

FY 2020 Annual Report of Accomplishments and Results

Connecticut
Connecticut Agricultural Experiment Station
University of Connecticut Storrs Agricultural Experiment Station
University of Connecticut Cooperative Extension System

I. Report Overview

The NIFA reviewer will refer to the executive summary submitted in your FY 2020 Plan of Work located in the Institutional Profile. Use this space to provide updates if needed.

1. Executive Summary (Optional)
<p>Over the past several years, new topics have emerged that are creating unique opportunities for research and extension to meet the needs of Connecticut's citizens. The Connecticut Agricultural Experiment Station (hereafter designated CAES) and the University of Connecticut Storrs Agricultural Experiment Station and Cooperative Extension System (hereafter designated UConn) partner in efforts to address these new challenges and opportunities.</p> <p>This Report of Accomplishments describes four critical issues for Connecticut that CAES and UConn jointly address based on our stakeholder input. These include (1) sustainable agriculture and food supply; (2) enhancing health and well-being; (3) sustainable landscapes across urban-rural interfaces; and (4) adaptation and resilience to a changing climate. Research and public engagement initiatives conducted in Connecticut often overlap into one or more of these areas.</p> <p>Our research and extension programs were highly successful despite the challenges presented by the COVID-19 pandemic. One example is Operation Community Impact, a program facilitated by UConn to connect surplus milk from the dairy industry with food pantries and citizens in need. During the reporting period this project moved over 100,000 pounds of dairy products from multiple processors to food insecure citizens statewide. The project had multi-state impacts as we collaborated with processors from other states and shared our program template with other Extension and community programs. This is one example of how we met the challenges our stakeholders faced this year – and others are included in our report.</p> <p>Funds are allocated separately to the two institutions, and as such, the report of accomplishments will continue to detail separate successes of CAES and UConn.</p>

II. Merit and Scientific Peer Review Processes

The NIFA reviewer will refer to your 2020 Plan of Work. Use this space to provide updates as needed or activities that you would like to bring to NIFA's attention.

Process	Updates ONLY
1. The <u>Merit Review Process</u>	No updates, please refer to POW
2. The <u>Scientific Peer Review Process</u>	No updates, please refer to POW

III. Stakeholder Input

The NIFA reviewer will refer to your 2020 Plan of Work. Use this space to provide updates as needed or activities that you would like to bring to NIFA’s attention.

Stakeholder Input Aspects	Updates ONLY
1. Actions taken to seek stakeholder input that encouraged their participation with a brief explanation	No updates, please refer to POW
2. Methods to identify individuals and groups and brief explanation.	No updates, please refer to POW
3. Methods for collecting stakeholder input and brief explanation.	No updates, please refer to POW
4. A Statement of how the input will be considered and brief explanation of what you learned from your stakeholders.	No updates, please refer to POW

IV. Critical Issues Table of Contents

No.	Critical Issues & Title in order of appearance in Table V. Activities and Accomplishments
1.	Sustainable agriculture and food supply: Food safety analyses from the Department of Analytical Chemistry
	Sustainable agriculture and food supply: Operation Community Impact
	Sustainable agriculture and food supply: Commercial Vegetable Crops Education
2.	Enhancing health and well-being: Novel strategies for mass testing individuals for SARS-CoV-2
	Enhancing health and well-being: Detection and Phytoremediation of Per- and polyfluoroalkyl substances (PFAS)
	Enhancing health and well-being: Tailored messages for health promotion and obesity prevention using e-health and m-health
	Enhancing health and well-being: Studies on the effect of bioactive in kelp on adipose tissue inflammation and fibrosis
3.	Sustainable landscapes across urban-rural interfaces: The role of protists in the plant microbiome
	Sustainable landscapes across urban-rural interfaces: Tick Control
	Sustainable landscapes across urban-rural interfaces: Resource Optimization in Controlled Environment Agriculture
	Sustainable landscapes across urban-rural interfaces: STEM Education Develops College and Workforce Readiness
	Sustainable landscapes across urban-rural interfaces: People Active on Trails for Health and Sustainability
4.	Adaptation and resilience to a changing climate: Weathering the Storm: On the Shore and in the Forest
	Adaptation and resilience to a changing climate: Connecticut Environmental Action Day

V. Activities and Accomplishments

Please provide information for activities that represent the best work of your institution(s). In your outcome or impact statement, please include the following elements (in any order): 1) the issue and its significance (e.g. who cares and why); 2) a brief description of key activities undertaken to achieve the goals and objectives; 3) changes in knowledge, behavior, or condition resulting from the project or program’s activities; 4) who benefited and how. Please weave supporting data into the narrative.

Critical Issue 1: Sustainable agriculture and food supply

1. Title: Food Safety analyses from the Department of Analytical Chemistry

Issue

The potential for food contamination with toxic pesticides or heavy metals is a persistent threat and of concern to stakeholders. Assurances that our foods contain safe and allowable levels of these constituents are needed by regulators, food producers, retail operators, consumers, and consumer advocacy groups. Moreover, Federal and state regulators request that analyses of foods be performed so as to enforce laws that allow for the recall of contaminated products from commerce. Fresh and manufactured foods, as well as animal feeds, need constant surveillance for contaminants such as mycotoxins, arsenic, and lead where toxicity can occur at very low levels (parts per billion (ppb) or even parts per trillion (ppt)). Accurate detection and quantitation of toxins at these levels in complex food matrices is challenging, requiring strict protocols and accurate calibrated equipment. By employing ISO 17025 Accreditation, we ensure the integrity of results.

Response

A CAES Hatch Fund project (CONH00147) along with State Funds (CONH00102, CONG005) and CONG00109, conducted surveillance programs for both human food and animal feed. Inspectors from other state agencies (CT Department of Consumer Protection; CT Department of Agriculture) or from the FDA routinely collect samples. Additional surveillance activities are conducted under the FDA Food Emergency Response Network (FERN). Methods have been validated according to ISO 17025 guidance and involve analysis for unknown pesticides/aflatoxins by simultaneous gas chromatography with triple quadrupole mass spectrometry (GC-MS/MS) and liquid chromatography with high resolution mass spectrometry (LC-MS/MS), as well as total arsenic analysis by inductively coupled plasma mass spectrometry (ICP-MS). Results are reported back to the appropriate agency in a timely fashion for regulatory response.

Outcome

During the period between February 2020 and January 2021, a total of 169 human food (fresh produce, dry herbs and juices), animal feed (wet and dry) and environmental (soil and water) samples were analyzed for pesticides. Of those, 64 samples were positive for 60 different pesticides, with concentrations ranging from 0.01 to 2.3 parts per million. However, only one of these pesticides was violative. Similarly, a total of 57 food samples were analyzed for arsenic, comprising of baby food, rice cereals, juices, and fruit smoothies. Of those, 3 samples were positive for arsenic; concentrations ranged from <10 to 86.6 ppb, with one sample exceeding the guidance limit, based on the food matrix. Also, a total of 81 animal feed samples were analyzed for total or specific aflatoxins. None of these samples was positive for aflatoxins. During the same period, a total of 95 juice and juice powders were analyzed for different toxins/poisons/pesticides, as well as heavy metals. Of those, only one sample was positive for inorganic arsenic at above the EPA proposed “action level” of 10 ppb. With US FDA funding and support, the CAES will continue to maintain and expand ISO/IEC 17025 Accreditation from the American Association for Laboratory Accreditation (A2LA) for these programs; the accreditation was renewed in January 2021. The CAES programs serve as the sole surveillance and monitoring effort in the state, assuring that the food supply within CT is safe and free from chemical and heavy metal contamination.

2. Title: Operation Community Impact

Issue

One of every nine residents in Connecticut struggled with food insecurity before COVID-19. For many individuals and families, challenges surrounding food insecurity increased when the pandemic arrived and continued throughout 2020. The stress associated with food insecurity challenges one of the most basic human needs and deepens income and health disparities.

Traditionally, 30% of fluid milk usually gets sold to restaurants, schools and institutions that are now closed due to COVID. This left a huge surplus of fluid milk on the market that could not be expeditiously processed into more shelf stable products like dried milk and butter. The price of milk for the farmers had dropped from \$19.00 per hundred pounds to \$13.00 per hundred pounds because of this surplus. Cows continued producing milk at the same rate. As a result, dairy farms across the Connecticut were forced to dump their milk because the dairy plants had such a surplus, with no room at the plants to store and process the milk because of the drop off in demand. Meanwhile, food pantries were in desperate need of more food to help provide nourishment for the increasing number of individuals with food insecurity, due to the pandemic and lost jobs.

Response

UConn Extension program leaders collaborated to form Operation Community Impact to address the food insecurity challenges that our community members were facing due to COVID-19. Extension Educators coordinated dairy foods donations and facilitated the donation of over 100,000 pounds of dairy products statewide.

Operation Community Impact coordinated with dairy cooperatives, 4-H members and volunteers, and the UConn Extension Expanded Food and Nutrition Education Program (EFNEP) to have dairy products donated and delivered to food pantries statewide. The two primary goals were to 1) address community food insecurity issues and 2) to reduce the amount of surplus milk that was being discarded due to the COVID-19 crisis. Through the distribution of these dairy products UConn helped feed families in need throughout the state.

UConn 4-H and EFNEP educators connected with local food pantries in each county to deliver the milk. 4-H members and volunteers, Extension educators, and EFNEP program partners delivered the milk from a central drop off location in each county. Other businesses and partners donated refrigerated trucks and space to assist with Operation Community Impact.

"I know firsthand how hard all farmers work to produce food for the rest of us," says Bill Davenport, the UConn Extension educator coordinating Operation Community Impact, and the Litchfield County 4-H coordinator.

"When I heard about dumping milk because of the supply issue due to the school and restaurant closures, I decided we need to try to get some of this milk out of the surplus to help farmers stay in business and into the hands of families who are food insecure," Bill says. "It makes no sense that we are dumping milk while there are people who desperately need food. Over 1,200 truckloads of milk were being dumped each day across the country,

so I decided to involve our amazing 4-H youth and parents to help connect the dots since the distribution of the milk is where the system is falling apart and need help. We helped move milk out of the surplus and into the refrigerators of people who desperately need it.”

Outcomes

The UConn 4-H dairy product distribution efforts went from May through September of the reporting year. Our efforts helped secure donations and distributed over 100,000 pounds of dairy products from the dairy surplus inventory to families across Connecticut. Those donations went to over 10,700 families in 57 towns through 96 food pantries. We had 88 families and individuals volunteer their time to help with the distributions.

Dairy Farmers of America donated the milk through their local facility, Guida's Dairy. The yogurt and sour cream were donated by the Agri-Mark Cooperative and Cabot. Ice cream was donated by HP Hood LLC. UConn 4-H members and volunteers donated thousands of hours distributing the milk in all eight Connecticut counties.

"Hartford County 4-H is excited to deliver this fresh milk to individuals and families throughout Hartford County. The actions of our 4-H members and volunteers, truly exemplify the words of the 4-H pledge "hands to larger service," states Jen Cushman, a UConn Extension educator and coordinator of Hartford County 4-H. Community service is a key component of civic engagement in 4-H. This project provides 4-H members the opportunity to make a difference in the lives of consumers and dairy producers.

Operation Community Impact would not have been possible without the efforts of many community partners, volunteers, food pantries and businesses in each of the counties that the project served.

3. Commercial Vegetable Crops Education

Issue

Contemporary food systems are shaped to generate profits and power for those who can maximize sales via the large-scale production and distribution of inexpensive food. The problem is that this system places far less value on the principles of sustainability, environmental integrity, economic vitality, and social equity. A sustainable food system can meet our needs for fresh, healthy, affordable food today without jeopardizing the ability of future generations from doing the same. This is a global issue that we are addressing locally, statewide, and regionally in New England. In Connecticut, 12% of households experience food insecurity, 33% of children are overweight or obese (more than half of whom are Hispanic and African American), an estimated one out of five residents eat no vegetables daily, 33% of our census tracts live more than a half mile from a healthier food retailer, and only 10% of our cropland is used to harvest fruits and vegetables.

Response

The goal of our commercial vegetable crops program is to increase vegetable production in our state, decrease reliance on outside food sources, increase economic viability of our vegetable producers, reduce the dependence of agricultural producers on pesticides while maintaining or improving productivity, crop quality, and quality of life. We educated growers statewide about the judicious and safe use of organic and synthetic pesticides and alternative pest control methods in commercial vegetable production.

COVID-19 impacted many outreach programs usually conducted face-to-face. However, we offered programming through an online certificate, Facetime, socially distanced farm visits, webinars, email updates, weekly pest messages, and other mediums.

Outcomes

In spring of 2020, our Vegetable Program launched an online Vegetable Production Certificate course for the first time with an objective to effectively deliver information to beginner vegetable producers, especially when in-person interactions are limited. The course had seven online modules, each module with a self-paced video, supplemental materials, and a short quiz. This course was designed to benefit beginner vegetable producers with 0-3 years of vegetable growing experience or no formal training in agriculture. The participants learned answers to the basic questions about farm business planning, planning and preparing for vegetable farming, warm and cool-season vegetable production techniques, season extension, identification of biotic and abiotic issues, and marketing. In the post-course evaluation survey (total number of course participants = 23), respondents indicated an average 34% increase in their knowledge from the course. The online certificate had 25 students total, and each student completed six hours of training, that included three hours of asynchronous and five hours of live video lectures.

“Participants learned answers to the basic questions about farm business planning, planning and preparing a vegetable farm, warm and cool-season vegetable production techniques, season extension, identification of biotic and abiotic issues, and marketing,” our UConn Extension educator says of the certificate course.

Vegetable integrated pest management education was delivered to over 600 vegetable growers and stakeholders every week from May to September 2020 through 19 weekly vegetable pest alerts focusing on pests, pest management and decision making, and safe pesticide use. “Thanks to your advice this past June we saved our garlic crop (most of it) from white rot,” one grower told us.

UConn Extension partnered with Washington State University and University of Tennessee to organize the soil-biodegradable plastic mulch professional development trainings to educate extension personnel, industry representatives, and other agricultural service providers regarding soil-biodegradable plastic mulch so they can provide this information to growers. Two professional development trainings were held for agriculture professionals in northeastern US, and for members of the American Society for Horticultural Science (ASHS). All participants found the training to be informative. In the northeastern US webinar, 27% of participants felt they learned a lot from the training session and 41% learned some new information (N = 58, n = 38). In the ASHS webinar, 48% of participants learned a lot from the training session and 48% of participants learned some new information (N = 30, n = 21).

2020 Annual Report of Accomplishments and Results (AREERA)

The Mashantucket Pequot Tribal Nation (MPTN) and UConn Extension are working together to enhance agricultural production, food security, and health of tribal community members. A team of Extension specialist in vegetable and fruit production, farm business management, marketing, youth development, health and nutrition, communications, evaluation and assessment is working with the MPTN. This project was funded in part by a USDA Federally Recognized Tribes Extension Program grant.

Critical Issue 2: Enhancing health and well-being:

1. Title: Novel strategies for mass testing individuals for SARS-CoV-2

Issue

The Issue SARS-CoV-2 first emerged in the United States in February-March of 2020. Early during the pandemic, we lacked the necessary tools to accurately determine how widespread the virus was throughout our communities. This was problematic because individual and community risk could not be accurately estimated, and therefore, public health policy decisions and recommendations were not fully informed. One reason for the dearth of infection rate data was the lack of availability and access to quick diagnostic tests. The development of novel strategies to assess community infection status will be integral to re-opening schools and the economy.

Response

With support from Multistate Hatch Funds (CONH00778 Biology, Ecology & Management of Emerging Disease Vectors), CAES Dr. Doug Brackney in collaboration with scientists at Yale University, began examining the utility of using wastewater from the New Haven East Shore Water Pollution Abatement Facility and five other wastewater treatment facilities across CT to detect and quantify SARS-CoV-2 genetic material (RNA). The data gathered from these studies was used to elucidate the burden of disease in the community and to predict present and future cases and hospitalization. In addition, CAES has been working with Yale researchers to develop a novel strategy for mass testing individuals by 1) validating the use of saliva as an alternative sample source, 2) streamlining sample processing and diagnostics, and 3) significantly reducing costs.

Outcomes

Examination of the wastewater samples demonstrated that we could accurately detect SARS-CoV-2 RNA in the wastewater and that levels SARS-CoV-2 correlated with increases in the number of positive cases and hospitalizations. In fact, increases in wastewater levels preceded the number of reported cases by 4-7 days and hospitalizations by 1-3 days. This data has since been used to build a predictive model that can forecast future levels of community transmission (<https://yalecovidwastewater.com/>). Examination of saliva as an alternative sample source for SARS-CoV-2 diagnostics revealed saliva to be more reliable, less invasive, and cheaper than the traditional nasopharyngeal swab. It was also demonstrated that elimination of the costly and time-consuming process of extracting viral RNA prior to testing did not significantly adversely affect sensitivity. The combination of the extraction-free approach with saliva was validated in a population of individuals associated with the National Basketball Association's 2020 "bubble". In this large trial, this novel approach was demonstrated to perform equally well as the gold-standard extracted nasopharyngeal swab samples. This approach, termed SalivaDirect, has since received FDA emergency use authorization and is now implemented by over 50 diagnostic laboratories across the country (<https://publichealth.yale.edu/salivadirect/>).

2. Title: Detection and Phytoremediation of Per- and polyfluoroalkyl substances (PFAS)

Issue

Per- and polyfluoroalkyl substances (PFAS) have been produced since the 1940s and are used in many applications, including firefighting foams and stainproof and waterproof coatings on fabrics and paper products. Recently, it has been reported that PFAS are highly toxic at extremely low concentrations; they can cause many negative health effects including hormone imbalances, cancer, high cholesterol, and decreased immune response. PFAS are very resistant to degradation, and their extensive use has led to widespread environmental contamination. They have been detected in drinking water, farm soils, food, and human blood samples. PFAS are a large class of contaminants, encompassing over 8,000 chemicals, which complicates their study. Additionally, the low levels of PFAS that can induce toxic effects are difficult to measure. Improvements in analytical methods are necessary for accurate PFAS measurement in different types of samples. It is also necessary to investigate methods of removing PFAS from contaminated sites.

Response

CAES Hatch Fund project, CONH00788 and Dr. Sara Nason are working on improved methods for measuring PFAS. The number of analytes in a method is typically a major limitation in PFAS analysis. FluoroMatch is a new software designed to detect as many PFAS as possible, and we assisted in its development. CAES researchers have used FluoroMatch to detect PFAS in soil contaminated with firefighting foam. Additionally, we are working on sample preparation methods for measuring PFAS in animal feeds, plant materials, human blood, and dried blood spots. These methods will allow us to participate in studies on PFAS exposure for humans, pets, and livestock. We are also investigating PFAS phytoremediation, where plants remove PFAS from soil, using hemp.

Outcomes

A trial phytoremediation experiment in 2019 yielded promising results (concentration decreases for several PFAS) and additional test plots were planted in 2020. This work has been in collaboration with community groups in Maine, USA. We are seeking funding to continue and expand this work. FluoroMatch software has been successfully published and used for PFAS detection and is currently in its second edition. We detected 42 PFAS in contaminated soil using FluoroMatch, including a range of compounds not included on typical analyte lists. Method validation for PFAS in measurements in blood, dried blood spots, and animal feeds is in development.

3. Title: Tailored messages for health promotion and obesity prevention using e-health and m-health

Issue

According to the CDC National Center for Health Statistics data childhood obesity is a serious problem in the United States putting children and adolescents at risk for poor health. The prevalence of obesity for children 2 to 5 years old was 13.9%, 18.4% among 6-11 year -old's, and 20.6%

among 12-19 years old's, and affected about 13.7 million children and adolescents. Children with childhood obesity are more likely to have health issues including but not limited to high blood pressure, high cholesterol, type 2 diabetes, asthma, and joint problems. They are more likely to become adults with obesity. A child's community can also contribute to risks of obesity by influencing their ability to make healthy choices.

<https://www.cdc.gov/obesity/data/childhood.html>

Response

UConn's Hatch project, "Tailored messages for health promotion and obesity prevention using e-health and m-health," is researching the use of tailored nutrition messages delivered by internet and/or mobile technologies on improving the diet healthiness of children and young adults in clinical or school settings. An online behavioral screener (PALS) was developed for children to self-report their behaviors and feelings to assess a child's and young adult's diet and physical activities. Survey participants receive 2-3 tailored messages that motivated and reinforced healthy behaviors with simple, catchy text and colorful pictures.

Outcomes

Study results support the online behavior screener (PALS) and tailored message program is acceptable and useful to children with their parents in a clinical encounter. Over 75% of surveyed participants reported PALS tailored messages were helpful and favorable for improving or maintaining the targeted behavior.

PALS was used at 2 middle-schools in Connecticut to assess 512 student's health behaviors and provided an average of 3 tailored messages and 1 general message. Students reported high liking of less healthy and low liking of healthier foods and behaviors, indicating the need of nutrition educations. Forty percent of the students reported food security concerns. Students reported (>73%) that the messages were helpful, and they learned new information. Most students reported trying one behavioral improvement.

A pre-post pilot study was conducted with tailored and school-wide health promotion messages coupled with low-impact school-based interventions. Children reported change in liking of foods and activity and school meals, resulting in healthier indexes of diet quality and perceived food security status. These pilot results suggested that behaviors were healthier at post-intervention with some improvement in mild food insecurity reported. This project has promoted healthier diet and physical activities in children for the prevention of obesity. In addition, the project has provided over 400 hours of supervised practice hours for students studying to become registered dietitian and other healthcare professionals.

4. Title: Studies on the effect of bioactive compounds in kelp on adipose tissue inflammation and fibrosis

Issue

Obesity is a state of chronic low-grade inflammation, which is causally linked to insulin resistance, type 2 diabetes and cardiovascular diseases. Fibrosis has been recognized as a major player in triggering obesity-associated inflammation and metabolic dysfunctions. However, limited information exists regarding the mechanisms for the link between adipose tissue fibrosis and inflammation and how food components alter the processes in obesity.

Response

A UConn Hatch funded project, “Studies on the effects of bioactive in kelp on adipose tissue inflammation and fibrosis,” is examining the health benefits of U.S. seaweed products. Previous studies show that kelp has anti-obese, anti-diabetic and anti-inflammatory properties, and that fucoxanthin, a major bioactive in kelp, exerts anti-fibrogenic and anti-inflammatory effects. Based on these findings, research is underway to evaluate whether kelp consumption can attenuate inflammation and fibrosis in the adipose tissue and systemic insulin resistance.

Outcomes

Study results suggest that fucoxanthinol and amarouciaxanthin A, bioactive compounds present in kelp, prevents fibrogenesis and oxidative stress in cells representing hepatic stellate cells, which are major cells involved in fibrosis. The long-term goal is to define the protective effects of bioactive food components in agricultural crops that alter obesity-associated diseases

Kelp is a new farming venture in the Long Island Sound. Two species of seaweeds are approved for cultivation and commercial sale in CT. Currently eight commercial operations have permits to cultivate seaweed in CT. Additional outreach opportunities were provided through CT Sea Grant and UConn Extension’s partnership and publication, [“The Seaweed Production and Processing in CT: A Guide to Understanding and Controlling Potential Food Safety Hazards.”](#)

Critical Issue 3: Sustainable landscapes across urban-rural interfaces

1. Title: The role of protists in the plant microbiome

Issue

Protists (diverse single-celled eukaryotes) are key players in soil and vegetative ecosystems. Bacteria-eating protists can strongly impact crop production and soil health by restructuring the bacterial microbiome and releasing organic nutrients for plant uptake. For example, protist treatments have been found to give plants greater access to nitrogen, increase biomass and yield, enhance the survival and activity of beneficial bacteria, and increase colonization by mycorrhizae. However, because protists have been so difficult to study, there is little understanding of the protist diversity in crop rhizospheres, the role of plants in determining protist communities, and of which protist species or functional attributes are of greatest benefit to plants.

Response

CAES Hatch project, CONH00656 explored the role of protist in plant health. These data led Pi Dr. Lindsay Triplett to begin a joint NIFA project with Dr. Daniel Gage (UConn (CONH 00658) to further understand the role of the protist microbiome in plants. Our goal is to understand the natural protist diversity in the plant roots and how they affect plant health. Toward this goal, we developed a new protocol to perform deep sequencing of the protists in the microbiome, and we collected root soil samples from maize and nightshade plants grown at two different Connecticut farms. Over 100 protists were cultured and are being maintained, and a collection of protist-associated bacteria was also established. Protist DNA was sequenced from root-attached soils. Ongoing work is aiming to characterize the growth rate, resilience, and prey selectivity of selected protist cultures, and to determine the impact of protist isolates on the maize bacterial microbiome, plant productivity, and soil nutrition.

Outcomes

We have found that the root surface selects for a distinct, reduced community of protists compared to the surrounding soil, in which a few specific protist groups are enriched. However, protist communities varied greatly from site to site. Characterization of protist cultures showed that protist isolates were not associated with the most abundant sequences, and comparison with sequence profiles identified groups of protists that may be difficult to isolate. Characterization of protist-associated bacteria identified strong plant-beneficial traits among bacteria that form long-term association with protists.

2. Title: - Tick Control

Issue

The increasing prevalence of Lyme disease and emergence of other human tick-associated diseases in the United States has become a major public health concern. Ticks are nuisance pests, can cause severe toxic, allergic, reactions, and are vectors of numerous viruses, bacteria, protozoa that impact not only humans, but companion animals and domestic livestock. While Lyme disease has been the impetus for most recent research on tick ecology and management, the lone star tick, *Amblyomma americanum*, the most common human biting tick in the southeastern United States, has been expanding its range in the northeastern and midwestern U.S. Previously considered primarily an aggressive nuisance, it is now associated with at least six human diseases, principally ehrlichiosis, caused by several Ehrlichia species, red meat allergy, and viral diseases caused by newly discovered Hartland virus and Bourbon virus. The discovery of established, reproducing populations of lone star ticks in Connecticut 2017 and 2018, along with increasing submissions of this tick by the public, and demonstrated overwinter survival of adult lone star ticks in Connecticut and Maine have made the studies on the control of *A. americanum* increasingly relevant to Connecticut, New England, and the United States.

Response

A CAES Hatch project, (CONH00398), evaluated the effectiveness of topical treatment of 10% permethrin delivered via 4-poster devices to white-tailed deer, *Odocoileus virginianus*, in the management of the discovered *A. americanum* population on a peninsula in southwestern, Connecticut. Using a high-density deployment of one device/12.7 ha, four 4-poster devices were deployed and maintained weekly through August 2018, 2019, and 2020. Host-seeking *A. americanum* were sampled during periods of peak activity seasons in the summer from 2018 to 2020. Male, female, and nymphal *A. americanum* were screened for *Ehrlichia* species in 2017 and 2019 and 2020.

Outcomes

In May and June 2018 and 2019, eleven deer were captured, tick burdens recorded, tagged, and released. We were successful in significantly reducing densities of host-seeking adults (93% reduction), nymphs (92% reduction), and larvae (96% reduction) of *A. americanum* from 2018 to 2020. We also documented a significant reduction (87%) in parasitizing adult and nymphal burdens on white-tailed deer from 2018 to 2019 and a reduction in the prevalence of infection with *Ehrlichia* species in adult ticks from 47% at the time the *A. americanum* population was discovered in 2017 to 7% in 2020. These data demonstrate that, when properly deployed in a density-dependent manner in terms of deer abundance, 4-poster devices can effectively manage parasitizing and host-seeking *A. americanum* populations and reduce the prevalence of two ehrlichial species of public health importance.

3. Title: Resource Optimization in Controlled Environment Agriculture

Issue

Hydroponic production in controlled environment agriculture (CEA) has many financial and environmental benefits such as high productivity, year-round production and low nutrient runoff. However, this system remains vulnerable to waterborne phytopathogens. Scientists have reported 20 to 100% yield loss in lettuce caused by *Pythium* spp. Current options to control plant pathogens in hydroponic nutrient solutions include energy intensive technologies (e.g. ultraviolet radiation, ozone) a limited number of synthetic formulations, to which pathogens have and may further develop resistance or biofungicides, that result in inconsistent efficacy and may reduce yields. Therefore, there is a critical need to identify amendments to shape microbiota in nutrient solutions to enhance activity of beneficial microbes without stimulating pathogen population and virulence.

Response

UConn's Rosa Raudales's research project as part of Hatch multistate, NE1835, is conducting studies on water use and alternatives to reduce refresh water use and evaluate alternative fertilizers and growing substrates for the production of greenhouse crops in greenhouses to maximize the efficiency and productivity of controlled-environment agricultural systems.

Outcomes

Science-based guidelines were developed to reduce the uncertainty of reusing nutrient solutions and root rot in hydroponics. Presentations were made to farmers in Connecticut. A four-part webinar series was developed and presented on nutrient and water management in hydroponics solutions, reaching a total audience of 351 individuals of whom 93% indicated increase in knowledge and 81% indicated intention to change a practice in their operation. Growers, representing 1.3 M ft of protected greenhouses, report adoption of preventive management strategies, reduced production costs and reduced losses after completing the training.

4. Title: STEM Education Develops Workforce Readiness

The United States ranks 27th among developed nations with college students receiving science or engineering degrees. We are 38th out of 71 countries in a measurement of math, science, and literacy skills in 15-year-olds. It is critical to engage youth in STEM related fields of study and introduce them to possible career opportunities in these areas. Nearly all of the 30 fastest growing occupations in the next decade will require at least some background in STEM. Women and minorities are under-represented in science careers and a diverse pool of trained scientists is needed to frame and solve problems and educate others. Statistics show that 63 percent of high school graduates are not prepared for college-level science and 57 percent are not prepared for college level math. Only one in five STEM college students feel their K-12 education prepared them for STEM college courses.

4-H programs provide youth with hands-on, engaging STEM experiences that build excitement around STEM topics and careers. STEM education is offered through 4-H clubs, afterschool programs, Science Saturdays, mini-camps, workshops, conferences, and competitions.

While the COVID pandemic created challenges for everyone, the UConn 4-H program was able to shift to programming to continue to meet the needs of youth audiences. Programs included a socially distanced tractor pull, 4-H summer library program and virtual escape rooms.

The socially distanced tractor pull was held for 35 of our members with engineering and math projects. Youth acquire engineering and math skills through their work on their tractors and with participation in the tractor pull. Tractors pull sleds with weights that become progressively heavier as the day continues. Tractor operators must be strategic and skilled. A successful pull requires momentum and torque however, the engines lose momentum and torque when they are continuously pulling weight. The winner of the competition is the operator that can modify his machine's engine to withstand the most pressure and successfully manage the engine throughout the demands of increased weight.

The 4-H Summer Library program in New London County started seven years ago with a program at the Waterford Library. The program added a few libraries every year. This year 12 libraries participated in the summer library program. UConn 4-H educators have a skillset that many libraries don't, and our partnership brings new resources to the libraries and introduces 4-H to audiences not typically reached through traditional 4-H clubs. We created a virtual program due to COVID-19 instead of offering the program in-person at each library. While we missed face-to-face programming, the virtual program allowed us to serve more libraries and impact more children. The summer curriculum included Ozobots, tiny robots that incorporate physical and digital aspects to teach coding. Youth are engaged with the lessons each week over the 10-week program.

The 4-H team assembled kits each week and delivered them to the library locations. Families then pick the kits up from the library. All youth participants watched the 4-H educator on Facebook Live each week with their activity. Each kit focused on a different STEM skillset for youth. Popular activities included being a brainiac and building ladybugs with LED antennas. We delivered 744 kits through the course of the summer.

Escape rooms have gained popularity with youth and adults worldwide as small groups work together to find clues, solve puzzles, and complete other tasks that allow them to escape from a room. UConn 4-H first introduced escape rooms in 2019 at the Middlesex County 4-H skill-a-thon event for youth ages 7-19. The escape room event was popular and a fun way for youth to build teamwork skills and test their 4-H knowledge. When COVID-19 cancelled all in-person events, our 4-H educator moved the escape rooms to a virtual format to provide youth with an opportunity to continue participating. The Secret Clover Stash virtual escape room was created using Google Forms. Several states from the northeast have adopted this escape room developed by UConn 4-H and are using it with their youth members. The states are collaborating with UConn 4-H on a Computer Science Pathways grant through Google and National 4-H. A second escape room version called "The Secret Clover Quest" is geared towards 4-H members of all ages. It was built in the format of a website through the use of Google Sites with gamification through Google Slides, Docs and Forms. UConn 4-H is collaborating with several other states and designing more virtual escape rooms.

These are just a few of the 9,985 4-H STEM projects held during the reporting year. In order to capture the impact of our STEM projects, we are conducting a longitudinal study on the 4-H Common Measures. To date, the data shows that 82% of participants learned new things about science through 4-H and 42% learned new things about engineering. We also collected the following qualitative responses from participants and partners:

Diego Marks participated in this year's tractor pull and is a youth that exemplifies the positive impact of our programs, and how Extension's efforts to pivot our traditional programs made a difference in the lives of our youth members. "In my spare time, I enjoy working on my tractors, and inventing items that help homeowners make chores easier and faster," Diego says. "Skills I have learned at school have helped me to fix and modify my garden tractors. My future career goals are focused on owning an engineering and construction company where large equipment is a daily part of my business. One of my goals in the future, is to be able to give back to the community and help others have a 4-H experience."

"We've really had a lot of success with the take-and-make program concept, and this has been an exceptional one that I certainly wouldn't have been able to put together on my own," says Frances McGrath of the Trumbull Library in Lebanon. "I've got people coming in who normally wouldn't come to the library, which is how you know you've got a winner. This has been great and the flexibility it allows for has been really positive." A parent shared, "The programming that you are offering through public libraries is fantastic. It adds some excitement to our week, and we are using the activities as a jumping off point for other projects, reading and fun. Thank you!"

"The Waterford Public Library is pleased to partner with New London County 4-H again despite challenging times," librarian Jennifer Smith tells us. "Many families have expressed interest and relief to know their kids can continue to participate in fun library STEM related virtual programming this summer."

5. Title: People Active on Trails for Health and Sustainability

Issue

Connecticut's bounty of natural and physical amenities - greenways, multi-use paths, parks, and forested area are some of the state's greatest assets for encouraging physical activity. The State of CT Department of Energy and Environmental Protection (DEEP) estimates that there are over 2,000 miles of multi-use trails within CT State Parks and Forests alone (and likely over 3,000 miles including those not in the park system). Connecticut is the only state in the nation with an entirely state funded recreational trails building program. Additionally, answering a growing demand from the young workforce for alternatives to car-based transportation as well as the potential improvements to public health and community quality of life, Connecticut has invested millions of dollars in trail-based infrastructure and connectivity.

While Connecticut has a wealth of resources to promote physical activity and exercising in outdoor spaces has been shown to impact physical and mental health outcomes, many outdoor assets remain underutilized or inaccessible to the populations who might most benefit from them. Even as trail use skyrocketed during the COVID-19 pandemic data collected from 987 multi-use trail users in Connecticut in 2020 through the Connecticut

Trail Census found that only 2.1% of trail users surveyed identified as Black or Hispanic [1] (compared to 12.2 % of the general state population). Similarly, while 32.9% [2] of the general state population reports incomes < \$50,000, only 13% of trail users surveyed were in this income range.

Significant disparities exist in Connecticut related to lack of physical activity and health risk. The 2015 Connecticut Behavioral Risk Factor Surveillance System Report finds that 35.2% of adults in households earning less than \$35,000 per year reported no physical activity in their leisure time in the last 30 days, compared to 14.4% of adults in households earning \$75,000 or more.

Physical inactivity contributes to increasing human health risks such as diabetes, anxiety, and other diseases caused by excessive inactivity. Research show that nearly 30% of U.S. children are either obese or overweight putting them at risk for poor health at a younger age. Overweight and obese children are likely to stay obese into adulthood due presumably to little change in their personal and household lifestyles while growing up. There are many factors that may hinder outdoor physical activities, but poor built environment conditions and social constructs can also create little motivation for the enjoyment of outdoor recreation services. These issues not only lead to physical and mental health issues at the individual level, but have community-wide consequences influencing community health, well-being, and resilience.

[1] Connecticut Trail Census. 2020 Intercept Survey Data Analysis. [Unpublished Report]

[2] US Census Bureau. American Community Survey Connecticut 2019 5-Year Estimates. Retrieved from <https://data.census.gov/>

Response

UConn Extension programs, The Connecticut Trail Census and People Active on Trails for Health and Sustainability (PATHS) were formed to promote physical activity and exercising in outdoor spaces. Our PATHS team is an interdisciplinary team of UConn Extension educators, faculty, and staff committed to understanding and promoting the benefits of trails and natural resources for health, community and economic development. Our team worked in a wide variety of departments and disciplines including public health and education, nutrition, community development, and landscape architecture. We use a social ecological approach to health education to increase trail use and decrease obesity in the audiences we serve.

In addition, the PATHS team includes personnel from our Expanded Food and Nutrition Education Program and collaborate on educational outreach for EFNEP audiences on trails use and health outcomes. Through this partnership, we introduced audiences to the trails in our state as another source of exercise, enjoyment, and transportation.

Connecticut Trail Census data showed increased rural trail use during COVID-19. This posed challenges and opportunities for trail and environmental management, public health, economic asset development, equity, and access. The increase in trail use is documented through Extension's data monitoring programs, trail manager surveys, and user surveys. In 2020, Connecticut trails saw a 162% increase in use in March 2020 compared to March 2019, as reported from our Connecticut Trail Census. Each month of 2020 saw consistently more trail users when compared to our data from 2019. While this has a positive effect on health outcomes of our populations, we pivoted resources to support land-use managers and ensure that all audiences could enjoy well-maintained, and sustainable trails.

Outcomes

COVID-19 presented many challenges, but there are opportunities for land use managers to improve health and access to trails and their amenities while maintaining environmental standards. According to our Extension work, 87% of new trail users in 2020 visited trails outside their home zip code. Extension provided data and resources to help land-use decision makers take leadership roles in understanding and acting on systemic environmental injustices.

We developed resources to help community members find new trails and provide access that improves health outcomes. We created community maps to connect people to trail resources, and a series of four trail videos that are in English and Spanish (eight videos total) that introduce new trail users to the basics of trails for health, recreation, and transportation.

The four trails' videos we produced are:

- Trail etiquette
- What to know before you go
- What to bring with you
- Reading trail blazes and handling emergencies

The videos are available on the Extension YouTube channel (739 subscribers and an annual reach of 305,200 people). The videos average time is 03:15 minutes and Spanish videos are available. We created a new trails brochure for the town of Colchester to help connect residents in the area with outdoor spaces.

We enhanced health outcomes and improved community development and equity in outdoor spaces for 16,375 low-income families in communities throughout the state through our partnership with the Expanded Food and Nutrition Education Program.

We leverage external funds to support the Connecticut Trail Census and PATHS projects, as well as our partnership with the EFNEP program. Our Extension team is conducting further research in several areas of this project and combines objectives from our sustainable landscape and health critical issues.

Critical Issue 4: Adaptation and resilience to a changing climate

1. Title: Weathering The Storm: On the Shore and in the Forest

Issue

Every year Connecticut residents become more accustomed to hearing the words superstorm, hurricane, and deluge. Residents can face days, or in worst case scenarios, weeks without power as tree companies and utility services remove the devastation left by yet another storm. The intensity and frequency of the storms is increasing, and they are slowing down, and hanging around a lot longer. Storms caused extensive damage and flooding on Connecticut's coastline, and as we move inland throughout Connecticut, passing storms have taken a detrimental toll on the state's utility lines, and sadly, some homes. The number of dead trees in the state increased dramatically because of Gypsy moth caterpillars and Emerald Ash Borers. With a state that has more than half its total land deemed as forest, trees have become a hazard in many areas.

Response

UConn Extension is addressing storm-related issues through a multi-faceted effort among our Smith-Lever funded educators and programs in land use, agriculture, and family and consumer sciences. Our programs serve land-use and municipal officials, communities, and residents in both rural and urban areas.

When the state saw immense damage in the years 2011-2012 from a hurricane, blizzard, and superstorm Sandy, an advisory group coordinated and led by our Extension educators convened and deemed that a tree biomechanics research program would help the state gather information necessary to better prepare for storms.

Adapt CT is an outreach partnership between Extension's Center for Land Use Education and Research (CLEAR) programs. The Climate Corps and the Climate Adaption Academy are two Adapt CT programs that exist as a means of educating students and those in the public on current issues with regard to climate change, as this is a main reason, we are seeing such fervent storms in Connecticut and other areas. Working with students, municipalities, and professionals of various organizations, the Climate Adaption Academy and Climate Corps are preparing Connecticut to take the next steps in making our shoreline more resilient and our state more sustainable. Municipalities often have tight budgets and don't have the resources needed to take the next step. These programs offer a solution; providing communities with the knowledge and resources necessary to take aim.

Our Extension educators work on programs that help the state better manage its coastline through educational resources for gardening along the coast with native plants and helping maintain the resilience of the shoreline. We are promoting and educating about living shorelines as one approach to increasing resilience to volatile storms. Living shorelines are a suite of shoreline stabilization techniques using natural

materials such as sand, plants or rock. Biodegradable coir logs, which are made of coconut fiber and native plants are one example of a living shoreline. This natural barrier slows down the waves and decreases their overall effect on the shoreline, while creating a place for plants to anchor in the soil and reduce coastal erosion. Living shorelines are more resilient over time than the manmade concrete and rock seawalls that can be damaged during major storm events and cause further beach erosion.

Scientists, engineers, and many other professionals can analyze the effects of wind on tree movement using the Stormwise program. Our Extension team collaborates with others on Stormwise. Data is observed once every 1/10th of a second, and we gain insights on tree demographics in the forest using airborne light detection and ranging technology (LiDAR). However, even with all the technology and scientific evidence the true nature of Stormwise aims its focus on arborists and perspectives from tree crews. The human dimensions aspect allows the program to develop an understanding of how people will react to new management of their forests and then provide them with the knowledge that its management is based on reducing storm damage.

Our educators start by finding out what is important to the arborists and tree crews, and then they work with forest and woodland owners to develop strategies to thin out the trees along the utility lines. Extension educators also explain that in these storms they have seen no evidence that more damage was caused by dead trees than strong young ones, saying that the trees against the power lines are easy for wind to destroy because they are crammed in an area.

Outcomes

We had 244 students participate in Extension's Environment Corps programs and they completed 53 community projects. We also had 130 municipal and state land-use officials attend a virtual workshop on managed retreat for coastal communities that Extension led and facilitated.

“After the 1938 hurricane destroyed a beach-front community in New London, the city acquired the property, razed what remained of the homes and turned it into a large public beach. Today Ocean Beach Park is one of the city's jewels. This is an example of using managed retreat 60 years ago and it has been very successful,” Bruce Hyde, one of our UConn Extension educator says.

Webinars on land use were offered throughout the year in place of in-person classes. We had 1,367 participants in 21 webinars and 1,960 Registrants. There were 560 views of recorded webinars during the reporting year.

Education about living shorelines and climate mitigation through landscape is shared through our Master Gardener program. We had 1,476 participants receive 26,676 hours of instruction in the Master Gardener program during the reporting year.

Stormwise continues tree biomechanics research and outreach and provides information about potential storm damage to land managers and residents prior to a storm event. UConn Extension's outreach education engages stakeholders to make proper management decisions. Our collaborative approach among many groups, contributes to the knowledge we already have, to make our forests in Connecticut more prepared

in the event of a storm. Workshops, educational seminars and collaborative partnerships provide all with the information necessary to stay safe and keep their community safe during any storm.

Our storm-related programs leverages funding from our Connecticut Sea Grant program, a National Science Foundation grant, and a partnership with the local electricity supplier to assist residents on the shoreline and inland with storm and tree-related issues.

Our Extension Disaster Education Network program is also assisting communities and residents with storm-related preparations. Services are focused on rural communities through a recent USDA grant-funded project. Our Extension educators are also helping the agricultural community prepare for natural disasters and mitigate the effects of climate change through their Extension work funded by Smith-Lever.

2. Title: Connecticut Environmental Action Day

Issue

The negative effects of climate change are a global crisis that we must address through adaptation, resilience and mitigation. Connecticut faces climate change in various formats from coastal flooding, to droughts affecting agricultural and other land, and temperature and weather changes.

Response

UConn Extension programs engage and educate citizens in climate adaptation. We promote resilient and well-adapted coastal Connecticut communities and economies. We enhance the management, conservation, and protection of ecosystems. We also promote human, plant, and animal health that is resilient to the effects of climate change. Our research and outreach are integrated to ensure well-informed decision making.

Extension has a long history of youth development through our 4-H program. We formed an interdisciplinary team and coordinated and hosted Connecticut Environmental Action Day (CEAD), a one-day conference. CEAD inspires middle school students to take active roles in addressing environmental and natural resource issues related to climate change. The objectives of CEAD are to increase awareness and community engagement among middle-school aged children with Extension's sustainability and 4-H programs.

Middle school students participated in two exploratory workshops in the morning session, and then created action plans for their home, school, and community during the afternoon session. Faculty, staff, and students from UConn worked with the students prior to and following CEAD to ensure the greatest educational impact and continued momentum on their environmental actions.

In 2020, we had over 100 middle school students from seven schools participate in the event on our university campus. They had the opportunity to choose two of 11 different workshops to participate in. Workshops were presented by Extension educators, students, and UConn faculty. In the afternoon middle schools created their action plans as a team; these sessions were facilitated by our Extension team members and UConn students that we trained as facilitators.

We also created a Climate Change Challenge that middle schools participated in as teams and earned points for their actions. Five schools participated as teams in the Climate Change Challenge. Over the two-month challenge, the schools amassed a total of 12,090 points for the climate actions taken by the school, individual families, and on a community level.

Our team developed educational curriculum kits for middle school teachers, 4-H club leaders and home school parents. We distributed 36 kits statewide and provided the resources for free on our website. Two educational videos were created as lesson plans, a tree ring exercise and a density lab. The educational videos are available, along with other resources, on our website. We also have educational kits in each of our county 4-H offices that 4-H club leaders and middle school teachers can borrow for programming or classroom instruction.

Outcomes

Each 4-H participant at CEAD engaged in the development of an action plan which they brought back to their school to implement. Plans for each school were presented at the end of the day. UConn students that study natural resources and the environment were trained to facilitate the action planning session for the 4-H members. Youth were encouraged to expand the application of their action plans to their home and community, in addition to the school. In 2020, we had multiple 4-H members report that they applied their action plan in their home and community.

Additionally, we had 11 UConn student volunteers with us at CEAD, and they contributed 24 hours to the project. We also reached 500 UConn students through the Climate Change Challenge. All students pledged to take one or more actions to improve the environment.

Specific feedback received from participating schools include:

“Our students left excited to get to work and have already reached out to our principal to get something started related to recycling. We came up with a lot of great ideas. Students loved learning about the green infrastructure and water systems on campus. Overall, students had a great experience and we're very happy to be included in this opportunity!” - Middle School Teacher

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“Some of the actions that the students took back from CEAD were to improve the recycling program in our school. At this point our school does not have a recycling program and students have begun recycling bottles and cans. The event was an awesome experience for our students (and adults).” - Middle School Teacher

“Our school reported the following actions as a result of the event:

- 1) Eliminating single use plastics at school including water bottles, styrofoam trays, and plastic cutlery
- 2) Increasing the number of water fountains with water bottle filling capacity to replace the water bottle vending machine.
- 3) They want to organize a school-wide day of education, similar to the day of action at UConn.
- 4) They talked about a possible education campaign to get more people to ride the bus to school.
- 4) The Changemaker Club got a few new members.

Thank you so much for organizing this day. We really enjoyed seeing the kids excited at the end of the day about actions they could take. We came back to school at the end of the event and showed the documentary film *From Paris to Pittsburg*.” - Middle School Teacher