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*
Lindsay Triplett, 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* – 88**
***Recurring operating expenses*:**

General Fund –	**$ 8,281,137**
Federal Funds –	**$ 4,487,887**
Other/Pass Thru –	**$ 987,248**
Total –	**$13,756,272**

***Organizational structure* – Administration, Analytical Chemistry, Entomology, Environmental Science and Forestry, 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 *Borrelia burgdorferi*, *Babesia microti*, and *Anaplasma phagocytophilum*, the infectious agents that

cause Lyme disease, Babesiosis and Anaplasmosis, respectively, 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, *Apis mellifera*, and register beekeepers (CGS Sections 22-89, 22-90); and survey towns for spongy moth (formerly known as gypsy moth), *Lymantria dispar*; Asian longhorned beetle, *Anoplophora glabripennis*; emerald ash borer, *Agrilus planipennis*; 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 112th) was held at our Lockwood Farm facility during the summer; more than 911 state residents had an opportunity to interact with scientists, hear presentations on scientific progress, view experimental plots and barn exhibits, hear from CT Department of Energy and Environmental Protection Commissioner Ms. Katie Dykes, and to make comments on research and outreach programs

Public Service

Public service remains a high priority. This includes public education to reduce pesticide use and promote non-chemical management of nuisance arthropods, protection of public health, conservation of natural habitats and species, protection of agriculture, and protection of urban structures and buildings. The public offices directly serve private citizens, pest management professionals, the real estate industry, nurseries, land care businesses, arborists, health departments, other medical professionals, charities, manufacturing, the hospitality industry, schools, colleges, and universities, housing authorities, museums, municipalities, libraries, law enforcement, native American tribes, state government, the media and scientific communities within particular 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, *Lycorma delicatula*; Asian longhorned beetle, emerald ash borer, southern pine beetle, *Dendroctonus frontalis*; box tree moth, *Cydalima perspectalis*; beech leaf disease, *Litylenchus crenatae mccannii*; and boxwood blight, *Calonectria pseudonaviculata*. The emerald ash borer 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. Box tree moth, a federally-regulated pest, was intercepted in a consignment of boxwood shipped to a Connecticut garden center. Only one larva was found, but inspection efforts are ongoing.

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 analysis. 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 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. The strategic plan and accomplishment reports are required by the USDA for funding support. Both documents are reviewed annually by federal officials.

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. This enhances Connecticut's economy and/or improves the well-being of state residents. For example, 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 (per- and polyfluoroalkyl substances, which are persistent contaminants comprised of synthetic organofluorine chemical compounds). In many instances, scientific results have national impacts.

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 17th year of funding ($5.1 million through 2025 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). 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 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 500 samples of human food for pesticide residues, heavy metals and toxins, including juice and juice powders, harvested food products and processed spices during the 2021-2022 fiscal year. Also, 250 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. The human food program (formerly 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. Breaking the numbers down, during the period between July 2021 and June 2022, CAES chemists analyzed 105 food samples for pesticides, 285 samples for arsenic, and 44 consumer complaint samples for contamination with foreign material product adulteration or tampering, and off taste/smell, among other contaminants of interest. An important highlight of this work during the year under review was the revelation of the presence of the insecticide carbofuran in imported fresh asparagus produce. Carbofuran is banned for use in the United States. This work resulted in the foreign processor of the produce being added to the "red list" attachment of FDA's Import Alert 99-05, *Detention Without Physical Examination Of Raw Agricultural Products for Pesticides*. This is a significant accomplishment requiring sample analytical packages from CAES to be reviewed by multiple regulators within the FDA. Similarly, the Animal Food program (formerly AFRPS or Animal Feed Regulatory Program Standard), conducted with the CT Department of Agriculture and the FDA, serves as the sole chemical surveillance and monitoring effort in the state for pet and livestock feed. A breakdown of the numbers showed that during July 2021 and June 2022, CAES scientists analyzed 84 animal feed samples for aflatoxins, 101 samples for macro minerals, 100 samples for copper, and 50 samples for fat, fiber, and protein, among other analytes of interest. 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 counterterrorism and law enforcement programs.
- **Hemp Testing and Adult Use Cannabis Programs:** 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 developed a program for THC testing of both grower and inspector collected regulated samples in 2019. This program continues to support farmers in the state who are growing this crop. To this end, a total of 104 pre-harvest samples were submitted to this program during July 1, 2021, to June 30, 2022, with the CAES

providing a 48-hour turnaround on analytical results so that the crop could be harvested in a timely fashion. In addition, basic research was incorporated into the program during the year to assess various varieties of hemp for compliance with THC levels throughout the growing season and the maximum potential yield of CBD. Separately, since the legalization of adult use marijuana in July 2021, there has been a need to develop a program for the analysis of marijuana products for their cannabinoid contents, as per label claims. The Station has been tasked by the Department of Consumer Protection, Drug Control Division to develop this program, which will involve testing marijuana products for THC, pesticides, mycotoxins, terpenoids, and heavy metals. Drug Control submits the samples to CAES, of which 9 samples were analyzed and reported back during fiscal year 2021-2022.

- **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. A total of 390,129 mosquitoes were trapped, represented by 21,931 pooled samples tested for arboviruses. West Nile virus was isolated from 208 pools, obtained from 10 species: *Culex pipiens* = 118, *Cx. Restuans* = 55, *Cx. Salinarius* = 8, *Culiseta melanura* = 8, *Psorophora ferox* = 8, *Aedes cinereus* = 6, *Ochlerotatus trivittatus* = 2, *Ae. Vexans* = 1, *Oc. Japonicus* = 1, and *Uranotaenia 5apphirine* = 1; WNV isolates were obtained from 50 trapping sites in 43 towns located among all eight counties. The first WNV positive mosquitoes were collected on June 21 and the last on October 18. The majority of WNV virus activity was detected in densely populated urban and suburban regions in Fairfield, Hartford, and New Haven counties. Six human cases of WNV-associated illness were reported (4 neuroinvasive, 2 fever), with no fatalities reported. The dates of onset of symptoms ranged from August 20 to October 14. Patients ranged from 35 to 77 years of age. All human cases were locally acquired, with no out-of-state travel reported. There two isolates of eastern equine encephalitis (EEE) made from mosquito pools: *Cs. melanura* = 1, *Oc. canadensis* = 1, from a single trap location in Voluntown collected on September 23. There were no EEE infections reported in humans or equines. Other mosquito-borne viruses isolated included: Jamestown Canyon virus = 18 isolates from 10 species (June 2 -September 21), Cache Valley virus = 41 isolates from 11 species (August 4 – October 13), Highlands J virus = 15 isolates from 6 species (August 16–October 14), Trivittatus virus = 6 isolates from 1 species (July 21– September 13), and Flanders virus = 1 isolate from 1 species (August 31). 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, threaten the ecological and recreational value of Connecticut's lakes and rivers, and have public health implications. Since 2004, the CAES Invasive Aquatic Plant Program (IAPP) has completed 392 aquatic vegetation surveys of 256 Connecticut lakes and 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 2021-2022, CAES IAPP surveyed 15 lakes and performed multifaceted research. Lake Candlewood, Connecticut's largest lake, was surveyed for the 13th 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 20th 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 https://portal.ct.gov/caes-iapp . Results are published in scientific journals, technical reports and in CAES bulletins.

- **Spongy Moth (Formerly Gypsy Moth), Emerald Ash Borer, and Spotted Lanternfly:** In March 2022, the Entomological Society of America changed the name of *Lymantria dispar dispar* from gypsy moth to spongy moth. In December 2020 through March 2021, a spongy 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 spongy moth fungus *Entomophage maimaiga* to inoculate and harm the caterpillars, approximately 45,548 acres were extensively defoliated in the spring and early summer of 2021. Monitoring for the emerald ash borer (EAB) 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 Subsequently, populations have been found in several areas of Fairfield and New Haven Counties, and SLF has been intercepted many times in a wide array of agricultural and commercial products. The SLF 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, Wild Bee Status, and Pollination:** Connecticut beekeepers as well as beekeepers in adjoining states continue to lose colonies 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 will continue through 2022 for all Connecticut beekeepers. The Bee Informed Annual Loss report for CT in 2021 was 65.7%, an increase from the previous year; the winter loss was 49.8%; the summer loss was 20.0%. Package bee sales for new beekeepers and for replacement colonies remains strong and replacement colonies are estimated to be over 7,000 units. The Wild Bee Monitoring Program has assessed that there are 378 species of bees documented for Connecticut. Four species are currently listed as species of conservation concern in Connecticut: *Bombus affinis*, listed as a species of Special Concern in Connecticut and federally listed as an Endangered Species; *Bombus ashtoni*, listed as a species of Special Concern in CT; *Bombus terricola,* listed as Threatened in CT, and *Epeoloides pilosula,* listed as Endangered in CT. The remaining species do not yet have a conservation status, and work is being done by CAES in cooperation with CT-DEEP and NatureServe to give subnational ranks to bee species in the state. Of note, surveys of native bumble bees in Litchfield County have detected persisting populations of *Bombus terricola* in limited locations. *Bombus terricola* was found in three new locations in 2021, in the towns of Norfolk, Goshen, and Winsted. In 2018 and 2019 it was found in Canaan, and in 2020 it was found in Canaan and Cornwall. A collaboration was formed between CAES and CT-DEEP in 2021, whereby CAES staff will monitor ecological development at a habitat enhancement project in Robbins Swamp Wildlife Management Area in Falls Village, Canaan. Surveys of wild bees, monarchs, and vegetation were conducted in 2021 once per month from April to September to establish a baseline from which to evaluate how plant and insect composition develop over time.
- **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 2021 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 Connecticut's eight counties, and screened for five human pathogens. The sample counts presented here reflect total specimens collected during 2021. Testing of 479 female and 500 nymphal *I. scapularis* ticks collected through 30 November 2021 found adult blacklegged ticks were infected with *B. burgdorferi* (52.9%), *B. microti* (16.9%), *A. phagocytophilum* (13.1%), *B. miyamotoi* (1.6%), and Powassan virus (0.82%). For nymphal blacklegged ticks, the results statewide were *B. burgdorferi* (21.6%), *B. microti* (8.4%), *A. phagocytophilum* (5.8%), *B. miyamotoi* (2.0%), and Powassan virus (0.0%). 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. An experimental program involving feeding white-tailed deer a treated bait for tick management was established in 2021 for control of lone star ticks, *Amblyomma americanum*, in Norwalk, CT and for blacklegged ticks, *Ixodes scapularis*, in Bridgeport, CT. A similar strategy for the systemic treatment of white-footed mice for juvenile tick and pathogen management was established in 2021 and is being tested in Guilford and North Branford, CT. Also, a study investigating spraying pesticides for tick management in late fall to avoid incidental mortality

of beneficial pollinator species (honeybees and butterflies) was initiated and concluded in 2022 and suggests that such a strategy was very effective.

- **Passive Tick Surveillance and Testing Program:** Ticks and tick-borne diseases continue to pose a major health concern for Connecticut residents. In recent years, populations of native ticks have progressively increased, and established populations of invasive tick species have been discovered in the state. As a result, an increasing number of communities are at risk of exposure to ticks and tick-borne pathogens. Increases in population densities, geographic range expansion, and the ensuing potential of greater interactions with humans and wildlife highlight the importance of ticks as a public health threat. It was estimated that 90% of the U.S. human vector-borne disease cases in 2017 were those transmitted by ticks. Based on recent estimates, 476,000 people have been treated for Lyme disease annually from 2010 to 2018. With a total of 14,571 Lyme disease cases from 2010 to 2019, Connecticut is among the 14 states from which 95% of all Lyme disease cases are reported and had the 9th highest incidence rate (disease cases per 100,000 population) in 2019. Similarly, the incidence of other tick-borne diseases, including anaplasmosis and babesiosis, has also been on the rise in Connecticut. In response to the growing challenges of ticks and tick-borne diseases, the CAES has established tick and tick-borne pathogen surveillance programs. These programs provide information on the abundance, distribution, and infection of tick vectors to assess the risk of human infection and track the range expansion of exotic and invasive tick species and their associated pathogens in the state. The passive tick and tick-borne pathogen surveillance program was established in 1990 following the first discovery of Lyme disease in Connecticut and several years of research on this disease at the CAES. Within the framework of the passive surveillance program, the CAES Tick Testing Laboratory (TTL) was initially mandated to screen the blacklegged tick for evidence of infection with *Borrelia burgdorferi*, the causative agent of Lyme disease. However, in 2015, the program was expanded to include testing for *Anaplasma phagocytophilum* and *Babesia microti*, the two important tick-borne pathogens responsible for human granulocytic anaplasmosis and babesiosis, respectively. The CAES-TTL receives nearly 3,000 tick submissions each year from residents, health departments, and physician's offices; however, this number has increased to 6,000 in recent years.

  Blacklegged/deer tick, *Ixodes scapularis*, is currently responsible for transmitting seven pathogens to humans, of which the three most common are *Borrelia burgdorferi*, *Babesia microti*, and *Anaplasma phagocytophilum*, causing Lyme disease, babesiosis, and anaplasmosis, respectively. In 2021, the CAES-TTL received a total of 5,685 ticks submitted by residents, health departments, and physicians' offices for identification and testing. Of these, 4,365 (76.8%) were identified as *Ixodes scapularis* (blacklegged or deer tick), 1,092 (19.2%) as *Dermacentor variabilis* (American dog tick), 213 (3.7%) as *Amblyomma americanum* (lone star tick), and 15 (0.3%) as other tick species. Of 4,196 adult female and nymphal blacklegged ticks screened for evidence of infection with three most prevalent tick-borne pathogens, 1,335 (31.8%) tested positive for *B. burgdorferi*, 189 (4.5%) for *A. phagocytophilum*, and 409 (9.5%) for *B. microti*. A total of 391 ticks were co-infected with two or more pathogens. Co-infection with more than one pathogen in ticks could lead to concurrent human infection with *B. burgdorferi* and *B. microti* or *A. phagocytophilum*, which may complicate diagnosis, lead to insufficient treatment, and increase the severity of disease.

  In addition, within the framework of a passive tick surveillance program, the CAES-TTL continues to monitor the range expansion of native ticks and incursion of invasive ticks in Connecticut. On August 26, 2021, we discovered an established population of the Asian

longhorned tick (*Haemaphysalis longicornis*) in New Haven County in addition to reported populations of this tick in Fairfield County in September 2020

- **Grapevine Survey:** CAES scientists continued their survey to assess the incidence of viruses that cause Grape Leafroll Disease (GLD) (Family: Closteroviridae) in the Connecticut vineyards. GLD is one of the most detrimental and widespread viral diseases of grapes worldwide and it is caused by six different species of viruses. This disease can cause up to $40,000 loss per hectare during a single growing season and the only strategy for managing GLD is to monitor vineyards and eliminate infected plants. From 2019 to 2021, over 11,600 leaf samples were assayed from 25 CT vineyards and over 50% tested positive for GLD. These findings stress the need for improving the sanitary status of planting materials to avoid the introduction and dissemination of viruses to vineyards in this important wine-producing region of New England. 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 the health of our forests. A new invasive disease of American beech called Beech Leaf Disease (BLD) can kill established beech trees in as few as three years. It is caused by the foliar nematode *Litylenchus crenatae mccannii* and was first identified in Connecticut by a CAES scientist in Fairfield County in 2019 on an American beech. Surveys and reports from the public (foresters, stakeholders, arborists) confirm that BLD is now found in all 8 CT counties. The extent and severity of BLD in 2022 is highest in Fairfield, New Haven, Middlesex, and New London counties, where large numbers of understory saplings exhibited nearly 100% bud failure and therefore produced no leaves. In addition, CAES scientists continue to monitor 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 2021-2022

Patents, Trademarks, and Licensing:

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.

Online Registration:

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.

Energy Conservation: 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.

CAES Projects:

CAES scientists received a USDA-NIFA grant, $636,000 to investigate nanoparticles as potential carriers of double stranded RNA (dsRNA) to control plant virus infections. Plant viruses cause an estimated $30 billion in crop loss every year worldwide. Since no viricide is available for direct control of these pathogens, there is an increasing demand for innovative and sustainable ways of managing virus epidemics in agricultural systems. Scientists at CAES have identified specific ribonucleic acid (RNA) molecules that induce RNA interference (RNAi), an evolved plant defense mechanism that we are seeking to activate or enhance, in plants and this can prime plants to successfully resist viral diseases. The scientists will use this funding to work on the last step of this multidisciplinary project, which is to develop a delivery system for these RNA molecules to protect crops against these devastating pathogens.

Two USDA-NIFA grants were continued by a CAES plant pathologist collaborating with CAES analytical chemists to investigate the role of nanoscale nutrients for plant health. Single applications of nanoscale sulfur (S) applied to tomato roots and foliage suppressed Fusarium wilt disease, increased yield, and had direct stimulatory effects of plant defense mechanisms. Since the popular heirloom cultivars of tomato are highly susceptible to the wilt disease, nanoscale S could offer a safe inexpensive strategy for tomato management. In addition, nanoparticles of phosphorus (P) that were embedded in bio-degradable capsules can allow P to slowly release around plant roots. The reduction in leachable P that would enter ground water and cause algal blooms has far reaching benefits in reducing costs to growers and damage to environmentally sensitive ecosystems.

A CAES forest pathologist has developed a highly sensitive molecular diagnostic system for early detection of the nematode, *L. crenatae mccannii,* that causes the Beech Leaf Disease currently threatening Connecticut's forests. Additionally, a DNA fingerprinting system based on 19 microsatellite loci has been developed for use in investigating the epidemiology of the disease. The Plant Disease Information Office responded to 159 inquiries about BLD from professionals, foresters, and homeowners. CAES scientists have formed a multistate partnership with several states to monitor the development and spread of BLD.

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 47 of 248 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 University of Connecticut scientists is investigating how single celled soil predators called protists can shape the plant microbiota and influence plant health. This year, the team reported the first survey of predators on plant leaves and pinpointed two groups of interest that could be investigated in fighting foliar plant disease. In 2022, CAES scientists were awarded an additional $819,000 in USDA funding to continue this research for four more years. The team will use the funds to identify how the plant beneficial function of bacteria in the rhizosphere is affected by protists. In the early stages of the project, the team has identified dozens of beneficial bacteria that protists could help establish. By understanding how these bacteria are enhanced or stimulated by predation, this project can pave the way toward using soil predators as a sustainable strategy toward enhancing crop growth and resilience.

CAES plant pathologists continued a USDA-funded project to understand the role of the flower microbiome in pollinator interactions, fruit development, and host resistance to the apple pathogen *Erwinia amylovora*. The scientists discovered that some flower colonizing yeast-like fungi, such as *Aureobasidium pullulans*, can induce host immunity in apple flowers. Through biochemical and molecular investigation approaches, scientists found that levels of the plant defense signal salicylic acid rise in flowers treated with the fungi, which resulted in excellent disease control efficacy against fire blight. Pathologists are also analyzing the metabolic requirements of *E. amylovora* for causing disease on apple trees. In the spring, apple trees transport nitrogen, primarily as amino acids aspartate, asparagine and glutamine, from roots to developing flowers and leaves, and *E. amylovora* requires these to grow. These assays will offer clues as to how disease establishment is affected by host metabolism, which will help scientists understand how to stop bacterial growth and disease through breeding and other strategies.

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 several domestic and international universities 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 Science and Forestry have made progress in several areas. The Environmental Chemistry program has been conducting research 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 on testing of modified carbon materials for removal and subsequent destruction of per- and polyfluorinated alkyl substances (PFAS) in drinking water. 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. Work also continued measuring PFAS in dried blood spot and whole blood samples, as well as on epidemiological studies on PFAS. Work has continued on designing methods to detect new and emerging contaminants in wastewater and related matrices.

Other Department of Environmental Science and Forestry 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 when mosquitoes from diverse genera are provided a non-infectious bloodmeal after the initial infectious bloodmeal significantly increased transport of a virus (West Nile virus, La Crosse virus, or Mayaro virus) 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, using their recently

developed axenic (bacterial-free) mosquito model, have demonstrated that not only the presence/ absence of bacteria can alter mosquito susceptibility to dengue and chikungunya virus, but that the composition of the microbiome can greatly impact susceptibility. 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. The Plant Health Fellows program is a federally-funded summer internship program initiated by CAES scientists and professors at Southern Connecticut State University. The program has provided mentored research experiences and career development training to 39 students since 2017, roughly 60% of whom are first generation college students or underrepresented minorities, and the majority of whom are from Connecticut. This year CAES and SCSU were awarded $500,000 from the USDA to continue the program for another 5 years, providing mentorship and career training to an additional 50 students.

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 spongy moth and other insect pests as listed below.

Service or Test Number	**2020-2021**
Inquiries answered (all departments)	18,063
Field visits and diagnostic tests	390
Nematode diagnostics	206
Soil Tests Completed	
New Haven	6,740
Windsor	4,174
Samples Tested	
Department of Agriculture	530
Department of Consumer Protection (DCP)	531
Department of Energy and Environmental Protection (DEEP)	75
CAES Departments	106
FDA, Municipal Health Departments, Cities/Towns, and Misc. Foundations	56
UConn Cooperative Extension	30
University research collaborations	1,200
Seed samples tested (vegetable, lawn, field crop)	358
Consumer plant samples tested	1,603

Boxwood blight samples	248
Grapevine samples tested for plant viruses	5,000
Nursery and Seed Inspections	
Number of registered nurseries	185
Phytosanitary certificates issues	817
Nursery stock containers and bare root	40,601
Nursery inspections	142
Tobacco (bales, boxes, bundles, and cartons)	63,501
Permits to move homeowner plants out of state	9
Seed (cartons and bags)	440
Acres of nursery stock inspected	5,000
Spongy Moth Survey	
Forest acres surveyed for spongy moth by air	1.8 million
Bee Inspection	
Beekeepers registered	912
Beehives examined for mites and foulbrood	1,568
Tick Identification and Testing – Active Surveillance	
Ticks identified	3,206
Ticks tested for human pathogens	1,010
Ticks infected with *Borrelia burgdorferi* (Lyme disease)	378 (37.4%)
Ticks infected with *Babesia microti*	130 (12.9%)
Ticks infected with *Anaplasma phagocytophilum*	95 (9.4%)
Tick Identification and Testing – Passive Surveillance	
Ticks identified	5,685
Ticks tested for human pathogens	4,365
Ticks infected with *Borrelia burgdorferi* (Lyme disease)	1335 (31.8%)
Ticks infected with *Babesia microti*	409 (9.5%)
Ticks infected with *Anaplasma phagocytophilum*	189 (4.5%)
Mosquito Testing	
Mosquitoes trapped, identified, and tested for EEE, West Nile, and other encephalitis viruses	390,129
Number of trapping sites	108