The Connecticut Agricultural Experiment Station

The Connecticut Agricultural Experiment Station
Putting Science to Work for Society since 1875

At a Glance

JASON C. WHITE, Ph.D., *Director*
Wade H. Elmer, Ph.D., *Vice Director*
***Established* – 1875**
***Statutory authority* – CGS 22-79 – 22-118**
***Central office* – 123 Huntington Street, New Haven, CT 06511**
***Number of employees* – 99**
***Recurring operating expenses*:**

General Fund –	**$ 7,099,014**
Federal Funds –	**$ 3,709,506**
Other/Pass Thru –	**$ 1,638,975**
Total –	**$12,445,226**

***Organizational structure* – Administration, Analytical Chemistry, Entomology, Environmental Sciences, Forestry and Horticulture, Plant Pathology and Ecology, Valley Laboratory (Windsor, CT), Griswold Research Center (Griswold, CT).**

Mission

The mission of The Connecticut Agricultural Experiment Station is to develop, advance, and disseminate scientific knowledge, improve agricultural productivity and environmental quality, protect plants, and enhance human health and well-being through research for the benefit of Connecticut residents and the nation. Seeking solutions across a variety of disciplines for the benefit of urban, suburban, and rural communities, Station scientists remain committed to "Putting Science to Work for Society, Protecting Agriculture, Public Health and the Environment," a motto as relevant today as it was at our founding in 1875.

Statutory Responsibility

Statutory responsibilities for The Connecticut Agricultural Experiment Station (CAES) focus on insects, ticks, plants and related diseases, and the development of methods to reduce pesticide use (i.e., integrated pest management). Within available resources, field and laboratory studies are conducted, as determined by the agency's Board of Control, state residents (e.g., growers), or as requested by the General Assembly, pursuant to Connecticut General Statute (CGS Section 22-81). Scientists and technicians analyze food and other items at the request of any state agency; test hemp for THC content at the request of the Department of Agriculture; test ticks for the infectious agents that cause Lyme disease, Babesiosis and Anaplasmosis upon request of a

state or municipal health officer or for scientific research purposes; test mosquitoes for public health threat from encephalitis viruses (CGS Sec 22-81a); oversee official control, suppression or extermination of insects or diseases, which are or threaten to become serious pests of plants; conduct research on integrated pest management (CGS Section 22-84a); inspect for diseases of honey bees and register beekeepers (CGS Sections 22-89, 22-90); and survey towns for gypsy moth, Asian longhorned beetle, Emerald ash borer, and other insect pests of economic or public health importance. In many instances, there are interactions with scientists or other officials in federal agencies. The Director is in charge of all matters pertaining to serious pests of plants and has regulatory authority (CGS Sections 22-84); responsibilities include the inspection and certification of nurseries, the registration of dealers of nursery stock, and enforcement of federal and state quarantines or regulations. Findings are reported to the public and scientific community by correspondence, lectures, media interviews, the agency's website, or published works. Emphasis is placed on submitting scientific manuscripts to peer-reviewed journals.

Station staff members provide prompt answers to routine and difficult but important agricultural, food safety, forestry, environmental, consumer protection, or public health questions by performing analyses; providing services to state residents; assisting small and large businesses, municipalities, state agencies and the scientific community; and by giving oral and written reports of research findings. Transferring new scientific information to the public and businesses is a high priority. The agency website (https://portal.ct.gov/caes) continues to be an efficient means of communicating research findings and reducing operating costs. Social media is also being used to reach out to our constituents via Facebook www.facebook.com/CT.CAES, Twitter www.twitter.com/CT_CAES, YouTube www.youtube.com/user/CTAGEXPSTATION, Instagram www.instagram.com/ct.caes/, and Pinterest www.pinterest.com/caes123. CAES also maintains a Wikipedia page http://en.wikipedia.org/wiki/Connectcut_Agricultural_Experiment_Station. Staff members gave 659 talks and interviews to civic groups and the media. Our annual open house event traditionally held at our Lockwood Farm facility during the summer was transitioned to a virtual event this year; more than 300 state residents had an opportunity to interact via Microsoft Teams with scientists, hear presentations on scientific progress, remotely view experimental plots and laboratories, and to make comments on research and outreach programs. The event was mediated through a Story Map platform and content is currently being made available to schools and educators throughout the state, with the message the CAES staff are available to assist in utilizing this scientific content for remote or hybrid instruction (https://storymaps.arcgis.com/stories/8e1933327a82456fb39d74714f635af2).

Public Service

Public service remains a high priority. The CAES serves a diverse group of state residents, large and small businesses, municipalities, and the scientific community within its areas of expertise. More than 48,000 jobs in agriculture, wood-products industry, and other business sectors are supported by the services provided by CAES staff members. People bring or mail samples or call with questions to the New Haven and Windsor facilities. Extensive contacts with state residents are particularly important for the early detection of emerging insect or plant disease problems. Global marketing of plants and plant products increases the chances for the introduction of invasive pests, such as the Asian longhorned beetle, Emerald ash borer, Southern pine beetle, and boxwood blight. The Emerald ash borer (EAB) was first detected in Connecticut on July 16, 2012, and has subsequently spread through a large portion of the state. The internal state quarantine for EAB was dropped in 2014 and all of Connecticut became part of the larger federal EAB

regulated area. State regulations control the movement of wood and other regulated articles into Connecticut. Expanding its range, the Southern pine beetle was detected in Connecticut on March 17, 2015, and attacks "hard" pines such as red pine, Scotch pine, Austrian pine, and our native pitch pine.

More than 40,000 state residents received direct assistance from staff members at the CAES during the past year. Station scientists also visit farms when difficult or unique problems arise and provide information to growers and the media when asked. In addition, scientists served on advisory boards and provided information to more than 150 stakeholder organizations. Employees of other state agencies, such as the Departments of Agriculture, Consumer Protection, Public Health and Energy and Environmental Protection, also requested help from Station staff members when they sent specific samples for chemical, biological or microscopic analyses. All of these activities helped identify emerging problems, facilitated prompt and accurate responses to state residents' inquiries, and ensured safe foods and other products. CAES Chemists, along with the Departments of Agriculture and of Consumer Protection, have established a regulatory testing program for hemp and hemp-related products. Receiving comments from citizens on evaluation or survey forms at public workshops, open house events, and other agency functions helps administrators gauge the effectiveness of research programs and services and provides opportunities to realign program goals. In addition, there is an annual assessment of whether or not objectives listed in the agency's 5-year strategic plan are being achieved. This strategic plan and accomplishment reports are requirements for USDA funds. Both documents are reviewed annually by federal officials.

New testing procedures are developed as needed to improve analyses, particularly when samples require more sensitive and specific methods. Scientific research at the CAES involves identifying a problem, investigating existing published knowledge, and designing experiments which will provide new information to help solve the problem, enhance Connecticut's economy, or improve the well-being of state residents. In many instances, scientific results have impacts nationally.

Specific examples include the following:

- **Food Safety:** Connecticut General Statute [Sec. 22-81(c)] directs the CAES to conduct analyses as requested by other state agencies. In addition, CAES chemists work closely with the US Food and Drug Administration (FDA) in the Food Emergency Response Network (FERN). CAES is now in its 15th year of funding ($3.89 million through 2020) under this program, with the current funding cycle concluding this year. Separately, CAES is completing its final year on a FDA grant that is enabling the Department of Analytical Chemistry to expand ISO 17025 Accreditation as described in the Food Safety Modernization Act (FSMA). This award is a continuation of a previous 5-year $1.5 million FDA grant that enabled acquisition of accreditation in December 2016. The accredited program involves a surveillance of fresh and manufactured foods for pesticides and arsenic; results are published in Bulletins that are freely available to the public. Separately and in conjunction with the CT Department of Agriculture, CAES is completing the final year of a 5-year FDA grant ($750,000) to bring animal feed chemical analysis under accreditation as described in FSMA. This project, which is measuring mycotoxin contamination in feeds, was brought under accreditation in February 2018 and has been expanded to include label guarantee analysis (fat, protein, fiber). These three FDA grants have recently been combined into a single cooperative agreement program to which the CAES has applied and is expecting to receive a notice of award effective September 1, 2020. Recent work with the FDA has had the CAES analyze juice/juice powders

(100 samples) for poisons, toxins, pesticides, and heavy metals. The second project was the analysis of imported mustard seed, mustard products (25 samples) with yellow food coloring for lead and chromium; results were submitted to FDA in December 2019. CAES staff have continued work with the FDA to develop the use of liquid chromatography with high resolution mass spectrometry for the detection of contaminants in food, including ricin and abrin. CAES chemists are also actively using this new platform in many of our state programs, including the analysis of foods and environmental samples for emerging contaminants such as PFAS. Three CAES staff members participated in the CT Interagency PFAS Task Force. Two CAES staff chemists have continued to serve as primary instructors for FDA training courses that deploy FERN food safety methods to both federal and state laboratories across the country. The Manufactured Food Regulatory Program Standards or MFRPS, which CAES conducts with the CT Department of Consumer Protection and the FDA, serves as the sole chemical surveillance and monitoring effort in the state, assuring that the food supply within CT is free from adulteration and contamination. Similarly, the AFRPS or Animal Feed Regulatory Program Standard, conducted with the CT Department of Agriculture and the FDA, serves as the sole surveillance and monitoring effort in the state for pet and livestock feed. Lastly, staff continue to work with the FBI Weapons of Mass Destruction Directorate (FBI WMDD), 14th Connecticut National Guard Civil Support Team (CST), CT State Police Emergency Services Unit, and CT Department of Public Health Bioterrorism Coordinator as a part of statewide counter-terrorism and law enforcement programs. For example, CAES chemists are currently assisting the CT State Police in an ongoing missing person's investigation.

- **Hemp Testing:** The 2018 Farm Bill allowed for hemp to be grown as a crop, but prior to harvest, the crop must be tested for THC content. In conjunction with the Department of Agriculture, CAES has developed a program for THC testing of both grower and inspector collected regulatory samples to support the farmers in the state who are growing this new crop. Over 100 samples were submitted to this program in the past year, with the CAES providing a 48-hour turnaround on analytical results so that the crop could be harvested in a timely fashion.
- **Mosquito-Borne Disease Surveillance:** Mosquito surveillance for eastern equine encephalitis (EEE) and West Nile virus (WNV) is integral to the public health response to these mosquito-transmitted diseases in Connecticut and provides an effective early warning system for citizens of the State (CGS Section 22-81a). CAES scientists and technicians monitor mosquito and encephalitis virus activity at 92 trapping sites from June through October. During 2019, a total of 239,960 mosquitoes representing 15,665 pools were trapped and tested for arboviruses. There were 122 isolations of EEE virus obtained from 15 mosquito species collected from 26 locations in 22 towns in six counties (Fairfield, Hartford, Middlesex, New Haven, New London, Windham). The first EEE-positive mosquitoes were collected on July 31, and last on October 17. Four human cases of EEE illness (Middlesex, New London Counties) were reported, with three fatalities. Dates of onset of symptoms were from August 21 to September 12. There were six horses (New London, Tolland, and Windham Counties), as well as pheasant and partridge flocks (New London County), identified with EEE infections. The majority of EEE virus activity was detected in eastern CT, primarily in the southeast corner from the RI border to the eastern Connecticut River Valley. A total of 82 isolations of WNV were made from 9 mosquito species collected from 26 locations in 23 towns in six counties (Fairfield, Hartford, Middlesex, New Haven, New London, Windham). The first WNV-positive mosquitoes were collected on July 30, and last on September 25. The majority of WNV activity was detected in densely populated urban and suburban regions in Fairfield, Hartford, and New

Haven Counties. One human case of WNV-associated illness, which was locally acquired (Fairfield County), with a date of onset in August, was reported. Additionally, there was one horse case of WNV. Other mosquito-borne viruses isolated included: Highlands J virus = 43 isolates from 9 mosquito species (August 12 – October 9), Jamestown Canyon virus = 23 isolates from 9 species (June 4 – September 4), Cache Valley virus = 2 isolates from 1 species (September 10 – September 30), Potosi virus = 2 isolates from 2 species (August 14 – September 24), and Flanders virus = 1 isolate from 1 species (July 8). CAES continues to closely monitor the expansion in Connecticut of two exotic mosquito species from Asia, *Aedes albopictus* (Asian tiger mosquito) and *Aedes japonicus*, which are aggressive human biters and have been implicated in the transmission of several human pathogens, including dengue, chikungunya, EEE, and WNV.

- **Invasive Aquatic Plants:** CGS Section 22-81(c) directs the CAES to perform experiments on plants. Invasive aquatic plants have been introduced in Connecticut from other parts of the world. With no natural enemies, they spread rapidly and threaten the ecological and recreational value of Connecticut's lakes and rivers and can also have public health implications. Since 2004, the CAES Invasive Aquatic Plant Program (IAPP) has completed 366 aquatic vegetation surveys of 246 Connecticut lakes and has found that 60% contain invasive plants. A total of 61 water bodies have been resurveyed to determine how invasive plants are changing the quality of lakes over time. In fiscal year 2019-2020, CAES IAPP surveyed 13 lakes and performed multifaceted research. Lake Candlewood, Connecticut's largest lake, was surveyed for the 11th consecutive year to determine the effects of winter drawdowns and introduced grass carp *(Ctenopharyngodon idella)* on the area and abundance of Eurasian watermilfoil (*Myriophyllum spicatum*), minor naiad (*Najas minor*) and curlyleaf pondweed (*Potamogeton crispus*). Nearby Squantz Pond was also surveyed. Government and local officials request CAES assistance in finding methods to protect their bodies of fresh water. We are in the 18th year of research involving the use of spot applications of herbicides to control variable watermilfoil in Bashan Lake. We had largely restored the lake to pre-infestation conditions prior to lowering the lake for dam repairs in 2014. Surveys of Bashan Lake in 2018 found a regrowth of variable watermilfoil and phragmites (*Phragmites australis*) at some sites. Targeted applications of a new herbicide called ProCellaCOR showed excellent control on variable watermilfoil at most of these sites. In June 2020, CAES IAPP oversaw a follow-up ProCellaCOR treatment of a few remaining sites. *Hydrilla* is a very troublesome invasive aquatic plant in many southern states. Following reports of the plant occurring in the Connecticut River, an investigative task force of over 30 experts from throughout the Northeast led by the CAES IAPP performed preliminary surveillance of the river from central Vermont to southern Connecticut in 2018. Hydrilla was found from just north of the Massachusetts/Connecticut border to a point between Hartford and East Haddam, where dense stands were found. The *Hydrilla* found in the river is more robust than seen elsewhere in Connecticut. CAES IAPP, in collaboration with the University of Wisconsin-Whitewater, performed genetic tests on the Connecticut River *Hydrilla* and found it to be a different strain than previously found in North America. This could mean the plant has an enhanced ability to spread, harm aquatic ecosystems and resist current control practices. Movement of this strain to lakes and ponds is of utmost concern. In 2020, CAES IAPP was commissioned to survey the southern portion of the river to document the full extent of *Hydrilla* infestation as well as other invasive species. Hydrilla was the dominant species in occupying 189 acres while Eurasian watermilfoil covered 130 acres. Fanwort (*Valisneria americana*), curlyleaf

pondweed, variable-leaf watermilfoil, and water chestnut (*Trapa natans*) were present in much smaller amounts. We will be surveying the remainder of the river in 2020 and preparing a management plan in response to the invasion. CAES IAPP has extensive public outreach via workshops, speaking engagements and a comprehensive website available at www.ct.gov/caes/iapp. Results are published in scientific journals, technical reports and in CAES bulletins.

- **Gypsy Moth and Emerald Ash Borer:** In 2019, we recorded 166,636 acres affected by gypsy moth, primarily in the eastern half of the state. Approximately 153,983 acres were dead, due to successive years of defoliation and drought stress. In December 2019 through March 2020, a gypsy moth egg mass survey was conducted in 80-95% favorable host sites on a 7-mile grid (102 sites) throughout Connecticut. Egg mass counts were low to non-existent in most locations, indicating the outbreak that began in 2015 is essentially over. Monitoring for the Emerald ash borer through *Cerceris* wasp colonies continued in 2019 and 2020 with EAB now confirmed in 159 towns, but undoubtedly present throughout the state. Biocontrol releases for EAB, which began in 2013 and have continued through 2020, have been successful with all three species of released parasitoids recovered within one year after release at each site.
- **Honey Bee Health and Pollination:** Colony inspections continue to find *Varroa* mite infestation and the virus complex associated with *Varroa* infestation as the primary reason for colony mortality, although losses were less than the previous year. In 2019, research conducted here at the CAES confirmed that only 11% of honeybee colonies were disease-free. That research documented that 89% of colonies were infected or had coinfection with two parasites (varroa mite and *Nosema apis*), which resulted in significant health challenges for Connecticut beekeepers. Varroa mite test kit distribution started in the last quarter for 2019 and will continue through 2020 for all Connecticut beekeepers. The Bee Informed Annual Loss report for CT in 2019 was 39.6%, with a winter loss of 36.84% and summer loss of 9.0%. Unofficial estimates indicate that over 6,000 packages of honeybees were imported into Connecticut for new beekeepers and to replace winter losses.
- **Tick-Borne Disease Research and Active Tick Surveillance:** Human cases of Lyme disease are prevalent, other tick-borne diseases are increasing, and new tick species are becoming more common. An active tick surveillance program was initiated in Connecticut in 2019 and continued in 2020 funded in part by a grant from the Centers for Disease Control and Prevention (CDC) through the Epidemiology and Laboratory Capacity (ELC) program at the Connecticut Department of Public Health. Ticks were collected at 40 paired publicly-accessible active tick surveillance sampling locations throughout CT's eight counties, resulting in the collection in calendar year 2019 of a total of 2,068 blacklegged ticks, 437 American dog ticks, 3 lone star ticks, and 2 Asian longhorned ticks (total 3,409 for the period July 1 – June 30). The 2019 testing results for adult blacklegged ticks were *B. burgdorferi* (46%), *B. microti* (13%), *A. phagocytophilum* (9%), *B. miyamotoi* (2%), and Powassan virus (1%). For nymphal blacklegged ticks, the results statewide were *B. burgdorferi* (15%), *B. microti* (6%), *A. phagocytophilum* (5%), *B. miyamotoi* (2%), and Powassan virus (0%). Testing of ticks collected in the first half of 2020 was delayed due to the coronavirus. Lone star ticks are increasingly being recovered in areas of the state such as New London County where they have not been collected before. A joint integrated tick management project in Guilford, CT supported by and in cooperation with the USDA Agricultural Research Service continues to evaluate combinations of deer-targeted 4-poster treatment stations, rodent-targeted bait boxes, and acaricide applications to reduce tick abundance and the risk of Lyme disease. A program

using the deer-targeted 4-poster to control a heavy, established population of lone star ticks, *Amblyomma americanum*, on Manresa Island in Norwalk, CT was continued in 2020.

- **Passive Tick Surveillance and Testing Program:** Tick testing for infectious agents that cause human disease is freely available to State residents. The objectives are to: 1) examine ticks for evidence of infection in order to better understand the epidemiology of tick-associated diseases in Connecticut, 2) inform residents of any potential health risk, 3) assist physicians and residents concerning treatment, and 4) identify and report new and invasive tick species that are unintentionally introduced into the State. In 2015, the Tick Testing Laboratory was expanded to test blacklegged ticks, *Ixodes scapularis,* for two additional pathogens. In the past, testing was limited to *Borrelia burgdorferi,* the Lyme disease agent, but in view of increasing human cases of tick-related illnesses in the state, testing has been expanded to include *Anaplasma phagocytophilum*, the causative agent of Human Granulocytic Anaplasmosis, and *Babesia microti*, the causative agent of Babesiosis. Of the 3,928 ticks submitted by Connecticut residents, health departments and/or physicians' offices during fiscal year 2019-2020; 3,125 were examined, of which 916 (29.3%) tested positive for Lyme disease, 164 (5.2%) for babesiosis, and 178 (5.7%) for anaplasmosis. New molecular-based testing methods have been implemented to reduce the average turnaround time for results to three days or less, representing a significant enhancement of the tick testing services. The number of lone star tick encounters by residents has been steadily increasing in Connecticut in recent years; locally acquired lone star ticks submitted by residents and health departments to the CAES Tick Testing Laboratory have increased significantly by 58% from the period of 1996-2006 to 2007-2017. During the past fiscal year, established populations of the lone star tick were discovered in New Haven County, in addition to existing populations in Fairfield County. Previously considered an aggressive nuisance pest, the lone star tick is now associated with several human diseases and medical conditions including tularemia, rickettsiosis, ehrlichiosis, Hartland virus disease, likely Bourbon virus disease, southern tick-associated rash illness, and red meat allergy. Even in the absence of disease transmission, lone star tick numbers can be extremely abundant, multiple bites are not uncommon, and bites can be highly irritating. Rising global temperatures, ecologic changes, reforestation, and increases in commerce and travel are important underlying factors influencing the rate and extent of range expansion for ticks and associated disease-causing pathogens.
- **Grapevine Survey:** A three-year statewide survey of Connecticut vineyards was initiated in 2019 to assess the incidence of grapevine viruses. Grape Leafroll Disease (GLD) is a viral disease and one of the most detrimental and widespread viral diseases of grapes, causing up to $40,000 loss per hectare during a single growing season. The only strategy for managing GLD is to monitor vineyards and eliminate infected plants. In 2019, over 5,260 leaf samples were assayed from seven large Connecticut vineyards and over 50% tested positive for GLD. CAES is partnering with the CT Department of Agriculture in knowledge dissemination and outreach. The long-term goal is to develop a statewide management plan that is mechanistically and economically feasible, which could then be adopted by all growers in Connecticut.
- **Forest Health Surveys:** New disease surveys have been initiated by CAES scientists to monitor our forests. A new invasive disease of beech called Beech Leaf Disease (BLD) can kill established beech trees in seven years. It is caused by the foliar nematode *Litylenchus crenatae mccannii* and was first identified by a CAES scientist in Fairfield County in 2019 on an American beech. Surveys in 2020 found that BLD had spread to additional parts of Fairfield County, as well as New Haven, Middlesex, and New London Counties. The disease has not

been seen in Litchfield, Hartford, Tolland, or Windham Counties. CAES scientists have formed a multistate partnership, funded by the U.S. Forest Service, to monitor the development and spread of BLD. CAES scientists will use population genetics methods to investigate disease epidemiology. In addition, CAES scientists are surveying the state for the expected appearance of oak wilt, a devastating vascular wilt disease caused by the ascomycete fungus *Bretziella fagacearum*. Symptoms of the disease can be easily confused with other biotic and abiotic factors that also result in crown dieback, and therefore, proper and complete diagnosis of oak wilt must be completed in the laboratory, using both traditional culturing methods as well as molecular techniques involving DNA extraction and PCR. This devastating disease typically kills oaks within a single season, and spreads rapidly via root grafts as well as vectoring by native sap beetles.

Improvements/Achievements 2019-2020

Statutory authority (CGS 22-82a) permits the CAES to seek patents, trademarks, and licensing agreements. License agreements have been established for a new cultivar of strawberry and four disease-resistant tobacco cultivars. Portions of the royalties are being used for operating costs and reinvesting into the crop research programs.

Efforts continue to reduce energy and other operating costs to become more efficient in performing research and delivering services to our residents. The agency has actively participated in the Governor's Lead by Example Energy Efficiency Program over the years. The agency has converted all interior and exterior lighting to LED technology, changed over from heating oil to natural gas to heat our buildings and is in the process of replacing old drafty windows with energy efficient windows to lower heating and other operating costs. Our renovated Jenkins-Waggoner Laboratory building, which opened in January 2015, received a federal LEAD gold energy efficiency certification. Plans to renovate failing infrastructure and facilities at our Valley Laboratory, as well as outdated CAES greenhouses, with state-of-the-art technology have been initiated.

The Experiment Station is utilizing the state's e-licensing software program for the online registration of nursery growers, nursery dealers and beekeepers. The program also allows inspectors to enter and store regulatory inspection data in the online program. The statutorily required registration and inspection process is much more efficient for both the agency and registrant and provides the agency and state with significant cost savings.

Plant pathologists continued to monitor and research boxwood blight, a disease caused by the fungus *Calonectria pseudonaviculata*. New to North America, the disease was first detected on boxwoods in nurseries in Connecticut in 2011 and on pachysandra in landscapes in 2012. This disease has continued to spread throughout North America. Boxwood blight was confirmed on 45 of 423 samples that were submitted to the Plant Disease Information Office. Best management practices (BMPs) in the mitigation of boxwood blight have been prepared and basic information on the fungus (including an identification guide with pictures of infected plants) are posted on the CAES website (https://portal.ct.gov/CAES/PDIO/Boxwood-Blight/Boxwood-Blight). Scientists are being sought out for national collaborations and CAES is a major part of a national SCRI grant selected for funding over the next four years.

Several new programs in Plant Pathology have been initiated. As mentioned above, our new fruit virologist has worked closely with the wine industry in the state and has identified seven large vineyards under threat from viral diseases. In addition, a collaboration with the virologist

and early career chemist have secured competitive in-house funds to begin synthesizing dsRNA molecules that, when applied topically on plant leaves, protect plants against target plant viruses for up to six days. Efforts are under way to develop an advanced nanoparticle-enabled delivery of dsRNAs to increase the "vaccination" effect of those molecules as a novel plant virus disease management tool. Another collaboration between a CAES plant pathologist and a University of Connecticut scientist, Dr. Daniel Gage, has focused on the roles of protists in shaping the bacterial communities on plant roots. Protists are single-celled soil organisms that can greatly enhance plant growth by releasing nitrogen or enhancing the effectiveness of beneficial microbial products. Major accomplishments this year included the development of a new method to enable the large-scale genetic identification of protists, fungi, and microscopic worms and insects attached to plants. Researchers also isolated over 100 protists from rhizosphere of crop roots in Connecticut to serve as organisms for future study. CAES plant pathologists have also acquired competitive USDA funding to understand the role of the flower microbiome in pollinator interactions, fruit development, and host resistance to plant diseases. By deciphering the pathogen distribution and evolution of virulence factors in plant pathogenic bacteria, CAES scientists hope to identify possible areas for disease management. Our forest pathologist has developed a new area of study that employs electrical-resistance tomography to nondestructively detect internal decay and cavities in trees. This technology determines if there is a lower frequency of internal decay in American elms that receive trunk injections for the treatment of Dutch Elm Disease. High value elm trees on the Washington DC Mall have been assessed by our scientists. These assays also estimate the amount of C in forest trees, thus refining current models of the role that forests play in sequestration of atmospheric carbon. CAES plant pathologists have made significant inroads into demonstrating a role for nanoparticles of copper and silicon in suppression of plant diseases of asparagus, eggplants, pumpkins, soybeans, strawberries, watermelon, and many ornamental plants. This novel strategy utilizes host nutrition of young plants to enhance disease suppression. CAES has hosted scientists and students from the University of Wisconsin, China (Sichuan Agricultural University) and Brazil (Federales University of Lavas) to conduct novel and innovative studies to understand how minimal amounts of nanoscale products can suppress disease and increase yields at significantly reduced economic and environmental cost.

CAES scientists are increasing our knowledge and understanding of the appropriate selection, location, and maintenance of trees in urban and suburban spaces to increase utility reliability, public safety, public health, environmental benefits, and reduce costs and risks for municipalities. Roadside trees and branches that fall during severe weather often cause extended power outages and extensive road blockages. CAES foresters are collaborating with utilities, environmental groups, landowners, and other state agencies to develop practical, cost-effective protocols to proactively foster healthy, storm-resistant roadside forests by integrating silvicultural and arboricultural practices. Ten demonstration areas including over 4,300 trees have been established throughout Connecticut. Lessons learned on tree selection and coordination from implementation at nine areas are being incorporated into treatments scheduled at the remaining sites. In addition, as part of a new program CAES scientists are testing the usability of ecophysiological and molecular markers for tree stress detection. This information will be used to develop diagnostic and management strategies to identify weakened trees, to reduce tree stress and to support tree health in urban environments.

Scientists in the Department of Environmental Sciences have made progress in several areas in FY2020. The Environmental Chemistry program has been conducting research in recent years on interactions of pollutants with environmental particles, the bioavailability of pollutants in

environmental particles, pollution prevention and remediation, chemicals in reclaimed wastewater reused for agricultural irrigation, natural chemical processes in the environment, and environmental analytical chemistry applied to characterization of pollution, assessment of human exposure, and remediation options. These studies are funded by the USDA National Institute of Food and Agriculture, the National Science Foundation, the SERDP program of the Department of Defense, among other sources. Studies have examined the fundamental properties of biomass chars derived from natural fires or deliberately produced and added to soil for agricultural or environmental applications (biochar). Of particular interest are properties of chars important for their removal of chemical contaminants in soil or water. Scientists in the department have been designing adsorbents that can enhance remediation of soil or water contaminated with excess nutrients (phosphate), arsenic, and crude oil. Other studies have focused on developing solid and soluble catalysts that can break down organic pollutants in water. Scientists conducted a pilot test on using hemp for phytoremediation of per- and polyfluorinated alkyl substances (PFAS) and found that hemp accumulated eight PFAS compounds and that soil concentrations of four PFAS significantly decreased over the course of the growing season. Additionally, they assisted in the development and testing of FluoroMatch, a new software for PFAS data analysis, and began to develop and validate sample analysis methods for PFAS in animal feeds and dried blood spots. Work has continued on designing methods to detect new and emerging contaminants in wastewater and related matrices, and a new project was initiated examining trends in chemical contaminants, pharmaceuticals and drugs of abuse in wastewater sludge produced during the COVID-19 pandemic. Other Department of Environmental Sciences staff scientists are conducting wetland experiments to investigate how plant traits of three common wetland plants (*Typha latifolia, Phragmites australis*, *Spartina pectinata*) and three water quality impairments (i.e., sea salt, road salt, N-enrichment) interact to alter greenhouse gas (carbon dioxide and methane) fluxes and sediment microbial community composition. Additionally, using a "marsh organ" experiment, researchers are investigating the effects of altering the elevation of plants in the wetland to characterize plant and microbe responses to sea level rise. These data suggest that as ocean water infiltrates coastal systems, there will be changes in wetland carbon cycling. In a study funded by the Centers for Disease Control and Prevention, CAES scientists evaluated the efficacy of two novel chemical lures to improve collection of mosquitoes that are poorly captured by standard trapping methods. The new trap lures enhanced collection of *Aedes triseriatus* and *Aedes japonicus* mosquitoes, and testing of these collections indicated the entomological risk of La Crosse virus is much higher in Connecticut than previously thought. Historically, La Crosse virus is only rarely detected in this region, but there are suspicions that the main vector species (*Ae. triseriatus*) is systematically under-sampled by conventional trapping methods. In laboratory experiments, scientists have discovered that *Aedes aegypti* mosquitoes having a non-infectious bloodmeal after the initial infectious bloodmeal significantly increased transport of a virus (Zika, dengue, or chikungunya) from the gut to the salivary glands, greatly increasing the insect's ability to transmit that virus to its host, and may help explain the explosive epidemic potential of viruses transmitted by mosquitoes. Scientists in the department have also developed an axenic (bacterial-free) mosquito model, which is a new advance for studying the interaction between mosquitoes, their microbiome, and disease transmission. Using this model, scientists in the department have shown that multiple mosquito species recruit the same bacteria from the environment, shedding light on those bacteria that play important roles in mosquito development and biology. A study using genomic analysis and computational biochemistry is elucidating the structure of the ribosome of microsporidia, a group of unicellular parasitic fungi that infect all major groups of animals. Future

work aims at finding methods to control microsporidial diseases in honeybees and silkmoths. During the COVID-19 pandemic, scientists at CAES have been working with researchers at Yale University on a number of SARS-CoV-2 related projects. One project focuses on using SARS-CoV-2 RNA concentration data collected from municipal wastewater sewage sludge to predict levels of community-wide transmission. In another project, researchers have developed a new strategy to screen individuals for SARS-CoV-2 that is cost-effective, scalable, and non-invasive, and further circumvents supply chain issues. This new approach, validated with numerous reagents and platforms, tests patient saliva directly without the need of costly trained medical care providers collecting the sample, RNA extractions, or sample collection devices and reagents. This approach, termed SalivaDirect, is currently pending FDA emergency use authorization.

The CAES reaffirms its continuing policy of commitment to affirmative action and equal opportunity employment as immediate and necessary objectives and relies solely on merit and accomplishment in all aspects of the employment process and research programs. CAES scientists were granted funds from a USDA proposal that funded the CAES/SCSU Summer Undergraduate Fellows in Plant Health and Protection program where undergraduates from Connecticut and elsewhere gained valuable experience working in CAES laboratories. The interns included 1 white male, 2 minority males, 4 white females, and 3 minority females. The goals of mentoring programs are to promote interest in science and provide specialized training. Station scientists also participated as judges in science fairs in New Haven and Hamden. Through these and other direct interactions, staff encouraged high school students to further their science education. The CAES continues to comply with diversity training requirements and is also participating in the University of Connecticut's Employee Assistance Program. The agency's goals in awarding contracts to small businesses and minority business enterprises were exceeded.

Information Reported as Required by State Statute

Scientists and technicians performed chemical, seed, soil, fertilizer, pesticide, animal feed, mosquito, and tick tests; answered inquiries; conducted plant, nursery, and bee inspections; and surveyed for the gypsy moth and other insect pests as listed below.

Service or Test Number	**2019-2020**
Inquiries answered (all departments)	15,709
Field visits and diagnostic tests	205
Nematode diagnostics	172
Soil Tests Completed	
New Haven and Windsor	10,160
Samples Tested	
Department of Agriculture	219
Department of Consumer Protection (DCP)	272
Department of Energy & Environmental Protection	105
CAES Departments	210
FDA, Municipal Health Departments, Cities/Towns, and Misc. Foundations	109
UConn Cooperative Extension	34
University Research Collaborations	223
Seed Samples Tested (vegetable, lawn, field crop)	392
Consumer Plant Samples Tested	2,029

Grapevine Samples Tested for Plant Viruses	5,260
Nursery and Seed Inspections	
Greenhouse plants	2,555
Nursery stock containers and bare root	40,019
Perennial plants	1,656
Nursery inspections	160
Tobacco (bales, boxes, bundles, and cartons)	178,916
Permits to move homeowner plants out of state	82
Seed (cartons and bags)	465
Acres of nursery stock inspected	5,000
Gypsy Moth Survey	
Forest acres surveyed for gypsy moth by air	1.8 million
Bee Inspection	
Beekeepers registered	562
Beehives examined for mites and foulbrood	1,273
Tick Identification and Testing – Active Surveillance	
Ticks identified	3,409
Ticks tested for human pathogens	528
Ticks infected with *Borrelia burgdorferi* (Lyme disease)	82
Ticks infected with *Babesia microti*	50
Ticks infected with *Anaplasma phagocytophilum*	37
Tick Identification and Testing – Passive Surveillance	
Ticks identified	3,928
Ticks tested for human pathogens	3,125
Ticks infected with *Borrelia burgdorferi* (Lyme disease)	916 (29.3%)
Ticks infected with *Babesia microti*	164 (5.2%)
Ticks infected with *Anaplasma phagocytophilum*	178 (5.7%)
Mosquito Testing	
Mosquitoes trapped, identified, and tested for EEE, West Nile, and other encephalitis viruses	239,960
Number of trapping sites	92