

## FY 2020 Annual Report of Accomplishments and Results

Vermont

University of Vermont Agricultural Experiment Station

University of Vermont Extension

### 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)

Please refer to the Executive Summary submitted in our **FY21** Plan of Work. This will provide the most up to date overview of Vermont's critical issues and how we, the University of Vermont Agricultural Experiment Station and UVM Extension, work together to address them.

The Vermont Agricultural Experiment Station (AES) and UVM Extension (EXT), housed within the College of Agriculture and Life Sciences (CALs), experienced several major transitions this year. In May 2020, we excitedly welcomed our new Dean, Dr. Leslie Parise, from the University of North Carolina-Chapel Hill where she had served as the chair of the Department of Biochemistry and Biophysics for the past decade.

Upon her arrival, Dr. Parise appointed CALs faculty member and Interim Dean of the college, Dr. Jean Harvey, as Associate Dean of Research for CALs, which included a new appointment as Director of the Vermont Agriculture Experiment Station.

UVM Extension has also seen significant change with the departure of Chuck Ross, former Director of Extension, in June 2020. Dean Parise stepped in as Interim Director. After a successful national search, we are pleased to share that Dr. Fitzroy (Roy) Beckford will become the next Associate Dean and Director of UVM Extension. Dr. Beckford comes to us with a global perspective and an impressive record of setting up successful programs and making lasting, impactful changes. Dr. Beckford will officially join the team on May 1, 2021.

In early 2021, CALs launched a Strategic Planning process to guide our efforts toward the following goals: 1) Build on our reputation for exceptional research and scholarship to maximize local to international impact; 2) Develop and support a dynamic community of students and

alumni who make a difference in the world; and 3) Create a culture of belonging that affirms the experiences and identities of diverse faculty, students, staff and community partners. The CALS community participated in three 3-hour strategic planning sessions in January to generate ideas and identify priorities within our goal areas. Data collected during those sessions are currently being catalogued and analyzed. Once this process is complete, we expect it to inform our AES and EXT efforts, primarily where and how we focus our research efforts.

The COVID-19 pandemic significantly impacted our operations. While in-person activities were limited, we have appreciated how much we were still able to accomplish over video conferencing while working remotely.

## 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>	Please reference our FY21 POW.
2. The <u>Scientific Peer Review Process</u>	Please reference our FY21 POW.

## 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
<p><b>1. Actions taken to seek stakeholder input that encouraged their participation with a brief explanation</b></p>	<p>Please reference our FY21 POW.</p>
<p><b>2. Methods to identify individuals and groups and brief explanation.</b></p>	<p>Please reference our FY21 POW.</p>
<p><b>3. Methods for collecting stakeholder input and brief explanation.</b></p>	<p>Please reference our FY21 POW.</p>
<p><b>4. A Statement of how the input will be considered and brief explanation of what you learned from your stakeholders.</b></p>	<p>Please reference our FY21 POW.</p> <p>Over this last year with the pandemic, we learned from our stakeholders that, while there was an initial supply chain disruption, farmers in Vermont were very entrepreneurial and creative. They pivoted quickly to increase sales in local markets and online. However, agricultural business needs also became more apparent, such as business technical assistance, succession planning, overcoming regulatory bottlenecks, and lack of universal high speed internet service across the state.</p>

### III. Critical Issues Table of Contents

No.	Critical Issues in order of appearance in Table V. Activities and Accomplishments
1.	Sustainability of Vermont Agriculture (and 7. Foundational and Exploratory Research in Agriculture)
2.	Resilience of Families and Individuals
3.	Development of Communities
4.	Quality of the Natural Environment
5.	Nutrition, Food Safety and Food Security
6.	Animal Health and Production

### 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.

No.	Project or Program Title	Outcome/Impact Statement	Critical Issue Name or No.
1.	<b>Building a Better (and Cheaper!) Portable Handwashing Station (Extension)</b>	<b>Relevance:</b> Handwashing has been shown to be one of the most effective ways to reduce the risk of transmission of human pathogens between people. But, sometimes we are inconveniently far from the closest wash room and sink. Hand washing stations provide a portable means of washing hands on farms, at farmers markets, and at recreational sites. When planning to open for the 2020 summer season, the Bennington Farmers Market (Vermont) identified a need for a moveable, public handwashing station to address concerns related to the spread of COVID-19.	Sustainability of Vermont Agriculture

		<p><b>Response:</b> UVM Extension Agricultural Engineer Chris Callahan and Agricultural Engineering Technician Andy Chamberlin evaluated commercial (expensive) products and DIY plans, and thought they could improve the product while lowering the cost. All these two needed was a weekend and a supply of readily available parts. The goals were to develop something almost anyone could build or assemble using inexpensive and easy-to-find parts; and make it hands-free (because everyone is concerned about touching water faucets, soap dispensers and trash cans), self-supported, and portable. They incorporated input from colleagues at the Vermont Agency of Agriculture Food and Markets (VT AAFM) and the Vermont chapter of the American Association of Retired Persons (VT AARP), making the stations ADA (Americans with Disabilities Act) compliant by paying attention to the dimensions and functionality.</p> <p>Callahan and Chamberlin came up with two approaches, using either a stand constructed from 2x4 lumber or a purchased rolling metal cart. The clean water supply is contained in a 5-gallon jug with a spigot. The spigot is spring loaded and operated by a foot pedal, or by hand for wheelchair users or individuals who have difficulty balancing. The used (gray) water collects in either a restaurant bus tray or an oil-draining pan and drains to a second 5-gallon jug, allowing for proper disposal -- and no puddles of water at your feet! An automatic, hands-free soap dispenser provides soap without the need for touching the container. A touchless paper towel dispenser always has the towel extended which the user can grasp and pull down to get a full sheet to dry off with. A trash can with a foot-operated lid and a liner completes the station, and prevents the used paper towels from blowing away.</p>	
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		<p><b>Results:</b> Callahan's initial build was used for the first time at the Bennington Farmers Market on May 30, and was constructed using about \$85 in lumber and materials. The automatic soap dispenser costs \$35, the towel dispenser costs \$16, and an appropriate trash can costs \$20, so the completed station will cost about \$156 in materials. Chamberlin's prototype, based on the rolling cart, came in at about \$180 in materials, but requires no carpentry, cutting, etc. and is easier to move since it is on rolling wheels. The team is eager to reduce the cost on each design, but recognizes that they already offer significant improvements for public use compared to both the inexpensive DIY approaches and self-contained, commercial station which costs about \$700 and don't offer the same functionality.</p> <p>Callahan and Chamberlin's portable handwashing station idea and designs are getting a life of their own, surprisingly, as there is already growing interest within the state (VT AAFM, AARP, etc.). Both DIY working prototypes intentionally use readily available or easily obtainable supplies, and basic assembly or carpentry skills. The team has developed the "Improving Handwashing Stations" factsheet (four pages, PDF) which includes basic assembly guidance and a bill of materials. The concept is to make the designs and basic approach available as open-source information, and possibly obtain financial support to purchase parts in bulk quantity to bring down the cost while working with partners to distribute supplies and plans to community organizations, enabling them to build what they need for their own communities.</p>	
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<p>2.</p>	<p><b>Hygienic Design for Agricultural Producers (Extension)</b></p>	<p><b>Relevance:</b> It can be challenging for agricultural producers to comply with cleaning and sanitizing requirements of the FSMA Produce Safety Rule [112.123(d)(1)] and market requirements. This is especially true when equipment hasn't been designed or built in consideration of this need [112.123(a) &amp; (c)]. The purpose of hygienic design is to intentionally create and/or improve spaces and equipment so that they can be cleaned and sanitized as appropriate. At the root of this practice is the reality that microorganisms such as human pathogens are small and can persist in even the tiniest of spaces in the right conditions. The role of hygienic design is to prevent this by incorporating design features into equipment and buildings to minimize or eliminate harborage of human pathogens.</p> <p><b>Response:</b> Existing publications and checklists related to sanitary design and hygienic design which had been developed for food processing and manufacturing plants were reviewed. Along with additional training, guidance from these resources were summarized and translated to the farm environment. As a result, five principles of hygienic design were outlined:</p> <ol style="list-style-type: none"> <li>1) Visible and reachable food contact surfaces must be used in order to enable thorough cleaning, sanitizing, and drying.</li> <li>2) Smooth and cleanable materials must be used.</li> <li>3) No collection points should exist where food, water, and pathogens can accumulate (harborage).</li> <li>4) Compatible materials must be used to allow for cleaning and sanitizing and to minimize wear and contamination.</li> <li>5) Prevent contamination by excluding contamination sources from the building, equipment, and produce.</li> </ol>	<p>Sustainability of Vermont Agriculture</p>
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		<p>Photographic examples from the field (good and bad) were incorporated into a guide and training materials. An evaluation checklist was developed to guide on-farm evaluation of equipment and buildings. This was summarized in a 1 hour workshop (PPT slides and handouts) that could be complemented with a hands-on equipment evaluation exercise that uses the evaluation checklist to apply the principles. An ad-hoc train the trainer program was conducted in fall 2019 to support winter grower trainings in 8 states.</p> <p><b>Results:</b> Extension educators and technical service providers now have a prepared workshop curricula that they can provide to growers to address a topic that previously was completely not addressed in the industry. To date, 12 workshops exposed 600+ growers from 8 states to these hygienic design principles and strengthened their ability to comply with the requirements of FSMA's Produce Safety Rule.</p> <p>Compliance with the Food Safety Modernization Act is critical to public health. Educating agricultural producers about hygienic design promotes understanding and compliance. Training Extension educators across multiple states to use and share resources increases the reach of educational curricula.</p>	
<p>3.</p>	<p><b>Farm Direct Sales During the Pandemic (Extension)</b></p>	<p><b>Relevance:</b> Small farms in Vermont have depended on a range of retail outlets to remain viable. These outlets have included wholesale accounts to restaurants, farmers markets as well as direct farm sales from farm stands located on the farm. When Vermont shut down due to the Coronavirus pandemic, Vermont farms had to pivot quickly to sell their produce to customers directly. Megan Bookless of ShakeyGround Farm</p>	<p>Sustainability of Vermont Agriculture</p>

		<p>explained, It was important to us to be able to meet a need we were seeing in our community. At the same time, we were sending out new instructions about pick-up dates, times, and safety protocols based on recommendations from the state.</p> <p><b>Response:</b> In April and May of 2020, eight UVM Extension programs partnered with farmers, agricultural service providers (including the Vermont Agency of Agriculture, Food &amp; Markets; NOFA-VT; Vermont Fresh Network; Vermont Farm to Plate) and community members to offer the Online Conversation Series: Sourcing and Selling Vermont Food in the Time of COVID-19. The Center for Sustainable Agriculture and Vermont Tourism Research Center collaborated with farmers, agricultural service providers and community members to deliver the seven-webinar interactive series. 439 farmers, service providers, NGOs, and government organizations learned about COVID-19 protocols for farm stands, virtual events, and equity and access in local food systems.</p> <p>Webinar themes included: Direct Sales, eCommerce &amp; Agritourism; Getting Started with Online Sales; Accepting SNAP/EBT as a Direct Market Farm; Meat and Dairy Direct Sales: Navigating Regulations, Licenses, and Aggregation Opportunities; Safely Selling Local Food at Farm Stands and CSAs during COVID-19; Keeping a Focus on Equity and Access in Local Food Systems; Virtual Farm &amp; Food Events; and Adapting Your Vermont Pick-Your-Own Operation for Covid-19 Practices. Farmers who were not able to make the timing of the lunchtime series could visit the recordings. Captions were also included to increase accessibility to the content.</p>	
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		<p><b>Results:</b> The strategies, challenges and resources covered in this series helped farmers make quick adjustments to new realities of local food sales, embrace the opportunity to have successful businesses, and serve communities in new ways. Many small vegetable farms experienced a boost in sales after implementing new direct sales methods and communication strategies that allowed them to sell directly to Vermont customers without physical contact. As Megan from ShakeyGround explained at the time, “We are seeing people order online who have never done it before and never purchased from us before. Small local farms are being valued as essential in a way I hadn’t seen before with people seemingly placing more value on local food. We’ve definitely seen an increase in sales.”</p> <p>ShakeyGround and other small Vermont farms are likely to continue their on-line ordering with many people are now enjoying the convenience of easily picking-up a pre-packed bag. It’s an interesting dance trying to make things more convenient for customers without increasing our hours in front of a computer when we need to get to the physical farm work outside. One research outcome of the "Sourcing &amp; Selling Vermont Food in the Time of COVID-19" webinar series is a new UVM College of Agriculture and Life Sciences project to assess what resilience means to Vermont farmers by surveying, analyzing, and mapping the networks of Vermont farmers with other support organizations.</p> <p>In spring 2020, the Coronavirus pandemic caused significant disruptions in the food supply. As a result, some farmers had to shift market channels in order to stay afloat. During a period when people are eating out less and preparing food at home more, many farmers have increased or shifted to</p>	
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		<p>direct sales to consumers. Providing spaces for producers to learn about the variety of direct sales strategies available to them is of critical importance in order to ensure a continual supply of food.</p>	
<p>4.</p>	<p><b>The Working Group on Improving Microbial Control of Arthropod Pests (Research)</b></p>	<p><b>Relevance:</b> In 2012, the wholesale value of floriculture crops in the US exceeded \$5.8 billion, and contributed \$25.5 million to Vermont's agricultural gross receipts. Vermont's 2012 greenhouse vegetable/tomato production was valued at \$10.7 million. However, in these protected environments, crops are highly susceptible to arthropod pests, especially western flower thrips (WFT). Historically growers relied on chemical insecticides to prevent damage, but because of resistance and human health and environmental risks, they are transitioning to IPM, whereby cultural and biological control tactics are combined to suppress pests, using insecticides as a last resort. Past research by the PIs demonstrated the value of marigold plant-mediated IPM systems to reduce WFT populations. Marigolds serve as a trap plant, attracting WFT from the crop, where biocontrol agents are applied.</p> <p><b>Response:</b> Western flower thrips (WFT) are one of the most significant pests of greenhouse ornamentals in the US. Despite years of trying to manage them with chemical insecticides and natural enemies, they continue to frustrate growers. This multi-faceted project assessed aspects of the use of marigold plant-mediated systems and insect-killing fungi for their integrated pest management to reduce growers' reliance on chemical pesticides.</p> <p>Growers of greenhouse ornamentals and vegetables and pest managers were the primary recipients of the information we develop. Extension</p>	<p>Sustainability of Vermont Agriculture</p> <p>Foundational and Exploratory Research in Agriculture</p>

		<p>personnel were key to dissemination of information on the revised plant mediated system of management in greenhouses using <i>Beauveria bassiana</i> endophytes in marigolds.</p> <p><b>Results:</b> Plant mediated systems use marigolds to lure thrips from the crop where a targeted treatment can be used to suppress populations over several weeks or months. Project research found that combining insect-killing fungi in this system eliminates the need for applying chemical insecticides and provides a sustained management approach. In addition, a regional educational program to introduce plant mediated systems to growers in northern New England was conducted. This has led to 90% of attendees reporting that they use biological control and improved scouting, both of which are key components of IPM.</p> <p>Over the course of this 5-year research project multiple presentations were given to greenhouse growers, senior scientists, graduate students and pest specialists reaching over 1,000s of individuals from the Northeastern US, introducing them to the potential of plant-mediated IPM systems and entomopathogenic fungi. The Entomology Research Laboratory website reaches hundreds of growers annually. All of these outreach activities have led to broader adoption of biological control and IPM and a reduction in chemical pesticide use in the Northeast. A poster presentation was given at the UVM Student Research Conference (SRC) in April 2020 and here is the link:  <a href="https://voicethread.com/myvoice/thread/14162786/87132034/80281692">https://voicethread.com/myvoice/thread/14162786/87132034/80281692</a></p>	
5.	<b>Genomic comparison of freezing and drought stress responses</b>	<b>Relevance:</b> Recent advances in diversified farming within the northeastern US have highlighted the need to increase native and crop diversity in order	Sustainability of Vermont Agriculture

	<p><b>across the temperate cereal grass clade Pooideae (Research)</b></p>	<p>to foster ecosystem services, such as maintaining soil quality and increasing biomass/yield, in the face of climate change. Cool season grasses (subfamily Pooideae) are a fundamental component of the native and agricultural Vermont flora, comprising the majority of forage, cereal, and turf grasses. However, the genetic basis for adaptations to environmental stresses in this group are only well understood for a few cultivars. Poooids have been diversifying in the northern temperate zone for ~45 million years, many species being adapted to seasonal cold through freezing tolerance/avoidance. Although the number of evolutionary origins is unknown, it is hypothesized that freezing tolerance evolved from a more ancestral drought tolerance pathway.</p> <p><b>Response:</b> AES engaged in research to determine the physiological and gene expression response of diverse poooids to freezing/drought stress, and to measure the degree to which these stress pathways overlap. The audiences for these efforts were primarily scientists and STEM students.</p> <p><b>Results:</b> Project findings have been published in two journals articles:</p> <p>Aayudh Das, Anoob Prakash, Natalie Dedon, Alex Doty, Muniba Siddiqui, Jill C Preston, Variation in climatic tolerance, but not stomatal traits, partially explains Pooideae grass species distributions, <i>Annals of Botany</i>, 2021, <a href="https://doi.org/10.1093/aob/mcab046">https://doi.org/10.1093/aob/mcab046</a></p> <p>Jill C. Preston, Siri Fjellheim, Understanding Past, and Predicting Future, Niche Transitions based on Grass Flowering Time Variation, <i>Plant Physiology</i>, Volume 183, Issue 3, July 2020, Pages 822–839, <a href="https://doi.org/10.1104/pp.20.00100">https://doi.org/10.1104/pp.20.00100</a></p>	
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		<p>Results from this project will inform agronomists about important target genes involved in drought and freezing stress that have the potential to increase stress tolerance in crop cultivars. Results should also be of interest more broadly to ecologists and evolutionary biologists interested in understanding how, and how quickly, plants can respond to climate change.</p>	
<p>6.</p>	<p><b>Enhancing Educational Programming for Beginning Farm and Ranch Women</b></p>	<p><b>Relevance:</b> The 2017 USDA Census of Agriculture reports that 36% of all farmers and ranchers are female, and 56% of all farms have at least one female decision-maker. The number of U.S. farms with a female principal operator nearly quadrupled over the past four decades, from five percent in 1978 to about 29% in 2017. But women farmers and ranchers encounter many challenges. More than 80% of women-operated farms reported sales and government payments of less than \$50,000 (Census of Ag, 2012). Women operators do not apply for and utilize agricultural support programs as effectively as their male counterparts, and the businesses of many beginning farm and ranch women (BFRW) are not surviving the first five years.</p> <p><b>Response:</b> Launched in October 2015, the 21st Century Management: Enhancing Educational Programming for Beginning Farm and Ranch Women project is working to expand opportunities for educators interested in improving, expanding and starting outreach programs for beginning farm and ranch women.</p> <p>This initiative, led by the UVM Extension Women's Agricultural Network, brought together a diverse, national team of educators, research and</p>	<p>Sustainability of Vermont Agriculture</p>

		<p>women working in agriculture to existing programs and curricula; identify gaps in targeting women; and create a central repository where educators can access curricula and training materials.</p> <p>“We view this project as a way to validate the important work that has been going on around the country for decades while acknowledging that women remain under-served in many areas of agriculture,” says University of Vermont Extension Professor Mary Peabody director of the project.</p> <p><b>Results:</b> Agricultural educators throughout the US are using tools and resources they learned about through the <a href="#">“Women in Ag Programs for 21<sup>st</sup> Century Farms and Ranches”</a> 2019 virtual conference to improve and expand programming for beginning farm and ranch women. The conference was held online in January 2019 and was designed to help organizations launch new programs and/or expand and improve existing programs for women farmers and ranchers. It attracted 120 agricultural professionals from 33 US states, Puerto Rico, the US Virgin Island and Washington DC.</p> <p>All of the 34 conference participants who responded to a follow-up survey said the conference increased their knowledge about resources, tools, models and approaches for working effectively with women farmers and ranchers. Of those, 75% said they planned to use new resources and tools in their programming within the next 12-24 months. Nearly 60% said they plan to increase programs for beginning women farmers and ranchers and over 80% believe that the quality of their programs will improve as a direct result of their participation in the conference.</p>	
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		<p>“I loved being in a workshop, albeit virtual, with so many women in the same field as me. The energy was high, and it made me excited for my organizations coming season,” said one conference participant.</p> <p>“This was a great format for younger and more experienced educators to share their tips and tricks for delivering quality programs, and a great opportunity for those of us less experienced to take part and learn from colleagues from across the country,” said another.</p>	
<p>7.</p>	<p><b>New Uses for Wool (Extension)</b></p>	<p><b>Relevance:</b> For over a decade, sheep producers have struggled with the drop in value for the wool their animals produce. Meanwhile, the annual costs associated with the shearing and collection of that wool have increased. Many producers have sought ways to increase the value of this raw product, which historically, was the most lucrative revenue source from sheep, before meat and milk products. If this cost in sheep production could instead be a source of revenue for producers, it would contribute greatly to a more profitable enterprise, especially for small operations, which is the case for a majority of those in Vermont.</p> <p><b>Response:</b> In 2016, UVM Extension Grazing Specialist, Kimberly Hagen, and Sustainable Agriculture Outreach Specialist, Suzy Hodgson, were awarded a USDA Value-Added grant to look at the issue, and explore the potential of value-added products made from this raw material. The team researched the existing infrastructure for value-adding processes, volume capacity, and expansion potential. They then convened a group of stakeholders from across the supply chain in New England, and hired Eugene Korsunskiy to lead them through a day of Design Thinking exercises to brainstorm ideas for the fibers potential.</p>	<p>Sustainability of Vermont Agriculture</p>

		<p><b>Results:</b> As a result of that work, conversations between those who attended the Design Thinking exercise have continued, and ideas are floated between stakeholders regularly. For example, discussions with a wood pellet manufacturer in southern Vermont explored the possibility of converting to pelletizing wool for part of the year. The team also engaged with a producer of pellets in Utah to explore a partnership to meet demands for eastern distribution. In addition, research trials at three farms in Vermont showed promising results of wool pellets to be used as an agricultural fertilizer. Most recently, two of the participants at the Design Thinking exercise forged a formal agreement: leftover fibers from the cleaning and carding process (normally a waste product and a cost to the mill to dispose of) at Battenkill Fiber Mill in Greenwich, NY, will be used in the crafting of Gryphon Doors, a specialty, handcrafted, energy efficient door made in Plainfield, VT. These are important steps, exhibiting the great potential of wool as a valuable raw material for value-added products, and a revenue source rather than a cost for sheep producers.</p> <p>Sheep producers are seeking ways to recoup the cost associated with shearing and collecting wool, while other producers and manufacturers are seeking environmentally friendly inputs. Creating mutually beneficial connections between these stakeholders, results in economic vitality for multiple business enterprises.</p>	
<p><b>8.</b></p>	<p><b>Improving Economic and Environmental Sustainability in Tree-Fruit Production through Changes in Rootstock Use (Research)</b></p>	<p><b>Relevance:</b> Apples are Vermont's second-most valuable specialty crop with total annual value over \$10 million. Most Vermont apples are grown for fresh markets and comprise traditional dessert cultivars. However, as dessert apple production has been level for over ten years, increased</p>	<p>Sustainability of Vermont Agriculture</p>

		<p>demand for organic apples and specialty cider apples presents opportunity for growers to exploit those alternative markets and increase sales. Production systems differ for organic and specialty cider apples, and changes from traditional systems presents a knowledge gap among both researchers and growers which limits growing for those markets.</p> <p><b>Response:</b> This project assessed rootstock effects on organic and cider apple production systems, as well as multiple leader training systems on cider apples for effects on tree growth, crop yield, and juice quality. Objectives and protocols were part of and informed by the multi-state NC-140 Regional Rootstock Evaluation Trial. Research is continuing on this long-term project. The primary audience for this work was commercial apple growers in Vermont and the surrounding region. Secondary audiences included national and international growers, collaborating researchers, and undergraduate and graduate students.</p> <p><b>Results:</b> This project was highlighted in the 2019 UVM Horticulture Research &amp; Education Center Program Open House, attended by 30 growers and community members. It is also serving as a core component of the UVM Farmer Training Program, with 25 students enrolled in 2019, and in the HREC undergraduate internship program, with 12 enrollees in 2019. In 2020, 20 undergraduate interns and 14 students in PSS 221: Sustainable Orchard Management course used the orchard for research and demonstration. Apple production systems are a complex collection of interrelated factors, and this project supports a larger, nationally and internationally-recognized ongoing research program supporting organic and cider apple production in Vermont.</p>	<p>Foundational and Exploratory Research in Agriculture</p>
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<p>9.</p>	<p><b>Evaluation of Common Milkweed as a New Fiber Crop and Native Pollinator Enhancer (Research)</b></p>	<p><b>Relevance:</b> Many factors are challenging our food system today including climate change, increasing population, and loss of biodiversity. It is estimated that production of 35% of the world's most important food crops rely on insect pollination for productivity. In the last decade, severe declines in pollinator populations have been observed across the world which can be largely attributed to decreases in habitat and agricultural practices. One way of protecting our pollinators is by providing pollinator habitat. Milkweed has been a plant of focus as it is the sole food source for monarch butterfly larvae. Although the market exists and there is a lot of interest from farmers to grow the crop, research is needed to understand all the aspects of milkweed cultivation if it is to be a successful crop in Vermont.</p> <p><b>Response:</b> This project aimed to identify effective methods of establishing milkweed as a commercial crop and to investigate the pollinator community that utilizes milkweed in Vermont. Over the project period, we worked with farms currently growing milkweed as a commercial crop, new farmers that are ready to plant milkweed, as well as farmers that were interested in the crop. The total target audience reached during the project period was over 500 farmers and closely related stakeholders.</p> <p><b>Results:</b> Project results were disseminated to the target audience at two field days, three workshops, and three conferences held throughout the project period. Grower meetings to teach farmers about establishing and harvesting milkweed attracted over 50 attendees. The Annual Crop and Soil Field Day held in July of 2017, 2018, and 2019 attracted over 600 stakeholders to learn about growing milkweed as a commercial crop. Winter grain conferences allowed researchers to deliver information to</p>	<p>Sustainability of Vermont Agriculture</p> <p>Foundational and Exploratory Research in Agriculture</p>
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		<p>over 300 members of the agricultural community in 2017, 2018, and 2019. Research reports were also distributed to online audiences (<a href="http://www.uvm.edu/extensions/nwcrops">www.uvm.edu/extensions/nwcrops</a>).</p>	
<p>10.</p>	<p><b>Developing a New Online Platform for Vermont Vegetable Growers (Extension)</b></p>	<p><b>Relevance:</b> Approximately 150 of the lead produce growers in Vermont Vegetable and Berry Growers Association (VVBGA) currently rely on the Extension-coordinated Community Accreditation for Produce Safety (CAPS) program to access and maintain their markets and comply with the FSMA produce safety rule.</p> <p>During the 2019 season, the CAPS program web developer (CIIDs) folded, leaving these growers and their estimated \$13 million of annual vegetable sales at risk. To maintain their markets, growers needed finish the 2019 program, with an unsupported web platform, as well as envision and develop a new platform to support the CAPS program for the 2020 season.</p> <p><b>Response:</b> During the 2019 harvest, UVM Extension developed and employed off-line tools to resolve errors on the old platform, and support the CAPS growers through the 2019 season.</p> <p>At the same time we convened a team of growers, service providers and regulators, in collaboration with web developer Tamarack Media, to design and develop a new platform to support the growing CAPS program for 2020.</p> <p><b>Results:</b> Over the fall and winter of 2019-20, we led hundreds of hours of coordinated effort to design and develop a new expandable home for the both the CAPS program, and other programs of the VVBGA at</p>	<p>Sustainability of Vermont Agriculture</p>

		<p><a href="https://vvbga.org/home">https://vvbga.org/home</a>. This platform supports growers to maintain and expand their markets, selling millions of dollars of sales, thousands of acres of land, and employing several hundred Vermont farm workers.</p> <p>This platform now hosts an improved integrated and customizable set of tools and resources for producers to verify implementation of best practices to manage food safety risk, as well as maintain the health of their soil. It also supports all other VVBGA member programs, links to other UVM grower resources, and to case studies and models from the VVBGA grower community.</p> <p>Because of this coordinated effort, the CAPS certificate program has been able to nimbly respond to increased market requirements, intensified by the COVID pandemic, allowing growers to link added verification to their “CAPS-Plus” certificate, which is now widely accepted buy regional buyers as a valid market access credential.</p>	
<p><b>11.</b></p>	<p><b>4-H Creates Free Activity Boxes for Vermont Youth during COVID (Extension)</b></p>	<p><b>Relevance:</b> In mid-April, Vermonters learned that due to the pandemic, town recreation and school-organized summer camps would be cancelled or running with drastically reduced capacity. Many families were left to figure out childcare as parents returned to work. In addition, due to COVID-related reduction in employment opportunities, some families were experiencing homelessness and living with extended family or in motels. With most opportunities for in-person summer education and engagement on hold, Vermont children and youth were in need of accessible opportunities for fun, learning, and connection.</p>	<p>Resilience of Families and Individuals</p>

		<p><b>Response:</b> Led by UVM Extension 4-H, over 30 organizations came together under the “umbrella” of the Vermont Youth Project (VYP) to design, build and distribute activity boxes for youth aged 6-14. Themed boxes were filled with non-perishable, inexpensive materials and an instruction manual for positive youth development activities and distributed every other week during the summer. Themes included “Dairy Month,” food, exploring nature and more. Online Zoom sessions were also offered to build community and have real-time support for activities.</p> <p>In Rutland and Addison Counties, 2,000 youth received these free activity boxes. VYP connected with the Vermont Agency of Human Services (AHS) and Department for Children and Families (DCF) to ensure that youth who might not have ready access to these boxes were served. As a result, a portion of the boxes went directly to youth living in hotels around Rutland County and another to youth in foster care.</p> <p><b>Results:</b> In direct response to the gap created by COVID-19, these activity boxes provided a regular source of learning, creation, and exploration for kids in Vermont. Feedback showed that youth were engaged! One parent shared the following: “Thank you all so much for the thought that was put into these boxes and the many activities that they have provided. All the activities were easy to accomplish and a great way to spend time together. We are so looking forward to continuing the program thanks again to all of you.” Families played and learned together, older siblings joined the fun by leading younger siblings through activities, and grandparents enjoyed quality learning experiences alongside their grandchildren. People came to pick up their boxes with tears of gratitude and joy!</p>	
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		<p>This project also received a lot of press, including a Vermont Public Radio story, a front page article in The Rutland Herald, and a 2-part piece on local CBS affiliate, WCAX:</p> <p>Keck, N. (2020, June 30). <i>Vermont Youth Project Of Rutland Puts Summer Fun In A Box</i>. Vermont Public Radio. <a href="https://www.vpr.org/post/vermont-youth-project-rutland-puts-summer-fun-box#stream/0">https://www.vpr.org/post/vermont-youth-project-rutland-puts-summer-fun-box#stream/0</a></p> <p>Lyons, O. (2020, July 7). <i>Program provides kids with summer camp in a box</i>. <a href="https://www.wcax.com">https://www.wcax.com</a>. <a href="https://www.wcax.com/content/news/Program-provides-kids-with-summer-camp-in-a-box-571662901.html">https://www.wcax.com/content/news/Program-provides-kids-with-summer-camp-in-a-box-571662901.html</a></p> <p>Mcardle, P. (2020, June 11). Educational boxes will be available for local kids this summer. <i>Rutland Herald</i>. <a href="https://www.rutlandherald.com/news/educational-boxes-will-be-available-for-local-kids-this-summer/article_bc2c577c-944a-5074-aafe-b2f58d945cd5.html">https://www.rutlandherald.com/news/educational-boxes-will-be-available-for-local-kids-this-summer/article_bc2c577c-944a-5074-aafe-b2f58d945cd5.html</a></p>	
<p><b>12.</b></p>	<p><b>Virtual Enrichment and Engagement for Youth (Extension)</b></p>	<p><b>Relevance:</b> When COVID-19 caused schools to close quickly in the spring, 4-H staff realized teachers would need time to adapt to online remote instruction. To help bridge the learning gap, 4-H stepped in with daily virtual youth enrichment programs for kids of all ages. Monday through Thursday, they dedicated an hour to programming designed to foster structure and continuity. Through synchronous, real-time engagement, young people not only explored new topics, but also made friends and maintained social connections during a time of unexpected physical isolation.</p>	<p>Resilience of Families and Individuals</p>



		<p><b>Response and Results:</b></p> <p><u>Distance Learning Socials:</u> Each Monday, youth “met” to learn about birding, photography, tree identification, community service, and more. Those who joined received a take-home challenge, then regrouped on Thursdays for an informal share-out of their findings and experiences. By going beyond a “watch this video and discuss” format, participants gained a real sense of belonging within the group and curiosity surrounding the topic. The nine sessions offered engaged a total of 103 young people, 25% of whom attended more than once.</p> <p><i>“I’m so grateful that [“Elsa’s] been able to set meaningful goals to keep her engaged with life, not just computer screens in this time of remote learning and social distancing.”</i></p> <p style="text-align: right;"><i>— Elsa’s mom reflecting on her daughter’s Distance Learning Socials participation</i></p> <p><u>QuaranTeen Time:</u> On Tuesdays, students in grades 7-12 explored college and career pathways, skill building and leadership opportunities. Ten sessions reached 125 individual teens exploring topics including “How to Advocate for Yourself,” “How to Match Your Interests with a Promising Career,” and “Youth Voices Matter: A Conversation with Lt. Governor David Zuckerman.”</p> <p><u>QuaranTeen Virtual Science Cafés:</u> On 12 Wednesdays, 208 students in grades 7-12 explored science, engineering and technology by connecting with real scientists, learning about their work, and asking questions.</p>	
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		<p><u>Clverbuds Connect Challenges</u>: This activity was designed for the youngest 4-H audience (K-2, ages 5-7). Participants watched a video demonstrating an activity and were then challenged to try it themselves, record the action, and post the video on the secure “Flipgrid” portal - all with adult supervision. New activities were distributed each Friday, covering topics like butterflies, dairy, recycling, trees and more. Between June and October 2020, there were 721 views of 21 videos, equaling 40.8 hours of shared learning.</p> <p>For more information about current at-home youth opportunities, visit <a href="https://www.uvm.edu/extension/youth/4-h-home">https://www.uvm.edu/extension/youth/4-h-home</a>.</p>	
<p>13.</p>	<p><b>Migrant Students Learn Beyond the Classroom (Extension)</b></p>	<p><b>Relevance:</b> Migrant students have limited opportunities for experiential “learning beyond the classroom” as a result of cost barriers, frequent moves, and lack of culturally appropriate/relevant resources and events. In addition, migrant parents/guardians face long work hours, language barriers, and additional challenges that make it challenging to access resources on parenting, children’s literacy, and other topics that can contribute to their children’s educational success.</p> <p>It is crucial that Migrant Education Program (MEP) be guided by feedback provided by both participants and parents/guardians. MEP can best support students’ educational success when we work in collaboration with those we serve.</p> <p><b>Response:</b> In February 2020, the UVM Migrant Education Program held a joint literacy and educational event and PAC for students and families in the northeast kingdom in partnership with the Fairbanks Museum and</p>	<p>Resilience of Families and Individuals</p> <p>Development of Communities</p>

		<p>Planetarium and the Children’s Literacy Foundation (CLiF). The event title “Let’s Explore!” brought together five parent/guardians and 12 children. The day began with a “story time” and instruction for parents targeted at English Language Learners and those with low literacy skills. CLiF gave each child three age appropriate books, including a topical science book based on the focus of the day. For the second part of the day, parents/guardians participated in a PAC while students attended two educational science based activity facilitated by museum educators. For the remainder of the day, students and parents had the opportunity to explore and interact with the educational exhibits at the museum with the guidance of staff.</p> <p><b>Results:</b> Feedback provided by parents/guardians on the day will help us to inform planning for future events. In particular, parents cited enjoying the opportunity to share some of their feelings, concerns, and hopes for the education of their children with both MEP staff and other parents/guardians. Given the geographic isolation and language barriers, these opportunities for parents to share among themselves are rare. Additionally, participants praised that the event was conducted in Spanish, an at best rare occurrence for them. The relationship that MEP has established with CLiF continues to grow and flourish.</p> <p>Children in migrant families have limited opportunities for “learning beyond the classroom” experiences, and their parents and guardians often face barriers in access to resources and capacity to engage with their children on educational activities. Providing curated educational experiences as family activities supports relationships and learning. Engaging parents and guardians in the assessment of the Migrant</p>	
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		<p>Education Program ensures the program design will continue to meet the needs of families.</p>	
<p>14.</p>	<p><b>Fiscal Management Education for Vermont Public Libraries (Extension)</b></p>	<p><b>Relevance:</b> Vermont's 183 public libraries are a foundational institution in Vermont communities, contributing significantly to the fabric and democratic governance of our communities as a place of gathering, learning, and inquiry. Total public library revenue, including \$19.5 million from local property taxes, was \$25.1 million in 2019, according to the Vermont Department of Libraries (VT LIB). Budgeting and budget management are important skills for every library director and their respective board of trustees. In early 2019, both the Vermont Department of Libraries' State Librarian and the Director of the Vermont League of Cities and Towns, Municipal Assistance Center, identified fiscal management of public libraries as an educational "gap" area that they wanted and needed assistance in.</p> <p><b>Response:</b> In the summer of 2019 UVM Extension began cooperating with the Vermont Department of Libraries by agreeing to teach budget management, including sessions for the VT LIB-sponsored "Certificate of Public Librarianship". The certificate series includes core classes on public administration, of which budget management is a vital part. [See: <a href="https://libraries.vermont.gov/services/continuing_ed/certificate">https://libraries.vermont.gov/services/continuing_ed/certificate</a>].</p> <p>UVM Extension taught two cohorts in the certificate program, the first October 2019, and the second cohort May 2020. The four-hour class teaches the basics of budgeting, accounting "lingo", budget management, and fiscal controls. A total of 48 libraries were represented in the combined two sessions, often by more than one employee (e.g., director</p>	<p>Development of Communities</p>

		<p>and assistant director). These libraries had a total combined revenue of \$11.16 million, or 44% of the 183 Vermont public library total.</p> <p><b>Results:</b> Based on day-of-teaching survey results (first session, which was held in-person), students reported that their appreciation for the totality of the budgeting process, and their understanding of the budget cycle, basic accounting terms, and financial controls increased dramatically. Recall that these library directors have authority and responsibility over approximately 44% of the sum total public library revenue in the state, \$11.16 million, of which \$8.32 million is from local municipalities. Increased understanding, appreciation and comfort in budgets, budget management, cash control, and more will help guide better decision-making and management, as well as improve fiscal controls for those libraries represented. Additionally, proper budgeting is grounded soundly in strategic planning, therefore competence in this important aspect of administration will help enhance following vision and mission through deliberate budgeting decisions. A follow-up survey of all participants is planned for first quarter of FY21 to gauge behavior change.</p>	
<p>15.</p>	<p><b>Slowing the Spread of the Emerald Ash Borer by Educating Communities (Extension)</b></p>	<p><b>Relevance:</b> Emerald ash borer has been the most economically damaging pest to US trees and forests. Now in Vermont it threatens to cost municipalities hundreds of thousands of dollars to manage hazard trees, as well as having significant impact on the environmental services provided by urban and community ash trees. Early detection of the borer is critical in that it gives the state information to help slow the spread of this pest, and gives municipalities time to prepare to manage it.</p>	<p>Development of Communities</p> <p>Quality of the Natural Environment</p>

		<p><b>Response:</b> Hanging purple pheromone traps is one way to detect the presence of the pest. UVM Extension’s Forest Pest Education Coordinator, collaborating with the state entomologist from the Agency of Agriculture and the Forest Health Division of Forests, Parks and Recreation, trained 39 volunteers to hang and monitor 116 traps in 50 towns throughout Vermont this year. Normally the training and trap distribution is done in person, but this year because of COVID, we created a video to train the volunteers and FPF distributed the traps through each of their five district offices.</p> <p><b>Results:</b> Forest Pest First Detectors are using the traps as a way to educate their communities about emerald ash borer: by creating posts about the purple traps for Front Porch Forum, by inviting neighborhood children to help with the monitoring, and by holding woods walks and talks for their neighbors with consulting foresters. In this way the volunteer-monitored traps help the state with early detection (last year EAB were caught in two volunteer traps, confirming new infestations in Alburgh and Derby) and community education.</p>	
<p>16.</p>	<p><b>Costs and Benefits of Natural Resources on Public and Private Lands: Management, Economic Valuation, and Integrated Decision-Making (Research)</b></p>	<p><b>Relevance:</b> Global climate is in the midst of rapid change associated with increasing concentrations of atmospheric greenhouse gases. Climate change is expected to shift carbon storage in forests both directly and through changes in the distribution and composition of forests across Vermont, but the nature and magnitude of forest change is uncertain. Projecting the responses of forests to climate change requires assessment of the influence of both (1) uncertainty in climate change projections and (2) sensitivity to the spatial resolution of climate data.</p>	<p>Quality of the Natural Environment</p>

		<p><b>Response:</b> UVM AES researchers assessed the uncertainty in projected forest change using an ensemble of climate change scenarios and spatial resolutions. Dynamic process-based vegetation models (PBMs) were run using a set of climate ensembles across a range of spatial scales. PBMs are process-based models that provide a mechanistic basis for projecting the distribution of forest trees in response to changing climate. The team assessed uncertainty in projected forest change and sensitivity of projections to the spatial scale of climate data by running our PBM across a set of projected future climates and spatial resolutions. This project served academics interested in the effect of climate change on forests but also managers and policymakers that are interested in the current and future states of Vermont forests.</p> <p><b>Results:</b> This research resulted in regionally downscaled climate projections for our region. The team downscaled a set of global climate models to a 1 km spatial grid for our study region using fine scaled topography. These data were used to drive a forest model to predict forest composition under future climate change scenarios. The following manuscripts have been published in scientific literature to disseminate project findings:</p> <p>Pugh, Thomas A., et al. (2020). Understanding the Uncertainty in Global Forest Carbon Turnover. <i>Biogeosciences</i>, vol. 17 (15), pp. 3961–3989., <a href="https://doi.org/10.5194/bg-17-3961-2020">https://doi.org/10.5194/bg-17-3961-2020</a></p> <p>Verrico, Brittany M., et al. (2019) Long-Term Monitoring Reveals Forest Tree Community Change Driven by Atmospheric Sulphate Pollution and</p>	
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17.	<p><b>Removing Phosphorus from Manure (Extension)</b></p>	<p><b>Relevance:</b> Excess loss of phosphorus (P) from farmland is the largest contributor to water quality degradation in Lake Champlain. A primary source of the P runoff from agriculture is the application of manure and the over-enrichment of P in soils. Even when farmers do not need the P in manure, they still need the nitrogen (N) in the manure in order to maintain crop yields. A solution is needed where P can be removed from the manure so that it can still be used for its N value.</p> <p><b>Response:</b> A large dairy farm invested in a manure P-removal technology, with the help of financial assistance from government sources. This technology was relatively new and was the first of its kind in Vermont; thus, its performance needed to be evaluated to ensure it did indeed remove significant levels of P from manure. A team led by UVM Extension undertook a 15-week intensive evaluation of the technology, culminating with a final report detailing performance.</p>	<p>Quality of the Natural Environment</p> <p>Sustainability of Vermont Agriculture</p>



		<p><b>Results:</b> The research found that the technology removed approximately 85% of the P from the manure. These findings were published in a peer-reviewed journal article and distributed to the NRCS and state agencies. As a result, NRCS is now considering including these technologies in their financial assistance programs. Additional public and private investments are also being made into the P-removal technology and process to ensure that final products are of maximum value and are marketable. Such technologies could dramatically improve water quality in the Lake Champlain Basin if widespread adoption occurred and a market was developed for the P-enriched byproduct.</p>	
<p>18.</p>	<p><b>Genomic Analysis of Climate Change Responses in Northeastern Red Spruce Forests (Research)</b></p>	<p><b>Relevance:</b> Climate change has already begun to affect the structure of our forests. Long-term monitoring of tree species composition has shown retreat of high elevation species upslope, as well as declines in abundance and productivity of climate-sensitive species. Red spruce is a dominant forest tree in high elevation forests throughout the northeastern United States and Canada, where it forms critical habitat for many other species of plants and animals. Biologists monitoring red spruce over the last several decades have noticed this species has declined in vigor and productivity in response to mid-winter injury events caused by mild temperatures followed by an abrupt return of cold freezing temperatures. These events are forecasted to increase in frequency with climate change, leading to potential loss of spruce abundance and resiliency in northeastern forests if it cannot adapt or disperse in response to changing climate.</p> <p><b>Response:</b> This research project addresses the potential for spruce to adapt to climate change by measuring its tolerance to mid-winter injury under field and controlled conditions, and determining the amount of genetic variation available for a response to climate-mediated selective mortality. In addition, the research builds upon and updates a long-term</p>	<p>Quality of the Natural Environment</p>

		<p>dataset of 50 years of forest monitoring to assess the extent of altitudinal range shifts in spruce and other forest trees, and use genetic tests to determine the distances over which pollen and seed are dispersing in recent times in response to climate warming compared to historical estimates from older established trees.</p> <p><b>Results:</b> Throughout this project, we engaged multiple scientists in collaboration related to our red spruce research, including both academics and government scientists working at the USDA Forest Service. In addition, we greatly expanded our sharing of results and collaboration with NGO conservationists and restoration ecologists working with the Nature Conservancy and other agencies to restore red spruce forests where they have been decimated, primarily in the Central Appalachian region. Across the history of the project, we met or exceeded each of our major goals; results have been shared via numerous publications, including:</p> <p>Butnor, J. R., et al. (2019). Phenotypic Variation in Climate-Associated Traits of Red Spruce (<i>Picea rubens</i> Sarg.) along Elevation Gradients in the Southern Appalachian Mountains. <i>Castanea</i>, 84(2), 128. <a href="https://doi.org/10.2179/0008-7475.84.2.128">https://doi.org/10.2179/0008-7475.84.2.128</a></p> <p>Verrico, B. M., et al. (2019). Long-term monitoring reveals forest tree community change driven by atmospheric sulphate pollution and contemporary climate change. <i>Diversity and Distributions</i>, 26(3), 270–283. <a href="https://doi.org/10.1111/ddi.13017">https://doi.org/10.1111/ddi.13017</a></p> <p>Capblancq, T., et al. (2020). Whole-exome sequencing reveals a long-term decline in effective population size of red spruce (<i>Picea rubens</i>). <i>Evolutionary Applications</i>, 13(9), 2190–2205. <a href="https://doi.org/10.1111/eva.12985">https://doi.org/10.1111/eva.12985</a></p>	
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		<p>Together, the combination of ecological monitoring, genetic analysis, and physiological tests provides a comprehensive picture of how forest trees will respond to climate change impacts.</p>	
<p>19.</p>	<p><b>Stormwater Education for Youth (Extension)</b></p>	<p><b>Relevance:</b> Stormwater runoff is a primary source of nonpoint source pollution to Lake Champlain, and a driver of cyanobacteria blooms in the lake that have become more common in recent years. To address this challenge, inhabitants of the basin must understand the mechanism by which stormwater can result in polluted water and ways that individuals, businesses, and communities can take action to use nature-based solutions to minimize and treat stormwater on site.</p> <p><b>Response:</b> Lake Champlain Sea Grant developed a stormwater curriculum to help middle and high school teachers and their students understand stormwater sources, nature-based mitigation measures (called green infrastructure), and take action to engage in stewardship activities to reduce stormwater runoff from school campuses. To make this curriculum most accessible to teachers, we developed a complementary university-level course open to both pre-service and in-service teachers.</p> <p><b>Results:</b> The course introduced critical concepts about stormwater and green infrastructure through hands-on learning, and supported eight teachers from five elementary through high schools in northwestern Vermont to educate and engage over 300 of their students in the learning and stewardship project implementation process during the fall semester 2019. Planned stewardship projects for spring 2020 included green roofs and rain gardens. The teachers also provided feedback to inform revisions to the curriculum for future use. One school (30 students and their families to ensure COVID safety guidelines were followed) was able to complete installation of their rain garden while safely physically-distancing during</p>	<p>Quality of the Natural Environment</p>

		<p>the spring 2020 COVID pandemic. A video of this is available at:  <a href="https://youtu.be/5jgvKq-QtAl">https://youtu.be/5jgvKq-QtAl</a></p> <p>Stormwater runoff is a primary source of nonpoint source pollution to Lake Champlain. Helping inhabitants of the basin understand ways that individuals, businesses, and communities can take action to use nature-based solutions to minimize and treat stormwater on site can result in a reduction in polluted water flowing into the lake.</p>	
<p>20.</p>	<p><b>A Network to Increase Pasture Land in the Northeast (Extension)</b></p>	<p><b>Relevance:</b> Food Solutions New England has calculated the need for 2 million acres of pasture land by 2060 to achieve its vision for local food production, which dovetails with the principles of regenerative agriculture and efforts to adapt to, and mitigate, climate change. This would require the quadrupling of current pasture acres. In order to achieve an increase in well-managed pasture across the Northeast, a New England team of partners must be strengthened, with shared goals and measurement.</p> <p><b>Response:</b> Active work has been progressing in states with dedicated staff able to start work immediately, such as Vermont, New Hampshire, and Southern New England. Over 13 on-farm events have taken place, including farmer and consumer-focused educational opportunities. Direct technical assistance has been documented in Vermont and Massachusetts, with an expansion of assistance planned across the region in 2020. The regional partners are connecting through social media, in-person and online meetings, and conferences to share resources and discuss coordinated opportunities.</p>	<p>Quality of the Natural Environment</p>

		<p>The advent of the Cedar Tree/New England Grazing Network (NEGN) project has already leveraged support for a portion of four technical assistance and outreach staff. A draft vision statement has been developed, and is being used as a basis to develop:</p> <ul style="list-style-type: none"> <li>• A web site (<a href="https://www.negrazingnetwork.com/">https://www.negrazingnetwork.com/</a>);</li> <li>• Facebook page (<a href="https://www.facebook.com/newenglandgrazingnetwork">https://www.facebook.com/newenglandgrazingnetwork</a>);</li> <li>• Instagram (<a href="https://www.instagram.com/new_england_grazing_network/">https://www.instagram.com/new_england_grazing_network/</a>);</li> <li>• and outreach materials for all of the partners.</li> </ul> <p>Ten general public/consumer events have taken place in Vermont and Massachusetts; topics have focused around use of livestock to manage invasive species, full-cycle regenerative agricultural integration of grazing livestock under solar arrays, business diversification to support the financial success of livestock farms, and how purchasing wool products from a regeneratively grazed farm connects consumers with clean water and carbon sequestration.</p> <p><b>Results:</b> The project participants are grazing-support and membership organizations seeking to improve resource and activity coordination as well as developing a shared set of measurement across the six New England states. Ultimately this work will benefit individual farmers across the region who make land management decisions. As such, the project now includes both inter-organization measurement of team work and shared activities, as well as on-farm condition measurement, farmer</p>	
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		<p>education and knowledge change, and multi-generational farmer relationships.</p> <p>All six states are now connected through five regional organizations (UVM, Vermont Grass Farmers Association, Granite State Graziers, The Livestock Institute of Southern New England, and Wolfe’s Neck Farm), with regular quarterly meetings and strategy planning sessions. In addition to expanding the shared audience for events, the partners are passing along financial and educational resources, discussing the expansion of regional efforts such as grazing sheep under solar panels and Dairy Grazing Apprenticeship, and have initiated online educational events to reach a wider audience.</p>	
<p><b>21.</b></p>	<p><b>Assessing the Effect of Climate Change and Shocks on Food Security at Varying Scales (Research)</b></p>	<p><b>Relevance:</b> There has been increasing focus on understanding the effects of climate change on agricultural systems, including necessary adaptations to ensure future food security. However, climate change is likely to affect food systems far beyond just agricultural production including through direct avenues such as transportation and trade, food storage and food safety and through more indirect impacts including agri-tourism loss. Despite the global nature of our food system there has been less focus to assess these non-production impacts and especially to understand how food security in the United States will be impacted through global climate change effects on food systems.</p> <p><b>Response:</b> This project conducted transdisciplinary research leading to the development of a framework to assess the potential impacts of climate change on food security within the United States and applied in Vermont. The team assessed ways in which climate change impacts food security</p>	<p>Nutrition, Food Safety and Food Security</p>

		<p>through a food systems framework using a multi-faceted approach. They first aimed to understand the relationship between food security and climate factors as well as other factors critical to a functioning food system that may be affected by climate change, then conducted a social media analysis of how US residents communicate about food surrounding climate shocks, and finally to utilize mental models through an interview process with residents in Vermont. Results were generated using mixed methods, ranging from complex systems and data science, interdisciplinary data integration, interviews, mental models, and text mining.</p> <p>Target audiences for this work have included multiple groups from the global to local scale. Academic manuscripts have contributed to the scholarly literature, but the project has also produced briefs that were distributed to farmers and Cooperative Extension as well as agricultural advisors.</p> <p><b>Results:</b> With survey data from 19 countries and more than 107,000 children, researchers found that “higher long-term temperatures are associated with decreases in overall child diet diversity, while higher rainfall in the previous year, compared to the long-term average rainfall, is associated with greater diet diversity.... Results suggest that warming temperatures and increasing rainfall variability could have profound short- and long-term impacts on child diet diversity, potentially undermining widespread development interventions aimed at improving food security.”*</p> <p>This project led to considerable outcomes and key results: six peer-reviewed publications, one research brief distributed through Cooperative Extension, and three separate presentations on the topic at the National Academies of Sciences and Medicine. Furthermore, the project directly</p>	
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		<p>resulted in collaborations across institutions as well as presentations to a wide array of policymakers and academics through the National Academies of Sciences for example.</p> <p>The full report can be found here:</p> <p>* Niles, M. T., Emery, B. F., Wiltshire, S., Brown, M. E., Fisher, B., &amp; Ricketts, T. H. (2021). Climate impacts associated with reduced diet diversity in children across nineteen countries. <i>Environmental Research Letters</i>, 16(1), 015010. <a href="https://doi.org/10.1088/1748-9326/abd0ab">https://doi.org/10.1088/1748-9326/abd0ab</a></p>	
<p>22.</p>	<p><b>National Animal Genome Research Program (Research)</b></p>	<p><b>Relevance:</b> Epigenetic modifications have the potential to influence variation in economically important phenotypes of agricultural species. The effects of 5-methylcytosine (5-mC) on economically important traits in livestock has been characterized but 5-hydroxymethylation remains largely unexplored. Hydroxymethylation is a recently discovered epigenetic modification that occurs when 5-mC is oxidized, is prevalent in brain tissues and promotes transcription.</p> <p>The overarching intent for this project was to generate a profile of 5-hydroxymethylation in three tissues of the bovine brain and investigate differential hydroxymethylation between two groups of cattle with extreme measures of docility.</p> <p><b>Response:</b> We utilized a combination of whole genome bisulfite sequencing (WGBS) and oxidative reduced representation bisulfite sequencing (oxRRBS) techniques to identify 5-</p>	<p>Animal Health and Production</p>



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		<p>hydroxymethylcytosine (5-hmC) across the genome at a single nucleotide resolution. Four unique brain tissues (prefrontal cortex, periaqueductal gray, cingulate gyrus, hippocampus) were analyzed for two groups of steers with extreme measures of docility (n=4 per group).</p> <p><b>Results:</b> Our findings identify hydroxymethylation in each tissue and across the genome. However, 5-hmC varied across chromosomes in a tissue-specific manner. Additionally, differential 5-hmC was identified between docile and non-docile animals in three tissues. The amount of differential 5-hmC varied significantly between tissues, emphasizing the tissue-specific nature of 5-hmC within the brain. Characterization of 5hmC in functionally distinct bovine brain tissues provides further functional annotation of the bovine. This innovated work was the first of its kind with regard to an economically important trait in any livestock species. Results of the bovine brain methylation and hydroxymethylation project have been disseminated through a publication as well as oral and poster presentations.</p>	
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<b>OPTIONAL Youth Development Expenditures (dollars)</b>	
State and/or Institution:	FY 2020 Expenditures (\$)
1862 Smith-Lever	\$259,813
1890 Extension	N/A