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 –	**$ 7,503,824**
Federal Funds –	**$ 3,925,809**
Other/Pass Thru –	**$ 1,873,295**
Total –	**$13,302,928**

***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

citizen, 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 oversees 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 488 talks and interviews to civic groups and the media. Our annual open house event (the 111th) was held at our Lockwood Farm facility during the summer; more than 1,024 state residents had an opportunity to interact with scientists, hear presentations on scientific progress, view experimental plots and barn exhibits, hear from Lt. Governor Susan Bysiewicz, and to make comments on research and outreach programs

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 Spotted Lanternfly, 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 throughout Connecticut. 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 or remote 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 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 or if a novel contaminant emerges, such as PFAS. 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 16th year of funding ($4.5 million through 2021) under this program, with the current funding cycle concluding in 2025. Separately, CAES has completed a FDA grant that enabled 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 has completed the final year of a 5-year FDA grant ($750,000) and successfully brought 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 accredited programs were audited in January 2021 by the Association for Laboratory Accreditation (A2LA) and accredited was extended to 2023. These three FDA grants were recently combined in 2020 into a single cooperative agreement program, the Laboratory Flexible Funding Model (LFFM), to which the CAES applied and was awarded in September 1, 2020. Under this model, CAES analyzed 499 samples of human food for pesticide residues, heavy metals and toxins, including juice and juice powders, harvested food products and processed spices during the 2020-2021 fiscal. Also, 479 animal feed samples were analyzed for toxins, heavy metals, and proximate analysis (protein, fat, and fiber) during the period.

- 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.

- **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. Up to 104 samples were submitted to this program during July 2020 to June 2021, 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 108 trapping sites from June through October. In response to the 2019 EEE outbreak, which resulted in 122 EEE isolates from mosquito pools, four human infections, and six equine cases, sixteen new mosquito trapping sites were added in 2020. During 2020, a total of 193,191 mosquitoes representing 15,665 pools were trapped and tested for arboviruses. There were 143 isolations of WNV made from 4 species: *Culex pipiens* = 125, *Cx. restuans* = 16, *Cx. salinarius* = 1, *Ochlerotatus japonicus* = 1, collected from 27 locations in 21 towns in three counties (Fairfield, Hartford, New Haven). The first WN positive mosquitoes were collected on July 8, and last on October 1. The majority of WN virus activity was detected in densely populated urban and suburban regions in Fairfield, Hartford and New Haven counties. Eight human cases (6 = neuroinvasive, 2 = fever) of WN virus-associated illness were reported, with dates of onset of symptoms from July 10, to October 1. Patients ranged from 24 to 76 years of age. All human cases were locally acquired, with no out of state travel reported. There were two isolations of EEE virus obtained from *Culiseta melanura* collected from 2 locations in 2 towns in two counties (New London, Windham), with EEE positive mosquitoes collected on August 5 and August 12. There were no EEE infections reported in humans or equines. Other mosquito-borne viruses isolated included: Cache Valley virus = 25 isolates from 8 species (July 13 – September 28), Jamestown Canyon virus = 13 isolates from 8 species (June 3 – September 23), and Potosi virus = 56 isolates from 7 species (July 13 – September 16). 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 3376 aquatic vegetation surveys of 285 Connecticut lakes and has found that 60% contain invasive plants. A total of 66 water bodies have been resurveyed to determine how invasive plants are changing the quality of lakes over time. In fiscal year 2020-2021, CAES IAPP surveyed 103 lakes and performed multifaceted research. Lake Candlewood, Connecticut's largest lake, was surveyed for the 12th 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 19th year of research involving the use of spot applications of herbicides to control variable watermilfoil in Bashan Lake. We have restored the lake to pre-infestation conditions. 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 anything previously found. 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. CAES IAPP was commissioned to survey the Connecticut portion of the river and the remainder to document the full extent of Hydrilla and other invasive species. This was completed in 2021. Hydrilla was the dominant species occupying 774 acres while Eurasian watermilfoil covered 214 acres. Fanwort (*Valisneria americana*), curlyleaf pondweed, variable-leaf watermilfoil, and water chestnut (*Trapa natans*) were present in much smaller amounts. CAES IAPP has extensive public outreach via workshops, speaking engagements and a comprehensive website available at portal.ct.gov/caes-iapp. Results are published in scientific journals, technical reports and in CAES bulletins.
- **Gypsy Moth, Emerald Ash Borer, and Spotted Lanternfly:** In 2020, we recorded no acres actively defoliated by gypsy moth. In December 2020 through March 2021, a gypsy moth egg mass survey was conducted on a 7-mile grid (102 sites) throughout Connecticut. Egg mass counts were high only in Litchfield County, which indicated the potential for an outbreak there in summer of 2021. Subsequently, without spring rains for the gypsy moth fungus, approximately 25,000 to 30,000 acres were extensively defoliated in the spring and early summer of 2021. Monitoring for the Emerald ash borer through *Cerceris* wasp colonies continued in 2020 and 2021 with EAB now present throughout the state. Biocontrol releases for EAB, which began in 2013 and have continued through 2021, have been successful with

all three species of released parasitoids recovered within one year after release at each site. The first established population of the spotted lanternfly (SLF) was detected in Greenwich, CT in September 2020 and subsequently found in New Canaan and Stamford. Further detections were likely given the expanding range of this insect first detected in Pennsylvania in 2014. The spotted lanternfly is an exotic, invasive sap-feeding planthopper that has the potential to severely impact Connecticut's farm crops, particularly apples, grapes, and hops, as well as several tree species. The Director of CAES established an SLF quarantine and defined regulated areas as those with known established populations effective July 1, 2021.

- **Honeybee Health and Pollination:** Connecticut beekeepers continue to lose colonies over winter in high numbers. Varroa mite infestation and the viral complex associated with varroa mite infestation continues to be the primary reason for colony mortality. Varroa mite test kit distribution started in the last quarter for 2019 and was continued through 2021 for all Connecticut beekeepers. The Bee Informed Annual Loss report for CT in 2020 was 56.5%, a slight decrease from the previous year; the winter loss was 36.6%; the summer loss was 18.3%. Connecticut annual bee losses were probably closer to 65 %. Package bee sales for new beekeepers and for replacement colonies is very high and is estimated to be over 7,000 units.
- **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 2020 of a total of 2,477 blacklegged ticks, 185 American dog ticks, 16 lone star ticks, and 1 Asian longhorned ticks (total 2,679 for the period July 1 – June 30). The 2020 testing results for adult blacklegged ticks were *B. burgdorferi* (48.2%), *B. microti* (8.6%), *A. phagocytophilum* (7.8%), *B. miyamotoi* (2.7%), and Powassan virus (0%). For nymphal blacklegged ticks, the results statewide were *B. burgdorferi* (20.6%), *B. microti* (6.8%), *A. phagocytophilum* (4%), *B. miyamotoi* (1.1%), and Powassan virus (0.4%). 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 where they have not been collected before, particularly in the 4 southern counties. 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 5,551 ticks submitted by Connecticut residents, health departments and/or physicians' offices during fiscal year 2020-2021; 4,188

were examined, of which 1,338 (31.9%) tested positive for Lyme disease, 413 (9.9%) for babesiosis, and 187 (4.5%) 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 from 0.2% to 3.3% in recent years. During the past fiscal year, established populations of the Gulf Coast and Asian longhorned ticks were discovered in Fairfield and New Haven Counties, in addition to existing populations of the lone star tick. 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. Gulf Coast ticks are involved in transmission of several pathogens of veterinary and medical importance, including *Rickettsia parkeri rickettsiosis*, a form of spotted fever, to humans, and *Hepatozoon americanum*, the causative agent of American canine hepatozoonosis, to canine species. The Asian longhorned tick is a vector for the viral agent of severe fever with thrombocytopenia in humans, among other pathogens. Furthermore, pathogenic *Theileria orientalis* Ikeda genotype has recently been detected in cattle and in ticks in Virginia, for which the longhorned tick is a known vector. Rising global temperatures, ecologic changes, reforestation, and increases in commerce and travel are important underlying factors influencing the rate and extent of range expansion of ticks and associated pathogens. It is anticipated that warming temperatures related to climate change may lead to the continued range expansion and abundance of several tick species, increasing their importance as emerging threats to humans, domesticated animals and wildlife.

- **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 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 funded by the USFS [no funding for surveys this year] found that BLD had spread to additional parts of Fairfield County, as well as New Haven, Middlesex, Litchfield, Tolland, Windham, and New London Counties; the disease has not been seen in Hartford County to date. CAES scientists have formed a multistate partnership with several states, yet to be funded by the U.S. Forest Service, to monitor the development and spread of BLD. A CAES scientist is using population genetics methods to investigate disease

epidemiology. In addition, CAES remain vigilant 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 2020-2021

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). Recent research at CAES has demonstrated effective control in landscapes and nurseries with chemical and cultural tactics and improved understanding of disease epidemiology to better model risk. Scientists are working with plant breeders to select boxwood plants resistant to the disease.

Another USDA-funded collaboration between CAES scientists and UConn scientists is investigating how single celled soil predators called protists can shape the plant microbiota and influence plant health. By eating and digesting bacteria, protists release nutrients into the soil and increase the activity of protist-resistant bacteria that are beneficial to plants. These properties can enhance the growth and stress resilience of crops. After performing collections at CAES farms in

Lockwood and Griswold, the team this year reported the first publicly available collection of plant-associated protists in the US, including species that were found to be very common in plant roots. This collection will serve as an important resource for researchers.

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 the apple pathogen *Erwinia amylovora*. We discovered that the bacterial microbiome on apple flowers gradually evolves to become dominated by two keystone bacterial families, *Enterobacteriaceae* and *Pseudomonadaceae*. Certain members of the microbiome, such as *Pseudomonas*, were found to negatively correlate with *E. amylovora* on flowers. Manipulation of the flower microbiome through microbial spray altered the microbiome structure and reduced fire blight infection. Scientists also studied the role of exogenous amino acids in *E. amylovora* infection using mutants deficient in the utilization of asparagine. Asparagine is a main nitrogen transport molecule from the roots to the flowers. These assays will offer clues as to how disease establishment is affected by the host metabolism. By deciphering the pathogen distribution and evolution of virulence factors in plant pathogenic bacteria, CAES scientists hope to identify possible areas for disease management.

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 late season disease suppression. CAES has hosted scientists and students from the University of Wisconsin, China (Sichuan Agricultural University), Brazil (Federales University of Lavas) and Pakistan (University of the Punjbab) 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. Advances in Christmas tree integrated pest management and transplant fertilization techniques now allow trees to be harvested one full year earlier, reducing inputs and increasing profits by about 10 percent.

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, including excess nutrients. 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. Another main research topic has been per- and polyfluorinated alkyl substances (PFAS). Scientists continued field trials using hemp for phytoremediation of PFAS and found that PFOS concentrations in the hemp plot soil decreased over the growing season. A new version of FluoroMatch software was released with increased capabilities for detecting unknown PFAS in LC-HRMS data. Another project focused on method validation for measuring PFAS in dried blood spot and whole blood samples, and work began on sample analysis for epidemiological studies on PFAS. Work has continued on designing methods to detect new and emerging contaminants in wastewater and related matrices. Sewage sludge samples from the first wave of the COVID-19 pandemic were analyzed and trends in chemical contaminant levels were examined. Opioids, disinfectants, and hydroxychloroquine increased in sludge between March and June of 2020, indicating potential increasing use during this time.

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 in use with FDA 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 part of an NSF grant that funded a Summer Undergraduate Research Experience program where undergraduates gained valuable experience working in CAES laboratories. The interns included 1 minority male and 1 minority female. The goals of mentoring programs are to promote interest in science and provide specialized training. Station scientists also participated remotely 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	**2020-2021**
Inquiries answered (all departments)	14,150
Field visits and diagnostic tests	139
Nematode diagnostics	172
Soil Tests Completed	
New Haven and Windsor	15,609
Samples Tested	
Department of Agriculture	479
Department of Consumer Protection (DCP)	508
Department of Energy & Environmental Protection	86
CAES Departments	66
FDA, Municipal Health Departments, Cities/Towns, and Misc. Foundations	72
UConn Cooperative Extension	13
University Research Collaborations	6
Seed Samples Tested (vegetable, lawn, field crop)	393
Consumer Plant Samples Tested	1,603
Boxwood Blight Samples	38

Grapevine Samples Tested for Plant Viruses	5,260
Nursery and Seed Inspections	
Number of registered nurseries	195
Phytosanitary certificates issues	531
Nursery stock containers and bare root	40,315
Nursery inspections	137
Tobacco (bales, boxes, bundles, and cartons)	90,462
Permits to move homeowner plants out of state	45
Seed (cartons and bags)	363
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	697
Beehives examined for mites and foulbrood	909
Tick Identification and Testing – Active Surveillance	
Ticks identified	2,679
Ticks tested for human pathogens	954
Ticks infected with *Borrelia burgdorferi* (Lyme disease)	309 (32.4%)
Ticks infected with *Babesia microti*	72 (7.5%)
Ticks infected with *Anaplasma phagocytophilum*	54 (5.7%)
Tick Identification and Testing – Passive Surveillance	
Ticks identified	5,551
Ticks tested for human pathogens	4,188
Ticks infected with *Borrelia burgdorferi* (Lyme disease)	1,338 (31.9%)
Ticks infected with *Babesia microti*	413 (9.9%)
Ticks infected with *Anaplasma phagocytophilum*	87 (4.5%)
Mosquito Testing	
Mosquitoes trapped, identified, and tested for EEE, West Nile, and other encephalitis viruses	193,191
Number of trapping sites	108