeholders. On August 6, 2003, an open house was held at the Station's farm in Hamden, Connecticut. About 910 persons attended this event and were able to visit experimental plots, demonstrations, and exhibits to hear updated scientific reports on control of invasive weeds in Connecticut lakes, basic techniques

for propagating plants, mosquitoes and West Nile virus, homeowner tree care tips, the phase out of pressure treated wood due to arsenic leaching, wind dispersal of corn pollen and other topics. There were over 60 exhibits and field plots describing work on organic farming; use of compost in nurseries; pesticide residues in water, food, and soil; light energy and photosynthesis; beetle pests of plants; reducing deer browse damage; and the use of salt to suppress root diseases in asparagus crops. In addition to the planned major open house events, small groups were given opportunities to visit the Station and hear brief presentations on selected topics of interest in laboratories. For example, on February 28, 2003, eight teachers, who instruct students in the Future Farmers of America program, visited the Station and heard reports on tick control, tick-borne infections, West Nile encephalitis, diagnostic services, and the dispersal of corn pollen. On July 23, 2003, students from the University of Connecticut toured laboratories where research on tick-borne pathogens was being conducted. Information gained by attending these events impacted stakeholders' lives by helping people to improve gardening practices, use less pesticides, and to avoid potential hazards in the environment.

The Experiment Station Associates (ESA), with a membership of about 910 stakeholders, continued to promote scientific activities of the Station and published a quarterly bulletin describing highlights of research accomplishments. Their bulletin was sent to their membership, state legislators, and hundreds of other people interested in Station research programs and events. In addition, a brochure on Station research programs was revised by the ESA for public distribution. These stakeholders requested the assistance of Station personnel in providing information for the brochures. Station scientists, including the Vice Director, gave oral presentations and reports to ESA members at their annual meeting on March 27, 2003 and at monthly Board of Directors' meetings. Members in attendance at the annual meeting heard a presentation by a Station scientist on chestnut blight research. All of these activities provided opportunities for stakeholder input on critical issues in Connecticut agriculture and related problems. Interactions with stakeholders have impacts because more people become aware of Station research programs.

Station scientists worked closely with growers in research programs to solve specific problems. Special assistance was given to arborists, veterinarians, public health officials, groundskeepers, landscapers, the nursery industry, fruitgrowers, and vegetable growers. The nursery industry is valued at about $400 million annually in sales. Many experiments were conducted in nursery fields and greenhouses and other farmers' properties at the request of these growers to reduce pesticide use and costs. Stakeholders were involved with the planning process and evaluation of

scientific results. An important problem emerged during this reporting period. The accidental introduction of a plant bacterial pathogen, *Ralstonia solanacearum* race 3 biovar 2, in the United States, prevented greenhouse owners from moving plants because of federal quarantines and state regulations. These stakeholders needed immediate assistance. Federal action orders and stop sale notices prohibited the movement of geranium plants from 22 greenhouse operations in Connecticut. Station staff members closely monitored quarantined plants and performed the required tests. These efforts yielded no infected plants, and quarantines were removed. This work had impact. The potential economic losses of tens of thousands of dollars in plant sales were avoided. Station scientists were called upon by the state legislature to work on another important problem: potential pesticide spray drift from a farm into nearby residential areas. Contrary to what homeowners' thought, the helicopter-applied fungicide was properly applied to the crop and did not drift from the target area. These findings had immediate impact and re-assured people that pesticide drift was not a problem. The use of pathogenic nematodes has improved the control of black vine weevil grubs in nursery and strawberry fields and has resulted in lesser amounts of chemical pesticides being used. The resulting new management practice can now be applied in other infested sites.

In this reporting period, pumpkin growers requested assistance on determining the causes of severe crop losses. A Station scientist responded and discovered that a parasitic fungus, *Fusarium solani,* caused the problem. This finding had an immediate impact on growers because fungicide treatments could be applied to save future crops. Also, a monitoring system for this infection was established to prevent future losses and to determine more precisely when the crops needed treatment. The monitoring program will lead to long-term benefits by preventing future crop losses and determining precise times for fungicide treatment.

Forest stands are extensive in Connecticut. Approximately 60% of the state's land area is classified as forests. The Station's McIntire-Stennis program focuses on forest insect pests, such as hemlock woolly adelgids (*Adelges tsugae*) and gypsy moths (*Lymantria dispar*); breeding timber and nut-producing chestnuts; the host/pathogen/parasite system of chestnut blight disease; and general management of forests. The latter includes work on reducing browsing damage caused by white-tailed deer, long-term studies of hardwood stands, cutting methods of hardwoods, and studies on unmanaged forests in Connecticut. Statewide surveys are being conducted for early detection of Asian longhorned beetles, emerald ash borers, and pine shoot beetles, exotic pests that could cause extensive economic losses and disruption of forest ecosystems. These studies are being conducted to

help preserve the $500 million annual wood product industry in Connecticut, which includes 350 firms that employ 3,600 loggers, millworkers, and other employees. There were 33 publications, 277 talks and interviews given, and 29 officership positions for Station staff in association with the McIntire-Stennis program.

The hemlock woolly adelgid, *Adelges tsugae*, is a destructive introduced pest of eastern hemlock and Carolina hemlock in 16 eastern states from Georgia to New Hampshire. With continued decline or death of hemlock trees, citizens requested assistance on control (biological and chemical). Pesticides can control *A. tsugae* on ornamental hemlocks but not in forests where thorough treatment with pesticides at ground level is difficult. At a stakeholder's request, a new initiative began in this reporting period. Tests are being conducted on systemic control (i.e., tree injection methods) of the pest with imidacloprid.

In earlier work, a Station scientist found that *Pseudoscymnus tsugae* is an effective beetle predator of all adelgid life stages. Foresters and the general public requested that these predatory beetles be mass-reared and released to help control *A. tsugae* in Connecticut. Accordingly, the beetle was released in sites infested with *A. tsugae*. As a part of an ongoing effort over several years, more than one million beetles have been released thus far in at least 100 sites in Connecticut and 15 other states. Beetles have been released in New Jersey and Virginia as a part of a cooperative multistate research program. Field research has demonstrated that the beetles are established at most sites. Therefore, these promising results provide immediate impact by showing that there is high potential for this beetle in biological control as an alternative to chemical control. Expected long-term benefits include healthy hemlock stands, less pesticides being used, less adverse effects on non-target and beneficial organisms, and a cleaner environment. Current studies are designed to develop an artificial diet for the beetle, to assess hemlock stand conditions, the patterns and timing of beetle release that will enhance the biological control effort, survival and dispersal of the beetles, and to determine the impacts of pesticides on the predatory beetle. Chemical applications are being modified to minimize adverse effects of pesticides on predatory beetles. Citizens now have a biological control program that may work in forests. The Station is also collaborating with the USDA Forest Service in improving colony health and mass-rearing methods for other related predatory ladybeetles imported from China.

The success of rearing *P. tsugae* has led to commercialization efforts and short-term impacts. The predatory beetles can now be purchased from ECOscientific Solutions in Scranton,

Pennsylvania. People have been buying the beetles for release on their properties. As more beetles are released, long-term impacts of reducing *A. tsugae* infestations are expected. The geographical range of the hemlock woolly adelgid is expanding northward in New England and continues to be of great concern to federal, state, local government officials, and to arborists who are called upon to treat infested trees. There are numerous requests for information and guidance from stakeholders in different states on where the infestations occur. Scientists, arborists, foresters, owners and employees of nurseries, members of the Mashantucket Pequot Tribe in Connecticut, and other stakeholders benefited from the McIntire-Stennis program on the Station's research of hemlock woolly adelgids. In a multistate effort, Station scientists continue to collaborate with other scientists in the Virginia Department of Forestry on a related adelgid: balsam woolly adelgid. Knowledge gained from work on the hemlock woolly adelgid is aiding in these new studies. Stakeholder input was also received from questionnaires sent to arborists, from attendees of a Station scientist's talks at meetings, and from telephone conversations with citizens. Experiments were designed and revised based on citizens' input and needs.

During this reporting period, a Station scientist continued to contribute new information on adelgids and the predatory beetle for a website at Cornell University and continued to advise numerous arborists and extension agents in Connecticut and in New York State so that biological and chemical control results could be disseminated to a broader base of stakeholders in different states. Finally, stakeholders are collaborating in field studies on control and include businesses (i.e., tree care companies) and USDA Forest Service personnel. Evaluations of the efficacy of beetle releases are being conducted for cooperators.

Gypsy moths continue to defoliate hardwoods in parts of eastern United States, albeit in localized patterns. In Connecticut, expansive defoliation of several thousand acres of forests occurred during the early 1970's, while over a million acres were affected in the early 1980's. Mortality of economically important hardwoods, such as oaks and maples, occurred and had a negative impact on lumber production and forest ecosystems. Pesticide applications to trees were extensive during outbreaks but still occurred to a lesser extent between major periods of infestation. Gypsy moths have been held at low populations by a pathogenic fungus, *Entomophaga maimaiga.* Although *E. maimaiga* has had an important overall impact on gypsy moths since 1989, it is unclear why this fungus does not totally keep the gypsy moth in check. Drought is an important limiting factor for fungus activity. Arborists and homeowners continue to ask questions about the long-term

effectiveness of *E. maimaiga* in forests. There continues to be concern expressed by forest managers and lumber producers. In response, Hatch and McIntire/Stennis funds have been used in long-term field and laboratory investigations to (1) develop an accurate and simple method for determining the abundance of resting spores of *E. maimaiga* in forest soils before gypsy moth eggs hatch; (2) develop a sampling method to determine the relationship between resting spore load in forest soils and subsequent incidence of infection in gypsy moth larvae; (3) determine the effects that fungal conidia from infected caterpillars have on initiating and sustaining epizootics of *E. maimaiga*; and (4) determine the importance of rainfall or lack thereof on fungus activity. The main goal of this research is to develop predictive models that could be used to estimate whether or not *E. maimaiga* would continue to keep gypsy moth populations in check and to provide information to forest managers and arborists to integrate into their program planning process. Mathematical models developed in previous reporting periods show promise in predicting fungal activity on caterpillar populations. There was immediate impact because foresters are now using the models in their management programs.

In addition to the displays of research results at the Station's annual open houses for the public, other exhibits were presented at two Connecticut Nursery and Landscape Association meetings, Connecticut Flower and Garden Show, Farm/City Week event, and at annual meetings of arborists. In addition, research results were presented to the Northeast Forest Pest Council, Eastern Plant Board meeting, and other regional forestry or regulatory meetings. Comments received by attendees of meetings were useful in modifying experimental designs.

The American chestnut population in eastern United States suffered a severe epidemic caused by an imported fungal pathogen, *Cryphonectria parasitica,* during the early 1900's. This blight reduced the American chestnut to understory shrubs, which decline, sprout from the base, decline and sprout again. There is continued strong public interest in reviving the American chestnut population, primarily for nut production, but also for wood products and to improve the diversity of hardwood forests. Enhancement of forest ecosystems benefits the overall health of all plants and animals, reduces soil erosion problems, and protects water resources. Immediate impact of research results is evident. Preliminary studies revealed that the blight fungus could be controlled by using a virus, which reduces the ability of the fungus to kill trees. The current focus of this long-term research project in Connecticut and other states in a USDA-approved, award-winning multistate McIntire-Stennis research project (NE-1015) is to breed timber chestnuts for resistance to diseases and to

introduce them into forests where native trees are preserved. The main goal is to allow natural crossing to introgress the resistance genes into the native population.

The first transgenic hypovirulent *C. parasitica* release was made in 1994 as a single-season experiment in the Housatonic State Forest in Sharon, Connecticut on American chestnut sprouts under a closed canopy of hardwood trees. A scientist at the University of Maryland and his co-workers made the transgenic forms from strains of the fungus isolated in the plots where tests were planned. The 24 experimental trees were examined in October 2002, and some of the other 241 numbered chestnut sprouts were examined as well. Hypovirulence is established in *C. parasitica* exposed trees and continues to do well.

The second transgenic release was made in 1997, also with native *C. parasitica* strains genetically engineered by the scientist from the University of Maryland to contain a nuclear DNA copy of the prototypic hypovirus genomic RNA. Water containing spores of these transgenic strains was sprayed onto sprouting American chestnut stems in a clear cut area of the Meshomasic State Forest in Portland, Connecticut. Stems in the control plot were sprayed with water. Both control and treated plots were examined in October 2002. Most of the living stems in the control plot have no cankers, or single, sunken cankers. Living stems in the treated plot have multiple, frequently swollen cankers. There is short-term impact of these results because in overall appearance, the chestnut sprouts in the treated plot are bigger and healthier than those in the control plot. Field releases were successful. Stakeholders are able to see the direct outcome of several years of work and look forward to long-term benefits of having American chestnut trees for nut production. This multistate project has made a significant contribution toward improving timber and nut-bearing chestnut trees in eastern North America. Chestnut trees are now growing in forest plots, there is improved stand diversity, and there are potential economic opportunities for chestnut growers, who have vested interests in local and international markets.

A Station scientist heads the chestnut research program in Connecticut. As in the past, she continued to interact with the following stakeholder groups: users of wood products (lumber, fencing, poles, etc.), commercial nut growers, and persons interested in forest health. This Station scientist has been writing annual articles for the Connecticut Forest and Park Association to reach stakeholders, to broaden interest in the research efforts, and to update research findings. There have been ongoing discussions with the National Wild Turkey Federation, the Mohegan Tribe in Connecticut, and the Connecticut Soil and Water Conservation Districts concerning new chestnut

selections for plantings. In addition, stakeholders have direct contact with Station scientists via the internet (www.caes.state.ct.us); e-mail addresses are listed on at least six chestnut web pages. There have been numerous opportunities for stakeholders to continue to learn about chestnut research and to comment on all aspects of the program.

White-tailed deer cause severe damage to nursery plantings, homeowner shrubs, and tree regeneration in Connecticut forests. Oak, an economically important tree for lumber production, has been affected along with eastern hemlock and maple trees. Deer remove saplings from the forest and are impacting forest composition. Foresters, nursery growers, and water authority officials have requested that research be conducted to find ways of protecting oak conifer seedlings in areas of high deer density. Experiments are being conducted in state forests, water company properties, and on lands owned by a power company (Northeast Utilities). Research cooperators in these organizations continue to assist Station studies by providing materials and labor, selecting plots for research, and in designing experiments. There currently is a solid expanding stakeholder base, which includes Great Mountain Forest and Hull Forest Products, in the research cooperative. Research findings have been disseminated to these and other professionals regularly.

Forest composition needs continual monitoring to ensure that quality forest resources are available in the future. Past work conducted at the Station outlined the general framework of forest stand dynamics, but these studies did not provide a means of predicting future development of an individual stand of trees with its unique initial composition and disturbance history. During a previous reporting period, foresters asked a Station scientist to address this shortcoming and to examine the factors that affect the growth and survival of individual trees. As in the past, research is supported by the State Division of Forestry-Connecticut Department of Environmental Protection, which protects the study sites. Work continues in additional plots with the cooperation of other stakeholders (White Memorial Foundation, Great Mountain Forest, and the Town of Manchester), who are participating in the research.

As several upland forest oak stands approach economic and biological maturity in southern New England, there is growing public concern over species composition following stand regeneration. At the request of state foresters and utility company officials, long-term studies are being continued to investigate six distinct cutting methods and their effects on regeneration composition and residual stand growth. The research is designed to provide information on crucial hardwood management issues and will benefit forest managers from New England to West Virginia.

Stakeholders from the State Division of Forestry-Connecticut Department of Environmental Protection, the Regional Water Authority, the White Memorial Forest, and Nature Conservancy are collaborating with a Station scientist and have had input on data collection methods. By participating in the research, these collaborators obtain current information. To seek further stakeholder input, a Station scientist presented his research findings at meetings of the following groups: New England Society of American Forester, Connecticut Tree Protective Association, Connecticut Forest and Park Association, The Nature Conservancy, local Audubon chapters, Mashantucket Pequot Tribal Council, and Association of Northeast Forest Watershed Managers.

Ticks are abundant in southern New England and transmit pathogens that cause Lyme disease, babesiosis, ehrlichiosis, and Rocky Mountain spotted fever. Males and females of the blacklegged tick (*Ixodes scapularis*) prefer deer as hosts. As deer herds grow, populations of these ticks increase. Stakeholders requested Station assistance on the identification of ticks removed from themselves or family members. The ticks were submitted to health care professionals (eg. local health departments), who subsequently transferred the specimens to the Station. Blacklegged ticks were tested for the DNA of the Lyme disease organism, and results were reported to health care professionals, who then reported the findings to stakeholders. Knowledge of infected ticks has a direct impact on people, particularly when illness occurs, because physicians can more easily diagnose Lyme disease and prescribe antibiotics. Another immediate benefit of this program is that more stakeholders become familiar with the Station and its research programs. The establishment of new records for infected ticks in towns also provides other short-term benefits by clarifying the geographical distribution of the Lyme disease agent. A Station scientist has worked closely with these health districts in eight towns on community-based Lyme disease prevention projects, monitoring tick populations and infection rates, and holding three educational workshops for commercial pesticide applicators. About 150 persons from over 50 private Connecticut companies were trained. Some of these persons received state certification to apply pesticides for tick control. Veterinarians requested Station assistance on performing antibody tests to determine if horses and dogs were exposed to different ehrlichiosis agents. Like the tick information, these results directly helped animal owners by diagnosing infections in their animals. Proper antibiotic treatment followed.

Stakeholder input also was obtained when scientists served as members of advisory boards, committees, or officers of organizations. During FY 2003, Station scientists interacted with stakeholders in the following public organizations or state or national committees:

Albert Einstein College of Medicine (Visiting Assistant Professor)

American Phytopathological Society

American Society of Horticultural Science Technical Program Committee

American Society of Plant Biologists

Animal Behavior Society

Association of Northeastern Herbaria

Bloomfield High School Advisory Board for Agri-Science

Branford Inland Wetland Commission

Branford Land Trust

Clay Minerals Society

Clear Lake Improvement Assoc.

Committee on Environmental Quality & Plant Health

Community Gardens, Knox Parks Foundation (Hartford)

Community Gardens Committee, New Haven Land Trust

Connecticut Academy of Arts and Science

Connecticut Academy of Science and Engineering

Connecticut Botanical Society

Connecticut Butterfly Association

Connecticut Christmas Tree Growers' Association

Connecticut Council on Soil and Water Conservation

Connecticut Endangered Species Committee

Connecticut Entomological Society

Connecticut Environmental Industry Council

Connecticut Forest and Park Association

Connecticut Greenhouse Growers Association

Connecticut Groundskeepers Association

Connecticut Invasive Plant Working Group

Connecticut Mosquito Management Program

Connecticut Nursery IPM Implementation Team

Connecticut Nursery & Landscape Association

Connecticut Pomological Society

Connecticut State Technical Committee

Connecticut Tree Protection Examining Association

Connecticut Tree Protective Board

Connecticut Urban Forestry Council

Cooperative Agricultural Pest Survey Committee

Florida Department of Agricultural and Consumer Services (Research Associate)

Eastern Plant Board

Environment Committee, Mill River Watershed Association

Epidemiological Committee of the National Plant Disease & Pest Detection Network

Goodwin Forestry Scholarship Committee

International Organizations for Biological Control

Invasive Non-Native Plant Committee

IR-4 Berry Fungicide Working Group

Journals

- Compost Science & Utilization (Editorial Board)
- Environmental Engineering Science (Editorial Board)
- Environmental Pollution (Editorial Board)
- International Journal of Phytoremediation (Managing Editor)
- Nematology
- Plant Nutrition
- Weed Science

Loosestrife Containment Committee

Lyme Disease Foundation

Madison Land Conservation Trust

National Christmas Tree Growers Association

Natural Areas Association

Natural Resources Conservation Service

New England Aquatic Plant Management Society

New England Pest Management Network

New England Plant Conservation Program

New England Society of American Foresters (Executive Committee)

New England Vegetable & Berry Growers' Assoc.

North American Blue Mold Warning System

Northeast Greenhouse & Ornamentals IPM Commodity Work Group

Northeast Organic Farming Association of Connecticut

Northeast Wildlife Damage Management Research and Outreach Cooperative

Northeastern Regional IPM Committee

Northeast Soil Testing Committee

Northeastern Forest Pest Control Council

Northeastern Weed Science Society

Northern Nut Growers' Assoc.

Peabody Museum, Yale University (Curatorial Affiliate)

RC & D Forestry and Stewardship Committee

Sigma Xi (Quinnipiac University Chapter)

Society of American Foresters

State of Connecticut Mosquito Management Program

Steward McKinney Wildlife Refuge

University of Connecticut, Department of Pathobiology (Adjunct Professor)

USDA Cooperative Agricultural Pest Survey Committee; USDA Natural Resource Conservation Service

Yale University (Adjunct Professor, Lecturer, Research Affiliates)

Program Review Process (Merit and Peer Review)

There have been no significant changes in the review processes since the 5-year Plan of Work was submitted. In accordance with the approved Plan of Work, scientific proposals of the Station were subjected for merit and peer review following federal register guidelines and the National Science Foundation model (http://www.eng.nsf.gov/pet/review-2.htm). Merit review for proposals followed criteria proposed by the National Science Foundation (NSF-99-172). The Station's processes of merit and peer review are evaluated annually by the Vice Director for effectiveness and compliance with federal requirements. Project outlines for Hatch, McIntire-Stennis, multistate

research funds, or grants were reviewed by qualified scientists within (including at least two Chief Scientists and the Director or Vice Director) or outside the Station. This process of review ensures that the planned research is relevant to established priorities that are consistent with stakeholders' changing needs, efficiently meets state and national USDA program criteria and goals, and has a reasonable likelihood of success. No federal funds were released for research on any project until CSREES approvals of project outlines and grant proposals were given. Reviews are kept on file in Chief Scientists' offices. Scientific peer review is required to determine the suitability and validity of the methods used (i.e., critically evaluate technical quality), originality of the study, and value of the work to the scientific community and public.

Station scientists are encouraged to publish their results in peer-reviewed journals that have national and international audiences and to write reports for the general public. Critical scientific reviews are important in ensuring quality science and accountability. Book chapters, symposia proceedings, Station bulletins, and state and regional publications are also acceptable means of communication to stakeholders. In addition to written reports, scientists presented their findings to their peers and stakeholders at international, national, and local meetings and conferences. Citizens who do not have scientific backgrounds are not excluded in this reporting process. They receive non-technical summaries included in Station publications for public use. Written or oral comments received were important in ensuring accountability, evaluating the usefulness of scientific accomplishments, and in the re-alignment of research programs to address changing needs and priorities.

Planned Programs

Program Goal #1: **An agricultural system that is highly competitive in the global economy.**

Research. Goal 1: Through research and education, empower the agricultural system with knowledge that will improve competitiveness in domestic production, processing, and marketing.

Performance. Goal 2. To increase market shares for targeted agricultural products of Connecticut.

Output Indicators. 1. As stated in the Plan of Work, the numbers of publications, talks, and interviews by scientists are tabulated annually and reported herein to document communication to stakeholders. There were 46 publications and 245 talks and interviews recorded for state FY 2003 in association with this program goal. There were 60 officerships and memberships held by Station scientists in stakeholders' organizations and national or state committees during this reporting period. Excerpts of letters from stakeholders regarding services rendered, media reports, and narratives of scientific accomplishments are on file. This information is available to those who are interested in the Station's research program and results.

Output Indicators. 2. As described below, research was conducted to produce value-added agricultural products. Progress made on growing quality fruits and vegetables, reducing farm costs, the control of apple scab, and on improved quality of nursery plants are examples of accomplishments. In this and other sections of the report, concise annual accomplishment summaries are presented under the respective outcome indicators listed and represent an extension of the Plan of Work. Accomplishment and impact headings are marked in bold type in each section. Impact statements are provided when the research has progressed to an appropriate stage of evaluation. Short- and long-term impacts are discussed to show behavioral changes by the intended users or economic, social, health, or environmental benefits for stakeholders. Whenever possible, efforts were made to present results summaries and impact statements in non-technical terms for clarity. In some cases, expected outcomes were realized early in the research effort (i.e., in the past three years or during this reporting period), while in other instances, more time is needed to complete research objectives and to meet expected goals within 5 years.

Outcome Indicators.

(1) Results of field studies on biological and cultural control of insect pests of vegetables will be reported to organic farmers during a farmer/scientist workshop. **Themes: Agricultural competitiveness, Agricultural profitability, Diversified/alternative agriculture, Innovative farming techniques, Niche market, Organic agriculture; Small farm viability; Sustainable agriculture**

Description: This workshop was held as planned during the first reporting period. Details on stakeholder interactions with scientists and on the publication of the conference proceedings were included in the first year's accomplishment report. This objective has been completed, and the main

goal of convincing vegetable growers to follow sustainable agricultural and IPM practices is being accomplished. **Impact:** several benefits are evident. Profitable alternatives are now available to farmers. Field test results promoted sustainability of organic crop production and are enhancing market expansion in New England. The long-term benefits of having no pesticides used in small farm plots and of utilizing composted materials will lead to a cleaner environment. Also, there is growing interest in organic farming, and there are now 33 organic farms in Connecticut. The produce is sold in farmers' markets, but consumer demands for organically-grown vegetables currently exceeds supply. As more farmers adopt organic farming practices, production will increase, more efficient and environmentally compatible management strategies will be developed, and there will be expanding economic opportunities in rural America. Long-term benefits of having a sufficient supply of vegetables with no pesticide residues are expected.

Sources of funds: Hatch and state

Scope of impact: state-specific.

These accomplishments and impacts also apply to goals #2 (safe, secure foods) and #3 (healthy, well-nourished population). **Themes:** food **safety** and **human** health

(2) a written record of proceedings of a farmer/scientist workshop on control of insect pests of vegetables will be prepared, including stakeholder discussions, and given to interested parties. **Themes: Agricultural competitiveness; Agricultural profitability; Diversified/alternative agriculture; Innovative farming techniques; Niche market, Organic agriculture; Small farm viability; Sustainable agriculture**

A book of proceedings on the workshop was prepared in FY 2000, as reported in the first year's accomplishment report, and was distributed to participants. The speakers provided a summary of their conference talks, and the audiotapes were used to document discussions among the participants. After minor editing, the book was printed by the Natural Resource Agriculture and Engineering Service. Feedback from conference participants and the impact of the conference were summarized in the 2001 report. This objective has been completed. The short-term impact is that there is a written record describing scientific discoveries and conference proceedings available to all interested persons, including growers who wish to start organic farming. The expected long-term benefits are that there will be continued efforts for collaboration among farmers and scientists, which

will lead to profitability for small farms in rural settings and increased supplies of organic vegetables to meet high consumer demands.

(3) Appropriate technology will be developed for users of the food and fiber system. **Themes: Hazardous materials; Water quality; Food quality; Food safety**

Description: Chlordane, a banned chlorinated hydrocarbon pesticide, continues to cycle in biotic and abiotic processes in the environment. Persisting in the soil for at least 20 years, there is concern that the pesticide may enter food crops and be released from the soil into the air.

Accomplishment/Impact: chiral gas chromatography with ion trap mass spectrometry methods were developed to detect and measure chlordane residues in soil and ambient air. Ambient air concentrations of chlordane in Connecticut are similar to those recorded for other areas of the country where this pesticide was used, but chlordane from a 40-year-old application site in Connecticut continues to volatilize. The new methods, found to be sensitive and specific for chlordane analysis, enable researchers to detect chlordane and other chlorinated hydrocarbon pesticides at different sites and to more accurately assess risk to the environment. This work has had impact. Scientists in other institutions are now using these procedures. For example, researchers in Hawaii are using the new methods to determine if oriental radishes and other root crops can be grown in soils contaminated with chlorinated hydrocarbons. Also, it is now known that chlordane residues persist for decades longer than previously thought. Finally, some growers in Connecticut are not planting edible plants in chlordane-contaminated soil to avoid possible short and long-term problems of contaminated foods. The expected long-term benefits are safer foods and more accurate monitoring of chlordane in the environment.

Sources of funds: Hatch and state.

Description: in response to stakeholders' requests, a detailed dose-in-soil/uptake-by-plants study was conducted using chiral gas chromatography to detect chlordane in crops. *Cucurbitae pepo* plants were grown in containerized soil in a Connecticut field plot containing four different concentrations of weathered chlordane contamination. The air surrounding the plants was monitored throughout the growing season. At harvest, roots, stems, leaves, and fruit were collected to determine chlordane content. The new study was designed to generate data which could be used to predict chlordane content in zucchini fruit if the chlordane soil contamination concentration was known.

Accomplishment/Impact: All zucchini plant parts contained chlordane. This finding had short-term impact by verifying that this crop should not be planted in contaminated soil. Consequently, growers are no longer planting zucchini in chlordane-contaminated soil. This is the first predictive tool available for a food crop contamination by a persistent soil-borne organochloride pesticide-chlordane. Use of these methods will result in long-term benefits of more accurately assessing chlordane and other pesticide residues in other crop systems and ensuring safe foods for consumers.

Sources of funds: Hatch and state.

Scope of impact: state-specific.

These accomplishments and impact also have application to goal #2 (safe, secure foods) goal #3 by ensuring a healthy, well-nourished population (**Themes: food safety and human health)**.

(4) Field trials of six cultivars of sweet corn will reveal a variety that is suitable for growing in northeastern United States and will have high yields and maintain sweetness and flavor of the product. **Themes: Agricultural competitiveness; Agricultural profitability; Small farm viability**

This objective has been completed, and there is no further work planned. Accomplishments and impacts were summarized in the first two accomplishment reports. Growers are planting the more desirable cultivars.

(5) Field and laboratory investigations of a pathogenic fungus, *Entomophaga maimaiga*, of gypsy moth caterpillars will determine whether or not this pathogen has the ability to infect caterpillars after several years of dormancy. **Themes: Forest crops; Biological control; Risk Management; Other (forest health)**

Description: gypsy moth caterpillars continue to defoliate oaks, maples, and other hardwoods in localized settings in Connecticut and other states. Town officials and the public requested assistance from Station scientists in monitoring this pest and forecasting defoliation to determine if spray programs were needed. Field and laboratory studies completed on this pathogen have led to the development of a computer model for predicting the effects of this fungus on gypsy moth caterpillar populations. The fungus' ability to infect caterpillars depends mainly on rainfall, but relative humidity is also an important factor.

Accomplishment/Impact: a computer model was useful in predicting *E. maimaiga* infections of gypsy moth caterpillars. Recent laboratory and field results provided new information on how many fungal conidial spores are produced in different-sized infected caterpillars. Also, during dry conditions, production of conidia ceased, but when relative humidity was high again, conidial production resumed. These findings had short-term impact because they helped refine an earlier version of a computer model and increased the accuracy of forecasting fungal infections. It is now possible to use incidence of fungus infection of caterpillars (i.e., % of larvae infected with the fungus) to estimate survival rates, either daily or seasonal, of the pathogen and to ultimately predict potential for gypsy moth defoliation. Foresters in New England are now using the computer model. Moreover, information obtained from field studies was shared with other stakeholders, (eg., town officials and the media), and, consequently, routine pesticide spraying of trees was not needed to

control gypsy moths. This change in behavior regarding preventive spraying resulted in immediate savings for homeowners and municipalities and greatly reduced the negative effects of pesticides in the environment. With improved natural resource management, the long-term benefits resulting from this work will be a cleaner environment, maintaining the beauty of trees on properties, reduced exposure of humans and other animals to insecticides, and decreased adverse effects on non-target, beneficial insects that help to control gypsy moth populations.

Sources of funds: Hatch, McIntire Stennis, and state.

Scope of impact: state-specific.

(6) Field experiments on the fungus that causes apple scab will indicate more precisely when fungal ascospores are released in orchards so that more timely fungicide applications can be made, amounts of chemical pesticide used in apple orchards can be reduced, and that yields and quality can be maintained or increased. **Themes: Adding value to agricultural products; Agricultural competitiveness; Agricultural profitability; Innovative farming techniques; Plant health, Precision agriculture; Integrated pest management; Small farm viability**

Description: Apple scab is a serious problem in orchards. The annual value of the apple crop in Connecticut is estimated to be about $7.3 million. Efficient control depends on a grower's ability to accurately predict onset of new infections on apple leaves and fruit. New infections occur when weather conditions are suitable and when there are sufficient amounts of fungal spores present. A quantitative model of atmospheric dispersal of plant pathogens is needed to assist fruitgrowers in making decisions on costs and benefits of alternative practices for disease containment and control.

Accomplishment/Impact: as a part of multistate, integrated activities (research/extension) to meet intermediate and long-term critical needs of fruitgrowers, a model has been developed to estimate probability of apple scab infection in Connecticut orchards. New work focused on determining probabilities of pathogen spread by long-distance atmospheric transport, compared with alternative pathways, such as human-mediated dispersal. Based on the model system and

information on biophysical parameters, the pathogen may be able to spread by means of leaps between regions of host plants separated in space. These results had short-term impacts because growers are now closely monitoring for apple scab infection in their orchards and are using IPM practices, such as mulch mowing, to reduce apple scab inoculum and thus minimize the need for fungicides. Moreover, product quality is achieved when there are pinpoint applications of fungicides. With more widespread acceptance by apple growers, nationally, these IPM practices could have the expected long-term benefit of saving about $3.5 million in fungicide costs. Another long-term impact, resulting from less pesticide usage, is a cleaner orchard environment, reduced exposure of humans and wildlife to pesticides, and reduced risk of run-off of fungicides into surface and ground water.

Results obtained from studies of apple scab are now being applied to another problem: drift of corn pollen from genetically modified plants. With recent and rapidly accelerating introduction of genetically modified corn into agricultural production, there is public concern over movement of pollen from genetically modified plants. Accordingly, it is important to quantify aerial dispersal of corn pollen. A scientific model is being developed to determine pollen survival and movement in the atmosphere to help determine how far genetically modified varieties of corn need to be planted from conventional corn fields. These results will be beneficial in determining regulatory buffer zones for experimental field trials when applications are submitted for USDA/APHIS/PPQ and state permits.

Source of funds: Hatch and state.

Scope of impact: multistate integrated research and extension (CT, NY).

This accomplishment also applies to goal #3 by providing a food source to ensure a healthy, well nourished population (**Theme: Human health**) and goal #4 which addresses greater harmony between agriculture and the environment (**Theme: Pesticide application**).

(7) Laboratory experiments on enzymes in plants will reveal which enzyme protects plants from photooxidative damage. **Themes: Plant genomics; Plant health; Plant production efficiency**

This objective has been met, and there is no further work planned. Summaries were reported in the past two accomplishment reports.

(8) Field and laboratory experiments on wood preservatives will determine if surface soil becomes contaminated. **Theme: Hazardous materials; Home lawn and gardening; Risk management**

Description: earlier studies in Connecticut have shown that chromated copper arsenate (CCA) preservative of wood products contaminates the soil. The pressure treatment procedure causes the preservative to deeply penetrate wood. Millions of board feet of CCA-treated wood have been produced annually and are used in decks, picnic tables, garden borders, posts, stakes, playground equipment, highway sound barriers, and utility poles. Stakeholders expressed concern over possible uptake of undesirable chemicals by plants grown near CCA-treated wood because vegetable gardens are sometimes planted near wood products containing CCA-treated wood. Experiments were conducted to determine if coating the CCA-treated wood would form a barrier to leaching of arsenic, a class A carcinogen.

Accomplishment/Impact: Percent reductions in arsenic were 70 to 80% when a water-based coating with acrylic and alkyd resins were used and 95% when polyurethane coatings were applied to the wood. These results had immediate national impact. Stakeholders now have a way to reduce leaching of arsenic from CCA-treated wood. Homeowners are now coating CCA-treated wood for use in vegetable gardens as well as decks. This practice offers long-term benefits of having less arsenic in the environment, including uptake by edible plants, where CCA-treated wood currently exists. Reductions in arsenic leaching decreases exposure of humans and other animals to a dangerous chemical, thereby reducing health risks. Moreover, findings on arsenic leaching have contributed to the EPA decision to phase-out all residential uses of CCA-treated wood, effective January 1, 2004. These actions will result in less human and other animal exposure to arsenic as a long-term benefit and reduce the buildup of arsenic in the soil.

Sources of funds: Hatch and state.

Scope of impact: state-specific.

These accomplishments also apply to national USDA goal #2 by providing information on the **Theme: Food safety** and to goal # 5 by providing information which enhances the quality of life for Americans (**Theme: Children, youth, and families at risk**).

(9) Forest health monitoring programs will detect emerging insect and plant diseases that may affect nursery-grown plants. **Themes: Agricultural competitiveness; Agricultural profitability; Invasive species; Plant health; Plant production efficiency; Risk management; Small farm viability; Ornamental/ green agriculture**

Description: the small Japanese cedar longhorned beetle (*Callidiellum rufipenne*) is an exotic insect native to Japan, Korea, Taiwan, and eastern China. This pest of arborvitae, junipers,

and cedar trees was discovered in Connecticut in 1998 and has recently been found in coastal areas from Massachusetts to North Carolina. In Connecticut, the beetle infested dead or weakened cedar trees predominantly in the southern part of the state. Stakeholders, including groundskeepers, owners of nurseries, and arborists, requested Station assistance on determining the geographic distribution and control of the pest in Connecticut.

Accomplishment/Impact: *C. rufipenne* infested dead or weakened cedar trees in 49 towns in southern Connecticut and is a threat to the $400 million nursery industry in the state. The small Japanese cedar longhorned beetle develops mainly on landscape and wild plants in the family Cupressaceae, but in the forests, these beetles attack eastern red cedar, common juniper, and Atlantic white cedar. Field studies revealed that the main period of reproductive activity of *C. rufipenne* lasted about 4 weeks in May. This new information had immediate impact and short-term benefits. Upon learning the results, nursery growers implemented beetle trapping systems in their fields as a part of IPM programs. When found, *C. rufipenne* was controlled by a well-timed application of Astro, a permethrin-based insecticide. Shipments of plants can now be made nationally and internationally without violating quarantines or other plant health regulations. In addition to reducing the agricultural pest, there are benefits of maintaining economic opportunities in rural areas and enhancing agricultural markets by allowing shipments of nursery stock. The expected long-term benefits of monitoring for beetles and applying well-timed pesticide treatments are that less insecticide will be used, thereby reducing costs for growers, protecting the environment from potential contamination of streams and ground water, and reducing human exposure to insecticides. In addition, well-timed applications of insecticide increases the quality and health of plants and the value of home, commercial, and other properties.

Sources of funds: Hatch, McIntire Stennis, and state.

Scope of impact: multistate (CT, MA, NJ, NY, RI).

Accomplishments also apply to goal #4 (**Theme: Pesticide application**).

(10) Laboratory and field experiments on chemical control of soil-inhabiting beetle larvae in container-grown nursery stock will reveal a more cost-effective and efficient method of treating nursery stock for national and international shipments. **Themes: Agricultural competitiveness;**

Agricultural profitability; Invasive species; Ornamental / green agriculture; Plant health; Small farm viability

Description: Japanese beetle and oriental beetle larvae are major pests in container-grown and field-grown nursery plants, such as rhododendron. The presence of these grubs in containers can lead to rejection of plant shipments or added pesticide treatments required by states or countries that import Connecticut nursery stock. In addition, Christmas trees are grown on about 6,000 acres by 500 growers. There are about 440,000 trees harvested annually, representing about 6% of the total 7.7 million trees grown. The annual gross revenue for the locally harvested trees is about $9 million. The nursery industry requested assistance from Station scientists to meet immediate critical needs on solving some specific pest problems.

Accomplishment/Impact: field tests conducted with potting media from five Connecticut nurseries revealed that the insecticide bifenthrin, applied to potting media in concentrations of 2ppm provided effective control of Japanese beetles. The short-term impact of these results is that a well-timed, low concentration of bifenthrin satisfies Japanese beetle quarantine regulations for plant shipments. International and interstate shipments of plants can be made, thereby enhancing agricultural markets in a global economy and expanding economic opportunities for nurseries in rural areas. Moreover, separate applications of chlorpyrofos, an insecticide that is hazardous to the users, to control rhododendron leaf gallmidge are no longer needed because bifenthrin treatments control this pest as well. These stakeholders are now using lower amounts of pesticides to protect quality potted plants from multiple pests and can save about $6.05 per 1,000 potted plants (#1-sized containers) in reduced costs of insecticides. These results have helped growers in Florida who have begun applying this knowledge to control an exotic June beetle in nurseries. The expected long-term

benefits of reduced pesticide use are cleaner environments in and near nurseries, many of which border residential areas, less human exposure to insecticides, and fewer potential problems with contaminated streams and ground waters. (Sources of funds, Scope of impact-see below).

Description: as a part of multistate integrated research/extension program (NE-187), field tests were conducted in Connecticut to evaluate the activity of bifenthrin on oriental beetle larvae.

Accomplishment/Impact: bifenthrin, applied as a root dip at 600ppm, was effective in synergistically improving the infection of last-instar oriental beetle larvae with *Heterorhabditis bacteriophora* nematodes. These findings had short-term national impact because the manufacturer of bifenthrin has added this insecticide to the Talstar F label, allowing nurseries and Christmas tree growers to protect transplanted nursery stock from white grub feeding. Such treatments permit national and international shipments of plants meeting phytosanitary requirements, thereby supporting economic opportunities for nurseries located in rural areas. Root dip treatments also improve pest management efforts at reduced costs. For example, in an intensive Christmas tree seedling nursery of 10 acres, there is a savings of $33,168 per acre in plant value by protecting plants from the oriental beetle. Expected long-term benefits include continued profitability for growers and the production of quality nursery plants, which increase the aesthetic value of home, commercial, and other properties.

Sources of funds: Hatch and state.

Scope of impact: multistate integrated research (CT, FL, MA, MD, ME, NJ, NY, PA, RI) and extension.

Accomplishments also apply to goal #4 (**Theme: Pesticide application**)

(11) Field and laboratory tests will reveal new methods of managing plant nematode, insect, and soil-borne pathogen infestations with reduction in pesticide usage on vegetable and fruit crops.

Themes: Agricultural competitiveness; Agricultural profitability; Emerging infectious diseases; Integrated pest management; Organic farming; Precision agriculture; Plant health; Plant production efficiency; Risk management; Small farm viability; Urban gardening

Description: annual vegetable production in Connecticut is valued at about $24.2 million. Many vegetable growers in the Northeast use cover crops, but little is known about which cover crops are most advantageous in pest management programs. Vegetable growers requested assistance on determining which cover crops provided the best option for controlling weeds. Ten cover crops were established in sweet corn plots during the fall: rye, rye combined with hairy vetch, crimson clover, oats and an unplanted control. Additional treatments were established following winter-killed oats in the spring: canola, annual rye grass, spring oats, spring oats combined with field pea, and another unplanted control following fall oats. Emergence cages, pitfall traps, and sweep and vacuum procedures were used to collect beneficial and pest insects. Across the cover crop treatments, there were 3 summer crop treatments: (1) plowed and planted with sweet corn, (2) mowed, strip-tilled and planted with sweet corn; and (3) mowed, and then allowed the cover crop to grow to maturity.

Accomplishment/Impact: both beneficial and deleterious microbes were found in higher densities in the root zone of corn plants in the strip-tilled treatment, but there were fewer deleterious microbes in the plowed treatment. Vegetable growers are now relying on plowed treatment methods to ensure quality products and to reduce weed problems with less reliance on herbicides. The long-term benefits of reduced herbicides in farms are less human exposure to pesticides, thereby reducing health risks, less run-off of pesticides into surface and ground waters, and reduced farm costs for weed control.

Sources of funds: SARE, Hatch and state.

Scope of impact: multistate integrated research (CT, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VT, WV).

Accomplishments also apply to goal #3 by maintaining a food source to ensure a healthy, well-nourished population (**Theme: Human health**).

Description: As a part of integrated multistate research and extension efforts (NE-9), 169 accessions of arugula (*Eruca sativa*) in the USDA germplasm collection were evaluated for resistance to flea beetles (*Phyllotreta cruciferae* and *Phyllotreta striolata*) as well as horticultural characteristics (earliness of harvest, yield, earliness of bolting, and leaf appearance). Arugula has become popular in restaurants and among certain ethnic groups. Vegetable growers, who want to grow arugula, have requested that tests be performed to identify a variety, which is resistant to flea beetles so that insecticide usage could be reduced or eliminated. There were no cultivars with resistance to flea beetles, but there were certain horticultural features, such as yield, early harvest, leaf quality, and delayed bolting, noted for some cultivars which would benefit growers.

Accomplishment/Impact: digital photographs of all the arugula accessions (as cotyledons and as harvestable plants) have been submitted to the North Central Regional Plant Introduction Station to be put on the Germplasm Research Information network. Data on yield and time to bolting have also been submitted. These findings had immediate national impact because plant breeders, growers, and scientists in seed companies are accessing this new information on arugula cultivars and are planting the new varieties. Long-term benefits are expected as high quality plants are grown to satisfy market demands and as growers in rural areas profit from harvests of higher-yielding plants.

Sources of funds: Hatch and state.

Scope of impact: multistate integrated research (CT, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VT, WV, USDA/ARS) and extension.

Accomplishments also apply to goal #3 by providing a food source to ensure a healthy well-nourished population (**Theme: Human health**) and goal #4 (**Theme: Biological control; Integrated pest management**).

Description: Apple tortrix (*Archips fuscocupreanus*) is an Asian leafroller pest that is new to New England. The caterpillars attack 87 species in 15 plant families; 68% of the plant species are in Rosaceae, which includes the economically important pome and stone fruits. In Connecticut, apple production is valued at $7.3 million. Fruitgrowers, who use insecticides as a preventive strategy, requested assistance on determining precise times for insecticidal treatments which would not decrease the number of beneficial insects in the orchards.

Accomplishment/Impact: in an unsprayed orchard, males were captured in pheromone traps for about 4 to 5 weeks between mid-June and mid-July, but larvae were most abundant in late April to early May. These results had immediate regional impact because growers learned that pre-bloom sprays for other insect pests in northeastern United States were sufficient to control apple tortrix, and no additional insecticide treatments were needed. This resulted in a savings of about $30 per acre in pesticide spraying costs. The expected long-term benefits of reduced pesticide spraying are a cleaner orchard environment with less pesticide residues, less human exposure to insecticides, thereby reducing health risks, less adverse effects on beneficial insects that keep apple tortrix and other fruit pests under control in IPM programs, the ability to produce quality fruit, and reduced risks of contaminating surface and ground waters.

Sources of funds: Hatch and state.

Scope of impact: multistate integrated research (CT, MA, NJ, NY, RI) including extension. Accomplishments also apply to goal #3.

Description: Black vine weevil is an important insect pest in strawberry fields. Damage caused by grubs feeding on plant roots and by adults feeding on foliage can result in a loss of about $2,000 per acre. Strawberry growers requested assistance on finding resistant varieties of plant cultivars so that pesticide treatments could be reduced.

Accomplishment/Impact: twenty one varieties of strawberry were tested in the greenhouse, and potential resistant cultivars were identified. There is promise for the development of a plant breeding program to improve resistance of strawberries to black vine weevil and other root weevils. Strawberry growers are now more willing to reduce pesticide applications if more effective, resistant cultivars can be developed. These stakeholders know that selected resistant cultivars can be economically advantageous by reducing pesticide costs and lowering farm maintenance requirements. Reduced pesticide usage will decrease risk of environmental contamination, lower residues on the fruit, and result in less human exposure to pesticides, thereby reducing health risks. Many strawberry fields are open to “pick-your-own” operations. With reduced pesticide usage, customers will be re-assured that the fields are safe to enter.

Sources of funds: Hatch and state.

Scope of impact: multistate integrated research (CT, MA, NY, RI).

These accomplishments also apply to national goal #3 by providing a food source to ensure a healthy, well-nourished population. **Theme: Human health** and goal #4 **Theme: Biological control; Integrated pest management.**

Description: Early dying disease of potato is caused by a fungus, *Verticillium dahliae,* and a plant nematode, *Pratylenchus penetrans*. There are about 250 acres of potato production in Connecticut. As a part of integrated multistate research and extension efforts (NE-171), the effects of green manure rotation crops were further assessed in 120 microplots infested with both pathogens.

Accomplishment/Impact: a single planting of Polynema marigold rotation crop significantly reduced *P. penetrans* recovery from roots of rye grown after the potato crop harvest. Also, marketable tuber yields increased. The short-term benefit of these results is that potato growers have become more willing to use a rotation crop to control *P. penetrans* instead of nematicides. Also, it is estimated that marigold rotation procedures can increase short-term profits for growers by about $500 per acre by reducing amounts of pesticides used. With IPM practices in use, the expected long-term impacts are less pesticide residues in potato fields, less risk of contaminating ground and surface water sources (eg., streams, lakes, and ponds), and less human exposure to pesticides, thereby reducing health risks.

Sources of funds: Hatch and state.

Scope of impact: multistate integrated research (CT, FL, MA, MD, MI, NY, PA, RI, WV) and extension.

These accomplishments also apply to national goal #3 by providing a food source to ensure a healthy, well-nourished population (**Theme**: **Human health**).

Description: lesion nematodes cause root damage, which may serve as an infection site for a fungus that causes black root rot of strawberry. The annual retail market value for strawberries in Connecticut is about $2.8 million for about 230 acres of production. As a part of integrated multistate research and extension (NE-171), experiments were conducted in a greenhouse to

investigate the interactions of lesion nematodes, *Pratylenchus penetrans*, root-feeding insects (Asiatic garden beetles), and the fungus *Rhizoctonia fragariae* on the development of strawberry root rot. Experiments were conducted in stakeholders' strawberry fields to determine the population densities and distributions of nematodes to improve IPM programs.

Accomplishment/Impact: both lesion and root-knot nematodes primarily infected feeder roots from structural roots or healthy perennial roots. Samples from an established strawberry bed were found to be most reliable and useful for diagnostic purposes when they include feeder roots and when taken in late May. These results had immediate impact. Growers are now using better sampling procedures and the new information on lesion nematodes to further develop their pest management programs in efforts to reduce amounts of pesticides used. Expected long-term benefits are less pesticide residues on strawberries and cleaner field production environments, many of which are near residential areas. "Pick-your-own" farm operations are very popular with consumers. Knowledge of pesticide reduction in growing areas will reassure stakeholders that they can enter strawberry fields and safely harvest fruit. With reductions in pesticide use, water quality of streams, lakes, and ground water also will be enhanced.

Sources of funds: Hatch and state.

Scope of impact: multistate integrated research (CT, MA, NJ, NY, RI) and extension.

Description: verticillium wilt, caused by a fungus, affects eggplant, potato, and tomato crops. Vegetable growers requested assistance on finding ways to reduce amounts of pesticides used. Earlier work indicated that the incorporation of cruciferous crop residues in tomato and eggplant fields reduced the impact of verticillium wilt. Additional studies were conducted to further evaluate the suitability of canola and kale as biological controls for this disease.

Accomplishment/Impact: without the additional use of green manures, the ameliorating effect of kale and canola from a previous treatment continues at least one year after incorporation into infected soil. Vegetable growers immediately benefited from these results because they did not have to reapply green manures. This also eliminated the need to apply fungicides and resulted in a net savings of about $250 per acre. Moreover, the positive results encouraged growers to accept IPM practices in efforts to reduce pesticide treatments. The expected long-term benefits are less pesticide residues in crops and soil, cleaner field environments, enhanced quality for surface and ground water supplies, and less human exposure to pesticides, thereby reducing health risks.

Sources of funds: Hatch and state.

Scope of impact: state-specific.

These accomplishments also apply to national goal #3 by providing food sources to ensure a healthy, well-nourished population. **(Theme: Human health).**

Description: Sodium chloride (NaCl) applications to asparagus fields can suppress a destructive disease called Fusarium crown and root rot caused by soil-borne pathogenic fungi. Application of salt to declining asparagus fields in rural areas can restore productivity. Previous work showed that NaCl does not inhibit the fungi. However, the mode of action is unknown. Experiments were conducted in a greenhouse to determine how salt suppresses fungal infections.

Accomplishment/Impact: suppression of Fusarium crown and root rot with NaCl is probably due to multiple mechanisms. Maximum suppression occurs when NaCl is directly applied to roots, but suppression still occurs on distal non-treated roots due to systemic mechanisms. The latter may be associated with a root-mediated alteration in the rhizobacteria. These results were significant and had immediate benefits because there are economic opportunities for farmers in rural

areas, and consumers can obtain locally grown produce. Growers are using NaCl in asparagus fields to control fungal infections, rather than relying on fungicides. Assuming that a grower receives $2.00 per pound for asparagus, a single application of NaCl could generate $1,495 per acre for a $50.00 investment in salt. The expected long-term benefits of reduced fungicide applications are less pesticide residues on the crop (safer foods) and in the soil, less pesticide run-off to streams and ground water supplies, continued savings for the grower, and less exposure of humans and other animals to fungicides. Some asparagus farmers have opened their fields at harvest time to consumers for "pick-your-own" operations. Knowledge that pesticide use has been reduced will re-assure stakeholders that it is safe to enter the crop production areas.

Sources of funds: Hatch and state.

Scope of impact: multistate integrated research and extension (CT, FL, MI, NJ, PA, WA).

These accomplishments also apply to national goal #3 by providing food sources to ensure a healthy, well-nourished population **(Theme: human health).**

Description: Fusarium wilt and fruit rot of pumpkin has been observed in Connecticut sporadically for many years. The disease is expected to be seed-borne, but no data exist to substantiate this hypothesis. A pumpkin grower lost an entire field to Fusarium fruit rot. This resulted in a loss of about $5,000. Stakeholders, who grow pumpkins on about 272 acres in Connecticut, requested assistance on determining the cause of crop losses and suggestions for a management program.

Accomplishment/Impact: seed from infected pumpkins were recovered and found to be colonized by the pathogen *Fusarium solani,* but the fungus did not affect germination in seedling tests. Pumpkin growers now know the specific cause of pumpkin decline. A monitoring system has been established in pumpkin fields to detect recurrent infections and to prevent further losses of a crop that is valued at about $1.1million in Connecticut. The expected benefits of the monitoring program are that growers know that future *Fusarium solani* infections can be detected and assessed early, a well-timed fungicide treatment can be made to avoid crop loss, and that it is unnecessary to treat in a preventive strategy. In the long term, less fungicides will be used, which will result in pesticide cost savings for the growers, cleaner field production areas, and less risk of human exposure to pesticides. Reduced fungicide use will reassure consumers, who wish to enter pumpkin fields, in "pick-your-own" operations, that the crop production areas are safe to enter.

Source of funds: Hatch and state.

Scope of impact: Multistate (CT, NY).

(12) Field testing of apples, grapes, raspberries, okra, leeks, sweet potato and other vegetable cultivars will identify high-yielding, marketable crops that are genetically resistant to plant diseases. **Themes: Agricultural competitiveness; Agricultural profitability; Niche market; Plant genomics; Plant health, Plant production-efficiency; Small farm viability**

Description: recent census data indicate that there are about 320,000 Hispanics in Connecticut. Among the 65 farmers' markets in the state, calabaza (tropical pumpkin) and winter squash received high consumer demand ratings. Surveys of consumers and growers at these farm

markets identified 45 vegetable and herb species that were of high interest. Growers requested further evaluations of new cultivars of calabaza, an ethnic crop desired by Hispanics.

Accomplishment/Impact: laboratory and field experiments showed that if transplants were started in the greenhouse in mid-May and were transferred to the field in mid-June, fruit from El Dorado and La Estrella cultivars would be mature for an October harvest. These findings had immediate impact by meeting the immediate needs of growers and consumers. Growers now know that calabaza can be grown in Connecticut and that there are potential profits. An average weight of 11.0 pounds per plant with an estimated yield of 30 tons/acre has been shown to be profitable for growers. At a retail price of $.69/lb, the potential market value of these new calabaza cultivars is about $41,000. Calabaza is now being grown as a niche crop in rural areas, and there is economic opportunities for these farmers. There are expected long-term benefits for growers and consumers. Growers have a new crop to plant for profits and Hispanics and other consumer groups can purchase locally grown calabaza. Farmers' markets and other retail establishments also benefit by selling a quality crop that is in demand.

Sources of funds: Hatch and state.

Scope of impact: state specific.

These accomplishments also apply to national goal #3 by providing food to ensure a healthy, well-nourished population (**Theme**: **Human health**).

Description: as a part of integrated multistate research and extension project NE-183, new apple cultivars were further evaluated for disease resistance, yield, and fruit quality to satisfy grower requests for information. There is continued interest among fruitgrowers to reduce pesticide applications and to provide high quality, high-yielding apple cultivars that are resistant to plant pathogens and insect problems.

Accomplishment/Impact: in laboratory studies of fruit from 24 cultivars, all varieties were susceptible to bitter rot. However, the cultivar "Suncrisp" had the slowest growth rate of bitter rot fruit infection, while "Ginger Gold" had the fastest rate. In field studies, the apple cultivars "NY75414-1" and "Sunrise" exhibited the most severe fruit split due to heavy rainfall late in the season. This information had immediate regional impact because growers have new information on cultivars being introduced to agricultural production. The expanding knowledge base on several apple cultivars provides growers with long-term economic benefits because comparisons can be made for a more informed and efficient selection process. Moreover, the identification of cultivars resistant to disease helps improve plant quality and reduce amounts of pesticides used, which will result in a cleaner orchard environment, reduced human exposure to pesticides, and less risk of ground and surface water contamination due to run-off.

Sources of funds: Hatch and state.

Scope of impact: multistate integrated research and extension (AL, AR, CT, ID, IN, MA, MI, NH, NY, NC, OH, OR, PA, UT, VA, VT, WA, WI, WV).

These accomplishments also apply to national goal #3 by providing food to ensure a healthy, well-nourished population (**Theme: Human health**).

(13) Field testing of flax cultivars will reveal which varieties are most suitable for growth in Connecticut. **Themes: Adding values to new and old agricultural products; Agricultural profitability; Diversified / alternative agriculture; Plant genomics**

This objective has been completed, and findings were presented in the first Annual Accomplishment report. The scientist conducting these studies has retired.

(14) Laboratory tests will identify more efficient methods of extracting taxanes from *Taxus* plants. **Themes: Adding value to new and old agricultural products; agricultural profitability; New uses for agricultural products**

This objective has been completed. Results and impacts were reported in the first and second Annual Accomplishment Reports.

(15) Laboratory tests will identify key genes involved with photoprotective response and photosynthesis. **Theme: Plant genomics; Plant health; Plant production efficiency**

This objective has been completed. Results and impacts were reported in the first three Annual Accomplishment Reports.

Allocated Resources. Fiscal and human (expressed as Scientist Years) resources are listed for federal FY 2003.

	Fiscal Resources				Human Resources	
	Federal*		State		Scientist Years	
Years	Target	Actual	Target	Actual	Target	Actual
1999	$447,704	$448,618	$2,417,000	$2,258,559	17.8	17.8
2000	447,704	$407,429	$2,417,000	$2,380,683	17.8	17.6
2001	447,704	$418,616	2,417,000	$2,490,608	17.8	18.3
2002	447,704	$472,244	2,417,000	$2,678,216	17.8	18.4
2003	447,704	$437,495	2,417,000	$2,177,548	17.8	15.5
2004	447,704		2,417,000		17.8	

*Federal Hatch funds only.

Program Goal # 2: A safe and secure food and fiber system.

Research Goal: To ensure an adequate food and fiber supply and food safety through improved science based on detection, surveillance, prevention, and education.

Performance Goal 1. To annually increase the research and knowledge base available from CSREES partners and cooperators on food safety and food-borne risks and illnesses.

Performance Goal 2. To increase consumer access to targeted agricultural products of Connecticut that provide greater assurances for safety.

Output Indicators. (1). The numbers of publications, talks, and interviews given by scientists were tabulated annually and are reported here to document interactions with stakeholders. During state FY 2003, there were 5 publications and 16 talks and interviews recorded in association with this program goal.

Output Indicators (2). The Department of Analytical Chemistry is responsible for testing agricultural products for pesticide residues. During FY 2003, produce was analyzed at the request of the State Department of Consumer Protection.

Outcome Indicators.

(1) There will be greater consumer access to safe Connecticut produced foods. **Theme: Food handling; Food safety**

Description: there are continued stakeholder concerns about pesticide residues in locally or foreign-grown produce and canned and frozen vegetables. Citizens and state officials requested assistance on analyzing foods for pesticide residues. Two hundred and seventy samples, submitted by the Connecticut Department of Consumer Protection as a part of marketbasket surveys or obtained in research studies, were analyzed for residues of pesticides, such as captan, dicofol, permethrin, chlorothalonil, endosulfan, iprodione, malathion, dieldrin, clorphyrifos, and ninclozolin.

Accomplishment/Impact: most samples analyzed had no pesticide residues or low concentrations well below tolerance levels established by U.S. EPA. However, a non-permitted pesticide residue (iprodione) was detected in quince imported from Chile. In another case, permethrin was detected in canned mustard greens. There was immediate national impact because these findings prompted a voluntary recall and destruction of the food products. In other instances, stakeholders learned that canned and frozen vegetables were safe to consume. The expected long-term benefits of food-testing programs for pesticides are that the public will be reassured that foods are being analyzed on a regular basis to ensure quality and safety and that there will be less human exposure to pesticides, which will reduce health risks.

Sources of funds: Hatch and state.

Scope of impact: state-specific.

Description: consumers notice or suspect that foods may be contaminated or involve potential product tampering. Complaints are filed with the Connecticut Department of Consumer Protection, and food samples are forwarded to the Station for analyses. Although most samples represent single incidents, some are indicative of widespread problems with manufacturing or packaging processes. Five-hundred and forty-five samples were examined and analyzed.

Accomplishment/Impact: Three problems were identified. Fungal material was detected in several bottles of apple juice. In another instance, macaroon cookies were rancid even though the product was sold well before the expiration date. Finally, an organic syrup was found to contain 1.5% ethanol and yeast. These findings had immediate national impact. Federal and state regulatory actions led to an embargo of all the syrup at a retail establishment. National recalls of products occurred after stakeholders, food producers, and the Food and Drug Administration were notified. Consumers had access to safe foods and inquiries were responded to. The long-term benefits of a

food-monitoring program are that stakeholders will have access to safe foods, will be reassured that foods are being analyzed on a regular basis, and will have a system in place to determine the cause(s) of food contamination in the event of bioterrorist activities.

Sources of funds: Hatch and state.

Scope of impact: state-specific.

(2) Laboratory studies will determine how maple syrup becomes contaminated with lead. **Theme: Food handling; Food safety, Human health**

This objective has been completed. Results and impacts were reported in the first three Annual Accomplishment Reports. The sources of lead contamination were identified and solutions were found to eliminate the immediate problems as short-term benefits. However, at the request of maple syrup producers, a quality control program has continued to reassure stakeholders that there is no resurgent lead contamination problem. This maple syrup monitoring program continues as a long-term benefit to consumers and maple syrup producers to re-assure stakeholders that the food product is safe.

(3) In cooperation with maple syrup producers, guidelines will be developed to lower or eliminate lead content in finished maple syrup. **Theme: Food safety, Human health**

This objective was completed and results were reported in the first Annual Accomplishment Report. The guidelines continue to be followed as a long-term benefit to prevent contamination of maple syrup.

(4) Results of laboratory investigations with state-of-the-art equipment will lead to the development of new procedures to detect pesticides in food and drinking water. **Theme: Food safety;**

Water quality, Human health

This objective has been addressed, and accomplishments/impacts have been reported in the first three Annual Accomplishment Reports.

(5) Field and laboratory studies will reveal when *E. coli* enters cider production during the fall and will clarify the natural history of *E. coli* in orchards. **Theme: Foodborne illness; Food safety, Human health**

Description: outbreaks of *Escherichia coli* in beef, lettuce, and apple cider have alarmed the public. Cider producers requested assistance on evaluating ultrasonic cleansing methods for decontaminating cider. Experiments were conducted to determine if these non-heat, low-cost methods would be suitable for cider production.

Accomplishment/Impact: low energy ultrasonication of contaminated (inoculated) cider for various times (0 to 10 minutes) was ineffective in lowering bacterial cell counts. High energy sonication reduced *E. coli* in cider. Stakeholders learned that compared to flash pasteurization and ultraviolet pasteurization, ultrasonication technology is not a viable alternative for sanitation of apple cider. These results had immediate regional impact because cider producers used the information to implement more efficient sanitation procedures for short-term benefits. Cider producers are now relying on flash and ultraviolet pasteurization methods to decontaminate cider without compromising product quality. The use of these methods also offers expected long-term benefits of reducing food-borne pathogens and associated diseases because the procedures ensure safe cider and may have application in the processing of other juices.

Sources of funds: Hatch and state.

Scope of impact: state-specific.

These accomplishments were conducted to meet the intermediate critical needs of stakeholders. Accomplishments also apply to goal #5 **(Theme: Human health)**.

Allocated Resources. Fiscal and human (expressed as Scientist Years) resources are listed for federal FY 2003.

	Fiscal Resources				Human Resources	
	Federal*		State		Scientist Years	
Years	Target	Actual	Target	Actual	Target	Actual
1999	$114,550	$114,951	$341,700	$252,328	2.6	2.4
2000	$114,550	$138,764	$341,700	$296,896	3.0	2.6
2001	$114,550	$141,277	$341,700	$419,336	3.0	3.9
2002	114,550	$155,273	$341,700	$312,448	3.1	3.6
2003	114,550	$122,824	$341,700	$294,071	3.1	2.9
2004	114,550		$341,700		3.1	

*Federal Hatch funds only.

Program Goal # 4: Greater harmony between agriculture and the environment.

Research Goal: Enhance the quality of the environment through better understanding of and building on agriculture's and forestry's complex links with soil, water, air, and biotic resources.

Performance Goal 1. To annually increase the research and knowledge base available from CSREES partners and cooperators on environmental sciences and agriculture, including conserving, maintaining, and protecting ecosystem integrity and biodiversity.

Performance Goal 2. To increase technology options available to agricultural producers to enhance profitability without damaging the environment.

Output Indicators. (1). The numbers of publications, talks, and interviews given by scientists were tabulated annually to document communication to stakeholders. During state FY 2003, there were 34 publications, 307 talks and interviews recorded in association with this program goal. The number of officerships and memberships in stakeholder organizations and national or state committees was 31 during this reporting period. Letters from stakeholders regarding Station programs and assistance, comments from the media, and narratives of scientific accomplishments are on file.

(2) Production practices options for reducing over-reliance on chemicals. See outcome indicators below for specific results.

(3) Methods of plant waste management that protect the environment. See outcome indicators below for specific results.

(4) Methods for re-working chemicals from soil and water. See outcome indicators below for specific results.

Outcome Indicators.

(1) Laboratory experiments will reveal more efficient, cost-effective methods of applying nutrients to greenhouse-grown tomatoes and other crops. **Theme: Nutrient management**

Description: the demand for tomatoes during colder months has encouraged at least 40 Connecticut growers to use greenhouses for production. Annual gross returns can reach $8,000 for one 30 x 96 ft. greenhouse. There are a number of cultivars of greenhouse tomato available, but it is unclear which varieties are most appropriate for production in Connecticut. Sensitivity to nitrogen

fertilizer varies greatly among cultivars, and there is a need to minimize excessive fertilizer use to reduce costs and to prevent contamination of surface and ground water supplies. To meet intermediate critical needs of stakeholders, different cultivars were tested in greenhouses under different fertilizer regimes. New cultivars included in tests (Crones, Micklow 102, and Quest) were evaluated for yield and fruit quality when adequate but not excessive amounts of nitrogen and potassium were used as fertilizer.

Accomplishment/Impact: the cultivars differed in yield, fruit size, and commonly occurring defects. Quest gave the highest marketable yield (10.4 pounds per plant) with minimal cracked skin defects. There was immediate short-term impact. Some growers have added Quest to their selection of cultivars and have implemented programs to reduce amounts of nitrogen and potassium nutrients in greenhouses. In addition to having quality fruits, increased production, and reductions in amounts of fertilizers used, there will be long-term benefits associated with less run-off of nutrients into streams and lakes, which can cause eutrofication. Consumers will also have plentiful supplies of tomatoes during colder months, and growers will have continued profitability for a crop that is in demand.

Sources of funds: Hatch and state.

Scope of impact: state-specific.

Results also apply to goal #1 **(Theme: Agricultural competitiveness; Agricultural profitability; Diversified/alternative agriculture; Plant production efficiency; and Small farm viability)** and goal #3 **(Theme: Human health)**.

(2) Laboratory tests will improve methods of detecting and degrading pesticides and other agricultural compounds that have contaminated soil and water. **Themes: Agricultural waste management; Hazardous materials; Soil quality; Water quality**

Description: effective application of *in situ* surfactant-aided biodegration for polynuclear aromatic hydrocarbon (PAH) compounds requires a sound understanding of the behavior of surfactants in these systems. With additional funding from Northeast Utilities, a Station scientist in collaboration with investigators from the University of Connecticut and Smith College conducted laboratory experiments to investigate the desorption of PAH compounds from an aged soil collected from a former manufactured gas plant site. Alfonic 1412-7, a non-ionic alkyl ethoxylate surfactant, and a broth of nutrients containing nitrogen, phosphorous and trace metals, were tested.

Accomplishment/Impact: at high concentrations, Alfonic significantly enhanced the extent and rate of release of PAH compounds from the soil. Evidence for soil organic matter desorption was also demonstrated. The addition of nutrients stimulated bacteria present in the contaminated soil to further enhance desorption by biodegradation. These results have immediate impact because scientists now know that desorption of PAH compounds from contaminated soils is possible. Consequently, there is strong interest in the scientific community to expand these studies for more widespread, practical uses in field settings as a long-term goal. There are several contaminated sites that currently have limited or no use because of the pollutants present. The expected long-term benefits of these studies are development of methods to remove pollutants from contaminated lands, which can be reclaimed for recreation or redevelopment, and the transfer of technology to the private sector. In urban settings where usable land is limited because of development, polluted conditions, or presence near residential areas, cleaning up contaminated sites is a high priority for municipal officials and industry. Reclaiming contaminated sites will have social impact because the overall aesthetic quality of lands will add value to commercial and other properties.

Sources of funds: Hatch and state.

Scope of impact: multistate (AR, AZ, CA, CT, FL, HI, IA, IN, KS, MN, MT, NV, NY, WA).

(3) Results of field experiments will lead to more efficient production and use of compost in agroecosystems, including stakeholders' gardens. **Theme: Recycling; Yard waste/composting**

Description: a farm located in eastern Connecticut is the largest producer of mushrooms in New England. Mushrooms are grown on media containing horse manure, straw, and other ingredients. After several crops of mushrooms, the media must be replaced. The old media is composted and distributed as a soil conditioner, but the waste materials accumulate because of limited demand. The owners of the farm requested assistance on finding ways of recycling spent growing media. Other stakeholders requested guidance on determining the effects of mushroom waste on the growth of ornamental plants in containers. There is interest among nursery owners and managers in using the spent media instead of the more expensive commercial fertilizers. Two varieties of chrysanthemum were grown in potting media containing 0, 25, 50, and 100%/volume mushroom waste compost.

Accomplishment/Impact: the greatest plant growth occurred in the lower amounts (25% or less) of mushroom waste compost, yet plants in all media were of high quality. These results had immediate impact because stakeholders now know that mushroom farm compost can be effectively used as an amendment to potting soil used in the production of ornamental plants. This promotes sustainable agriculture, and in rural areas, growers have begun to use the composted material. The expected long-term benefits of using composted materials will be cost savings for the nursery industry, more efficient plant production processes, and less accumulation of spent media at the

source. Moreover, by employing sustainable agricultural practices, the mushroom waste compost does not enter and pollute aquatic systems nor occupy valuable space at farm facilities.

Sources of funds: Hatch and state.

Scope of impact: state-specific.

Accomplishments also apply to goal #1 (**Themes: Home lawn and gardening; Plant production efficiency**).

Description: there is a need to find ways of recycling leaves and plant matter because many landfills have reached capacity and have been closed in Connecticut. At least 80 municipalities are composting leaves. Homeowners and farmers want to use composted leaf materials, but there are concerns about possible organic pollutants being present. Since composted leaf matter may be used in gardens, stakeholders have requested assistance to determine if persistent organic pollutants (POPs) are present in composted matter. Accordingly, commercial and municipal compost materials were screened for chlordane, a banned pesticide that can persist in contaminated soil.

Accomplishment/Impact: nine of 13 commercial samples and all 39 municipal materials tested contained chlordane at generally low concentrations ranging from 5 to 415 parts per billion. It is suspected that the source of chlordane may be leaf litter collected from residential settings. Consequently, this pathway can not be ignored in further assessing the movement of POPs in the environment. These results provide short-term benefits because, until further studies are conducted, contaminated compost is not being used to grow edible plants. Other studies revealed that zucchini takes up chlordane from contaminated soil. Accordingly, the composted materials are being used with shrubs and newly planted trees instead of being placed in vegetable gardens or larger vegetable crop production areas. The long-term benefits will be a more efficient and safe use of composted plant matter and a method of re-cycling materials to enhance the quality of ornamental plants of

homeowner, commercial, and institutional properties. Fertilization of shrubs and trees will improve the aesthetic quality and values of properties.

Sources of funds: Hatch, state, and Environment Protection Agency

Sources of impact: state-specific

Accomplishments also apply to goal #1 (**Themes**: **Home lawn and gardening; Plant production efficiency; Human health; Food safety; Agricultural waste management).**

(4) Laboratory analyses will identify which mosquito species are important in the transmission of eastern equine encephalitis and California group encephalitis viruses so that there will be minimal use of pesticides for control in forested areas and a more precise time interval defined for application of pesticides. **Themes: Biological control; Integrated pest management; Pesticide application; Other (Wildlife science)**

Description: Eastern equine encephalitis (EEE) and West Nile encephalitis (WNE) viruses infect birds and mammals, including humans beings. It appears that WNE virus is well established in the United States, and even though it has been active in Connecticut each year since 1999, its ability to persist over several years is unknown. To meet the immediate needs of stakeholders to learn if mosquitoes are infected, a statewide mosquito surveillance program was continued during the summer to determine the extent of viral infections.

Accomplishment/Impact: there were 51 isolations of EEE virus and 53 isolations of WNE viruses from 14,649 pools of mosquitoes representing 190,692 mosquitoes. Of these, EEE virus and WNE virus were detected in 11 and 14 mosquito species, respectively. The majority of the isolations were from densely populated areas of southern Connecticut. Results were reported to the media and to state and local health officials. This information reached hundreds of thousands of stakeholders. Knowledge of widespread occurrence of infected mosquitoes had immediate impact on people. They

used repellants and took other precautions to minimize mosquito bites. The elderly were informed about elevated fatality rates for their age group. Local health departments treated catch basins and other stagnant acquatic areas with larvicides to reduce mosquito populations. Although there were 17 human cases of WNE reported, there were no fatalities. Considering the widespread occurrence of WNE virus in birds and mosquitoes, this was a positive outcome. Annual surveillance and research programs offer long-term benefits because patterns of virus prevalence in the environment will be clarified. If viral activity decreases to low levels, then pesticide applications can be reduced accordingly to meet the immediate needs, thereby reducing costs for municipalities and human exposure to pesticides. Reduced pesticide use will also decrease risk of environmental contamination (i.e., ground and surface waters) and lessen the adverse effects on non-target organisms. Finally, having a mosquito surveillance/virus isolation program will facilitate the detection of pathogens in the event of bioterrorist activities.

Sources of funds: Hatch and state.

Scope of impact: state-specific.

These accomplishments also apply to national goals #1 **(Themes: Animal health; Risk management)** and to goals #3 and #5 by providing information on emerging human and veterinary diseases so that there would be a healthy population and enhanced quality of life for citizens living in rural and suburban areas (**Themes: Human health; Children, youth, and families at risk**).

(5) New antibody tests will be developed for the laboratory diagnosis of Lyme disease and granulocytic ehrlichiosis in human beings, domesticated animals, and wildlife species (i.e., deer and mice) to determine specific localities where there is risk of infection and a need to inform

stakeholders. **Themes: Integrated pest management; Pesticide application and management; Other** (**Emerging infections; Wildlife science)**

Description: *Anaplasma phagocytophilum* (formerly *Ehrlichia phagocytophila*) causes granulocytic ehrlichiosis in horses, dogs, and humans in the United States and Europe. Pathogens are transmitted by *Ixodes scapularis* ticks in eastern United States and by related ticks in western United States and Eurasia. To meet immediate critical needs of veterinarians, physicians, and other stakeholders, class-specific enzyme-linked immunosorbent assays (ELISAs) were developed to improve laboratory diagnosis. Human serum samples were analyzed in enzyme-linked immunosorbent assays (ELISA) with a recombinant fusion protein of *A. phagocytophilum*, the causative agent of human granulocytic ehrlichiosis (HGE).

Accomplishment/Impact: the newly developed ELISA was capable of detecting antibodies during early weeks of infection, as well as in later periods of illness. There was high sensitivity (94%) and specificity (99%). These results had immediate impact. The new test has been used as an adjunct experimental method for laboratory diagnoses of HGE in the Connecticut State Department of Health and Yale University. A small biotechnology firm is pursuing the production of a commercial assay. To continue to meet short-term needs, serum samples from ill persons have been tested at the Station on an experimental basis, and 132 persons have benefited from assay results thus far. The expected long-term benefits of this research advancement are that a much larger group of people will receive proper antibiotic treatment as a result of more accurate diagnostic tests and that the technology can be applied to develop antibody-detection systems for veterinary diseases. With commercialization of the assays, thousands of stakeholders in the United States will benefit by regaining their health or improving the health of dogs and horses they own.

Sources of funds: Centers for Disease Control and Prevention, Hatch, National Institutes of Health, and state.

Scope of impact: multistate (CT, GA, NY) and integrated research and extension.

These accomplishments also apply to national goals #1 **(Theme: Animal health)**, #3, and #5 by providing important information on a new emerging animal and human disease, granulocytic ehrlichiosis, so that there would be a healthy population and enhanced quality of life for citizens living in rural and suburban areas (**Themes: Human health; Children, youth, and families at risk; Promoting business programs)**.

Description: like human beings, dogs are infected by the Lyme disease agent and sometimes show signs of limb/joint disorders (eg., arthritis). Laboratory diagnosis for serum antibodies is difficult because current tests lack specificity. At the requests of veterinarians and dog owners, experiments were conducted to improve antibody tests. Dog serum samples were tested for antibodies to the Lyme disease agent to determine patterns of host immune responses.

Accomplishment/Impact: In Western blot analyses, there were antibodies present in naturally exposed dogs that had no vaccinations for Lyme disease. A variety of surface proteins of the disease organism were immunologically recognized. There were immediate benefits of this research. New recombinant antigens (ie., fusion proteins) were produced and are being used in enzyme-linked immunosorbent assays (ELISA) for laboratory diagnosis in conjunction with Western blot methods. Technological information has been transferred to a collaborator, who is working with a biotechnology firm to commercialize an assay. Dogs with lameness and fever are being properly diagnosed for Lyme disease. Also, it is apparent that laboratory diagnosis requires a two-step process, as recommended for determining human infections. Serum samples are now being tested in commercial laboratories by an ELISA as a pre-screening step, and if positive, are retested by

immunoblotting to confirm the presence of antibodies to specific proteins. The expected long-term benefits of improved diagnostic tests are a healthy dog population, lower costs of treatment, and enhanced quality of life for dog owners.

Sources of funds: Centers for Disease Control and Prevention, Hatch, National Institutes of Health, and state.

Scope of impact: multistate (CT, TX)

These accomplishments also apply to national goals #1 **(Theme: Animal health)** and to goals #3 and #5 by providing geographic distributional information on a new emerging animal and human disease, granulocytic ehrlichiosis, so that there would be a healthy population and enhanced quality of life for citizens living in rural and suburban areas (**Theme: Human health; Children, youth, and families at risk**).

(6) Field experiments will reveal prevalence of infected ticks near human dwellings and effective methods of controlling ticks that transmit pathogens to mammalian hosts. **Themes: Biological control; Integrated pest management; Other (Wildlife science)**

Description: The blacklegged tick, *Ixodes scapularis*, transmits a Lyme disease spirochete (a bacterium) to a wide range of mammalian and avian hosts in North America. This tick also transmits pathogens that cause human babesiosis, human granulocytic ehrlichiosis, and equine and canine ehrlichioses. Homeowners have requested assistance on developing methods of controlling these ticks, preferably biological control, in localized settings around homes. An entomogenous fungus, *Metarhizium anisopliae* strain 52, was evaluated for tick control on residential properties. Applications were made with a high volume hydraulic sprayer to the lawn perimeter and to several

marked woodlots adjacent to the lawns. There were pre-treatment and post-treatment tick counts in control and treated areas.

Accomplishment/Impact: The viability of fungal spores was 70%, and tick mortality rates were acceptable. The immediate benefit of this work is that *Metarhizium anisopliae* does indeed have potential for controlling the blacklegged tick. Although fungal pathogens may not be as effective as synthetic chemical pesticides in controlling ticks, they offer a reasonably effective alternative to chemical tick control for short-and long-term benefits. The company that manufactures the fungal formulation is now pursuing EPA registration so that licensed pesticide applicators can use the product. The expected long-term benefits of biological control of ticks are decreased environmental problems due to the use of chemical pesticides, which often affect non-target, beneficial insects, and reduced human exposure to pesticides, thereby decreasing health risks. Reductions in pesticide use will also decrease risk of ground and surface water contamination.

Sources of funds: Centers for Disease Control and Prevention, Hatch, and state.

Scope of impact: multistate: CO (CDC), CT. These accomplishments also apply to national goals #1 **(Theme: Risk management)** and #3 and #5 by providing important information on Lyme disease so that there would be a healthy population and enhanced quality of life for stakeholders living in rural and suburban areas (**Themes: Human health; Children, youth, and families at risk**).

Description: adults of the blacklegged tick, *Ixodes scapularis*, prefer deer as hosts. The rise in populations of this tick in eastern and upper midwestern United States is correlated with increases in numbers of deer. Deer also cause automobile accidents and destroy nursery plants, tree saplings in forests, and homeowners' shrubs. At the request of the nursery industry, new studies have been initiated to track deer movement in forests, estimate population densities, and to control deer by a humane sterilization method. Sixteen male deer were captured and tranquilized for sterilization, and

a sclerotizing agent was injected directly into selected tissues to block the epididymus and prevent sperm flow. Investigations in Connecticut are integrated (research and extension) in an approved multistate project NE-1005.

Accomplishment/Impact: The sclerotizing agent caused a scar to develop within the epididymis, thus blocking the flow of sperm. The sterilization method being considered is successful, and treated males continue to engage in normal mating and mate-guarding behavior. These findings have immediate impact. Scientists in other states are now using this method in experiments on deer management. The expected long-term benefits of improved deer management programs are lower deer populations over broad areas, a reduction of deer damage to homeowner and nursery plants, and fewer automobile accidents. Decreasing deer herds will also improve the health of forests by reducing damage to saplings in the understory and, like homeowners' properties, improve the aesthetic quality of lands.

Sources of funds: Hatch and state.

Scope of impact: multistate (CT, MD, NJ, PA, VA, WV).

Themes: Human health; **Children, youth, and families at risk; Forest resource management**. This project also applies to goal #1 (**Theme: Ornamental/Green Agriculture**).

(7) Laboratory analyses will determine concentrations of pesticide residues in air, water, or soil samples submitted by state regulatory agencies. **Themes: Air quality; Hazardous materials; Pesticide application**

Description: the Department of Analytical Chemistry analyzes samples for municipalities. During this reporting period, there were suspected dog poisonings. A town police department requested immediate assistance on determining the unexplained deaths of two dogs. Municipal police

submitted stomach contents, meat, and a dog treat bag for analyses to determine the cause of possible poisoning of the dogs.

Accomplishment/Impact: results of analyses provided an immediate answer. The samples contained the insecticide, bendiocarb, which is known to kill dogs. The signs exhibited by the poisoned dogs were consistent with published information. Although it is unknown how the dogs came in contact with the insecticide, the town police department received a prompt response to their inquiry and were able to continue their investigations. Dog owners were informed of the cause of death for their pets. The long-term benefits are that the analytical procedures used were effective at detecting bendiocarb and can be used in similar future cases to clarify unexplained mortality in pets. Moreover, police department officials are an under-served group. These stakeholders now know that they can rely on Station assistance in the future for solving cases.

Sources of funds: Hatch and state.

Scope of impact: state-specific. These accomplishments also apply to goal #1 **(Theme: Risk management).**

(8) Laboratory and field studies will identify species of entomopathic microsporidia that may be used to control mosquito larvae in wetland habitats and thereby reduce chemical control. **Themes: Biological control; Integrated pest management**

Description: microsporidia are protozoan pathogens that can infect mosquito larvae and, thereby, be used in pest management programs to reduce amounts of chemical insecticides used in aquatic habitats. To meet the long-term critical needs of stakeholders and research objectives in an integrated multistate research (S301) project, studies were conducted on the comparative phylogeny of *Amblyospora* species, which live in copepods as intermediate hosts. Emphasis was placed on the

life cycle of a microsporidian parasite, *Hyalinocysta chapmani,* which infects an important mosquito (*Culiseta melanura*) involved in the transmission of eastern equine encephalitis viruses to birds.

Accomplishment/Impact: the microsporidan parasite lives in an intermediate copepod host, *Orthocyclops modestus,* and is acquired by larval *Cs. melanura* in aquatic habitats following the oral ingestion of uninucleate spores from infected copepods. The high overall prevalence rates of lethal infection observed in larval populations of *Cs. melanura* at one site, were among the highest recorded for any mosquito-parasitic microsporidium and indicate that *H. chapmani* has great potential as a biological control agent. Two publications appeared in the *Journal of Eukaryotic Microbiology* and the *Journal of Invertebrate Pathology.* The former featured the scientific findings by showing the life cycle of the microsporidian on the cover of the journal. These activities had immediate national impact by generating interest in the scientific community. Insect pathologists and industry officials are now pursuing the development of the protozoan for biological control. The expected long-term benefits of having biological controls for mosquitoes are that less chemicals will be used in sensitive aquatic ecosystems, some of which drain into rivers, lakes, and Long Island Sound; there will be less impact on non-target organisms; and there will be reduced human and other animal exposure to pesticides, thereby reducing health risks. Moreover, having an effective biological control for *Cs. melanura* will greatly reduce or prevent amplification of EEE virus in birds and, thereby, reduce the risk of human infections.

Sources of funds: Hatch and state.

Scope of impact: multistate (AL, AR, CA, CT, FL, GA, ID, IL).

Accomplishments also apply to goals #3 **(Theme: Human health).**

(9) Field and laboratory experiments will determine the growth of woody and herbaceous nursery crops in media amended with biosolids compost and if this nutrient source is suitable for commercial use. **Themes: Agricultural waste management; Ornamental /green agriculture; Biobased products; Recycling; Other (Biosolids compost)**

This objective has been completed. Results and impact statements were presented in the first three Annual Accomplishment Reports.

(10) IPM programs developed for nurseries will reduce amounts of pesticides used and result in more efficient uses of agricultural chemicals by producers. **Themes: Integrated pest management; Pesticide application**

Description: in a collaborative effort with extension specialists at the University of Connecticut, educational training sessions were held and field studies were continued at the request of stakeholders to determine if amounts of pesticides used in nurseries have declined as a result of implementing IPM practices. Detailed pesticide records were available for five nurseries (pre-and post-IPM adoption) where on-site assistance was given to establish IPM programs. Two of these firms have large production facilities located near residential areas or close to Long Island Sound, where sensitive ecosystems exist.

Accomplishment/Impact: 89 growers received educational training and information on IPM practices in meetings or during special sessions conducted in nurseries. Insecticide/miticide usage in two small nurseries declined by about 358 pounds of product after IPM programs were established. This translated into a short-term benefit of a combined $3,967 decrease in cost for insecticidal

product. Expected long-term benefits include the production of quality plants with less adverse effects on beneficial insects that help control pest species in nurseries; less pesticide contamination of ground water, streams, and rivers; and less human and animal exposure to pesticides, thereby reducing health risks. Moreover, nursery growers are more convinced that IPM practices are effective. This change in attitude among growers will help achieve other expected long-term benefits of more widespread acceptance of IPM programs and having an overall cleaner environment.

Accomplishment/Impact: an economic analysis was performed for two model nurseries of different sizes, where IPM practices included early plant monitoring and the use of specific insecticides for pinpoint treatment of the active pest life stage. Rhododendron leaf miner (*Lyonetia latistrigella*) was the target pest. Although overall pesticide costs initially increased per acre, no labor was needed to remove leafminer damage, resulting in a savings of $15,360. With modifications in timing of chemical treatment and increased production, there was a $360 increase in net returns per acre. On a per unit basis, the total cost fell 7 cents (overall $77,000 reduction), including insecticide cost declines of 16 cents (overall $17,600 reduction). In the second nursery, similar well-timed chemical treatments and increased production led to a $416 increase in net returns per acre. On a per unit basis, the total cost fell 2 cents (overall $8,220 reduction), and the insecticide cost dropped 16 cents (overall $6,576 reduction). There were immediate short-term impacts because growers produced quality plants and benefited financially by using IPM practices. These stakeholders are now more enthusiastic about future cost savings. Further acceptance of IPM practices by other growers will lead to expected long-term benefits of having cleaner nursery environments, which in some cases, border residential areas, reduced risk of ground and surface water contamination, and decreased human and animal exposure to pesticides, thereby reducing health risks. Also, less

chemical treatment is positive for beneficial insects, which control pest species in nurseries and contribute to the overall success of IPM programs.

Sources of funds: Hatch and state.

Scope of impact: state-specific, integrated research and extension.

These accomplishments also apply to national goal #1 **(Themes: Agricultural competitiveness; Agricultural profitability; Ornamental/Green agriculture; Precision agriculture; Small farm viability).**

Description: in a collaborative effort with extension specialists at Cornell University, field studies were conducted in nurseries growing ornamental perennials in containers. Stakeholders requested assistance on finding non-chemical weed management alternatives. Herbicide treatments add extra costs to farm management. Plots consisted of three newly potted, 1 gal containers each of the following perennials: coreopsis, coneflower, blue fescue, daylily, bee balm, ribbon grass, and phlox. Replicated treatments included untreated checks, the granular herbicide pendimethalin, pine bark mulch, cocoa hull mulch, recycled paper pellets, pelletized wool, pendimethalin covered by Penn Mulch and pendimethalin covered by Wulpak.

Accomplishment/Impact: all of the non-chemical treatments performed as well as or better than pendimethalin treatments in preventing weeds. Effective non-chemical methods of controlling weeds were identified, and growers have begun to use these practices to protect the value of their plants. This is a departure from past practices, which were predominantly chemically oriented in approach. The expected long-term benefits are that the reduction of herbicides in nurseries will decrease run-off problems associated with surface and ground water supplies and there will be less human exposure to pesticides, thereby reducing health risks.

Sources of funds: Hatch and state.

Scope of Impact: multistate (CT, MA) and integrated research and extension. These results also apply to national goal #1 **(Themes: Agricultural profitability; Plant health; Ornamental/green agriculture; Plant production efficiency; Small farm viability).**

Allocated Resources. Fiscal and human (expressed as Scientist Years) resources are listed for federal FY 2003.

	Fiscal Resources				Human Resources	
	Federal*		State		Scientist Years	
Years	Target	Actual	Target	Actual	Target	Actual
1999	$205,373	$205,057	$1,310,000	$1,446,155	15.5	17.1
2000	205,373	$222,280	$1,410,000	$1,510,458	16.0	17.1
2001	205,373	$207,127	$1,410,000	$1,600,558	16.0	18.6
2002	205,373	$139,394	$1,410,000	$1,721,621	16.5	16.5
2003	205,373	$200,222	$1,410,000	$2,012,206	16.5	20.8
2004	205,373		$1,410,000		16.5	

*Federal Hatch funds only.

Multi-Institutional, Multi-Disciplinary, and Multistate Programs

The Station's Hatch projects, CRIS/CSREES accession numbers, and state and federal Hatch funds are listed in separate tables to document multi-institutional, multi-disciplinary, and multistate programs (Tables 1-3). Table 4 shows a distribution of funds for this part of the research program and the ≥25% required amounts for formula funds. Table 5 shows integrated activities with extension systems in land-grant universities, while Table 6 and Table 7 report actual distributions of Hatch and state matching funds for federal FY 2003. The CRIS code for The Connecticut Agricultural Experiment Station is CONH.

Table 1. Multi-Institutional (FY 2003)

Hatch Project	CRIS Access.#	Collaborating institutions and businesses
CONH 133[c]	0183165	CT Dept. of Consumer Protection
134	0183796	U.S. Environmental Protection Agency (EPA)
135	0187947	None
136	0188720	CT Dept of Consumer Protection, US EPA
239[c]	0177684	Yale University (New Haven, CT), Univ. of Oxford (UK)
240	0188383	Yale University, Univ. of Oxford (UK)
241	0191156	Yale University
242[b]	0191890	Yale University
344[d]	0078445	Centers for Disease Control (Atlanta, GA and Fort Collins, Co), Georgia Southern Univ. (Statesboro), IDEXX Laboratories (Westbrook, Maine), Yale Univ., Univ. of Connecticut (Storrs), University of Iowa, University of Texas (Houston), L^2 Diagnostics (New Haven)
358[c]	0133614	Yale Univ.
360[c,d]	0133932	Dept. of Agriculture (MD and NJ), Univ. of Idaho, Cornell Univ.
365[a,c,d]	0163201	Cornell Univ. (Geneva Exper. Station)
371[d]	0179183	Univ. of Connecticut (Storrs), Cornell Univ.
372[c,d]	0179689	Univ. of Connecticut (Storrs), Cornell Univ. (NY), Univ. of Rhode Island
374	0185235	Yale Univ., CT. Dept. of Health
375[a,d]	0183834	Univ. of CT (Storrs), Univ. of Mass., Univ. of Rhode Island, etc.
377[d]	0191684	Cornell Univ., Univ. of CT (Storrs), Rutgers Univ., Univ. of Maine, Univ. of Mass, Univ. of New Hampshire, Univ. of Rhode Island
378[b,d]	0195135	University of Connecticut (Storrs), Univ. of Massachusetts, Cornell University

551[a,d]	0167653	Cornell Univ., W. Virginia (Univ.), Univ. of Georgia, Univ. of Arkansas, Virginia Tech. Univ., Michigan State Univ.
556[c]	0178482	Univ. of CT (Storrs), Hopkins and Stonington CT vineyards
557[c]	0180059	CT. Vegetable Producers, CT. Greenhouse Growers Assoc.
559[d]	0186018	CT. Dept. of Environmental Protection, CT. Nursery & Landscape Assoc., Cornell Univ., Penn. State Univ., Rutgers Univ., Univ. of Maryland, Virginia Polytechnic Inst., West Virginia Univ.
560[a,b,d]	0190494	Cornell Univ., Rutgers Univ., Penn. St. Univ., Univ. of Maryland, Virginia Polytechnic Inst., West Virginia Univ.
561[b]	0191645	CT. Dept. of Agriculture
562[a,b,d]	0191991	Cornell Univ., Univ. of CT, Michigan State, Univ. of Nebraska, Univ. of New Hampshire, Rutgers Univ., Ohio State Univ., Penn. State Univ.
563[b,d]		CT. Vegetable Producers, CT. Greenhouse Growers Assoc.
625[d]	0178255	Yale Univ., Univ. of CT (Storrs), Cornell Univ., Wageningen Agric. Univ. (Netherlands)
626[c,d]	0181858	Univ. of CT (Storrs), Univ. of Florida, Michigan St. Univ., Penn. State Univ., Washington State Univ.
627[c]	0185405	Univ. of CT (Storrs)
628	0187597	USDA Forest Service
630[b,d]	0195468	University of CT (Storrs), Michigan State Univ., Penn. State Univ.
695[a,d]	0139748	Univ. of Mass., Cornell Univ. (Ithaca & Geneva), Penn. State Univ., Univ. of CT (Storrs), Michigan State Univ.
766[c]	0181763	Biolog. Bundesanstalt fuer land-und Forstwirtschaft (Germany)
768[a,d]	0170382	Several states cooperating on S-301, USDA/ARS Center for Med. Agric. & Vet. Entomology
769	0187670	State of CT. Dept. of Transportation
770[a,d]	0184011	Several states cooperating on W-082
771	0188384	Univ. of CT (Storrs)
772[b]		Biolog. Bundesanstalt fuer land-und Forstwirtschaft (Germany)

	804[c,d] 0179283	Univ. of CT (Storrs)
	805	Univ. of CT (Storrs)

[a]USDA approved multistate research project.

[b]New Hatch project approved during reporting period.

[c]Hatch project expired during reporting period.

[d]Includes integrated activities (research/extension).

Table 2. Multi-Disciplinary (FY 2003).

Hatch Project	Scientific Disciplines
CONH 133	analytical chemistry, toxicology
134	analytical chemistry, food production systems
135	analytical chemistry, food production systems
136	analytical chemistry, toxicology
239	plant biochemistry, molecular genetics, plant physiology, immunology
240	plant biochemistry, molecular genetics, plant physiology
241	plant biochemistry, molecular genetics, plant physiology
242	plant biochemistry, molecular genetics, plant physiology
344	acarology, microbiology, immunology, molecular biology, epidemiology, human and veterinary medicine, wildlife diseases
358	insect pathology, molecular biology
360	entomology, horticulture, integrated pest management (IPM)
365[a]	plant genetics, entomology
371	acarology, entomology, IPM
372	agronomy, IPM, analytical chemistry, economics, entomology, insect and plant pathology
374	bacteriology, molecular biology
375[a]	entomology, plant pathology, IPM
377	entomology, ecology

378	entomology, IPM
551[a]	horticulture, plant pathology, plant genetics, entomology
556	horticulture, plant genetics
557	horticulture, plant physiology
559	animal behavior/ecology, deer management
560[a]	animal behavior/ecology, deer management
561	horticulture, waste management systems
562[a]	horticulture, plant physiology
563	horticulture, plant physiology
625	meteorology, plant pathology, epidemiology, biophysics, biological control
626	mycology, plant pathology, horticulture, molecular biology
627	plant pathology, biological control
628	plant pathology, mycology
630	mycology, plant pathology, horticulture, IPM
695[a]	nematology, plant pathology, entomology
766	environmental toxicology, soil chemistry
768[a]	protozoology, invertebrate pathology, entomology
769	soil microbiology, horticulture, composting
770[a]	soil chemistry, environmental toxicology
771	soil and water chemistry, environmental toxicology
772	environmental toxicology, soil chemistry
804	analytical chemistry, horticulture, weed management
805	analytical chemistry, horticulture, weed management

[a]USDA approved multistate research project.

Table 3. Multistate Collaborations (FY 2003).

Hatch Project	CSREES Multi-state Project Number	Participating states
CONH 133		
134		
135		
136		
240		
241		
242		
344		CT*, GA, ME, IA, SC, TX
358		
360		MD, NJ, ID
365	NE-009[a]	CT*, DE, ME, MD, MA, NH, NJ, NY, PA, RI, VT, WV
371		CT*, NY
372		CT*, NY, RI
374		
375	NE-187[a]	CT*, FL, ME, MD, MA, NJ, NY, PA, RI
377		CT*, MA, ME, NH, NJ, RI
378		CT*, NY
551	NE-183[a]	AL, AR, CT*, ID, IN, MA, MI, NH, NJ, NY, NC, OH, OR, PA, UT, VA, VT, WA, WI, WV
557		
559		MD, NJ, NY, PA, VA, WV
560	NE-1005[a]	MD, NJ, NY, PA, VA, WV
561		
562	NE-164[a]	CT*, MI, NE, NH, NJ, NY, OH, PA,

563		
625		CT*, NY
626		CT*, FL, MI, PA, WA
627		
628		
695	NE-171 [a]	CT*, FL, MA, MD, MI, NY, PA, SC, WV
766		
768	S-301 [a]	AL, AR, CA, FL, GA, ID, IL, KY, LA, ME, MN, MS, NJ, NY, NC, SC, TN
769		
770	W-082[a]	AR, AZ, CA, CT*, FL, HI, IA, IN, KS, MN, MT, NV, NY, WA
771		
772		
804		CT*, MA
805		CT*, MA

[a]USDA approved multistate research project.

CT* = University of Connecticut (unaffiliated with The Connecticut Agricultural Experiment Station).

Table 4. Distribution of Hatch and state matching funds at The Connecticut Agricultural Experiment Station (C.A.E.S.). Federal FY 1999, FY 2000, 2001, 2002, and 2003 data for Multi-Institutional, Multi-Disciplinary, and Multistate Projects.

			SY units	
	Connecticut		Multi-	Total
Fed. Hatch Funds	State Funds	Total	Categories	Hatch Program
FY 99 $375,854	$1,287,854	$1,663,282	15.7	37.3
FY 00 $392,951	$1,579,780	$1,972,731	15.9	37.3
FY 01 $354,106	$1,668,647	$2,022,753	18.1	40.8
FY 02 $346,197	$1,769,108	$2,115,305	15.9	38.5
FY 03 $351,342	$1,598,218	$1,949,560	17.1	39.2

Total funds available for entire Hatch program (FY 2003) at C.A.E.S.	$760,541
% Hatch funds dedicated to multi-institutional, multi-disciplinary, and multistate programs	46.2%

Table 5. Integrated research activities between The Connecticut Agricultural Experiment Station (C.A.E.S.) and extension programs in land-grant universities during federal FY 1999, 2000, 2001, 2002, and 2003.

				SY units	
		Connecticut			Total
	Fed. Hatch Funds	State Funds	Total	Integrated only	Hatch Program
FY 99	$288,340	$977,827	$1,266,167	8.5	37.3
FY 00	$298,777	$1,022,467	$1,321,244	8.1	37.3
FY 01	$260,671	$1,181,464	$1,442,135	10.6	40.8
FY 02	$255,442	$1,328,591	$1,584,033	9.9	38.5
FY 03	$309,537	$1,453,215	$1,762,752	14.4	39.2

Total funds allocated to entire Hatch program at C.A.E.S. in FY 2003	$760,541
% dedicated to all multi-categories and integrated activities with CT and other states	40.7%

The Connecticut Agricultural Experiment Station dedicated Hatch funds to integrated activities with extension systems in land-grant universities in different states. In Connecticut, $265,898 was dedicated to integrated activities in FY 2003 with extension at the University of Connecticut, an institution not affiliated with The Connecticut Agricultural Experiment Station.

Table 6. Distributions of projected and actual Hatch and state matching funds and SY units at The Connecticut Agricultural Experiment Station for Multi-Institutional, Multi-Disciplinary, Multistate, and Integrated Activities for federal FY1999, 2000, 2001, 2002, and 2003.

	Federal Hatch*	State funds*	Scientist Years
Projected	$260,360	$845,500	10.0
Actual (FY1999)	$288,340	$977,827	8.5
Actual (FY2000)	$298,777	$1,022,467	8.1
Actual (FY2001)	$260,671	$1,181,464	10.6
Actual (FY2002)	$255,442	$1,328,591	9.9
Actual (FY2003)	$309,537	$1,453,215	14.4

*Funds distributed to all “multi” categories with integrated activities.

Table 7. Distributions of projected and actual fiscal and human resources (SY units) dedicated to the entire Hatch and associated state research program for federal FY1999, FY2000, FY2001, FY2002, and FY2003.

	Total Federal Hatch	Total State Match	Total SY
Projected	$767,627	$4,068,700	36.8
Actual (FY1999)	$768,626	$3,957,042	37.3
Actual (FY2000)	$768,473	$4,188,037	37.3
Actual (FY2001)	$767,020	$4,510,502	40.8
Actual (FY2002)	$766,911	$4,712,285	38.5
Actual (FY2003)	$760,541	$4,483,825	39.2

Progress Reports: Integrated Activities

(Hatch Act Funds)

Federal FY 2003

Program descriptions: As presented in form CSREES-PLAN (2/00), 11 programs (13 Hatch projects) were listed for integrated activities (Hatch Act Funds). In a previous section of this Annual Report of Accomplishments and Results (including the Tables), descriptions and impact statements are given regarding progress made on the planned integrated and other programs. Form CSREES-REPT (2/00) reporting expenditures for FY 2003 follows brief research summary statements for these specific programs.

1. Tick-borne infections: physicians and veterinarians rely heavily on antibody test results to help diagnose Lyme disease and granulocytic ehrlichiosis. Newly developed enzyme-linked immunosorbent assays (ELISAs), containing a recombinant fusion protein, had high sensitivity and specificity when human sera were tested. Experimental test results have led to proper diagnosis, which have benefited 132 people thus far. In other work, Western blot analyses of dog sera determined patterns of immune responses in Lyme disease infections. Certain surface proteins of the disease organism were immunologically recognized by the dogs during early and late stages of illness and are good candidates for the production of new recombinant fusion proteins for use in ELISAs. Aside from the immediate benefits of diagnosing dog illnesses, technology for these new tests has been transferred to state-operated and commercial diagnostic laboratories. A biotechnology company is considering commercialization of antibody assays for human and veterinary diagnostics.

2. Managing insects on vegetable crops: field experiments on the use of different cover crops to control pest insects and weeds were continued in plots containing sweet corn. Both beneficial and deleterious microbes were present at higher densities in the root zone of the corn plants in a strip-tilled treatment plot. Strip-tilling resulted in competition between the remaining cover crop material and corn growth. Growers have learned that strip-tilling methods are not ideal for management of cover crops and, accordingly, farm management practices have been modified.

3. Plant genetic resources (NE-9): research continued on the evaluation of arugula (*Eruca sativa*) cultivars. Organic farmers are interested in growing arugula, a popular salad green, and have requested assistance on finding resistant cultivars to flea beetles. Of the 169 cultivars evaluated, none showed resistance. However, there were other positive traits, such as yield and early harvest noted for some cultivars. All data and digital photographs of all accessions have been submitted to the curator of the oilseed brassicas at the North Central Plant Introduction Station for public use. Seed company officials, plant breeders in universities, and growers are now accessing the information, which is helping them to develop new varieties of arugula.

4. Managing insects in apple orchards: apple tortrix (*Archips fuscocupreanus*) attacks 87 species of plants in 15 families; of these, 68% of the species were in Rosaceae, which includes economically important pome and stone fruits. Larvae are most abundant in late April to early May in orchards. Growers learned that a general pre-bloom spray for a variety of insect pests was found to be sufficient to control apple tortrix. Fruit growers benefited in the short term by not having to add costs for additional insecticidal spraying. In the long term, the orchard environments benefit by

having fewer insecticidal treatments. Reduced insecticidal treatment also benefits beneficial insect predators which help control pest species and form the basis for IPM programs.

5. Integrated pest management (IPM) for Connecticut nurseries: five nurseries received intensive on-site assistance to implement IPM practices. Examination of pesticide records showed that insecticide/miticide usage decreased by 358 pounds of product due to more efficient farming practices. In other work, economic analyses were performed for two nurseries where IPM practices were implemented for a rhododendron leafminer problem. There was increased plant production and lower costs of insecticidal treatment as a result of the IPM program. Growers have become more enthusiastic about implementing IPM programs. In addition to reduced costs of insecticide treatments, the long-term benefits of cleaner nursery environments and more effective biological control of pest species will be achieved.

6. Management of insects in soil and other pests (includes NE-187): field tests conducted in five nurseries revealed that the insecticide befenthrin, applied to potting media at concentrations of 2, 5, 10, or 20 parts per million (ppm) had a half life of 2 to 3 years. A 90% control rate was achieved for oriental and Japanese beetles when 2 ppm bifenthrin was used. Nursery growers learned that there can be effective grub control with minimal amounts of insecticide. With a reduction in pesticide use, there will be short-term benefits of reduced farm costs and long-term impacts of having cleaner nursery environments.

7. Evaluation of new apple cultivars (NE-183): Work continues on the evaluation of 24 apple cultivars. In laboratory tests of fruit, apples of all cultivars were susceptible to bitter rot. The fruit

fungal infection had the slowest growth on the cultivar “Suncrisp”. This new information had immediate impact because fruit growers can more efficiently select the most desirable cultivars for their farms.

8. Suppression of soil-borne diseases: Verticillium wilt affects tomato and eggplant crops. Field studies revealed that the use of green manures, consisting of cruciferous crop residues, continues to suppress disease for at least two seasons after incorporation into soil. Consequently, vegetable growers did not have to apply fungicides and there was an immediate benefit of saving $250 per acre in pesticide costs. The long-term impacts include cleaner farm environments and increased participation of growers’ acceptance of IPM programs.

9. Analysis of risk for plant diseases: Apple scab, caused by a fungus, remains a serious problem for fruit growers. A model has been developed to estimate probability of apple scab infection in orchards. Growers now have a more accurate means of determining when to apply fungicides to apple trees. With widespread acceptance by apple growers, nationally, there are potential savings of $3.5 million in fungicide costs. Long-term benefits of less pesticide use will result in cleaner orchard environments and enhanced water quality with reduced run-off problems.

10. Integrated pest management of plant parasitic nematodes (NE-171): strawberry root rot is caused by a fungus, *Rhizoctonia fragariae*, after lesions are caused by a parasitic nematode, *Pratylenchus penetrans.* Experiments were conducted in the field to more accurately determine nematode activity. Lesion and root-knot nematodes primarily infected feeder roots. In two seasons, *P. penetrans* populations peaked during late May and then declined. The short-term impact is that

plant pathologists and growers now know when to take diagnostic samples from fields to implement more efficient control measures; IPM programs have improved. Long-term impacts include less pesticide residues on strawberries and cleaner field production areas.

11. Herbicides/weed control: weeds growing in nurseries require costly herbicide treatments. Growers have asked for assistance on finding less expensive, non-chemical weed management alternatives. Pine bark mulch, cocoa hull mulch, recycled paper pellets, and pelletized wool showed promise for suppressing weeds in containers. These results had immediate impact. Growers have begun to use non-chemical control methods, which is a departure from previous practices. The reduction in herbicides in nurseries, many of which are near residential areas, will enhance surface water and ground water quality by decreasing pesticide run-off problems.

U.S. Department of Agriculture
Cooperative State Research, Education, and Extension Service
Supplement to the Annual Report of Accomplishments and Results
Multistate Extension Activities and Integrated Activities
(Brief Summaries Precede This Page)

Institution The Connecticut Agricultural Experiment Station (New Haven)
State Connecticut

Check one: ___ Multistate Extension Activities
_X_ Integrated Activities (Hatch Act Funds)
___ Integrated Activities (Smith-Lever Act Funds)

	Actual Expenditures				
Title of Planned Program/Activity	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004
Tick-borne infections	$ 61,204	$42,307	$44,475	$42,671	
Managing insects on vegetable crops	6,367	7,294	5,503	361	
Plant genetic resources (NE-9)	9,117	2,581	1,672	219	
Managing insects in apple orchards	68,890	61,222	58,148	40,782	
IPM for Connecticut nurseries	4,649	2,511	2,603	279	
Management of insects in soil (NE-187)	1,722	9,915	11,277	586	
Evaluation of new apple cultivars (NE-183)	1,699	4,346	58,992	9,251	
Suppression of soil-borne diseases	44,279	8,875	9,657	62,592	
Analysis of risk for plant fungal disease	17,989	54,833	8,017	13,323	
IPM for management of plant nematodes (NE-171)	69,690	63,654	55,098	56,001	
Herbicides/weed control	13,171	3,133	17,623	47,283	
Total	$298,777	$260,671	$255,442	$273,348	

_____ _____
Director Date

Form CSREES-REPT (2/00)

Assistance to the Under-Served and Under-Represented/Equal Employment Opportunity

The Station's Affirmative Action Officer annually distributed a Policy Statement on nondiscrimination and revised its Affirmative Action Plan in accordance with Connecticut regulations (46a-68-31 through 46a-68-74). During this reporting period, the Policy Statement was given to women, minority, and other employees and their unions and was posted in several locations visited by the public on Station property, including both experimental farms. The Station's policy on affirmative action and equal employment applies to all aspects of research programs and the employment process, such as applications, job qualifications, job specifications, recruitment, hiring, promotion, personnel policies (including those against sexual harassment), job structuring, orientation, training, counseling, grievance procedures, evaluation, layoffs, and termination. Pursuant to Connecticut regulations (46a-68j-21 through 43), special efforts have been made to increase purchases of items or services received from businesses owned by women and minorities. Highlights of activities for FY 2003 are described below as they relate to specific goals and procedures outlined in the Station's approved Plan of Work to assist the under-served and under-represented. The stated goals for these programs are consistent with USDA management goals on multi-cultural diversity issues.

Goals & Procedures: Program Delivery

Special efforts were made to reach under-served and under-represented groups during this reporting period. A notice was sent to members of 26 organizations serving protected groups to invite minorities to apply for positions and participate in existing research programs. Career specialists in two New Haven high schools were contacted to recruit minority students for research mentorship programs. Important objectives are to cultivate the interest of these persons

in agriculture, increase diversity among beneficiaries of Station research, seek further citizen input on research programs, and to disseminate research findings to stakeholders.

A new initiative, started last year, was continued during this reporting period. In an effort to attract minority students to agricultural research and to train these persons for future work, a joint program between The Connecticut Agricultural Experiment Station and the Sound School in New Haven was reaffirmed. An entomologist (White Female) at the Station assisted on writing a grant proposal for USDA funds with a focus on plant science and horticulture. The program was awarded, and during federal FY 2002, five junior or senior students (three White females, one Black female, and one Hispanic female) living in urban settings were interns under the mentorship of six scientists (five White males and one White female) at the Station. During this reporting period, one Hispanic male, one Black female, one Hispanic female, and a White male worked under the supervision of three White male and one White female scientists. This program had immediate impact. It encouraged minority student participation in Station programs, promoted workforce diversity at the Station, provided specialized training for the interns, and stimulated interest in agricultural sciences. Some of these students have entered college and are pursuing science majors.

Construction of a new building (Johnson-Horsfall Laboratory) is near completion. An elevator will be available for physically challenged persons. The old building, Johnson Laboratory, is being refurbished and is connected to the new building with the same methods of access to meet ADA requirements.

A cottage, located in a woodland area adjacent to open fields at Lockwood Farm in Hamden, has been refurbished to allow small groups of stakeholders (30 or less persons) to meet. The remodeled facility meets all code regulations, including those for physically challenged persons. The intent is to attract stakeholders to the experimental farm so that they would have more frequent contact with Station staff and study plots.

The rise in the Hispanic population in Connecticut has resulted in changes in the state's labor force. For example, many Hispanics are working for nurseries, tree care, and landscape companies. With limited English proficiency in this employment group, there is a need to communicate in Spanish so that these workers can effectively perform their duties. A Station forester (White male) taught two classes on arboriculture in Spanish in Connecticut to 20 attendees so that they could broaden their educational backgrounds and obtain arborist licenses.

The courses included topics on tree structure, biology, and on pruning techniques. On May 14 & 15, 2003, this Station scientist taught similar classes in Atlanta, Georgia at the US Forest Service Hispanic Green Industry Workers Workshop. In addition, fact sheets on mosquitoes and ticks were written in Spanish and made available to Hispanic stakeholders in Connecticut.

Goal 1: Annual public events will be scheduled to meet the needs and interests of all stakeholders, including those of under-represented groups as a means of increasing their participation and inviting stakeholder input.

Procedures: Public events will be scheduled annually during the spring, summer, and fall. Notification of Station events will be published in the Experiment Station Associates Bulletin, which is distributed to state legislators and the Associates' membership, and announced through the media (newspapers and a radio station). Efforts will be made to invite minority students. Public tours of Station facilities will be organized.

Report: Open house events occurred regularly during this reporting period. Plant Science Days were held in the spring (April 22, 2003) and summer (August 6, 2003) in the main auditorium and Lockwood Farm, respectively. Notifications of these events were made as described above.

About 900 persons, including minorities, attended the Plant Science Day event held in August at the Station's main research farm (Lockwood Farm) in Hamden, Connecticut. Minorities attended the event and had opportunities to meet scientists and to see experimental plots. A bus provided transportation within the farm to allow physically challenged and elderly citizens better access to research plots. Wheelchair accessible paths exist in the improved bird/butterfly demonstration garden plot to allow better access for all persons. About 90 citizens attended the Plant Science Day in the spring at the Station's main auditorium in New Haven. Selected laboratories were opened for public inspection. To reach other minorities, the Station participated in Farm/City Week, Connecticut Flower and Garden Show in Hartford, and other annual fairs. These efforts had immediate impact. Hundreds of students, including Blacks and Hispanics from area high schools, attended these events and saw Station exhibits. Persons of diverse racial and ethnic backgrounds had opportunities to become familiar with the Station's research programs, to learn of its findings, and to meet scientists, administrators, and other staff members.

Goal 2: The Station will work closely with inner city garden communities and encourage good agricultural practices.

Procedures: Station personnel will aid inner city residents by plowing garden plots and assisting on solving insect and plant disease problems. Groups of stakeholders will be invited to see experimental plots on Station-owned farms.

Report: During each spring, the Station farm manager at Lockwood Farm in Hamden, Connecticut and his assistants plowed inner city garden plots in New Haven for no fees. Seeds for vegetables were once again donated by Station scientists. This enabled the poor, who live in different neighborhoods, to have gardens as a source of fresh vegetables. As in the past, minority students from New Haven were allowed to grow vegetables at the Station farm in Hamden. These efforts had many short-term benefits. Stakeholders learned about agriculture, became familiar with Station staff, and brought home fresh produce to their families. Including vegetables in a diet improved nutrition. Entomologists and plant pathologists gave assistance, as needed, to minimize pest problems. Minorities and other residents of New Haven were encouraged to attend Station events and to tour the experimental farm plots. Another Station scientist continued his work with the Knox Foundation in Hartford to help select sites for inner city gardens. Soil samples were tested to determine needs for fertilizers.

Goal 3: The Station will donate produce to charitable organizations in food-sharing programs to meet the needs of the poor.

Procedures: Station personnel will make and maintain contacts with charities and coordinate the harvest and distribution of produce to organizations in food-sharing programs.

Report: About 8 tons of fruits and vegetables grown at the Station's farms in Hamden and Windsor, Connecticut were donated to charities, including food-sharing programs in the New Haven and Hartford metropolitan areas. Apples and potatoes from Station farms were distributed to elderly citizens at a fall event. Improved nutrition was a short-term benefit.

Report: Public Notifications

The Station has a continuing policy of commitment to affirmative action and equal employment. In addition to a Policy Statement, there was re-notification of the general public of all bidders, contractors, subcontractors and suppliers of materials that the Station will not

knowingly provide services and programs from or do business with anyone who discriminates against protected persons. A list of objectives for affirmative action was given during this reporting period to each Station employee. One of the objectives ensures equal access and nondiscrimination in all terms and conditions of all research programs. Employees and their unions were invited to review and comment on the Station's state-approved Affirmative Action Plan. All job notices included statements that the Station is an Affirmative Action/Equal Employment Opportunity Employer and were posted on the Station's Home Page (http://www.caes.state.ct.us), published in newspapers, sent to colleges and universities, submitted to scientific societies, and mailed to members of organizations representing protected persons in Connecticut. Public notification efforts had immediate impact because minority applicants were hired and there was improved workforce diversity. Policies regarding discrimination and equal opportunity were clearly stated or expressed in official Station documents or as a part of various program activities, including contract compliance. Station policies on equal employment and against discrimination were reviewed during this reporting period by the Director and Vice Director of the Station and are consistent with those of the United States Department of Agriculture outlined in memos on Departmental Regulations dated February 25, 1998 and March 16, 1998 from the Office of Civil Rights and the Office of the Secretary, respectively.

Goal 1: Job candidates will be notified of program availability and requirement of nondiscrimination on the basis of race, color, national origin, sex, disability, and other categories covered by state and federal laws.

Report: All procedures described in the Plan of Work and the first three Annual Accomplishment Reports were followed during this reporting period.

Diversity Training, Minority Training, and Employment

The Station is committed to further development of innovative programs to increase applicant flow from minorities and to train women and members of protected and non-protected groups. Three White females were granted educational leaves to improve their skills. One of

these persons is seeking her Ph.D. One Other male was hired as a Postdoctoral Research Scientist in FY 2003. Civil rights training for newly hired staff members is required to improve employee relations. Pursuant to Connecticut regulations (Public Acts 99-180, 00-72, and 01-53), 17 newly hired permanent or temporary Station employees received a minimum of 3 hours of diversity training and education. Dr. Louis A. Magnarelli, Vice Director and Affirmative Action Officer, conducts an annual diversity training program, which has received approval by the State Commission on Human Rights and Opportunities. The objectives are to increase workforce diversity, provide employment opportunities for promising students interested in science, and to promote harmony among staff members and the public. Station staff members, including the Vice Director and Chief of Services, have been in contact with career specialists in area high schools and with other community leaders to reach minorities in urban settings. A teacher at the Sound School in New Haven continued to cooperate with Station administrators by recruiting four high school students during the summer of FY 2003 to work as interns in a USDA-funded project. These students learned about agricultural research at the Station and participated in Plant Science Day held in August at the Station's farm.

During summers, there are extensive field studies and needs for technical assistance. Station funds and federal dollars were made available to support research programs and to hire college students as Summer Research Assistants. These students worked closely with scientists as apprentices in the field and laboratory and learned about agricultural research. This mentorship program has been successful. During FY 2003, one Black male, two Black females, two Hispanic females, and two Other females were hired along with 17 white males and 16 White females to learn new skills.

A volunteer program is available for students to work part-time during the summer and school year. One White male assisted entomologists and learned new skills. Training gained by this person strengthened his educational background by providing "hands-on" experience.

To assist the under-served and under-represented in more advanced research, a workforce of four Other males and three Other females remain employed as Postdoctoral Research Scientists. The training these minorities received from two White male scientists improved their qualifications for future permanent employment and upward mobility. Funds from federal grants, including those from USDA, enabled these persons to work as Postdoctoral Research Scientists in FY 2003 under the direct mentorship of established scientists.

Special Crops Program

Stakeholders of different ethnic groups continue to receive the Station's assistance on growing specialized crops, such as arugula, okra, jilo, leeks, artichokes, sweet potatoes, Calabaza (squash), and Chinese cabbage. Sweet potatoes are very popular at farmers' markets. Jilo is in demand in Connecticut and New York City markets. A Station scientist field-tested these crops to determine quality and yield. These efforts had immediate impact. There is increased interest among vegetable growers to raise ethnic crops, which represent an emerging "niche market", and produce is available in local markets. In response to stakeholder requests, another Station scientist is conducting field studies to find desirable cultivars of arugula and conducting research on organic farming practices.

Assistance to Mohegan and Pequot Tribes

Members of the Mohegan and Pequot tribes in Connecticut continue to rely on the Station for information and direct assistance on composting, forest/wetlands management, and control of hemlock woolly adelgids. There is new interest from members of the Pequot Tribes in establishing greenhouses for tomato production. Four Station scientists continue to cooperate with tribal officials in finding ways to grow tomatoes, improve efficiency of composting paper products, to better manage forests and wetlands in concert with commercial development of land, and to biologically and chemically control adelgids. The long-term impacts of these outreach efforts are: there will be locally grown produce that can be used in restaurants on tribal properties, efficient re-cycling of paper product waste materials, and preservation of forests and wetlands.

Contract Compliance Program

In accordance with Connecticut regulations (Sec. 32-9(n) and Sec. 46a-68-35), the Station is required to report annually to the State Commission on Human Rights and Opportunities regarding the agency's efforts in awarding a fair proportion of its contracts for service or

materials to small contractors, including businesses owned by minorities and women. Although a large portion of the Station's budget for services and materials must be awarded to businesses that have state contracts through the Department of Administrative Services, a small portion of the budget is available for outside bidders. This program yielded short-term benefits. During state FY 2003, $194,921 was awarded to small contractors. This amount greatly exceeded the state-approved goal ($50,943). There were 25 Minority Business Enterprise set-aside purchases and contracts worth $59,902, which also greatly exceeded the state-approved goal of $12,736. Contracts were awarded to businesses owned by African Americans, persons of Iberian Penisula background, and women.

Evaluation of the Success of Multistate, Multi-Institutional, Multi-Disciplinary Programs and Joint Research/Extension Activities

As presented in Tables 1 and 2 of this Annual Accomplishment Report, several Hatch projects continue to be linked to outside collaborating institutions or businesses and include a multi-disciplinary approach to research. Scientific collaborations are normally formed between scientists and are not mandated by administrators. The Director and Vice Director encourage collaborative work, however. These joint efforts are sometimes successful in obtaining grant funds. Some statutory requirements require cooperation among state agencies. Many scientists at The Connecticut Agricultural Experiment Station are trained or have gained experience in different scientific disciplines and actively seek expertise from other investigators within or outside the institution when needed.

Multistate collaborations are likewise extensive (Table 3). Of the 37 Hatch projects listed, 19 (51%) have multistate collaborations. Scientists at The Connecticut Agricultural Experiment Station continue to interact with colleagues in at least 42 other states. The 8 USDA-approved multistate projects (NE-009, NE-164, NE-171, NE-183, NE-187, NE-1005, S-301, and W-082) include an extensive blend of scientific expertise for research and extension.

There are 11 programs (including 13 Hatch projects) identified as research/extension integrated activities. In most cases, the extension component is in the University of Connecticut.

As in past accomplishment reports, there are four key questions that need to be re-considered: (1) did the planned program address the critical issues of strategic importance as described in the institution's Plan of Work; (2) did the planned program address the needs and inputs of the under-served and under-represented populations in the state; (3) did the planned program meet and describe the expected outcomes and impacts; and (4) did the planned program result in improved program effectiveness and efficiency? Good progress continues to be made regarding all of these key questions. A special effort was made to describe short-and long-term impacts on how results led to positive changes in the behavior of stakeholders and (or) economic, environmental, product quality, human /animal health, or social benefits. We affirm that our program is meeting the stakeholders' needs as described in the Plan of Work and in this Annual Accomplishment Report. The critical issues stated in each of the program goal sections of the Plan of Work are based on stakeholder input. Contact with stakeholders is a continual process, and research programs are modified based on public needs. Solutions have been found for some problems, such as finding ways to reduce pesticides, but new problems arise. Expanding the clientele of stakeholders and increasing their involvement in research programs remains a high priority. Farmers, who work along with scientists on solving problems, provide valuable space for experimental plots and benefit by having continual discussions with scientists and by receiving early results. We recognize the need to obtain financial data, whenever possible, to more clearly show profitability and impact of our research programs. In this report, we have provided specific information on economic impacts (i.e., dollars saved, increased profitability measures, adoption of more efficient farming practices, etc) for projects where sufficient progress has been made. Brief descriptions of short- and long-term impacts are included throughout this document to demonstrate the relevance of the scientific findings and to ensure accountability.

Research goals are being accomplished. The critical issues of producing new and value-added agricultural products and commodities; protecting crops and forests from insect pests and plant diseases; testing new crops for ethnic groups; improving small farm production; promoting sustainable agriculture, improving crop quality and yields; food safety; protecting soil and water from pesticide and other chemical contamination; reducing the use of pesticides and fertilizers in agricultural systems; finding ways to utilize farm and homeowner wastes (i.e., composted plant materials); and the issues of emerging human and veterinary pathogens transmitted by ticks and mosquitoes have been addressed. Many of these programs are linked to scientists in other states.

Efforts are being made to identify and meet the needs of the under-served and under-represented. The main laboratories of the Station are located in New Haven. This has helped staff members meet and work with minority groups in an urban setting. Other initiatives being carried out at our Valley Laboratory in Windsor have assisted us in addressing the needs of the under-served and under-represented in the Hartford area and in farming areas where Hispanic and other minority populations are increasing. Recent census data indicate a dramatic rise in the Hispanic population in Connecticut. A Station scientist, who speaks Spanish, taught courses for Hispanics on arborist-related topics in Connecticut and to attendees from different states in Atlanta, Georgia. Also, by growing ethnic crops that they desire, we are attempting to reach these people. Opportunities are given for the under-served and under-represented to attend Station open houses. Working with minority groups on the inner-city garden programs is particularly effective in describing the scope of our agricultural research. Fruits and vegetables from state and Hatch-supported research projects were donated to charitable organizations, food-sharing programs, and senior citizen groups to help improve nutrition. Minorities received training when hired to assist on USDA grants and Hatch-supported research projects. Knowledge

gained from research on composting techniques and forest management benefited members of the Mohegan and Pequot tribes in Connecticut. In general, the multi-faceted research programs and outreach efforts are successful in addressing the needs of a broader base of under-served and under-represented persons. Continual program expansion is needed, however, to assist more individuals.

The multistate, multi-institutional, and multi-disciplinary programs continue to increase program effectiveness and efficiency by allowing for successful collaborations, reducing unnecessary duplication of research experiments, and by better utilizing dwindling resources of participating institutions within and outside Connecticut. Scientific collaborations often accelerate progress. Examples of improved efficiency resulting from recent research include the application of sensitive and specific chiral gas chromatography with ion trap spectroscopy methods for detecting chlordane residues in soil and air, the use of IPM practices to monitor pest problems and to reduce costs of controlling plant pathogens and insects, finding uses for biowastes, and developing more sensitive and specific diagnostic tests for human and veterinary diseases associated with ticks. The availability of research data from USDA-approved multistate projects, particularly in the Northeast, has resulted in more efficient experimental design and better utilization of equipment and facilities located in cooperating institutions during times when state budgets are under severe pressure. Moreover, the impact statements for multistate projects, approved by the northeastern Experiment Station Directors, have greatly facilitated the communication of research findings to a broad national audience. Information is available to all on the northeast regional association's (NERA) home page. The development of the National Information Management and Support System has greatly facilitated reporting and public access.

Integrated activity (research/extension) remains productive. Good progress continues to be made on solving insect and plant disease problems in agricultural production systems. For example, plant-parasitic nematodes affect a variety of crops, and interactions of scientists from several states (NE-171) have resulted in testing nematode-resistant and antagonistic crop germplasm and biocontrol agents in a wide range of environments and crop systems. Moreover, nursery and vegetable growers are now using new, non-chemical control methods and IPM practices to reduce costs of operations. Reductions in the uses of pesticides in agricultural production areas have been achieved. The inclusion of research/extension specialists in other USDA-approved projects, such as NE-009, NE-164, NE-171, NE-183, and NE-187 and NE-1005, has made these programs more effective in meeting stakeholder needs by providing a more concentrated and coordinated effort. All integrated programs identified in this Annual Accomplishment Report continue to have functional extension components where research results are reported to stakeholders in extension publications or at meetings. A brochure on native alternatives for invasive ornamental plant species is very popular among nursery growers and the public. A turf manual on the management of pests is nearly sold out. More stakeholders, however, need to be encouraged to access national databases for results of USDA-approved multistate programs. Greater public awareness of USDA internet programs is needed. During 2000, a homepage was established for NE-171 “Biologically Based IPM Systems for Management of Plant-Parasitic Nematodes” at the Station website: (http://www.caes.state.ct.us/coopregionalresearchproject/multistatenematode.htm). Growers in all regions of the United States have access to scientists, research information, and science-related activities and programs. The feedback from growers and other stakeholders continues to be positive. Finally, there is growing public concern over possible terrorist attacks. Stakeholders

have asked questions about how we are protecting our food supply. Efforts are needed to accelerate the linking of diagnostic laboratories to quickly detect and report introduced plant and animal pathogens. This coordinated effort should go beyond land-grant universities and include USDA/APHIS/PPQ, and state agencies, such as ours, where significant resources are dedicated to analyses of crops and food products for hazardous chemicals and biological organisms. Funding for a national diagnostic laboratory network should include all partners of USDA/CSREES.

In conclusion, the Station's multi-programs with joint research/extension activities have been making progress in solving specific stakeholders' problems on farms and in homes and businesses. The frequent visits of scientists to farms are often made to more efficiently find solutions to problems. Although applied research activities dominate, there remains a strong core program for basic research.

Certification

This fourth Annual Report of Accomplishments and Results was prepared by Dr. Louis A. Magnarelli, Vice Director, with input from Station scientists and is submitted as a part of specified reporting requirements, as mandated by the Agricultural Research, Extension, and Education Reform Act of 1998 and as allowed under the USDA's guidelines for preparing accomplishment reports.

Dr. John F. Anderson, Director