Minnesota (University of Minnesota) Annual Report - FY2021

Report Status: Approved as of 07/08/2022

Contributing Organizations

University of Minnesota

Executive Summary

Overview

This report highlights the accomplishments of University of Minnesota Extension and the Minnesota Agricultural Experiment Station (MAES) in 2021. Impacts achieved by the University of Minnesota have made a difference in addressing 10 critical issues, as outlined for NIFA in 2019.

Extension reports on impacts for 16 programs related to these critical issues made by its four program centers — Agriculture, Food and Natural Resources; Community Vitality; Youth Development; and Family Development. Extension's Regional Sustainable Development Partnerships (RSDP) connect Extension to local stakeholders for several critical issues and manage the work of Clean Energy Resource Teams (CERTs). MAES highlights research within its five partner colleges that is making a difference related to these critical issues.

In many cases, MAES research informs Extension programming. Many of the 18 Extension program results and 17 research project results highlighted in this report were achieved jointly by Smith-Lever and Hatch programs.

Critical Role of NIFA Capacity Funding in 2021

COVID-19 has exacerbated already persistent racial inequalities in Minnesota. Ranking nationally at the top or near the top of race-based disparities in terms of health (fourth), economics (second), and education (first), these gaps widened during the pandemic.

Black, indigenous and people of color (BIPOC) have died of COVID-19 at double and triple the rate of white people. Low-income jobs were lost at much greater rates and poverty increased at a faster rate for people of color. Minnesota's legislators and Minnesota Departments of Health and Human Services declared racism a public health crisis in the aftermath of the 2020 murder of George Floyd.

This is a backdrop to USDA's promise to "build back a better future for historically underserved communities" and to "take steps to level the playing field for our constituents." The National Institute of Food and Agriculture (NIFA) developed a national framework for a clear pathway for addressing health equity.

University of Minnesota President Joan Gabel has also promised a commitment to equity, diversity and inclusion. People working in research and Extension in 2021 became more aware, acknowledged roles in inequities and co-created opportunities in partnership with those who are negatively affected by disparities.

USDA-NIFA capacity funding provided the University of Minnesota with fundamental annual support that allowed researchers, Extension specialists and Extension educators to adapt, coordinate and respond to the needs of Minnesota. Many of the impacts featured within this report reflect these priorities and the mobility that was required to adjust to the changing needs of our state and University.

Extension Summary of 2021 Activities

In 2021, Extension reached approximately 568,000 adults and youth through direct educational programming and reached tens of thousands more through partners. Online access was increasingly important in 2021, and individuals came to Extension's website 12 million times to find needed information. Extension programs have met people where they are by producing 17 podcasts that are listened to in cars, tractors and while gardening. Blogs and social media have also continued to grow in importance for reaching target audiences.

With Extension's ongoing commitment to reach underserved audiences, several program areas achieved parity in programming. Twenty-four percent of Minnesotans are now Black, indigenous and people of color (approximately 14 percent in Greater Minnesota). Examples of programs near or beyond parity, or beyond parity with new members, include:

- 24 percent of family resiliency program participants were Minnesotans of color.
- 32 percent of health and nutrition participants were Minnesotans of color, while 100 percent are low-income.
- 30 percent of newly recruited "First Generation" 4-H'ers were youth of color, while 10 percent of youth development participants overall were Minnesotans of color (a drop in overall parity that may be related to the pandemic).
- 19 percent of community economics participants were Minnesotans of color.

Extension hosted 5,234 events in 2021, not including the events and activities of 800 chartered 4-H clubs and the 17,600 young people participating in livestock showcase events. Online education surged during the pandemic, yet in-person education is recovering. Extension has trained and supported volunteers who committed 973,556 hours of service to Minnesota's youth, natural resources and communities in 2021. The independent sector values these contributions at $27,785,288.

MAES Summary of 2021 Activities

This report summarizes the effort and results of over 150 capacity-funded research projects conducted by more than 100 project directors at five University of Minnesota colleges: College of Food, Agricultural and Natural Resource Sciences (CFANS), College of Biological Sciences (CBS), College of Veterinary Medicine (CVM), College of Education and Human Development (CEHD), and College of Design (CDES). While the research efforts are reported under critical issue areas, the majority of this research is broad-based and interdisciplinary and has impacts on multiple critical issues.

Though Hatch funding accounts for less than 10 percent of the annual funds for MAES research, NIFA non-discretionary funds are essential to generating research outcomes like those highlighted in this report. NIFA non-discretionary funds support general use infrastructure, including greenhouses and research fields, ensuring that researchers have what they need to start projects and generate outcomes and impacts. They also provide critical funding for staffing that allows us to leverage and match other external funding sources. Notably, these funds are used to assist early-career faculty as they start research programs. Without these funds, there would be less applied research, less real-world application of research and less integration of research and Extension.

Critical Issue: Building Strong, Resilient Families

Resilience is the process and outcome of successfully responding to stressful experiences. Families under stress can improve resiliency through access to high-quality education and skill development that improve long-term outcomes.

Extension in this category includes programs in parenting education, family financial literacy, military families and new collaborative work in addressing the opioid crisis in rural Minnesota. Extension reached 10,186 people in this area through direct education, while a model of fostering coalitions and networks brings wide ripple effects. Programs in this category held 460 events and published 18 peer-reviewed research reports. Impacts highlighted for 2021 come from programs in parenting and family financial literacy.

MAES researchers furthered studies related to technology's impact on family communication, elder financial exploitation, and the effectiveness of and access to various health services in rural areas. Researchers are also developing training tools and resources to aid workers helping refugee families acclimating to Minnesota.

Research project highlight from REEport: *Gender identity and sexual orientation in rural contexts: Implications for parenting, youth development, and service providers*, Jenifer McGuire

There has been rapid cultural shift across the United States and in Minnesota in factors relevant for sexual and gender minority persons, those whose sexual orientation and/or gender identity or expression fall outside heterosexual or cisgender societal norms. This cultural shift has taken hold first in urban areas, and is enacted with less consistency throughout rural America. Rural healthcare centers have fewer resources available for specialized gender care support, so care often requires travel to urban centers. One area of critical need is assessment approaches that measure the full spectrum of gender diversity and can be used by a broad spectrum of the healthcare community.

Researchers from the U of M Institute for Sexual and Gender Health worked with gender clinics to identify the need for new clinical assessment measures that reflect binary and non-binary identities. Researchers developed two new assessment tools: the Genderqueer Identity Scale (GQI), the Family Gender Environment Scale (FGE). They also revised two longstanding gender instruments to address the

full gender spectrum that includes non-binary identities: the Utrecht Gender Dysphoria Scale (UGDS-GS) and the Body Image Scale (BIS-GS). Researchers made all four assessment tools available for free online.

Many clinical assessment measures cost money to administer or score, so making these gender identity instruments available for free makes them more accessible to healthcare providers in all settings. Over 103 entities have signed collaborative agreements to download and use the measures and 45 have indicated a desire to share data with the researchers. The collaborators include community clinics and hospitals, clinicians in private practice, and university based gender clinical research programs. Improving clinical assessment tools and making them more accessible connects more gender diverse youth with the services and support they need.

Critical Issue: COVID-19 Response and Recovery

Per instruction from the USDA PARS staff, we are not highlighting individual projects and programs related to our COVID-19 response and recovery efforts as a standalone critical issue. Many of our researchers and Extension program leaders reported on the modifications made to their projects to respond to and address challenges presented by the pandemic.

Extension addressed many challenges related to COVID-19, as stated in the 2021-25 Plan of Work. Efforts are embedded in several of the program and project results highlighted in this report. Extension results/impacts with COVID relevancy are about: Co-creating culturally relevant health and nutrition programs with diverse communities (includes section on vaccine hesitancy); meat processing bottlenecks and other business supply chain challenges; the health of diabetic and prediabetic individuals who are more at-risk for COVID-related complications and death; and youth isolation through more safe outdoor exploration and continued “4-H at Home” activities.

Examples of research projects looking at the economic impacts of COVID-19 are highlighted in the Resilient Communities and Economies critical issue. Our researchers are also using Hatch funds to respond to COVID-19 by:

- Studying how how COVID-19 is impacting regional supply chains
- Working on diagnostic technologies that can identify virus variants and help control viruses to prevent them from spreading
- Gaining insights on family financial anxiety during the pandemic
- Tracking the way COVID-19 has disrupted in-person addiction recovery programs and developing new interventions to help individuals who don’t have access to in-person services

Critical Issue: Crop, Plant and Food Development and Production

The need to feed a growing population while preserving the environment is a key concern of the field of agriculture today. In Minnesota, crop and landscape plant industries contribute to the rural and state economy. The University of Minnesota focuses on improving productivity, profitability and environmental stewardship.

In this category, Extension reached 70,367 adults and 28 youth, not including the Master Gardener volunteer program, which reached 85,933 Minnesotans. Educational events, 229 in number not including Master Gardener events, were held both in person and online, reaching 477 underserved participants (people of color). Faculty members published 92 peer-reviewed research articles. A force of 2,790 Extension Master Gardener volunteers contributed 135,822 hours of service. Severe drought challenged crop producers and horticulture in 2021, and supply chain bottlenecks challenged crop producers. Extension responded with research-based information addressing agronomic, horticultural and financial considerations, as well as the impact on rural stress.

Impacts highlighted for 2021 come from Extension programs in food safety (Serve It Up Safely), Regional Sustainable Development Partnerships work on the perennial grain Kernza, Institute for Agricultural Professionals, Gardening from the Ground Up and Master Gardener.

MAES researchers advanced projects that leverage data to model agricultural and climate scenarios, create new agricultural and horticultural varieties suited to Minnesota’s current and changing growing conditions, and investigate and develop more sustainable agricultural production practices.

Critical Issue: Health and Nutrition

Minnesota's poverty rate is low, but statistics mark some of the largest health and economic disparities in the country. The University of Minnesota focuses on making systemic changes that promote the health and wellbeing of Minnesotans.

Extension reached 60,852 individuals through health and nutrition direct education and partners/systems. Faculty members and educators in the Extension Center for Family Development published 34 peer-reviewed research articles, most of which were on topics in health and nutrition. Impacts highlighted for 2021 include coaching prediabetic individuals and their families in preventing the disease, and co-creating culturally relevant health and nutrition programs with diverse communities.

MAES researchers studied new practices and interventions to help individuals deal with addiction and recovery, intimate partner violence, and managing chronic health conditions like diabetes. Researchers advanced studies on how various nutritional elements impact health outcomes and moved technologies that will improve the health and wellbeing of thousands of Minnesotans towards commercialization.

Critical Issue: Integrated Animal Systems

Minnesota's livestock industry includes dairy, poultry, swine, and horse farms throughout the state. The University of Minnesota focuses on increasing the sustainability, profitability, and quality of care across the livestock industry.

Extension in this category reached 80,016 adults and 938 youth. Educational Events, 238 in number, were held both in person and online, reaching 191 underserved participants (people of color). Faculty members published 61 peer-reviewed research articles. Impacts highlighted for 2021 come from programs in the Regional Sustainable Development Partnerships and beef research and education.

UMN researchers tested new production practices, optimized nutrition, and measured the effectiveness of various biosecurity practices to improve animal health and living conditions. They increased their understanding of how viruses mutate and spread throughout swine and poultry populations and worked to develop vaccines to fight devastating disease outbreaks.

Critical Issue: Natural Resource Management

Minnesota is home to one of the most biodiverse land systems in the U.S. Minnesota's forests provide timber, wildlife habitat, recreation, wilderness and biodiversity to the state. The University of Minnesota focuses on improving environmental conservation across the state.

Extension reached 152,043 adults and 16,608 youth in this category, with 3,617 adults contributing 231,327 hours of volunteer service. Educational events, 1,860 in number, were held both in person and online and the programs reached 17,762 people of color. Faculty members published 28 peer-reviewed research articles. An impact highlighted for 2021 comes from Pesticide Safety and Environmental Education.

In 2021, MAES researchers advanced research that is creating the best habitat to sustain and increase pollinator populations, contributing to greater understanding of and measures to combat invasive species in Minnesota, conserving wildlife, and protecting Minnesota’s forests, air quality and water resources.

Research project highlight from REEport: *Biology, Control and Biotechnological Uses of Forest Fungi*, Robert Blanchette

The invasive emerald ash borer (EAB) has killed millions of ash trees in the U.S. and Canada. Minnesota is home to one of the largest concentrations of ash trees in the country, and all of them are threatened by EAB. Current control measures for high valued trees include injection with insecticides but other methods such as biological control that have broad application and sustained long-term effective control are just being evaluated.

The larval stage of the emerald ash borer feeds on the layer of ash wood just beneath the bark, causing disruption of water and sap flow that results in tree death. The EAB larvae also leave behind tunnel galleries on tree trunks that fungi colonize. The fungal community associated with EAB larval galleries is poorly understood and the role these fungi may play in tree death or to control the beetle is not known. A team of UMN researchers in collaboration with the Minnesota Terrestrial Invasive Plants and Pests Center and several Minnesota communities collected over 1,000 fungal samples from EAB-infested ash across Minnesota. The team identified various fungi living in EAB-infested trees — a critical first step in finding fungi that may be harnessed to control the spread of EAB.

The team identified three distinct types of fungi associated with EAB infestations in Minnesota: 1) fungi that cause cankers or dead spots, 2) fungi that cause the rapid decay of the trees’ wood, and 3) entomopathogenic fungi - that is, fungi capable of parasitizing the insect and killing it or slowing its spread. Prior to this discovery, managers simply weren’t sure what fungi – good or bad – were associated with local EAB infestations.

Identifying and documenting the prevalence of these three groups of fungi - especially the fungi that attack the beetles - is a critical first step in finding fungi that may be harnessed to control the spread of emerald ash borer. The team is now studying whether any of these beneficial fungi could be used to fight the invasive insect by preventing EAB larvae from developing or by attacking the eggs or adult beetles.

Since it was first found in the state in 2009, EAB has spread across 31 counties in Minnesota. With nearly one billion ash trees in Minnesota, the spread of emerald ash borer will have a serious impact on our forests and communities. Ash trees help maintain the water table and habitat in wet, forested areas and reduce air pollution and storm water runoff in urban areas. Homeowners and municipalities

spend millions of dollars annually to treat, remove, and replant ash trees. In many cities, the main strategy to control the beetle is aggressively cutting down ash trees and insecticide treatments. Identifying species of fungi that attack emerald ash borer is a crucial first step in developing new biological control measures to fight this devastating tree pest.

Critical Issue: Resilient Communities and Economies

External forces such as globalization and demographic shifts can't be controlled, but local responses can. Resilient communities grow local leadership, plan for a sustainable future, and support local businesses.

Extension in this category includes programs in agricultural business management, economic development, and leadership and civic engagement. In agricultural business management, 4,740 adults were reached, including 73 people of color. Extension held 91 events on topics related to farm management and tax issues and faculty members published three peer-reviewed research articles.

Between community economics and leadership and civic engagement, Extension reached 12,758 adults and 79 youth, including 1,863 people of color. Volunteers contributed 1,318 hours of service. 210 events were held. Faculty members published four peer-reviewed research articles, and programs provided 133 applied research reports.

Extension's Regional Sustainable Development Partnerships (RSDP) contributed impacts in this critical issue. RSDP engages 618 adult Minnesotans in volunteering, advising, and project implementation and outreach. Volunteers contributed 14,163 hours. RSDP reached 15,941 adults and 4,093 youth in 2021.

MAES researchers explored COVID-19 related economic issues like supply chain shortages and extreme volatility in certain ag markets. Researchers also advanced studies looking at the economic impacts of climate change and various federal and state policies.

Critical Issue: Sustainable Energy and the Bioeconomy

Minnesota continues to diversify its renewable energy landscape and bioeconomy. The University of Minnesota focuses on developing system-wide solutions that look at not only the output but inputs as well. Researchers are finding new uses for renewable products and developing more sustainable energy and manufacturing processes. Extension is working to connect individuals and communities across Minnesota to the resources they need to implement community-based clean energy projects.

In 2021, Extension programming by Clean Energy Research Teams (CERTs) was delivered through 28 public education events and at an additional 391 meetings and presentations hosted by others. The Clean Energy Job Board, CERTs' most popular resource, hosted 222 postings. CERTs published 159 new stories to give others a sense of what's possible, to allow them to learn from peers and to inspire them to take action. CERTs distributed stories through the MN Energy Stories email newsletter digest, reaching more than 13,000 Minnesotans.

In 2021, MAES researchers advanced technologies that use agricultural and natural resources byproducts and waste products to produce energy and other sustainable products. Researchers also collaborated with manufacturing industry partners to develop new processes to create adhesives and polymers from renewable materials, rather than products of fossil fuels.

Critical Issue: Water Resources and Quality

Renowned as the Land of 10,000 Lakes and the headwaters of the Mississippi River, Minnesota's waters are critical to the state's identity and economy. The University of Minnesota focuses on improving the health and biodiversity of lakes, rivers, streams, and wetlands throughout the region.

Extension in this category reached 30,055 adults and at least 17 youth, with 73 volunteers contributing 1,866 hours of service. Educational events, 159 in number, were held both in person and online. Faculty members published 10 peer-reviewed research articles. Impacts highlighted for 2021 come from the Nutrient Management and Nitrogen Conferences, the Soil Management Summit, and the Starry Trek event to monitor starry stonewort.

University of Minnesota researchers are helping Minnesota manage our current water resources and prepare for the impacts climate change may have on our ecosystems. Minnesota is projected to have higher amounts of precipitation and larger precipitation events. In 2021, our researchers made progress on several projects that are helping Minnesota communities manage and treat wastewater and stormwater. Researchers also advanced projects that will keep nutrients in fields and out of waterways and that are monitoring how upstream practices affect watersheds downstream.

Critical Issue: Youth Development

Of the million young people living in Minnesota, 35 percent are under-engaged in enrichment experiences and 40 percent report not having a meaningful connection to a caring adult in their community. Many of these youth, of every age, gender, race, socio-economic status, religion, and family type, are not on a positive pathway.

Extension in this category reached 25,771 4-H youth participants, with 6,700 screened adult volunteers. 4-H remains committed to ensuring positive experiences for members and their families who are entirely new to discovering the 4-H program. Internally, these are called First Generation members. In 2021, 61 percent of all new members, 3,600 young people, were First Generation members.

Additionally, education of youth workers over the course of 49 events reached 3,733 adults who in turn, through their own organizations, will affect the lives of many more youth for whom Extension does not collect data.

Faculty members published six peer-reviewed research articles, and educators also produced four youth development podcasts and 34 blog posts on youth development topics. Because Extension also reaches youth through other critical issue areas, this report counts a total of 46,302 youth reached through direct education.

In 2021, MAES researchers studied how technology can be used to increase parent engagement with children's educational institutions, how young people lead philanthropic efforts, and the financial practices of college students.

Research highlight from REEport: *Educators toolkit for addressing racial trauma*, Tabitha Grier-Reed

Hate crimes in the United States have increased by record numbers in recent years. A movement toward nationalistic, xenophobic, nativist attitudes regarding race, religion, immigrants, refugees, and other outgroups is occurring in rural Minnesota and elsewhere, particularly as demographics shift. Experiences of danger, threats of harm, shame, and/or humiliation due to one's race is traumatic, and this racial trauma can be experienced directly or vicariously. In the age of social media, like many videos, racial trauma can go viral, where exposure to racially traumatic events has been associated with increased anxiety, depression and post-traumatic stress disorder (PTSD) as well as negative academic outcomes such as lower GPA.

To help educators be more effective in meeting the needs of diverse students, researchers worked within the African American Student Network (AFAM) to study and identify examples of racial trauma in students' experiences as well as evidence of posttraumatic growth. They synthesized key findings from AFAM and related research into recommendations for other educators and institutions to develop tools to create spaces that support students experiencing racial trauma.

The team developed The Educator's Toolkit for Addressing Racial Trauma website and professional development materials. The toolkit brings together student voices, resources and scholarship to help teachers and professors in Minnesota and beyond support Black students. Educational personnel including teachers, psychologists, professors and others (e.g., consultant/designer/advisor) provided feedback during the pilot phase which resulted in important changes such as explicitly identifying resources for K-12 versus postsecondary educators. Positive feedback included the benefits associated with not only defining and contextualizing racial trauma but also having clear strategies and advice for supporting students on the website. The practicality of the toolkit was emphasized. Since the website launched, there have been 1,274 page views with an average time spent per view of 1 hour and 41 mins suggesting meaningful engagement with the toolkit.

Empowering educators with the language and tools to effectively support students encountering experiences of racial trauma in ways that foster growth introduces an assets-based narrative that balances the focus on adversity with possibilities for wellbeing and positive development. In fact, research undergirding the toolkit has found that posttraumatic growth seems connected to Black students' ability to flourish. This is important, particularly in Minnesota which is known for the steep achievement gap between Black and White students, and where tools and resources that contribute to the ability of Black students to flourish and that shift from deficit to strengths-based approaches are sorely needed. Importantly, on a national scale given the negative psychological consequences associated with racial trauma such as anxiety, depression and posttraumatic stress, The Educator's Toolkit for Addressing Racial Trauma provides resources that can assist in addressing "the nation's youth mental health crisis."

Merit and Scientific Peer Review Processes

Updates

No changes from 2021 Plan of Work. Promotion and tenure data are below.

Extension

Eight individuals successfully were promoted through the 2020-2021 promotion cycle.

MAES

Following the merit review process laid out in the 2021 Plan of Work, MAES supported researchers were evaluated for promotion/tenure within their partner college in accordance with University policy.

As the primary receiver of MAES funds, we provide updated CFANS tenure track data annually:

- As of May 2022, CFANS has 183 tenured faculty and 31 non-tenured.
- Of those, 126 are full professors with tenure, 57 are associate professors with tenure and 31 are assistant professors.
- In 2021, 8 assistant professors were promoted from assistant to associate professor and 2 faculty were promoted from associate professor to full professor.

Stakeholder Input

Actions to seek stakeholder input that encouraged their participation with a brief explanation

None.

Methods to identify individuals and groups and brief explanation

None.

Methods for collecting stakeholder input and brief explanation

None.

A statement of how the input will be considered and brief explanation of what you learned from your stakeholders

Extension Updates

County Investments: In Minnesota, counties negotiate contracts with Extension that provide them access to educators who deliver local programming from Extension's four centers. Every three years, the cost of these programs /positions is negotiated between Extension Administration and the Association of Minnesota Counties. As a means of aligning the local educator prices across the four centers and increasing the number of Agriculture, Food, and Natural Resources (AFNR) educators, Extension reduced the contract price for AFNR educators by 12 percent. The price of 4-H Youth Development educators and Master Gardener coordinators increased by 2.25 percent. This strategy resulted in a 2.175 FTE increase in AFNR positions and a .47 FTE increase in 4-H Youth Development over the previous year. Ultimately, 65 counties increased their investment, and 22 counties decreased their investment. Overall, county investments in Extension programming increased by 1.78 percent ($314,690), demonstrating that local leaders continue to value Extension's expertise and impacts.

State and local advisory committees are key contacts for Extension leaders.

Regional Sustainable Development Partnerships (RSDP):

In 2021, regional boards, work groups and idea generators coordinated by RSDP influenced Extension priorities, especially related to five critical issues. Regional boards used stakeholder input to inform 158 community projects across these issue areas.

Crop, Plant and Food Development and Production: Volunteer work groups weighed priorities and opportunities and tapped University of Minnesota teams for sustainability projects. With the support of community-university partnerships, RSDP helped the perennial grain crop Kernza make its way onto farm fields and through supply chains to consumers, with benefits to soil health, water quality and local economies. A USDA grant is supporting continued research on RSDP's innovative "backhaul model," which is piloting a new method for connecting small- and medium-sized crop producers to wholesale markets by leveraging empty wholesale truck space and using rural grocery stores as a docking station. And RSDP is coordinating a hazelnut grower network in North Central Minnesota to connect interested farmers with hazelnut breeders developing new cultivars.

Resilient Communities and Economies: Volunteer work groups identified project priorities. As a result, RSDP worked with the Minnesota-based nonprofit 100 Rural Women to advance leadership networks for women across rural Minnesota. In Southwest Minnesota, RSDP supported digital engagement strategies during the COVID-19 pandemic. Videos and webinars served as virtual elements of the We Are Water Minnesota exhibit, which advanced local sustainability goals and partnerships. RSDP supported virtual workshops with diverse vegetable farmers with expertise in soil health; materials were made available in Hmong.

Natural Resource Management and Water Resources and Quality: Volunteer work groups identified local priorities for environmental stewardship. RSDP collaborated with University of Minnesota Duluth and The Nature Conservancy in a statewide Forest Assisted Migration Project, which is helping Minnesota's northwoods stay resilient to climate change. RSDP and community partners released new and improved farm-scale winter greenhouse designs, which have been downloaded from Extension's website more than 2,000 times. A tribal community project with Leech Lake Early Childhood Development, the Megwayaak Project, drew upon the known benefits of playing in nature to connect children to the outdoors.

Sustainable Energy: Based in Extension RSDP, the Clean Energy Resource Teams (CERTs) is a statewide partnership helping individuals and communities advance clean energy projects. Regional steering committees guide CERTs' work and serve as the clean energy work groups. Regional steering committee members gather and exchange ideas to inform programming.

Integrated Animal Systems: RSDP regional boards and work groups identified supply chain bottlenecks, which were exacerbated by the COVID-19 pandemic, as a critical issue facing Minnesota farmers, retailers and consumers. RSDP worked with community partners and Extension educators to conduct research and advance solutions to a lack of meat-processing capacity facing Minnesota livestock producers. Activities included surveying meat processors across Minnesota on their workforce needs, conducting case studies of processing facilities, exploring market opportunities for halal and kosher meat markets, and working to improve access to meat processing for tribal communities.

Other stakeholder engagement outcomes:

A host of critical partners inform and support Extension programming. Below are four 2021 examples:

- Vaccine hesitancy was a priority topic nationwide in 2021 and University of Minnesota Extension efforts appear in this report. Extension learned from and collaborated on vaccine education community events with the Minnesota Department of Health, the University of Minnesota Medical School's Department of Family Medicine and Community Health, as well as with local community stakeholders, such as Somali community leaders and grocery store owners.
- Youth Development: County investments in 4-H youth development programming were largely maintained or increased (see County Investments update). A return to in-person activities was welcome and celebrated among multiple partners and groups as ways of protecting health during the pandemic were improved. Online activities continued to be popular with those concerned about exposure to COVID-19 and with those who found virtual gatherings to be convenient and effective.
- Crops and livestock representatives: Minnesota crop farmers and livestock producers are well represented by associations that have deep relationships with and respect for Extension. They need the University to align research and education with the challenges they face and collaborate on solutions, as well as to advance agriculture as a career through 4-H and the Institute for Agricultural Professionals. In crops research and education, some key relationships are with the Minnesota Corn Growers, Minnesota Soybean and Minnesota Wheat. Issues that Extension addressed with them in 2021 were a severe drought, weed management, diseases and insect pests, and other agronomic issues. In livestock research and education, some key relationships are with Minnesota Milk Producers, Minnesota Pork and Minnesota Beef, poultry associations, and a growing number of groups producing lamb and goat. Drought also affected livestock in 2021, as did biosecurity and supply-chain issues. Biosecurity education and efforts in 2021 were key in protecting many farms from the highly pathogenic avian influenza that is unfortunately affecting many other farms in 2022. The COVID-19 pandemic complicated tax issues for both crops and livestock producers, and Extension tax courses for agricultural professionals are one of the impacts highlighted in this report.
- The Statewide Food Shelf Survey is the only survey of its kind in the state and is conducted every two years by SuperShelfMN, a partnership organization of which University of Minnesota Extension is a founding member. The survey aims to better understand the food access needs of food shelf clients across the state. Results from the survey informed Extension's 2021 health and nutrition programming and progress on the SuperShelf concept, which treats food shelf clients with dignity and improved experiences. Extension has implemented the survey, and will do so again in 2022, collaborating with the Minnesota Department of Health, Hunger Solutions Minnesota, Regional Food Banks, Foundation for Essential Needs and other partners. A working group includes food shelf clients and managers among key food-access stakeholders.

Highlighted Results by Project or Program

Critical Issue

Building Strong, Resilient Families

Family Financial Literacy

Project Director

Catherine Dehdashti

Organization

University of Minnesota

Accession Number

7000106

Financial Educator Certificate Program prepares frontline staff

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Frontline agency staff helping limited income families with financial tasks often have not been formally trained in financial education or may not have options for professional development to meet their needs.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

University of Minnesota Extension family resiliency educators have expertise in financial education and online facilitation and curriculum. A research colleague in family social science consulted with Extension educators as they developed the Financial Educator Certificate (FEC) program, an online, asynchronous course. The goal of FEC was to develop a quality, affordable, scalable and self-sustaining financial educator certification program in Minnesota to meet the needs of frontline workers who work with families and their financial concerns on a regular basis.

In the past year, online professional development education, accessible at any time, has become more necessary for workers who may be dealing with multiple challenges in their work and personal lives. The course is comprised of 10 modules and conducted from September to April in a cohort (group) method, in which modules are opened at two- to three-week intervals and the online participants work at a common pace throughout the year. The course incorporates a variety of learning activities to meet varied learning styles and new technologies to make the course engaging for learners. Flipgrid, videos, quizzes and Zoom are just a few of the tools used. The modules include earning, spending, saving, borrowing, asset protection, consumer protection, financial behavior theory, financial education delivery models and program evaluation.

Briefly describe how your target audience benefited from your project's activities.

Extension educators advertised the course from May to August, making use of email and social media with targeted audiences, including community action programs, community colleges, four-year colleges and universities, high school teachers, and professional organizations. Educators adapted the course to address the current and emerging needs of students, particularly those related to COVID-19 issues.

The 2020-21 cohort had 15 graduates completing all requirements. Twenty-one students enrolled in the 2021-22 cohort and are currently engaged in the coursework.

Individuals reported their personal outcomes, including feeling “refreshed” as their personal financial selves, feeling committed to “paying themselves first,” having reviewed their credit reports, employed cost-cutting strategies, created a budget and reduced personal debt.

One former participant said, "Personally, FEC equipped me with the tools and resources to interrupt generational poverty, create economic security, and build wealth. Professionally, It contributed to my ability to better serve community members to create a spending plan, close money leaks and overcome the cycle of living paycheck to paycheck."

Briefly describe how the broader public benefited from your project's activities.

Organizations have benefitted from each learner's enhanced ability to teach financial education and improve program and delivery quality. Individuals increased knowledge and built confidence to manage their own finances and work with others to become financially secure. For some individuals, there have been new opportunities, such as financial coaching or counseling that organizations had not previously been involved with. The course provides them with the delivery skills to carry out these programs with many future client beneficiaries.

Parenting Education

Project Director

Catherine Dehdashti

Organization

University of Minnesota

Accession Number

7000109

Fathers model positive behaviors with activity, healthy eating

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

University of Minnesota Extension focuses on parents and caregivers because they are perhaps the most critical protective factor for child and youth outcomes. However, too often men and fathers are not included when it comes to parenting education and health and nutrition programs. Parents and caregivers have been challenged during the pandemic, especially those from BIPOC and other marginalized communities (those with limited income families, families with disabled caregivers, etc.). For families to function well in these challenging times, all parents and caregivers need skills and tools, regardless of sex/gender.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

During the past year, Extension's Supplemental Nutrition Assistance Program Education (SNAP-Ed) program in Minnesota has focused on developing more programs specifically tailored to men and fathers.

In one case, men and their children from diverse cultural backgrounds, speaking multiple languages, were invited to participate in an in-person, nature-based event. Men, fathers and their family members from diverse backgrounds joined to build relationships with each other and to learn outdoor physical activity skills, such as paddle boating, canoeing, bike riding, fishing, camping, and how to make and eat healthy foods.

Another project, Latino Fathers Promoting Healthy Youth Behaviors (AFRI Padres Informados), aimed to prevent obesity among Latino adolescents by engaging families, especially fathers or other male caregivers in the household (foster parents, uncles, grandparents or older brothers), and their child (10-14 years old) in a culturally and linguistically appropriate prevention program. The project adopted a community-based participatory research approach. Extension staff actively partnered with community organizations serving Latino populations in both urban and rural areas in Minnesota. The curriculum was adapted from an evidence-based parenting curriculum titled *Padres Informados, Jóvenes Preparados.* This eight-week program has shown to be effective in improving Latino parenting practices for preventing youth substance abuse. The adapted program focused on improving behaviors by increasing parent involvement in positive parenting practices. The positive parenting practices included providing a supportive environment for healthy eating and physical activity, setting expectations, and role modeling. Other behaviors included fruit and vegetable consumption, participating in family meals, and engaging in physical activity.

Briefly describe how your target audience benefited from your project's activities.

Men and fathers who participated in this SNAP-Ed program took their own pictures of their activities inside and outside of the classes as a participatory evaluation method. At the end of the program, they selected and shared their own photos with other participants and staff members (Men and Fathers PhotoVoice report).

Comments included “This program made me go outside more and do more physical activity,” “I learned new skills like bike riding, canoeing and camping,” and more.

The Padres program showed reductions in fathers’ intakes of sugar-sweetened beverages, sweets/salty snacks and fast food and improvements in adolescents’ weight status outcomes. Attending at least seven of eight sessions was associated with lower father unhealthy food intakes and lower adolescent sweets/salty snack intakes. When all sessions were attended and when mothers also attended, body-mass index of adolescents was lowered.

Fathers reported they became role models for eating more fruit, and adolescents reported that fathers communicated screen-time expectations. The Padres program was conducted entirely by distance after the COVID-19 pandemic.

Briefly describe how the broader public benefited from your project's activities.

Youth benefit when all parents and caregivers are engaged in family life. The men and fathers in this SNAP-Ed program said they looked forward to the gatherings every week, and the outcomes showed in their many submitted photos showing fathers grocery shopping for and preparing healthy foods with their children, and spending time together outdoors through physical activity. Photographic evidence shows the kind of close relationships that help buffer the stressful times youth and parents, especially those in BIPOC and low-income families, have experienced during the pandemic.

For the Padres program, favorable results showed that parent diet and physical activity will lead to healthy outcomes. Further adolescent outcomes are anticipated but may take more time to appear when a program’s focus is on teaching the modeling role to parents.

Elder Financial Exploitation: Family Risk and Protective Factors

Project Director
M Stum
Organization
University of Minnesota
Accession Number
1013907

Progress Report

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Elder family financial exploitation (EFFE) is one of the most prevalent and growing types of elder abuse. The costs and consequences of EFFE go beyond the older victims, to family members, and society creating a significant elder justice crisis. The voices and perspectives of affected family members and older victims are largely absent from existing EFFE literature.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The overall goal of this multi-state project is to better understand the phenomena of elder family financial exploitation (EFFE) from multiple levels and lines of inquiry with an eye toward prevention and intervention. Participants are utilizing sub-group mixed methods research strategies and a socioecological theoretical model to address existing gaps in the EFFE emerging literature. Given common interests in family systems and EFFE, Axton Betz-Hamilton, a project participant from South Dakota State University and I continue to work as a collaborative sub-project team. Our sub-group contributed to the following project objectives in the past year: A) understanding family members’ experiences related to EFFE, C) Conceptual and theory development; and D) disseminating findings and implications to identified target audiences.

Betz-Hamilton, myself, and a graduate student are working on a manuscript to contribute new knowledge about the heterogeneity of EFFE perpetrator profiles. Analysis was completed, findings and discussion drafted, literature reviewed and summarized, and methods section developed. First submission to a journal was in May, 2021; revision and resubmission to another journal was June/July). The manuscript has been revised and is currently under second review for the Victims and Offenders journal (Elder family financial exploitation offenders: Examining the complexities of problematic behaviors) Elder

family financial exploitation (EFFE) affects victims, families, and society, yet little is known about the problematic behaviors of EFFE offenders. The purpose of this study was to (a) explore the range and scope of problematic behaviors of EFFE offenders; and (b) examine common combinations of EFFE offenders' problematic behaviors. Interviews were conducted with 28 non-victim, non-offender family members from 23 families. Seven themes reflecting problematic offender behaviors were identified: mental health concerns, financial dependence, other abuse, financial irresponsibility, substance abuse, a sense of entitlement, and legal problems. An in-depth understanding of the behaviors was identified, including how and why behaviors were connected to each other. Offenders exhibited two to six problematic behavioral themes. The findings suggest a need for multiple, integrated interventions that fit the complex behavioral realities of individual offenders and the family systems in which EFFE occurs.

A version of the perpetrator problematic behaviors paper was presented at the 2021 Association for Financial Counseling and Planning Education (AFCPE) annual symposium and will be published in the symposium proceedings (in press). Betz-Hamilton, A., Stum, M., & Chan, A. (2021, November). Elder family financial exploitation offenders: Examining the complexities of problematic behaviors. Proceedings of the 2021 Association for Financial Counseling and Planning Education Symposium.

Briefly describe how your target audience benefited from your project's activities.

Identified target audiences for the multi-state project include gerontology and family scholars, a range of practitioners involved in prevention and intervention of EFFE, and intergenerational family members (adult children and older parents). In the past year our team and my sub-project collaborated on dissemination efforts to reach a range of multidisciplinary scholars and practitioners interested in elder abuse/exploitation. A theory focused manuscript was accepted for publication in the Journal of Family Theory and Review reaching a wide range of family scholars (on-line and now in print December 2020). A paper on perpetrator behaviors was presented at the 2021 Association for Financial Counseling and Planning Education (AFCPE) annual symposium and will be published in the symposium proceedings (in press) reaching family financial scholars and practitioners. A professional development webinar was offered to address identified needs of professionals associated with the MN Elder Justice Center.

Briefly describe how the broader public benefited from your project's activities.

An understanding of risk and protective factors in family systems is critical to optimize and inform EFFE prevention and intervention strategies. Developing family system strategies can help to reduce the costs and consequences of EFFE for elders, family members, and society

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

One Family Social Science graduate student has been active in the project during the past year, gaining hands-on experience with qualitative interview data analysis, systemic reviews, and co-authoring presentations and publications. Professional development (via webinar) on EFFE from a Family Systems Perspective was offered to 120 professionals as partners with the MN Elder Justice Center (May 2021).

Publications:

- Chan, A, & M. Stum. (December 2020). The state of theory in elder family financial exploitation: A systematic review. The Journal of Family Theory and Review. 492-509. https://doi.org/10.1111/jftr.12396

- Chan, A. & M.Stum (November 2021). A Family Systems Perspective of Elder Family Financial Exploitation: Examining Family Context Profiles. Journal of Applied Gerontology. Online. https://journals.sagepub.com/eprint/3JNAZNJBPDWVGADQSY3B/full

In project year 4 my contributions to the multi-state goals will continue to focus on Stum & Betz-Hamilton sub-project collaborative efforts. A minimum of one referred journal manuscript acceptance is expected by Spring 2022.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Elder family financial exploitation (EFFE) is one of the most prevalent and growing types of elder abuse. EFFE is part of a larger emerging elder justice crises with immeasurable costs and consequences for elders, their family systems and society. The negative impact of elder abuse goes well beyond the economic losses, impacting an elder's physical, mental, emotional and psychological health and well-being. The costs and consequences of EFFE also extend to family members and state and local governments. EFFE can result in elders and family members increasing short and longer term reliance on a range of public resources and programs (i.e. physical and mental health).

Researchers from the University of Minnesota and South Dakota State University completed an analysis of elder family financial exploitation perpetrator profiles. The research team interviewed non-victim, non-offender family members that experienced EFFE to examine common combinations of EFFE offenders' problematic behaviors. They identified seven themes reflecting problematic offender behaviors: mental health concerns, financial dependence, other abuse, financial irresponsibility, substance abuse, a sense of entitlement and legal problems. Researchers gained an in-depth understanding of the behaviors, including how and why behaviors were connected to each other.

This deeper understanding of the factors that make individuals likely to perpetrate elder family financial exploitation will help a range of practitioners develop stronger EFFE prevention and intervention strategies. Gerontology and family scholars, policymakers, and intergenerational family members can use these research findings to better understand the complex behavioral realities of EFFE offenders, and take steps to prevent or stop the abuse. Developing effective family system strategies will help reduce the costs and consequences of EFFE for elders, family members and society.

Critical Issue

Crop, Plant and Food Development and Production

Food Safety

Project Director
Catherine Dehdashti
Organization
University of Minnesota
Accession Number
7000112

Serve It Up Safely courses reduce foodborne illness

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Certified food protection managers (CFPM) oversee the safe production of food in restaurants, day cares, institutions and other places where people eat outside of the home. In order to reduce the number of foodborne disease outbreaks, which can result in hospitalizations or death, training is required every three years to renew certification. In Minnesota, there are over 35,000 CFPM and they oversee the work of many more food handlers.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

University of Minnesota Extension offers 12 continuing education course options for CFPM which can also be used for employee training. Courses range from cleaning and sanitizing, food allergens, employee health and hygiene, and preventing foodborne illness. In 2021, there were 1850 participants in the 12 courses.

Key to the success were shorter training sessions and on-the-job assignments, which present opportunities for managers and employees to learn together. The "why" of procedures is made clear, helping employees understand the importance of their work for the health of the public.

Briefly describe how your target audience benefited from your project's activities.

Course evaluations in 2021 show that:

- 94 percent strongly agree/agree that they can use what they learned in the course at their job.
- 80 percent strongly agree/agree that they will change their food safety practices based on what they learned in the course.
- 94 percent strongly agree/agree that they will use what they learned in the course at their job training others.
- 89 percent strongly agree/agree that they will use what they learned by adding or updating standard operating policy/procedures.

Briefly describe how the broader public benefited from your project's activities.

Certified food protection managers that complete the training primarily work at health care facilities, schools, retail markets and restaurants. Having properly trained CFPM who share that knowledge with their employees can help to reduce the outbreak of foodborne diseases, thus helping to protect the health of Minnesotans.

Closing Out (end date 09/07/2023)

Expanding Knowledge of the Biology and Management of Important Soybean and Corn Diseases in the Northern U.S.

Project Director
Dean Malvick
Organization
University of Minnesota
Accession Number
1016485

Expanding Knowledge of the Biology and Management of Important Soybean and Corn Diseases

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Numerous different diseases constrain yield and profitability of soybean and corn crops in Minnesota and the North central U.S.A. The goal of this project is to develop and exploit new information on the biology and management of important pathogens and diseases of these crops with the aim of decreasing their impact on crop yield and quality. The project includes research activities in laboratory, greenhouse, growth chamber, and field locations, as well as survey work on distribution and characteristics of important pathogens.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Soybean and corn and are the crops of greatest acreage and economic value in Minnesota and the Midwestern U.S.A. My research group along with many cooperators and collaborators has been advancing knowledge of several diseases of these crops.

Selected activities and accomplishments:

- Tar spot is an invasive disease of corn caused by the fungus *Phyllachora maydis that can cause significant loss of corn grain yield*. We confirmed tar spot for the first time in Minnesota in 2019, and in 2020-2021 we detected and confirmed this disease in nine counties in southern and central Minnesota where it had not been detected previously. These results document a greatly increased distribution of tar spot in Minnesota where it could cause economic losses for corn producers.

- The soilborne, invasive fungus *Fusarium virguliforme* (Fv) causes sudden death syndrome (SDS) of soybean and root rot of other legumes. Very little was known about the population biology of this pathogen in the central and northern U.S. We characterized a set of *F. virguliforme* isolates from the Midwestern U.S. representing a south to north latitudinal gradient from Arkansas to Minnesota. We genotyped the isolates and conducted plant assays to assess virulence. Three distinct population clusters were differentiated across the isolates. Although isolates ranged in virulence classes from low to very high, little correlation was found between virulence phenotype and cluster membership. Similarly, population structure and geographic location were not highly correlated. The results support three genetically distinct population clusters of *F. virguliforme* in the U.S., with two of the clusters contributing most to spread of this fungus across the Midwest.

- Sudden death syndrome (SDS) has been managed primarily with partial host resistance over the past 20 years. More recently, specific seed treatments have been developed to manage SDS. We have conducted fields studies to determine efficacy of selected seed treatments, and our results suggest that some seed treatments can be effective in managing SDS.

Briefly describe how your target audience benefited from your project's activities.

The primary target audiences are soybean and corn producers, agricultural professionals including crop consultants, plant pathologists, soybean and corn breeders, and extension educators. This project has been developing and exploiting new information on the biology of significant diseases of soybean and corn that is used by this audience, which is leading to reduced risk of disease, improved disease management, and to training of scientists and agricultural professionals who will addres critical needs in the future.

Briefly describe how the broader public benefited from your project's activities.

Food is critical to human survival, and this project address some of the challenges to manage crop diseases and maintain and increase food production in environmentally sustainable ways. In addition to addressing specific technical and scientific questions about crop diseases and their management, this project contributes to graduate education, undergraduate student research experiences, training and professional development for postdoctorial scientists, and training of extension educators and agricultural professionals in the private sector. Results and information from this project were transferred to crop producers, crop consultants and other agricultural professionals, scientists, and extension educators. This was accomplished via extension education programs at multiple locations in Minnesota, blog posts, newspapers and magazines, radio, one-on-one consultations, telephone and email communication, and via virtual extension education program. Technical results have been presented to scientific audiences via on-line conferences, and University seminars,; and via journal publications and published abstracts.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Soybean and corn are the crops of greatest acreage and economic value in Minnesota and the Midwest U.S. Diseases decrease yield and profitability costing farmers millions of dollars each year. When a new disease emerges in the state, it's essential for farmers to learn how to identify the disease as well as how to treat it and prevent it from spreading.

University of Minnesota research is increasing understanding and preventing further spread of tar spot in corn and sudden death syndrome in soybeans.

- **Tar spot** can result in significant corn yield losses, depending on weather, severity, and timing of disease development. Risk of disease is highest where the disease has occurred previously. Through proactive research and Extension efforts, UMN researchers have detected and confirmed this disease in nine Minnesota counties where it had not been previously identified. Early detection allows UMN researchers to understand the risk of the disease spreading and to collaborate with farmers to manage the disease in future growing seasons.

- **Sudden death syndrome** (SDS) of soybeans can result in yield losses greater than 50 percent. SDS has been spreading north and west into states including Minnesota, Nebraska, and Wisconsin. UMN researchers have verified the effectiveness of seed treatments to manage SDS. Knowing which seed treatments are most effective gives soybean farmers a tool they can rely on to prevent SDS.

Proactive disease monitoring and management helps keep our food, feed and fiber supplies stable and prevent economic losses for farmers. Soybean and corn producers and agricultural professionals use the knowledge generated from this project to manage disease outbreaks and reduce the risk of spreading tar spot and sudden death syndrome. Ultimately, managing disease risk limits yield and economic losses.

Improving crops for fresh markets

Project Director
Thomas Michaels
Organization
University of Minnesota
Accession Number
1013256

Improving crops for fresh markets

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

The problem addressed by this project is that there is currently insufficient breeding and evaluation work being done to provide existing fresh market vegetable and specialty crop growers with unique cultivars of diverse crops that are well adapted to growing conditions in Minnesota and adjoining states. This project will help fill that gap by breeding adapted cultivars of some crops and for others identifying cultivars bred elsewhere that are adapted to Minnesota and adjacent states. This project will support the success of Minnesota's small farm vegetable and specialty crop producers, strengthen the market chain from breeder to consumer by encouraging new growers to take up fresh market vegetable production, stimulating seed production and informing food retailers, chefs and institutions about the availability of unique and diverse fresh market crops.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Dry Edible Beans

Selection among populations of commercially available heirloom dry beans resulted in the identification of two breeding lines from Jacob's Cattle Gold and Peregion. Internal performance trials indicated had yield exceeding the seed yields of the original populations while retaining the characteristic seed coat colors and patterns associated with the original heirloom populations. Crosses between rootrot resistant breeding lines and commercial dry bean cultivars and heirloom selections resulted in several breeding lines with early maturity and seed yield exceeding check cultivars in internal trials. Some of these breeding lines were selected to have a specific uniform expression of seed coat color and pattern unique to that breeding line while other breeding lines were intentionally selected to be a mixture of harmonious seed coat colors and patterns. These breeding lines are at a stage where they are ready for disease-free seed increase and subsequent regional testing prior to release.

Hydroponic Carrots

Four commercial carrot cultivars, 'Danvers', 'Yaya Hybrid', 'Chantenay', and 'Imperator', were trialed in a self-watering semi-hydroponic bin system intended for use in urban personal gardens such as those on apartment balconies. Bins were filled with substrates consisting of various mixtures of nonrenewable and renewable materials including: perlite, coconut coir, coarse sand, and vermiculite and irrigated by wicing a hydroponic nutrient solution from an internal reservoir at the bottom of the bin. Results from the study indicated that sand-dominated substrates, especially 75% sand medium, yielded on average the longest taproot length and fresh weight.

Hydroponic Lettuce

Several lettuce breeding lines were selected for unique appearance and performance in static hydroponics from genetically variable populations purchased from Wild Garden Seed, Willamette Valley, Oregon. These lines performed well in internal trials in the hydroponic salad table. We to collaborate with Pillsbury United Communities in Minneapolis to evaluate performance of these breeding lines in an urban farming setting using their Freight Farm vertical greenhouse located in north Minneapolis.

Sweet Sorghum for Syrup and Food Grain

Selections made from Ames Amber and Rox Orange heirloom sweet sorghum populations are in early states of evaluation. Good tasting sorghum syrup has been made from selections from both cultivars. This past year the selections were evaluated for dual purpose syrup and grain production. Seed harvested from Ames Amber is satisfactory for use as a grain for porridge or grits and for grinding into flour as a substitute for corn meal, but has some bitterness and dark specks in the ground flour from dark seed coat particles. Seed from Rox Orange has more promise as a grain and flour souce than that obtained from Ames Rox Orange grain is less bitter than Ames Amnber and has far fewer seed coat specks in the flour. Sorghum syrup from these breeding lines has been shared with a local food writer and this resulted in a new project collaborating with emerging and new immigrant farmers who will be helping evaluate and select sorghum lines, and learn syrup-making at New Roots Farm Incubator Coop near Moorhead.

Industrial Hemp for Food Grain

As part of this project, seed from naturalized hemp plants has been collected annually since 2019 from across south and central Minnesota. So far, progeny from approximately 500 collected female plants have been evaluated for characteristics associated with grain production including early maturity, moderate plant height (7-9'), moderate branching in space plantings, dense inflorescences, reduced shattering and high grain yield. The populations are still in early stages of selection and no breeding lines have been isolated or evaluated in trials. Collaborative projects with University of Minnesota and University of Manitoba food scientists has shown that hemp protein isolated from regionally grown commercial grain cultivars has good solubility in acid conditions as well as good gelation and water retention. These characteristics suggest that protein isolated from hemp grain could have utility as an ingredient in processed foods. Use of protein isolate from hemp grain in processed foods could dramatically increase demand for the grain and stimulate increased production acreage in Minnesota.

Briefly describe how your target audience benefited from your project's activities.

In previous years this project was responsible for conceiving and designing the University of Minnesota Hydroponic Salad Table for personal salad greens production in urban settings. The Director of Food Systems for Pillsbury United Communities (an NGO working toward justice and food security in Minneapolis) reported that over 50 residents of one of their housing enterprises had built and operated a hydroponic salad table for personal use. These salad tables provide one or two large salads each day from a small, inexpensive 18" x 24" hydroponic system that requires no electricity for pumps or other complex components. Residents growing a hydroponic salad table have very convenient access to fresh salad greens all growing season.

The hydroponic salad table concept has been expanded to produce carrots for fresh consumption and storage using the same sized bin as is used for the salad greens, but the deep water nutrient solution is replaced by a sand-based growth medium held over a reservoir of nutrient solution that wicks into the growth medium. Carrots were chosen as the crop for production in this system because they are a favorite snack for children and because they will store well if, at the end of the growing season, they are left in the bin under cool conditions until harvest.

Sorghum syrup production has been demonstrated to University of Minnesota students and others annually for over five years. Two of those former students have begun sweet sorghum production and are helping evaluate our selections from Ames Amber and Rox Orange heirloom populations. Further, emerging farmers who are new immigrants from Congo and Burundi will be helping with additional selection and evaluation of sweet sorghum at the New Roots Farm Incubator Co-op near Moorhead, MN. They hope to establish their own farms and market sorghum as one of their products. The former students and emerging farmers will also be assisting with evaluation of our dry bean selections.

The overall goal of the industrial hemp for food grain project is to provide farmers with an additional, viable crop for inclusion in their rotations. Growers are keen to find new, economically viable crops for their rotations that deliver ecosystem services. Industrial hemp for food grain holds promise for both economic viability and ecosystem services. Hemp's extensive, deep root system effectively sequesters carbon, builds organic matter and may intercept more leached nitrate than other crops. In addition , hemp is from a botanical family (Cannabaceae) unlike from other widely grown crops and might put different demands on, and provide new benefits to agricultural soils. If the grain can be used for oil extracion and then the presscake used to produce a high value protein isolate, demand for food grade hemp grain could dramatically increase and make a hemp crop a viable option in Minnesota crop rotations on large and small farms alike.

Briefly describe how the broader public benefited from your project's activities.

The Hydroponic Salad Table and Carrot Bin both target the broader public and so the public, particularly urban public in food deserts, are direct beneficiaries of this work. With some support and following available instructions, gardeners and non-gardeners alike can conveniently produce a salad a day, and also grow carrots, on a very small footprint that is idea for west and south facing balconies in urban settings.

The dry bean work will result in supply of unique dry beans with exciting seed coat colors and patterns that will be available through CSAs, Farmers Markets and food coops for home cooks to use when making recipes calling for dry beans. We are intentionally selecting beans for their ability to be cooked quickly and without seed coat damage from the dry state (no prior soaking) in “Instant Pot” type electric pressure cookers.

New selections of industrial hemp for food grain production will offer to consumers a new food and a food ingredient substitute where hemp protein isolate will take the place of soy, pea and whey protein isolates. Some individuals may have sensitivities or allergic reactions to existing protein isolates. At this time sensitivities and allergies to hemp protein isolates have not been reported.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Since 2019, shortly after Minnesota developed an industrial hemp pilot program, industrial hemp for food grain production was added as a crop under investigation by this project Also at that time potato was dropped as a crop under investigation by this project due to the hiring of a new potato breeder in the Horticultural Science Department who took responsiblity for specialty type potatoes in addition to her focus on conventional commercial type potatoes.

The hydroponic salad table and industrial hemp projects have stimulated the curiosity of many students and reseach experiences drawn from this project are regularly shared in the classroom. Three undergraduate students have recently completed undergraduate research project associated with lettuce, carrots and industrial hemp. This Fall, one of these students will be starting a MS degree program focusing on ecosystems services provided by industrial hemp.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Nearly a third of Minnesotans lived in areas with low access to healthy, affordable foods in 2016 and over 15 percent of Minnesota’s census tracts qualify as federally designated food deserts (Wilder Research). Land access is a challenge for potential home gardeners who want to grow their own healthy foods but reside in urban areas and/or multifamily living residences.

Previous work related to this research project led to the design of the University of Minnesota Hydroponic Salad Table for personal salad greens production in urban settings. This hydroponic system can be built with 10-gallon storage totes and other inexpensive materials and requires no external power source. Now researchers have expanded the hydroponic salad table concept to produce carrots using the same system as is used for the salad greens. Researchers found which carrot cultivars and combinations of materials and nutrient solutions yield the best results in this growing system and have started sharing these results publicly. The team chose to study how to incorporate carrots into this hydroponic growing system to give families a vegetable that may be more appealing to children.

The University of Minnesota Hydroponic Salad Table enables individuals who have little or no access to land but who have a 2' x 4' outdoor space to grow salad greens, and now carrots as well. The Food Systems for Pillsbury United Communities (an NGO working toward justice and food security in Minneapolis) reported that over 50 residents in their housing enterprises have built and operated a hydroponic salad table for personal use. The hydroponic growing system plans are available for free online, so anyone with internet access can obtain this information to start their own hydroponic growing system.

With pandemic-driven supply chain issues disrupting food availability and rising food costs, enabling individuals to grow vegetables at home on a small footprint improves access to healthy foods for those who live in food deserts or have limited access to land.

Multi-state Coordinated Evaluation of Winegrape Cultivars and Clones

Project Director

Matthew Clark

Organization

University of Minnesota

Accession Number

1013836

Multi-state Coordinated Evaluation of Winegrape Cultivars and Clones

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

This project addresses testing new grape varieties and breeding lines in multiple-states to evaluate for variety release and grower recommendation. Additionally, wine making practices are discussed. The goal is make preliminary investigations of genotype x environment interactions for novel grape varieties.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Provided testing material to multiple sites for evaluation. Data from sites (Iowa State and U. Wisconsin-Madison) informed our breeding team as to which varieties to move forward. We have chosen to patent and release MN1220, a variety that has been part of the NE1020-NE1720 multi state program thanks to the quality data. This variety is not suitable for our location (zone 4) but having testing sites in USDA zone 5 meant that we could be confident in variety release for those areas.

Briefly describe how your target audience benefited from your project's activities.

Target audience (regional wine makers and grape growers) benefit from the data collected in these reports. New varities have been trialed at multiple states and the information gained has helped in making recommendations to growers. Our data focuses on winter injury and cold hardiness as well as disease resistance. This data is importatn for sustainability for stake holders.

Briefly describe how the broader public benefited from your project's activities.

The grape and wine industry in Minnesota represents over $80M per year in economic impact. This includes toursim, winery, and grape production sectors. Rural economies in Minnesota benefit from these agribusiness that support cultural enrichment, community gathering spaces, and introduce agriculture to consumers.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

New NE2220 proposal has been submitted and is in review.

Multi-state Coordinated Evaluation of Winegrape Cultivars and Clones

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Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

New NE2220 proposal has been submitted and is in review.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

With changing climate and increased weather variability, finding new grape cultivars that are well adapted to their growing regions, is important to sustain rural tourism, winery, and grape production sectors. Planting a poorly-adapted cultivar in the wrong place is a costly mistake. Vineyards can face expensive replanting and retraining costs after winter injury, and poorly adapted cultivars tend to ripen inconsistently and produce inferior wines.

After more than 20 years of evaluation in a variety of environments across the Midwest, the MN1220 grape variety is being released under the name 'Clarion'. Clarion has a less vigorous growth habit than other cold-hardy varieties and its loose grape bunches contribute to reduced disease and insect pressure for conventional production methods - making it easier and more affordable for growers to manage in the vineyard. Clarion grapes produce superior quality white wines compared to other cold-hardy white varieties - making it more appealing to wineries and consumers.

Clarion grapes are well adapted for USDA Zone 5, expanding the options available to grape growers, wine producers, and wine consumers across midwestern states like Iowa, Nebraska, Illinois, Indiana, and southern Minnesota and Wisconsin. Growers in these regions can diversify their plantings with a resilient cultivar that is well-suited to their growing conditions. The 20-plus years of evaluation in a variety of environments will give growers confidence that they're making a good investment when planting Clarion grapes.

Crop Plant and Food Production

Project Director
Catherine Dehdashti
Organization
University of Minnesota

Accession Number
7000113

Education for agriculture professionals gives deeper understanding to those new to the field

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Extension historically has provided farmers research-based education on crop production. However, as farming has become more complex, more farmers have turned to consultants and agriculture professionals to advise them on specific decisions related to farming. The University of Minnesota Institute for Agriculture Professionals (IAP) connects agriculture professionals with the latest crops research to help them better advise farmers on economically and environmentally wise crop management decisions.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The IAP's Field School for Agriculture Professionals is a two-day summer hands-on program that combines training with real-world field scenarios. In July 2021, the field school was offered in person again after being canceled in 2020 due to the pandemic. 129 participants from across the midwest came to St. Paul to learn from University of Minnesota researchers and Extension specialists. The first day focused on core principles in agronomy, entomology, weed and soil sciences to build a strong foundation of skills and knowledge. The second day built on that foundation by giving participants a choice of timely, cutting-edge topics.

Briefly describe how your target audience benefited from your project's activities.

The IAP's Field School for Agriculture Professionals provides a valuable continuing education opportunity to agronomists, crop production retailers, seed dealers, consultants, crop protection industry representatives, government agency personnel and summer field scouts. Attendance was the highest for first-time attendees, showing that IAP's goal to focus on recent and incoming hires in the ag industry is being met. Faculty and educators dedicate effort toward recent graduates and others that are just entering the industry, especially on the first day of the event, in order to develop the foundational knowledge and skills needed to be successful in an agriculture professional's career.

Participants report coming to the event to enhance and remain current with current crop diagnostic skills. In an evaluation of the event:

- 94 percent agreed/strongly agreed that "I have a deeper understanding of the subject matter."
- 89 percent strongly agreed that they "have situations in which I can use what I have learned at this program."
- 67 percent agreed that "I will change my practices based on what I learned today."

Briefly describe how the broader public benefited from your project's activities.

Providing professional development to agriculture professionals on research-based practices in agricultural production systems can lead to reduced or more efficient use of fertilizers and pesticides, more sustainable long-term management of soils and crop pests, improved water quality, and increased long-term profitability.

Communities benefit as pesticide exposure to people and the environment is reduced, water quality is enhanced, and more farmers have increased disposable income, which has a multiplier effect in the community.

The crop protection industry and producers benefit as valuable pest management technologies are preserved via delayed resistance development.

New crops provide ecosystem services and economic opportunities

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Designing new agricultural systems that provide healthy food and protect both farmers and the environment is a grand challenge for the future of agriculture.

Over time, the once diverse Minnesota agricultural landscape became a system in which only one or two crops might be grown on a farm and for only a short portion of the year. This uniformity results in significant costs to the ecosystem, diets and farmers' economic resilience. With active roots in the soil for only a few months, there is low water-use efficiency, increased nutrient leaching and soil erosion, and ecosystem services are not provided for bees and natural predators. Without the proper roots in place, nitrate nitrogen leaves the system and pollutes surface and groundwater, and soil health is compromised.

Too often, farmers lack economically viable solutions to make the necessary changes.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The University of Minnesota Forever Green Initiative is developing a suite of new crops including the perennial intermediate wheatgrass Kernza, hybrid hazelnuts, elderberries and new winter-hardy oilseeds that protect water and soil, provide income to farmers and supply exciting end products.

University of Minnesota Extension is providing the infrastructure development necessary to move these new crops to markets. Extension's Regional Sustainable Development Partnerships (RSDP) supply chain specialists build relationships among researchers, growers, retailers and consumers. This includes identifying farmers interested in piloting the new crops and businesses interested in incorporating them, and connecting these farmers and businesses with the raw materials for product testing and development. Extension RSDP also works with Extension educators to host in-person and virtual field days to provide education on the new crops. For example, at a 2021 Kernza field day event, Extension educators taught growers and communities about soil health and how these crops play a role in that development.

Briefly describe how your target audience benefited from your project's activities.

Because of the collaborative efforts among researchers, Extension, farmers and industry partners, Kernza, a crop developed by the University of Minnesota and The Land Institute, is now receiving significant attention. Kernza was named by Whole Foods as a top food trend for 2022, and Cascadian Farms Kernza cereal is now on Whole Foods shelves across the country. Martha Stewart Living also featured Kernza on marthastewart.com. Small business owners, such as bakers, have collaborated by testing Kernza's properties in baking and shared their results. Creating more awareness of Kernza and its benefits helps create demand for the product, further motivating farmers to grow the crop and allowing the crop to provide more ecosystem services.

Briefly describe how the broader public benefited from your project's activities.

As a whole, new perennial crops benefit both farmers and the public by providing profitable cropping systems that farmers can adopt while increasing soil health and improving water quality. By improving awareness of and access to Kernza, businesses have access to a new food ingredient to incorporate into products that provide nutritional value to consumers.

Horticulture and Master Gardeners

Project Director
Catherine Dehdashti
Organization
University of Minnesota
Accession Number
7000111

Gardening from the Ground Up teaches environmentally friendly practices

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

With the onset of the COVID-19 pandemic in spring 2020, county-based University of Minnesota Extension educators noticed a trend in calls from their communities that expressed a new and returned interest in gardening. There was a need to provide information on gardening basics, as well as interest in more environmentally friendly practices that could better protect the ecosystem. As the needs and interests continued in 2021, a successful series called Gardening from the Ground Up was expanded.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Several county Extension educators joined together to create an online educational series. Four webinars were held in 2021, attracting 934 participants. Seminars included Starting a Garden from Scratch, Selecting and Starting Plants for your Garden, Tree and Shrub Maintenance and Lawn Care, and Pest Management. Participants included backyard/hobby gardeners, community gardeners and Master Gardener volunteers, who multiply the knowledge by sharing it in their communities.

Briefly describe how your target audience benefited from your project's activities.

After the webinars:

- 98 percent of participants said that they learned at least one thing they could use in their garden or yard.
- 92 percent said that they know how to create a garden or prepare their garden for a successful start.
- 98 percent said that they have a better understanding of how to start seeds.
- 94 percent understand how to prune trees.
- 100 percent said that they know the proper timing for lawncare activities.

Select quotes from surveys:

- I am glad that I took the class. I always learn and keep learning. Thank you for putting it together.
- I greatly appreciate the opportunity to distance-participate, and you did a great job providing a variety of relevant and fascinating topics.
- Loved the beneficial insects the best - all of your speakers have been so knowledgeable!
- Excellent information; some ideas I will use immediately, and some thoughts I will store for future use.
- So much useful information and presenters are so well versed and easy to listen to. Thank you so much! I will share info with fellow family gardeners!
- Excellent sessions - good introduction level, not too deeply technical.
- Wonderful! I cannot believe all the resources you are providing.

Briefly describe how the broader public benefited from your project's activities.

Better gardening practices can help to maintain soil health, reduce the use of pesticides and create more pollinator-friendly habitats. Gardening and increased green space can also help with the wellbeing of people.

Master Gardener volunteers build resilience, responsibility

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Gardening has continued to grow in popularity, particularly during the pandemic. People and communities seek resources to effectively garden, grow food and protect their landscapes. With the plethora of information available online, it can be difficult for gardeners to find reliable information tailored to their region's climate and growing conditions, and to help them implement best practices.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The University of Minnesota Extension Master Gardener volunteer program includes nearly 2,800 active Master Gardeners who share University of Minnesota horticultural expertise in every county of the state of Minnesota. Master Gardener volunteers help their neighbors understand and use research-based information and practices that can improve their quality of life while minimizing negative impacts on the environment and natural resources.

In 2021, University of Minnesota Extension's Master Gardener volunteers provided 135,822 hours of service across the state.The Master Gardener program offered 1,446 educational events that engaged 85,933 participants. Highlights from the 2021 Master Gardener report, include

- Master Gardeners conducted research on pepper varieties for the cold climate of northern Minnesota, benefiting gardeners and donating hundreds of pounds of peppers to local food shelves.
- Teachers in after-school programs reported students became more responsible after learning from Master Gardeners how to give plants the care they need to survive.
- Master Gardeners taught at a community garden run by Mayo Clinic Health System at the Eastridge Clinic in Mankato, which serves more than 50 low-income individuals. The collaboration included a wellness class on growing and using lavender plants, an aromatherapy practice that recovering addicts report gives comfort.

Briefly describe how your target audience benefited from your project's activities.

The Extension Master Gardener volunteer program provides a meaningful opportunity for volunteers to engage with their communities. Among the benefits that they bring to communities: county programs worked with 130 community gardens and 65 school-based gardens, and assisted with 36 Habitat for Humanity projects/homes. Groups donated 12.7 tons of produce to food banks and pantries, installed/maintained 21 rain gardens, and installed/maintained 212 pollinator gardens. These efforts increase access to healthy foods and enhance local environments.

Briefly describe how the broader public benefited from your project's activities.

Because of the work of Extension Master Gardeners, more people are growing food locally, planting pollinator-friendly gardens and creating resilient landscapes that help manage stormwater runoff. Their efforts also help young people develop into contributing members of society, and help those who are struggling grow in their wellness.

Now more than ever, Master Gardener volunteers are connecting with people to share University research-based knowledge on priorities that are important to Minnesota residents. Coaching people to grow food locally, increase green space and improve environmental conditions benefits communities across the state. Programs help to improve overall health and wellbeing.

Critical Issue

Health and Nutrition

Health and Nutrition

Project Director

Catherine Dehdashti

Organization

University of Minnesota

Accession Number

7000108

Co-creating culturally relevant health and nutrition programs with diverse communities

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Minnesota's 350 food shelves were on pace to end 2021 with 3.7 million visits, just below the record 3.8 million in 2020. Hunger in African American, Latino and Native American communities is higher than in other communities due to systemic racial injustice. The pandemic exacerbated food insecurity among families with children and communities of color.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

In 2021, University of Minnesota Extension developed, field tested and studied outcomes of culturally relevant programs with diverse cultural communities. Extension involved participants in designing educational processes, worked with agencies and partners with the trust of diverse communities, supported BIPOC staff and vendors to design programs and processes for members of their unique communities, and worked with the University community on how to engage diverse communities.

In addition to work addressed through other programs with Hispanic and Latino audiences, Extension worked with and for the benefit of Indigenous, Black and Somali communities throughout Minnesota on culturally relevant nutrition, COVID awareness, addiction and resilience.

Briefly describe how your target audience benefited from your project's activities.

Indigenous communities

Extension, with partners, has consistently enlightened communities to the struggles of opioid addiction in tribal communities. Changemaker retreats mobilized willing communities into action. Multiple projects are changing local systems so that they better support adults and their children through addiction and recovery, and so that communities can become better educated about life-saving options, such as testing for fentanyl contamination and administering rescue medication.

Extension also co-created a culturally driven health promotion model called SAGE+ for preventing diabetes and other chronic disease for Indigenous middle-aged women. Staff who are members of the Anishinaabeg tribal community worked with a community organization and the American Indian elder's lodge in an urban setting to reconnect members to cultural healing and healthy eating through indigenous foodways and traditions.

Black communities

Partnering with Old Ways, a national organization led by Black researchers and partners, Extension educators tested the A Taste of African Heritage (ATOAH) nutrition education program in an urban setting. Pilots of the ATOAH with 22 participants resulted in 97 percent and 93 percent participation rates, even though maintaining participation across multiple sessions has historically been difficult. Understanding of African Heritage Foods by participants grew, and 89 percent agreed that the cultural focus will influence their eating and healthy lifestyle choices and have already tried curriculum recipes at home.

Somali communities

Nine Somali grocers working with Extension educators increased their knowledge about COVID-19 and vaccines and have taken steps to protect themselves and their customers. The grocers play culturally relevant health information and recommendations on TV screens in the grocery stores and distribute information developed by Extension in partnership with the School of Public Health. One grocer said, “These recommendations are perfectly written and it’s very important for me to know how to reduce the risk of contracting the disease and share this information with our customers.”

WhatsApp is the most popular messaging platform across Africa, and many in Minnesota’s Somali community use it to communicate with friends and family. One educator translated the curriculum into bite-sized culturally relevant messages. One hundred percent of the participants indicated behavior changes in diet, physical activity and shopping habits. They ate more fruits, vegetables and whole grains; read labels and bought from a shopping list; and increased exercise. Participants learned to prevent chronic illnesses, understand parenting styles and child development, and communicate better with their children overall and about sensitive topics like substance use.

Briefly describe how the broader public benefited from your project's activities.

Following the racial crisis of 2020 in Minnesota after the murder of George Floyd, Minnesota Extension was encouraged by the USDA’s promise to “build back a better future for historically underserved communities” and by the National Institute of Food and Agriculture’s (NIFA) plan to develop a national framework for a clear pathway for addressing health equity. This wide-ranging work – during the COVID-19 pandemic – delivers on this promise for underserved communities right now and builds the framework for the future. Communities have become part of the program development process, and Minnesota Extension will continue to develop programs in this way, becoming an example USDA and NIFA can share with other states.

Coaching prediabetic individuals and their families in preventing type-2 diabetes

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Of Worthington, Minnesota’s 42 percent Hispanic or Latino residents, approximately 16 percent will develop type-2 diabetes, and 35 percent have prediabetes. Preventing or delaying the onset of type-2 diabetes became even more crucial during the COVID-19 pandemic, as diabetes is a major risk factor for increased health effects and death from the virus. Furthermore, Hispanic and Latino populations face health disparities that often mean they have less access to health care to coach them on prevention.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

I CAN Prevent Diabetes (ICPD) is a year-long Extension SNAP-Ed program designed to help individuals diagnosed with pre-diabetes prevent or delay the onset of type-2 diabetes. Trained lifestyle coaches (SNAP-Ed educators) guide participants through weekly discussions about healthy eating, the benefits of regular movement, coping with stress and more. They support participants in their efforts to lose weight and become more active. In 2021, new distance delivery allowed people to take part in the lifestyle change program regardless of their location. Before the pandemic, the courses were all in-person.

Briefly describe how your target audience benefited from your project's activities.

In late September 2021, University of Minnesota Extension SNAP-Ed received full recognition from the CDC-recognized National Diabetes Prevention Program (DPP), effective until September 2026, for delivering ICPD via distance learning. This distinction is only given to organizations that meet the highest standards for average weight loss, attendance/retention and physical activity minutes reported by participants.

Evaluation from a previous year showed that Extension ICPD participants who completed the program lost an average of 6.2 percent of their body weight. A weight loss of 5 percent to 7 percent of body weight (10 to 14 pounds for a person weighing 200 pounds) reduces the risk of developing type-2 diabetes by 58 percent in adults at high risk for the disease (National Diabetes Prevention Program).

Several participants of the virtual program shared that the class was incredibly convenient and allowed for more sharing and bonding with other members as well as the lifestyle coach.

Despite the unforeseen and ongoing challenges of COVID-19, individuals in programs with National DPP oversight were successful in achieving their goals. At 12 months, 63 percent of completers met their risk reduction goals, with a 5 percent weight loss, 4 percent weight loss and 150 minutes of physical activity, and .2 percent reduction in baseline Hemoglobin A1C.

Briefly describe how the broader public benefited from your project's activities.

Diabetes is a chronic disease that affects approximately 8 percent of Minnesotans, with 18,000 new cases diagnosed each year. When people have diabetes, their risk of other major health conditions dramatically increases, including heart disease, kidney disease, nerve problems and vision loss. The cost of their regular health care increases. In 2017, people with diagnosed diabetes in Minnesota had an estimated medical cost of $4.7 billion dollars and people with undiagnosed diabetes had an estimated additional cost of $373 million dollars. When individuals are supported in preventing diabetes, it reduces the costs associated with their medical care and the burden on medical and insurance systems generally. Diabetes is the most expensive chronic condition in the United States, with $1 out of every $4 health care dollars spent on caring for people with diabetes. For those older than 65, costs are mainly paid by Medicare, a government-sponsored program. For each person who completes the program, the cost savings over 10 years (minus the cost of running the program) is $3,926.

Sources:

https://www.health.state.mn.us/diseases/diabetes/data/diabetesfacts.html

https://www.cdc.gov/chronicdisease/programs-impact/pop/diabetes.htm

https://nccd.cdc.gov/Toolkit/DiabetesImpact/Dashboard

Critical Issue

Integrated Animal Systems

Detection and Control of Porcine Reproductive and Respiratory Syndrome Virus and Emerging Viral Diseases of Swine

Project Director
Declan Schroeder
Organization
University of Minnesota
Accession Number
1021135

edefining the PRRSV paradigm: Persistence, Re-infection, Re-emergence and Spread

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Porcine reproductive and respiratory syndrome viruses (PRRSVs) are (+)ssRNA viruses that are the causative etiological agent of PRRS; a syndrome that is responsible for the largest health-related losses in the U.S. swine industry. Despite the research effort allocated to PRRS in the U.S., key aspects of the disease evolution, diagnosis and control are yet-to-be resolved. Here we propose to leverage resources from multiple groups within the CVM, directed at the multistate project NC229, to develop an ambitious plan that will fill key gaps in our knowledge on PRRSV persistence, re-emergence and spread.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Over this reporting period we showed that PRRSV continues to mutate, causing disruptive PRRS outbreaks in farms that lead to reproductive failure and respiratory disease-associated mortality. In an ASM Microbiology Resource

Announcements paper published on August 15, 2021, we present four new PRRSV type 2 variants in the United States belonging to four distinct orf5 sub-lineages within lineage 1. This paper uses and reports on the newly developed Oxford Nanopore Technologies NGS approach to PRRSV sequencing.

In addition to the ASM paper, we published on June 5, 2021, in Vaccines that PRRSV can be subdivided and the most prevalent lineage (Lineage 1, accounting for approximately 60% of available sequences) can be subdivided into eight sublineages.

Bayesian coalescent SkyGrid models were used to estimate each sub-lineage's effective population size over time.

We show that a new sub-lineage emerged every 1 to 4 years and that the time between emergence and peak population size was 4.5 years on average (range: 2-8 years). A pattern of sequential dominance of different sub-lineages was identified, with a new dominant sub-lineage replacing its predecessor approximately every 3 years.

Regarding PRRSV epidemioogy, intitial results were promising. However, a combination of challenges in the logistics of the platform operation, COVID-related restrictions, and confidentiality issues prevented the success of SPREAD based modeling experiments. Specifically, (1) SPREAD require data to be shared with Australia, which raised concerns among US swine producers, and (2) because of COVID-related restrictions imposed by Australia, it was not possible to meet in person with our collaborators to try to overcome logistics issues. There do not seem to be good perspectives for progress on the use of the SPREAD platform. For those reasons, these experiments were discontinued 1+ year ago and efforts were focused on the sequencing based experiments of the project.

Briefly describe how your target audience benefited from your project's activities.

We communicated our results diretly to stackholders. Here are a fewways in which we accolmplished this:

Schroeder, VanderWaal, Corso, Rovira, Paploski & Kikuti: presented to veterinarians at the Leman virtual conference in Sept, 2020

Schroeder & VanderWaal: attended the CRWAD and North American PRRS symposium (both virtual), December2020

We also published our results in two key high impact peer reviewed journals. The scientific community understands the need and benefit gained from a PRRSV genome based surveillance program.

Briefly describe how the broader public benefited from your project's activities.

Given the impact of SARS-CoV-2 on society as a whole, the broader general public is now more familarwith the concepts around variants, breakthroughs, spread and immune escape. Our project highlights that these concepts also holds true for swine and its virus variants.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Porcine reproductive and respiratory syndrome viruses (PRRSVs) cause PRRS - a syndrome that is responsible for the largest health-related losses in the U.S. swine industry. Despite the significant research effort allocated to PRRS in the U.S., key aspects of the disease evolution, diagnosis and control are yet-to-be resolved. The viruses spread and mutate rapidly. The circulation of multiple PRRSV strains at the same time is a challenge in PRRSV diagnostics, surveillance and control.

University of Minnesota researchers showed that PRRSV continues to mutate, causing disruptive PRRS outbreaks that lead to reproductive failure and respiratory disease-associated mortality. The research team documented four new PRRSV type 2 variants within lineage 1 in the U.S. over the past six years. They also found the most prevalent lineage (Lineage 1, accounting for approximately 60 percent of available sequences) can be subdivided into eight sublineages. Researchers leveraged these findings to create models to estimate each sublineage's effective population size over time. The models allow researchers to identify how often new sublineages emerge and the time between emergence and peak population size.

Given the impact of COVID-19 on society as a whole, the broader general public is now more familiar with the concepts around variants, breakthroughs, spread and immune escape - these concepts also hold true for swine and its virus variants. This research increases the scientific community's understanding of the way porcine reproductive and respiratory syndrome viruses mutate. By actively monitoring PRRSV evolution and increasing the understanding of how the virus mutates, researchers can better anticipate and respond to new variants, and hopefully reduce the spread and persistence of PRRS outbreaks. Better control of PRRS will contribute to healthier swine, fewer PRRSV-related losses for swine producers and a safe and stable food supply.

Environmental Impacts of Equine Operations

Project Director
Krishona Martinson
Organization
University of Minnesota
Accession Number
1021154

Environmental Impacts of Equine Operations

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

This project incorporates research on horse husbandry, manure management, pasture management, and carcass disposal with the goal of minimizing negative environmental impacts of equine operations. This project will review existing data, investigate and conduct research where data is lacking, and incorporate all data to assist horse owners, and those who advise them, in realizing the value of horse best management practices.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The primary goals that I contribute to are pasture and carcass management practices. We continue to explore grazing forages other than perennial, cool-season grasses in horse pastures. We recently found that berseem clover, annual ryegrass, and winter rye appear to be the best-suited cover crops to extend the grazing season in horse pastures. These species tended to be nutrient-dense but were lower yielding, and the grasses tended to have an inverted Ca:P ratio. Unfortunately, herbage of purple top turnip and daikon radish was not preferred by the horses and considered unpalatable, although the cover crop species yielded well and were nutrient-dense. Additionally, we found that teff, an annual warm-season grass, could be successfully grazed by horses. When compared to a cool-season grass and alfalfa, teff had lower amounts of amino acids; however, the only difference in horse plasma amino acid was decreased threonine concentrations in horses grazing teff. Additionally, teff has lower nonstructural carbohydrate and higher fiber values compared to cool-season grass and alfalfa. When grazed by horses, blood insulin levels were lower for horses grazing teff compared to the cool-season grass in the fall and late fall. As a result, the lower nonstructural carbohydrate and higher fiber values of teff could help decrease the insulin response of horses grazing in the fall and late fall. To explore equine carcass composting as a disposal option, a survey was first used to gauge owners and veterinarian perceptions surrounding this option. One thousand two hundred and twenty-five horse owners and 244 equine veterinarians completed the survey. The majority of respondents were female between 41 and 60 years of age with long-term industry involvement. Horse owners (86%) and veterinarians (84%) that preferred chemical euthanasia tended to prefer burial (58% and 42%, respectively) over other mortality disposal methods. Only 12% of horse owner respondents had ever tried composting and only 25% of veterinarian respondents had ever recommended composting. Horse owner (47%) and veterinarian (67%) respondents indicated they would be more open to trying and recommending mortality composting if more scientific research were available. Therefore, equine mortality composting shows potential as a primary disposal method for the equine industry. Research and educational programs are key to industry-wide acceptance of equine mortality composting. To provide horse owners and professionals with research-based

information, a study was designed to evaluate equine mortality composting in the Upper Midwest during fall and spring, document sodium pentobarbital concentrations throughout the process, and determine nutrient content of finished compost. We found that horse mortalities were successfully composted and piles contained only large bones after 6 months of composting. Sodium pentobarbital remained detectable at trial conclusion (<0.002 to 1.49 mg kg-1 dry matter); however, composting reduced the estimated quantities of sodium pentobarbital by ≥94%. Compost from each season met ideal land application values for organic matter (45 – 48%), pH (7.3 to 7.6), and electrical conductivity (3.3 to 3.4 mmhos cm-1). Low NPK and high C:N ratio (20 to 30) indicate compost could partially replace synthetic fertilizers when land applied. These findings suggest equine mortality composting is an effective management practice during fall and spring in the Upper Midwest. While remaining sodium pentobarbital residues were minimal, further research is needed to determine environmental implications of composting chemically-euthanized equines.

Briefly describe how your target audience benefited from your project's activities.

The target audience for this project is horse owners, industry professionals, and University faculty. Study results were disseminated to our audience primarily through University Extension programming efforts. Programming efforts included website information, e-newsletter articles, posts on social media sites, online courses, infographics, and in-person presentations at workshops and field days. Additionally, industry and University professionals were reached through society and professional meetings and conferences and peer-reviewed publications. This audience has used our research results to advance their knowledge of horse pasture and carcass management to optimize best management practices. Specifically, our audience now has viable options to extend the grazing season through the use of alternative forages proven safe for horses. Additional, composting has been identified as an environmental safe and viable option for horse mortality management. Scientifically, these research discoveries have helped fill technical voids and have served as spring boards for future research on related topics.

Briefly describe how the broader public benefited from your project's activities.

There has never been more public pressure on livestock owners to ensure proper care and welfare of their stock, including horses. Our research aims at optimizing horse forage utilization, which accounts for the major feedstuff (e.g. forages) in the horse ration. This information is helpful to the broader public in two main ways. First, horse owners and professionals have access to applied, cutting edge, research-based information that helps improve horse management, care, and feeding. By disseminating this information widely, horse owners are better able to make better, more informed decisions. This pleases the general public, sheds a positive light on animal husbandry practices, and helps to remove societal pressures from livestock owners. Additionally, because of our project, horse owners have access to research-based information and can help educate the general public on recommended horse husbandry practices focused on forage utilization. A more educated general public is key to gaining support and acceptance for practices commonly seen in U.S. animal agriculture production and management. The United States is home to over 7.2 million horses. With an estimated annual mortality rate of 1.4%, approximately 100,800 equine mortalities occur annually. In contrast to other livestock, horses are not usually consumed by humans and have long lifespans. As a result, a majority of horses are humanely euthanized for terminal medical conditions. Our research on composting as a horse carcass best management practice has far reaching public health ramifications and has proven imperative to protecting wildlife, domestic animals, and the environment. We are confident that composting provides a practical and environmentally-friendly alternative to traditional equine mortality management options year round in the Upper Midwest.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

There are no major changes or problems to report for this project. Over the course of this project, professional development opportunities have included participation in the virtual and in-person annual project meetings and the virtual Animal Mortality Management Symposium. This project has provided training to 3 graduate students (2 MS, 1 PhD), and 2 undergraduate students. We primarily disseminated information to horse owners and professionals through our strong online presence. Historically, we've reached (both directly and indirectly) about 5 million horse owners and professionals annually through in-person Extension programs and field days, our monthly e-newsletter, website visitors, YouTube videos, Facebook posts, infographics, podcasts, and online certificate courses. The UMN Extension Horse YouTube channel currently has over 1,000 subscribers and over 200,000 video views, the Facebook page has over 21,000 followers and a 5 year average annual reach of 4 million people, over 4,000 people were signed-up for the monthly e-newsletter, and over 1,000 people have enrolled in our online courses since 2016. These diverse dissemination channels give horse owners, professionals, University

colleagues, governmental officials, and the public 24/7/365 access to information. We plan to continue to collect and summarize data and publish results through scientific and Extension channels that enhance our audience's understanding of pasture and carcass management. These efforts will help us continue to accomplish project goals.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

All classes of adult horses require a majority of their feed be supplied from forages (hay or pasture), and most adult horses can meet their daily energy needs from forages alone. Due to the importance of forage in the horse diet, it is critical to optimize equine forage utilization and health.

UMN researchers found that the nutrient-dense berseem clover, annual ryegrass and winter rye are the best-suited cover crops to extend the grazing season in horse pastures. Other higher yielding forages were not preferred by the horses and considered unpalatable. Researchers also found that teff, an annual warm-season grass, could be successfully grazed by horses. Teff has lower nonstructural carbohydrate and higher fiber values compared to cool-season grass and alfalfa. As a result, researchers found that teff could help decrease the insulin response of horses grazing in the fall and late fall.

There has never been more public pressure on livestock owners to ensure proper care and welfare of their stock, including horses. These findings give horse owners, industry professionals and University faculty viable options to extend the grazing season through the use of alternative forages proven safe for horses. Horse caretakers can incorporate berseem clover, annual ryegrass and winter rye into their horses' diets with confidence that it will provide the nutrition needed for the animals to thrive. Adding these plants to pasture rotations also provides more ground cover and environmental services to the surrounding ecosystems.

Closing Out (end date 09/07/2023)

Management factors influencing productivity and welfare of dairy cattle

Project Director
Marcia Endres
Organization
University of Minnesota
Accession Number
1016470

Management factors influencing productivity and welfare of dairy cattle

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Management practices on the farm can have profound effects on dairy cattle welfare and productivity. In order to better address questions related to dairy welfare one needs to understand animals' behavioral needs and also learn whether behavior changes can help us detect disease earlier, therefore reducing disease severity and mortality on the farm, and improving productivity. Using technologies such as robotic milking systems and automated milk feeding systems, we can collect individual animal data on a daily basis to achieve this goal.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Using data collected from automatic system software on automatic milking farms we found that various on farm and individual cow factors can influence cow performance. Factors include feeding management (feed table management intensity, number of feeds in the robot, amount of feed in the robot), milking frequency and milking interval, postpartum body weight change and rumination time, among others. We also learned that calf feeding behavior data from automated milk feeding systems can be useful to monitor health in pre-weaned dairy calves, preventing serious disease and reducing mortality.

Briefly describe how your target audience benefited from your project's activities.

Our project results have been shared with researchers at scientific meetings and regional projects; in conferences attended by consultants, veterinarians, nutritionists, extension educators, and dairy producers; at field days for dairy producers; and in the classroom (dairy production class). The information we disseminated helped these various attendees with improving their clients' or their own dairy operation leading to better animal welfare and productivity.

Briefly describe how the broader public benefited from your project's activities.

The broader public cares about how animals are managed, how well they live. When animals are productive and healthy, and have good welfare, the animals, the farmers, and society benefit. It is a win-win-win.

Overcoming nutritional and quality barriers for increased used of corn co-products in swine diets

Project Director
Gerald Shurson
Organization
University of Minnesota
Accession Number
1013366

Overcoming nutritional and quality barriers for increased used of corn co-products in swine diets

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Corn distillers co-products have become major ingredients used in the U.S. and global feed industry. This project involves conducting several experiments to obtain new knowledge and develop strategies to improve the use of corn co-products in swine diets.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Studies have been conducted to determine the maximum diet inclusion rate of new high protein corn co-products to optimize growth performance of pigs. We have published our work on determining the prevalence and concentration of antibiotic residues in DDGS; capability of virginiamycin, penicillin, and their combination to cause antibiotic resistance of selected Lactobacilus strains; extent of virginiamycin degradation during ethanol and corn co-product production; and a comprehensive risk assessment was completed to determine the risk of virginiamycin residues in pork, chicken, and beef exceeding published MRLs from various countries. In addition, we published a study showing that the addition of an antioxidant (TBHQ) to diets containing oxidized corn oil had minimal effects on oxidative status of nursery pigs.

Briefly describe how your target audience benefited from your project's activities.

The target audience of industry and academic swine nutritionists have benefited from the results published from multiple research studies by improving pecision nutrition feed formulation and undestranding the benefits and limitations of using corn co-products from the U.S. ethanol industry in animal feeds.

Briefly describe how the broader public benefited from your project's activities.

Optimizing the utilization of by-products and co-products from agricultural and food industrial processes in animal feeds is essential for reducing negative environmental impacts of our food production system and improving sustainability of food animal production.

Livestock

Project Director
Catherine Dehdashti
Organization

University of Minnesota
Accession Number
7000114

Helping producers and processors understand and address meat-processing bottlenecks

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Even before the COVID-19 pandemic, Minnesota's small and mid-size livestock producers lacked access to affordable processing facilities that could accommodate smaller quantities. In a 2020 survey of Minnesota farmers, a majority said that processing options were not adequate. COVID-19 exacerbated the issue with the closures of large local meat-processing plants.

Small meat-processing businesses can be challenging to start and to run. In addition to upfront costs, owners need skilled labor to meet seasonal demand. In a study conducted by University of Minnesota Extension's Regional Sustainable Development Partnerships and partners, limited access to skilled labor emerged as a key challenge. Demographic shifts could exacerbate the issue. Other research has found that two-thirds of the owners of small meat-processing facilities in Minnesota were at or near retirement age, and half of the facilities were more than 40 years old. Other challenges include finding capital to modernize processing equipment and paying competitive wages when profit margins are low.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Extension's Regional Sustainable Development Partnerships worked with community partners and University of Minnesota researchers to form a meat-processing working group to understand the needs and challenges facing Minnesota's small- and medium-scale livestock producers. A report can be found here: COVID-19 and Local Meat Processing in the Midwest: Challenges and Emerging Business Practices.

Key activities in 2021 included:

- Engagement in a working group involving meat processors, livestock producers, the Minnesota Farmers Union, the Minnesota Institute for Sustainable Agriculture, the Sustainable Farming Association of Minnesota, the Minnesota Department of Agriculture and others.
- Developing case studies of Midwest meat processors to illuminate their challenges and emerging best practices.
- Surveying processors around the state to understand workforce issues, including needs for meat-cutting training and apprenticeship.
- Identifying challenges in small-scale meat production facing tribal communities.
- Working with Extension educators and partners to explore market opportunities and barriers for expanding halal and kosher meat markets.

Briefly describe how your target audience benefited from your project's activities.

Work with partners in this area contributed important research to understanding the challenges faced by small and mid-scale meat processors. Relationships formed among farmers, processors, retailers and nonprofits working together to address the issues in the industry. For example, Extension's work on halal meat access built connections between halal producers and grocery stores in the St. Cloud area, which increased access to halal meat for members of the surrounding Somali community

Efforts of the meat-processing working group also contributed to state government allocation of funding for the creation of new meat-cutting training programs. The Staples campus of Central Lakes College and Ridgewater College in Willmar and Hutchinson are preparing to offer meat-cutting programs starting in 2022.

Briefly describe how the broader public benefited from your project's activities.

The meat-processing working group's efforts are helping to keep small and mid-scale meat processors in business in Minnesota. Increasing the availability of and access to meat-cutting training programs in Minnesota provides the industry with a skilled workforce and provides workers with pathways to careers. A more robust skilled workforce will allow more small and mid-scale meat processors to keep their businesses open for local livestock producers to have their meat processed. Processing meat near to where the livestock are raised makes locally grown food more accessible and affordable for consumers.

Improving beef practices from farm or ranch to the consumer's table

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

While Minnesota ranks 10th nationally in beef production, with an annual profit of more than $2 billion from beef product sales, Minnesota cattle producers and the beef industry face many complexities and challenges along the route from farm or ranch to the consumer's table.

Challenges to production during the summer grazing season include internal parasites, summer stressors, flies, forage availability, weed control and how to reduce feed costs through grazing late into the season.

Additionally, increased attention on animal welfare, food safety and sustainability means that consumers have more focus on the meat industry. Ensuring more consistent training across the industry can provide better safeguards for beef production.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

For the summer production issues, the University of Minnesota Extension beef team organized a six-part webinar series to address challenges faced by Minnesota beef producers.

For the meat production issues, the national Beef Quality Assurance Program helps producers become certified on best practices in cattle handling, management and care. States customize the program to the needs of their own producers. Extension educators are local trainers for the program in Minnesota.

A detailed survey conducted in 2020 and 2021 yielded responses from nearly 400 Minnesota cattle producers from 78 of the state's 87 counties. The resulting report underscores the complex birth-to-harvest route for beef cattle in Minnesota, where small farms still play a major role in the beef industry.

Briefly describe how your target audience benefited from your project's activities.

The summer production webinars reached 152 beef producers. Attendees represented 55 counties with a range of operation sizes. Producers benefited from learning how to implement practices to improve their production and efficiency. Improvements to efficiency strengthen both economic and environmental sustainability for cow-calf operations. Seventy-one percent of respondents reported they would do something differently based on what they learned from the webinar series.

The 422 participants for twelve Beef Quality Assurance trainings learned best practices for feed regulations, market cows/bulls, biosecurity, recordkeeping, cattle handling, transportation, animal health, antimicrobial stewardship, injection site management and facilities management. Again, 71 percent plan to change their practices based on what they learned. Nearly 50 percent of the participants had herd sizes of 100 or more, so changes in practices could impact at least 17,000 cattle.

The results of the survey, seen in the report titled Movement and Management in Minnesota's Beef Industry: Results from a Survey of MN Cow-calf and Feedlot Producers, will help dictate where Extension, University of Minnesota researchers and producer groups place future research efforts.

Briefly describe how the broader public benefited from your project's activities.

Improving the economic and environmental sustainability for cow-calf operations strengthens rural economies and minimizes the environmental footprint related to cattle production. Beef production education and the survey conducted in collaboration with beef producer groups help the industry get to that point.

Beef Quality Assurance training, in addition to the above research and education, helps consumers know that Minnesota's beef producers are committed to raising safe, high-quality, wholesome and nutritious beef.

Critical Issue

Natural Resource Management

Master Naturalist

Project Director

Catherine Dehdashti

Organization

University of Minnesota

Accession Number

7000110

University of Minnesota Extension Master Naturalist volunteers contribute 95,505 service hours

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

There are not enough professionals and officials to maintain a healthy natural environment for all of the land and water in Minnesota and to educate the public about how they can conserve natural resources. Minnesota is an ecologically diverse state and there is no one-size-fits-all way of taking care of the state's land and waters.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Citizens who care about the environment can be on-the-ground resources that connect valuable information to local groups when they make decisions that affect local ecosystems. Citizen scientists can also educate others about science and science-based solutions.

University of Minnesota Extension recruits, trains and supports volunteers who conduct projects that benefit communities. Certification requires 40 hours of training on Minnesota's unique ecological areas, called biomes. Four biome trainings were held for 330 volunteers and 101 volunteers participated in four advanced training courses.

Briefly describe how your target audience benefited from your project's activities.

Extension Master Naturalist volunteers perform at least 40 hours of service each year, volunteering for nonprofits, state agencies, nature centers and University research programs. They also bring their new knowledge to their jobs and communities. In 2021, of the 2,000+ Master Naturalist volunteers, 827 who submitted reports contributed a total of 95,505 service hours to statewide Minnesota environmental stewardship. (During the pandemic, fewer volunteers submitted hours.) Projects included supporting and informing restoration and conservation management on public lands, collecting data, and delivering environmental education.

A group of 266 Extension Master Naturalist volunteers gathered on National Public Lands day to help mitigate invasive species and assist with sustainable forest and rangeland management at 19 sites across Minnesota, including federal, state and municipal public lands. During the four-day global City Nature Challenge, 689 volunteers reported more than 5,000 observations to iNaturalist, representing 962 different species.

Briefly describe how the broader public benefited from your project's activities.

The environmental problems facing our planet are formidable, so enlisting Extension Master Naturalist volunteers to assist professionals leverages the help needed, and Master Naturalists volunteer with great enthusiasm that gets others in their communities excited about conservation. They multiply the education when sharing their knowledge through their volunteer work in many settings and can make significant contributions toward improving and protecting Minnesota's natural environment.

Natural Resources Management

Project Director
Catherine Dehdashti
Organization
University of Minnesota
Accession Number
7000115

Pesticide safety education minimizes the harm of pesticides to people and the environment

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Proper pesticide safety education minimizes the harm of pesticides to people and the environment. In addition to Minnesota's 17,000 certified farmers, more than 11,000 occupational and professional licensed and certified applicators need access to updated research and education in order to renew their certification and to continue providing services using best practices. Education is critical to proper and safe pesticide use and minimizes the harm of pesticides to people and the environment.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

University of Minnesota Extension Pesticide Safety & Environmental Education (PSEE), provides statewide education and leadership for pesticide safety. PSEE provides education for Minnesota's 17,000 certified farmers and other agricultural producers through its Private Pesticide Applicator Program. PSEE is the major provider in Minnesota of education to the more than 11,000 occupational and professional licensed and certified applicators in natural resources, agriculture, horticulture, public health, and other industries and business sectors.

In Minnesota, Certified Private Pesticide Applicators can renew their certification by participating in a Private Pesticide Applicator recertification training (PPAT) every three years or by completing an exam. In 2021, 28 online private pesticide recertification courses were held for 1,312 people and another 4,455 people completed mail-in or online exams. Additionally, 28 commercial/non-commercial (CNC) workshops were held for 2,436 people.

Briefly describe how your target audience benefited from your project's activities.

Evaluations from the Private Pesticide Applicators online courses show that as a result of the training:

- 77 percent agree/strongly agree that they are more likely to check for endangered, threatened or Critical Habitat Species.
- 88 percent agree/strongly agree that they are more likely to follow recommended laundering procedures for pesticide-contaminated clothing.
- 79 percent agree/strongly agree that they are more likely to calibrate their sprayer equipment.
- 77 percent agree/strongly agree that they are more likely to utilize University of Minnesota research-based information in pest management decisions.

Similar success was seen in the commercial/non-commercial course evaluations. As a result of participating in a fall 2021 CNC recertification training:

- 70 percent agree/strongly agree that they will change at least one of their practices based on what they learned in the course.

- After viewing the Guidelines for Bee Lawn Management module, 68 percent would be comfortable explaining managing bee lawns to a client and/or colleague.

- As a result of this course, 92 percent were either already or plan to be more likely to read label statements carefully, distinguishing between mandatory and advisory statements.

Briefly describe how the broader public benefited from your project's activities.

Responsible management of pests and pesticides is essential to public health, safety and environmental protection. Extension provides education for anyone who uses pesticides at home, on farms, in buildings, and in managing natural resources and landscapes. PSEE addresses a wide range of pesticide issues from water quality, waste management, endangered and threatened species, food safety, pollinator protection, invasive species, land and building use policies, and more. Proper training for pesticide applicators creates greater safety for the general public by minimizing unnecessary pesticide use and contributing to safer food, cleaner water and a healthier environment.

North American interdisciplinary chronic wasting disease research consortium

Project Director
Peter Larsen
Organization
University of Minnesota
Accession Number
1024247

North American interdisciplinary chronic wasting disease research consortium

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Chronic wasting disease is distributed widely in North America, affects multiple cervid species, and does not respect jurisdictional boundaries. Research across multiple disciplines is needed to fully address the complexities of CWD and acquire the knowledge needed to limit or eliminate its spread.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The Minnesota team has successfully achieved Goal #3, which is to identify methods cabable of generating recombinant prion protein substrate that would support a national CWD RT-QuIC testing network. RT-QuIC is a highly advanced and sensitive diagnostic assay for the detection of CWD prions. We are making the substrate availble to CWD research consortium research partners and are also suppling it to the USDA for their RT-QuIC validation process. The recombinant substrate will be commerically available as MNPROtein in 2022. MNPRO also led a variety of activities aimed at the evaluation of social values and effective communication within culturally diverse communities at both local (Amish and Hmong) and Tribal Nation levels (Goal 5). Our team has also established an ecological research site to investigate the spread of CWD prions in a natural setting. The site consists of approximately 12 acres of forested land where CWD postive deer carcasses were illegally dumped. A fence was constructed across ~15 acres to prevent the wild white-tailed deer herd from entering the location. We worked with state partners to secure the site, tested remains and confirmed the presence of CWD prions, and are now monitoring prion spread in soil, plants, and water associated with the site.

Briefly describe how your target audience benefited from your project's activities.

The Minnesota Center for Prion Research and Outreach (MNPRO) routinely communicates CWD research and outreach progress to a variety of stakeholders, including state agencies and lawmakers. This is accomplished through testimonies at the legislature (minimum of twice a year) and bi-weekly meetings with the MN Dept of Natural Resources and Board of Animal Health. With respect to Goal #3, we have informed the CWD research consortium that MNPRO has optimized the mass production of the recombinant substrate for RT-QuIC testing and that we are ready to share the substrate to diagnostic labs for research purposes. We are also working directly with the USDA to assist their validation process of the RT-QuIC assay. We published two peer-reviewed manuscripts relating to our CWD research activities in 2021:

Schwabenlander, M. D., G. R. Rowden, M. Li, K. LaSharr, E. C. Hildebrand, S. Stone, D. M. Seelig, C. S. Jennelle, L. Cornicelli, T. M. Wolf, M. Carstensen, and P. A. Larsen. Comparison of chronic wasting disease detection methods and procedures: implications for free-ranging white-tailed deer (*Odocoileus virginianus*) surveillance and management. Journal of Wildlife Diseases, 1-13.

Li, M., M. D. Schwabenlander, G. R. Rowden, J. M. Schefers, M. Carstensen, P. A. Larsen. RT-QuIC detection of CWD prion seeding activity in white-tailed deer muscle tissue. Scientific Reports, 11:1-11.

Briefly describe how the broader public benefited from your project's activities.

Project leaders from the University of Minnesota (Peter Larsen, Tiffany Wolf, Marc Schwabenlander) have conducted a wide variety of outreach activites aimed at sharing the latest science on Chronic Wasting Diesease to a number of stakeholders (e.g., general public, state lawmakers, undergraduate and graduate students, etc.). We have expanded our outreach efforts outside of Minnesota to include Michigan and Texas. Specifically, we provided the Michigan DNR with a 3D printed full-scale white tail deer head to assist with their outreach to hunters regarding appropriate tissue sampling for CWD testing. We also presented CWD information to the general public throughout the San Antonio area in Texas. These activities were conducted through our MNPRO center. We estimate our outreach activities and media coverage of our CWD research efforts have successfully reached thousands of people across several states during 2021.

We published two CWD articles in popular press outlets in 2021, including one specfically highlighting our public outreach efforts:

Schwabenlander, M., A. E. Pendleton, T. Wolf, P. A. Larsen, R. J. Larsen. A complex disease simplified: innovative tools help present chronic wasting disease education to diverse audiences. Human Dimensions of Wildlife.

Larsen, P. A. RT-QuIC: the future of diagnostic testing. North American Elk Journal. May 2021, 33:28-31.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

The MNPRO leadership (Larsen, Wolf, Schwabenlander) hold weekly meetings with staff and students that focus on CWD research, especially relating to RT-QuC diagnostics (Goal #3) and human dimensions (Goal 5) relating to Chronic Wasting Disease. Training and professional development for students, staff, and postdocs ranges from learning new molecular laboratory protocols to conducting interviews with tribal partners. Staff and students have also provided public seminars and presentations regarding our CWD-research and outreach activities. We will continue to work to develop robust protocols for detecting CWD prions in environmental samples (soil, water, plants) in order to more accurately assess contamination levels. These protcools will be made available to the broader research consortium and scientific community through peer-reviewed publication. We will continue to produce the recombinant protein substrate and provide that substrate to the RT-QuIC testing network. Our outreach efforts will focus on the development of website content, interactive displays for public events, and continued presentations both virtually and in person.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Chronic Wasting Disease (CWD) is a highly transmissible, 100 percent fatal disease that affects white-tailed deer, mule deer, red deer, sika deer, caribou, reindeer, elk, and moose — all animals known as 'cervids'. Infected cervids might not show symptoms for months. In the meantime, they spread the disease by shedding prions into the environment which can remain

infectious for years, putting other animals at risk. Minnesota's first positive CWD test appeared in 2010. The disease now has a foothold in southeastern Minnesota and is threatening the state's billion-dollar hunting industry.

In 2021, University of Minnesota researchers successfully developed a novel approach to field testing chronic wasting disease using a technique known as RT-QuIC. RT-QuIC is a highly advanced and sensitive diagnostic assay for the detection of CWD prions. This field-deployable technology identifies CWD-positive animals in less than 24-hours and is cheaper than using traditional testing equipment. Researchers are working with the USDA to assist their validation process of the RT-QuIC assay. They're also making the substrates that support CWD testing available to diagnostic labs for research purposes. The substrates will be commercially available as MNPROtein in 2022.

This field test has the potential to support a national chronic wasting disease testing network and cut down on testing bottlenecks. Increasing the rate at which CWD is identified is an important step in fighting the disease and protecting cervid populations across North America. The test will also help prevent CWD prions from entering the public food supply. It is yet unknown whether CWD can spread to humans, but the CDC recommends against eating meat from CWD-infected animals and both the FDA and the USDA declared CWD-positive venison unfit for human or animal consumption.

Closing Out (end date 09/07/2023)

Bionanotechnology and Artificial Intelligence for Rapid Diagnostics in Food, Agriculture and the Environment.

Project Director

Abdennour Abbas

Organization

University of Minnesota

Accession Number

1016484

Nanosensors and Artificial Intelligence for Rapid Diagnostics in Food, Agriculture and Environment.

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Our projects address tissues related moelcular diagnostics in food safety and agriculture, and environmental remediation.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Please see the following sections for the answer to this question.

Briefly describe how your target audience benefited from your project's activities.

Our projects mainly adress challenges in food safety, agriculture and the environment:

1- Agriculture: We have developped a new technology to enhance the detection of oak wilt and other forest diseases, which would empower scientists and agencies that monitor forest health. (See our publication in Plant Health Progress).

2- Food Safety: We developed technologies for rapid purification of viruses from compex matrices, which would enhance viral and microbial detection. A company (Frontline Biotchnologies) is founded to transfer the technologies to the market.

3- Environmental remediation: We have developed several technologies for the capture and destruction of pollutants such as PFAS and mercury from water. These technologies are under commercialization to benefit the public. Also, our technology for the complete destruction of PFAS is expected to lead the EPA to ban landfil and incineration.

Briefly describe how the broader public benefited from your project's activities.

The primary goal of our research is to transfer technologies to the market in a way that benefits society and improves people's lives, by cleaning the environment, enhancing agriculture and food safety and public health. Our reserach is currently benefiting the broader public through two ventures:

1- Claros Technologies Inc.: An advanced materials company founded by the PI in 2018, and is currently employing 20 people after raising $6.8M in seed round and Series A of financing. The company has already commercialized antiviral face masks for the public during the pandemic, and is currently commercializing a new technology for the capture and destruction of PFAS pollutants and mercury from water. Claros Technologies received SBIR funding from the USDA, DOD, EPA and CDC.

2- Frontline Biotechnologies Inc.: A biological purification company, founded by the PI on 2021, developing novel technolopgies for bioconservation and for wastewater-based epidemiology. Frontline Biotechnologies receied SBIR funding from the USDA in 2021.

The objective of these two companies is to solve important issues for the public and industry and create sustainable jobs and sustainable human development.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Results have been disseminated through scientific publications for the scientific community and news articles for the general public:

Publications

1. "M J. Moore, J. Juzwik, O. Saiapina, S. Ahmed, A. Yang, A. Abbas*, "Use of Sodium Hydroxide DNA Extraction Methods for Nested PCR Detection of *Bretziella fagacearum* in the Sapwood of Oak Species in Minnesota", *Plant Health Progress*, 2022, .https://doi.org/10.1094/PHP-03-21-0057-RS

2. Gonzales, H. Aboubakr, A. Abbas*, "Durable nanocomposite face masks with high particulate filtration and rapid inactivation of coronaviruses", *Scientific Reports*,**11**, 24318 (2021)

3. Z. Xia; E. A. Leslie 1 ; J. W. Brockgreitens; A. Abbas*, "PFAS-Container Interaction: A Case Study of PFOS Defluorination using Acoustic Cavitation", 2022, Submitted.

4. V. T. Novi, A. Gonzalez, J. Brockgreitens, A. Abbas*, "Highly Efficient and Durable Antimicorbial Nanocomposite Textiles", 2022, Submitted.

News Media Coverage

1. "Novel Synthesis of Nanocomposite Antiviral Face Mask is Effective Against COVID-19", *Azo Nano*, 2021. Read more..

2. "Chemical sponge: U of M professor creates filter for 3M pollution", ***Pioneer Press***, 2021. Read more..

3. "A Technology Race to Stop the Mass Killing of Baby Chicks", ***Wall Street Journal,*** 2021. Read more..

4. "University of Minnesota spinoff developing protective apparel raises $5.3M in first VC raise", ***Star Tribune***, August 2021. Read more..

5. Minnesota's Claros commercializes 'green-chemistry' pollution fixes, Star Tribune, *Start Tribune*, March 2021. Read more..

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Polyfluoroalkyl substances (PFAS) have been widely-used in consumer, commercial, and industrial products. These “forever chemicals” persist in the environment over long periods of time and are linked to harmful health effects in humans and animals.

This research developed nanoparticle filters to capture and destroy PFAS from water. These filters are more effective at removing PFAS pollutants than the remedies currently in use. Instead of relying on landfilling or incinerating activated carbon that holds PFAS, nanoparticle filters capture and break apart the PFAS molecules permanently. This nanoparticle filter technology is being commercialized to clean up public waters.

Fourteen communities in Minnesota’s TC-metro area have high levels of PFAS in their drinking water as a result of nearby manufacturing activities that took place over 50 years ago. When these nanoparticle filters are commercially available, these Minnesota communities, as well as communities worldwide, will have access to an effective and efficient method to remove PFAS and other pollutants from their water.

How do soils form in the Anthropocene?

Project Director
Kyungsoo Yoo
Organization
University of Minnesota
Accession Number
1013562

How do soils form in the Anthropocene?

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

My project addresses the magnitude and direction of soil changes due to human activities. I mainly focus on agriculture and human-mediated earthworm invasion as a driving force that shapes the soils in the Anthropocene.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Research Activities:

(a) In 2021, we completed our field survey of exotic earthworms in Alaska. This work was funded by National Science Foundation. The work now establishes that invasion of exotic earthworms is broadly occurring and accelerating in their speeds in Alaska. Our work provides critical information for the Alaska DNR to re-assess their policies on live baits. Our work also identified gardening as a major earthworm introduction mechanism in Alaska, and the results have been disseminated through the gardeners in the state.

(b) In 2021, my research group made big progress in collecting data on our Jumping Worm project funded by Minnesota Invasive Plants and Pests Center. Our work has been featured through many news media in the state, and we are engaged in citizen science as well. Furthermore, I contributed to creating a list of common names for the exotic earthworms of Asian origins. This list is in the process of being adopted by significant reporting sites for invasive organisms (eg., i-Naturalist and EDDMapS.). I have been also providing our scientific findings to citizen organizations who were concerned about jumping worms.

(c) My group began to work on mountain indigenous coffee farming in Oaxaca and Veracruz, Mexico. My graduate student, Azucena Sierra, completed her first fieldwork in the summer of 2021. I had long been keen to initiate a research program on mountain agriculture because it is crucial for poor smallholders in developing countries.

Outreach

(a) After developing and offering ESPM 3051: Lands and Humans in World Cultures, my next idea was to create a documentary film series based on the course material. The course and the documentary films address the soils in the Anthropocene. I made a push to transform the idea into reality during my sabbatical leave. In 2021, I produced significant scripts and collaborated with a South Korean filmmaker, Daehyun Kim. In 2021 fall, we were awarded roughly 40,000 US dollars of funding by an international film festival organization in South Korea. Our first documentary film will be premiered at the film festival in May 2023.

Briefly describe how your target audience benefited from your project's activities.

Academic audience: In 2021, I was a coauthor of three peer-reviewed papers. A Geoderma paper, which is the product of my NSF CAREER project, demonstrated that soil carbon turnover time and soil carbon chemistry remain unaltered by changing erosion rates in mountain landscapes. We also published a paper from another NSF-supported study on the economic landscapes in American Samoa. This paper demonstrated that soil fertility and geomorphic characteristics in the island Ta'u, American Samoa, together with the evolving socio-economics, have shaped the geography of upland human habitats. A book chapter from the project is also in the press. The book chapter highlights how non-human factors – particularly animals affecting soil fertility - contributed to the evolution of human societies in the Pacific Islands.

Briefly describe how the broader public benefited from your project's activities.

My work on earthworm invasion in Alaska has gathered much attention from the conservation and gardeners groups in Alaska. We demonstrated that earthworm invasion was not confined to small areas in the state but was occurring widely across different regions in Alaska. Our work also established fishing and gardening as the major source of invasive earthworms. Data from our intensive fieldwork is being shared with the conservation and gardeners groups by our local collaborators in Alaska.

My work on jumping worm invasion in Minnesota helped citizen groups in Minnesota to become aware of the damages that jumping worms can cause to the gardens and forests and to mobilize to potentially slow down or stop the further introduction and dispersal of jumping worms. I worked closely with UMN Extension education agents and Minnesota Department of Resources researchers to produce education materials for citizen scientists and gardeners. I was also the expert who provided the Extension agents with the state-of-knowledge on jumping worms and their effects as they talk to citizens. I also spoke directly to the general public on the seriousness of exotic earthworms through media and at Minnesota State Fair.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Jumping worms are a group of invasive earthworms known for their leaping, snake-like movement. They often dramatically damage the quality and nutrient content of the upper layer of soil. Jumping worms can trigger erosion, threaten plant growth and decrease soil community biodiversity. Jumping worms were first discovered in Minnesota in 2006 and have since spread to several counties in the state.

Jumping worms are not well established in Minnesota yet, so researchers are proactively educating the public about this invasive pest. Through collaborative work with Extension and the Minnesota Department of Natural Resources, researchers have trained hundreds of anglers and gardeners to survey for, identify, and report jumping worms in their communities. "BioBlitz" events bring citizen scientists together to search for jumping worms in public recreation areas near known infestations. An interactive map allows residents to see if jumping worms have been recorded in their county and how many times. Media coverage has also been leveraged to educate the public on the steps to take to safely dispose of and avoid transferring jumping worms.
Increasing awareness of jumping worms and mobilizing Minnesotans to contribute data to jumping worm research has slowed down, and will hopefully stop, the further dispersal of jumping worms in Minnesota's forests and gardens. Data turned in by citizens is helping UMN researchers to increase understanding of jumping worm behavior, spread and survival in Minnesota. Ultimately, limiting the spread of jumping worms protects Minnesota's productive soils and the ecosystems and industries that rely on them.

Critical Issue

Resilient Communities and Economies

Agricultural Business Management

Project Director
Catherine Dehdashti
Organization
University of Minnesota
Accession Number
7000117

Educating tax professionals on agricultural tax issues

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Having access to current, up-to-date information related to agricultural taxation issues is a critical component of a farmer's overall financial risk management strategy. Taxes have been recently further complicated by the continued COVID-19 pandemic and several natural disasters, including hail and drought. There are many considerations for farmers to take into account when filing taxes. Most rely on tax professionals to advise them through the best options for their operation.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The University of Minnesota Extension Agricultural Tax Issues course is held every fall and targets income tax professionals who work with farmers. The course also is relevant to agricultural professionals such as agricultural lenders and farm management instructors. It covers what's new in taxes for the year. Extension's course has been approved by the IRS Registered Preparer Office. The course covered eleven educational topics that included: tax planning for high-income years, sales of farm assets, crop insurance, net operating loss (NOLs), new legislation, farm partnerships, depreciation, healthcare options, carbon credits, like-kind exchanges and the sample income tax return.

Briefly describe how your target audience benefited from your project's activities.

The 2021 Agricultural Tax Issues course was attended by 224 participants. Evaluations showed that:

- 93 percent of respondents indicated either they strongly agree/somewhat agree that: "My understanding of current Agricultural Tax Law Issues has increased my ability to assist and counsel clients/producers regarding their tax-related management decisions."

- 92 percent of respondents indicated either they strongly agree/somewhat agree that: "I am better prepared for the upcoming tax planning and tax preparation season."

Briefly describe how the broader public benefited from your project's activities.

Having updated tax information enables farmers to make the best tax decisions for their operations, thus strengthening their financial sustainability. More financially sustainable farmers contribute to a stronger rural economy.

Economic Analysis of Dairy Markets and Policy

Project Director
Marin Bozic
Organization
University of Minnesota
Accession Number
1020136

Economic Analysis of Dairy Markets and Policy

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

The dairy industry is an important sector of Minnesota agriculture. There are 2,600 dairy farms in Minnesota, producing over 1 million gallons of milk, processed in over 30 dairy plants across the state and generating $1.8 billion in milk sales annually. This project focuses on analyses and dairy sector models useful for policymaking in the area of milk pricing and dairy safety net programs.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

During the reporting period, we developed a model for evaluating trends in benefits from Federal Milk Marketing Orders and evaluating causes of extreme price volatility during the COVID-19 pandemic. We also developed a new version of the decision-support model for Dairy Margin Coverage.

Briefly describe how your target audience benefited from your project's activities.

For our research on milk pricing, target audience includes policy makers in the U.S. Congress and U.S. Department of Agriculture, policy analysts at dairy trade associations, cooperatives and privately held dairy processors, and academic researchers. Our research contributed to understanding to causes of negative producer price differentials in 2020 and impact of several contemplated policy interventions.

For our outreach work on Dairy Margin Coverage tool, target audience are U.S. dairy producers.

Briefly describe how the broader public benefited from your project's activities.

Milk and dairy products are considered food items of national policy importance. Our research contributes to debate on impact of policy measures implemented to enhance orderly marketing of perishable dairy products and stability of retail prices. Decision-support tool targeting smaller dairy farms contribute to vitality of smaller family farms in Minnesota and nationally.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Training and Professional Development Opportunities:

A graduate student was employed during summer 2021 on a project funded by U.S. Department of Agriculture, to help with preparation of the decision-support tool on Dairy Margin Coverage.

Dissemination of results (outreach activities):

- Bozic, M. and C. Wolf. 2021. Negative Producer Price Differentials in Federal Milk Marketing Orders: Explanations, Implications and Policy Option. Working Paper 21-01. URL: https://dairymarkets.org/PubPod/Pubs/WP21-01.pdf

- Bozic, M. and C. Wolf. 2021. Analysis of Producer Price Differentials for March 2021. Information Letter 2021-01. URL: https://dairymarkets.org/PubPod/Pubs/IL21-01.pdf

- Bozic, M. and M.W.Stephenson.2021. Dairy Margin Coverage Decision-Support Tool. URL: https://dmc.dairymarkets.org/

Plans for next reporting period:

- **Terms of trade / milk supply agreements.** We are conducting a review of policy frameworks implemented by other countries to govern relationships between dairy producers and milk buyers.

- **Depooling in Federal Milk Marketing Orders (FMMO).** We are pursuing a research manuscript on optimal depooling by dairy processors, i.e. opting out of the voluntary federal milk pricing regulation framework. We are exploring how different policy measures affect processors' willingness to remain regulated under FMMOs.

- **Optimal hedging strategies using USDA programs.** We are exploring how different strategies using Dairy Revenue Protection affect

Major changes or problems:

COVID-19 presented challenges for in-person collaboration with stakeholders and graduate students, and with childcare for the PI. Research output volume and timeliness has been moderately affected by these external factors.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

The dairy industry is an important sector of Minnesota agriculture. There are 2,600 dairy farms in Minnesota, producing over 1 million gallons of milk, processed in over 30 dairy plants across the state. Minnesota's dairy industry generates $1.8 billion in milk sales annually, but the industry is significantly impacted by federal policies related to pricing and milk contracts.

UMN researchers developed a model for evaluating trends in benefits from Federal Milk Marketing Orders (FMMO) and evaluating causes of extreme price volatility during the COVID-19 pandemic. This model and pandemic-driven demand fluctuations showed how the FMMO put Midwestern dairy farmers at a price disadvantage to producers in other areas of the country due to the way fluid milk is priced and where it is produced. These findings generated a greater understanding of the causes of negative producer price differentials in 2020 and allowed researchers to evaluate the impact of several contemplated policy interventions.

Milk and dairy products are considered food items of national policy importance. This research allows policymakers in the U.S. Congress and USDA, policy analysts at dairy trade associations, and cooperatives and privately held dairy processors to consider new policy measures that could enhance orderly marketing of perishable dairy products and stability of retail prices. As Congress prepares to write the 2023 farm bill, this research supports changes to the Federal Milk Marketing Orders that will increase fairness in milk contracting and help dairy producers better manage risk.

Enhancing Rural Economic Opportunities, Community Resilience, and Entrepreneurship

Project Director
Laura Kalambokidis
Organization
University of Minnesota
Accession Number
1015227

Enhancing Rural Economic Opportunities, Community Resilience and Entrepreneurship

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Rural communities face a wide range of economic development challenges. This project analyzes policies and factors that contribute to the viability and resiliency of rural communities. Specifically, the project focuses on the availability and affordability of child care and its links to workforce availability. Volatility in Minnesota's state revenues pose risks to the communities relying on state government expenditures. Improving the accuracy of state revenue forecasts can reduce forecast errors, providing more certainty to local government budgets. This project develops and tests methods for forecasting Minnesota's tax revenues to lower forecast errors and better manage budgetary risk.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

A key goal under Objective 1 is to identify infrastructure needs (broadly defined) to help address chronic and pandemic-driven labor shortages. In support of this objective, we analyzed data on trends in child care supply in rural and urban Minnesota and reported these findings to the Minnesota Department of Human Services. In order to understand the link between child care

availability and local labor markets, researchers developed and analyzed measures of child care accessibility across the dimensions of supply, cost and quality based on the spatial distribution (e.g., travel time) between families and child care providers. We compared trends over the period prior to the pandemic and since 2020 in order to identify local areas with child care shortages. We developed maps and data visualizations to show the variation in child care access for families in different parts of Minnesota. In addition, we analyzed how public funding for child care and early education impacts the supply and quality of child care over time and across rural areas in order to identify strategies that work to increase supply of child care. We continued our analysis of the factors associated with the decline in the number of licensed family child care providers in Minnesota.

Also under objective 1, regarding research on tax revenue forecasting, we calculated the forecast errors for Minnesota's general fund revenue forecast for the current biennium (two-year budget period). We produce two revenue forecasts per calendar year, in February and November. The difference between the level of revenue forecast and the amount actually collected at the end of a biennium--the forecast error--is a gauge of forecast accuracy. The mean absolute error (MAE) is the average of the errors' absolute values (that is, treating negative and positive errors the same). Since accuracy in forecasting a single biennium's revenues improves the closer we get to the end of the two-year period, we calculate separate errors for each time a biennium is part of the forecast: 32, 29, 20, 17, 8, and 5 months from actual. We then average those errors over fiscal years (FY) 1990-91 to the most recent closed period, FY 2020-21. The February 2021 forecast for FY 2020-21 is the third February forecast, five months ahead of closing. The MAE for five-months-ahead forecasts is 0.7 percent of non-dedicated revenues, or about $0.33 billion for the current biennium. Consequently, the range of closing values for FY 2020-21 total revenues is $47.563 billion +/- $0.33 billion, or $47.233 to $47.893 billion.

Briefly describe how your target audience benefited from your project's activities.

State and local policymakers have benefited from research findings to inform their policy decisions with regards to funding child care providers in areas of greatest need and managing the budgetary risk of tax revenue volatility. Other researchers have benefited from our development and dissemination of new measures of child care access and revenue forecasting methods.

Briefly describe how the broader public benefited from your project's activities.

Expansion of the supply of high-quality child care will help families access the care they need and may expand the availability of labor in rural areas. Our project helps to identify those areas with the greatest mismatch between families needing child care and availability of supply. The economic vitality of Minnesota's communities depends on investments made by state government. The state operating and capital budgets provide funds for public infrastructure, education, health care, workforce development, business development, and more. By improving the accuracy of state revenue forecasts, our project provides consistency and certainty to local governments' and nonprofit organizations' budgets.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Training and professional development opportunities:

One doctoral student in Applied Economics, Rodrigo Franco, contributed to the analysis and preparation of the data. Funding for the student was provided through other sources.

Dissemination of results (outreach activities):

Two webinars were conducted with federal and state policymakers as well as a presentation to Minnesota state agency staff to describe the findings and policy implications. Results of the revenue forecast error analysis have been published as the "Revenue Uncertainty Report" on the Minnesota Management and Budget (MMB) website. Our work on Minnesota's revenue volatility has been published as the "Budget Reserve Recommendation Report" on MMB's website. The November 2020 and February 2021 "Budget and Economic Forecasts" are published on MMB's website and were presented to the governor, legislative leadership, and the press via in-person meetings, teleconferences, and news conferences.

Plans for next reporting period

In the next period, we plan to present results from the analysis of factors associated with declining family child care in rural Minnesota at an academic conference and will submit a manuscript to a peer-reviewed journal. We will continue to analyze changes in child care supply and financing due to the COVID-19 pandemic and will work with state policymakers to provide information useful for their child care supply-building efforts.

In December 2021 (outside the current REEPort reporting period) we published the November 2021 "Budget and Economic Forecast" and the December 2021 "Revenue Forecast Uncertainty Report." We will improve our forecast error and revenue volatility models. We will also continue conducting analyses of the capital gains and corporate income tax forecasting models.

Major changes or problems

The ongoing COVID-19 pandemic has had a huge impact on the child care sector and has led to some changes in our research plans. While a primary focus of this research project continues to be the supply and demand for child care in rural areas, some of our work has shifted to provide analysis and rapid feedback to policymakers to help them understand the changing needs of families and child care providers and to support development of policies in response to the crisis.

Peer-Reviewed Publications DOIs (not approved for collection yet):

Elizabeth E. Davis, Hasan K. Tosun and Mallory Warner Richter. 2021. After COVID-19, Will Child Care Survive in Rural Areas? *Choices*. Quarter 3. https://www.choicesmagazine.org/choices-magazine/theme-articles/rural-development-implications-one-year-after-covid-19/after-covid-19-will-child-care-survive-in-rural-areas (NIFA funding acknowledged)

ORCID (not approved for collection yet):

Elizabeth E Davis ORCID 0000-0001-9636-1473

Laura Kalambokidis ORCID 0000-0002-5371-2648

“Other Products” (working with NIFA program staff to define what the agency needs and uses in this category):

Invited webinar presenter: “After COVID-19, Will Child Care Survive in Rural Areas?" Webinar sponsored by C-FARE: Rural Communities One Year Post COVID-19, July 12, 2021. https://www.cfare.org/new-blog/rural-communities-one-year-post-covid-19

Invited panel presenter. **“**Promoting Sustainability of Child Care Programs during the COVID-19 Pandemic: Considerations for States in Allocating Financial Resources.” Sponsored by the Office of Child Care and OPRE (U.S. DHHS). January 6, 2021

Reports:

Budget and Economic Forecast (Minnesota), Kalambokidis, Laura, editor(s). St. Paul, Minnesota: Minnesota State Office of Management and Budget, Economic Analysis, **February 2021**. https://mn.gov/mmb-stat/000/az/forecast/2021/budget-and-economic-forecast/february-2021-forecast.pdf

Budget and Economic Forecast (Minnesota), Kalambokidis, Laura, editor(s). St. Paul, Minnesota: Minnesota State Office of Management and Budget, Economic Analysis, **November 2021**.https://mn.gov/mmb-stat/000/az/forecast/2021/budget-and-economic-forecast/november-2021-forecast.pdf

Budget Reserve Report (Minnesota), Laura Kalambokids, editor(s). St. Paul, Minnesota: Minnesota State Office of Management and Budget, Economic Analysis, **September 2021**. https://mn.gov/mmb-stat/000/az/forecast/budget-reserve/report-2021.pdf

Revenue and Economic Update (Minnesota), Kalambokidis, Laura, editor(s). St. Paul, Minnesota: Minnesota State Office of Management and Budget, Economic Analysis, **January 2021**. https://mn.gov/mmb-stat/000/az/forecast/2021/revenue-and-economic-update/january.pdf

Revenue and Economic Update (Minnesota), Kalambokidis, Laura, editor(s). St. Paul, Minnesota: Minnesota State Office of Management and Budget, Economic Analysis, **April 2021**. https://mn.gov/mmb-stat/000/az/forecast/2021/monthly-revenue-review/march.pdf

Revenue and Economic Update (Minnesota), Kalambokidis, Laura, editor(s). St. Paul, Minnesota: Minnesota State Office of Management and Budget, Economic Analysis, **July 12, 2021**. https://mn.gov/mmb-stat/000/az/forecast/2021/revenue-and-economic-update/july.pdf

Revenue and Economic Update (Minnesota), Kalambokidis, Laura, editor(s). St. Paul, Minnesota: Minnesota State Office of Management and Budget, Economic Analysis, **October 11, 2021**. https://mn.gov/mmb-stat/000/az/forecast/2021/revenue-and-economic-update/october.pdf

Revenue Forecast Uncertainty Report (Minnesota), Kalambokidis, Laura, editor(s). St. Paul, Minnesota: Minnesota State Office of Management and Budget, Economic Analysis, **March 2021**. https://mn.gov/mmb-stat/000/az/forecast/uncertainty/2021/march-report.pdf

Revenue Forecast Uncertainty Report (Minnesota), Kalambokidis, Laura, editor(s). St. Paul, Minnesota: Minnesota State Office of Management and Budget, Economic Analysis, **December 2021**. https://mn.gov/mmb-stat/000/az/forecast/uncertainty/2021/december-report.pdf

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

The availability and affordability of child care is closely linked to workforce availability. According to the Minnesota Department of Human Services, the number of family child care providers statewide peaked above 14,000 in 2002 and has declined steadily since then, falling below 8,000 by 2019. In rural areas, more of the child care is provided by home-based providers than child care centers, and there is a shortage of home-based providers across rural Minnesota.

Expanding on ongoing research analyzing child care accessibility, supply and demand, researchers developed and analyzed measures of child care accessibility across the dimensions of supply, cost and quality based on the spatial distribution between families and child care providers. The pandemic presented new challenges to child care providers, so researchers also compared pre-pandemic trends to data from 2020 and 2021 to identify areas in Minnesota with child care shortages and determine whether the shortages are chronic or pandemic-driven. Researchers shared these results directly with the Minnesota Department of Human Services and state and local policymakers to provide rapid analysis and feedback on the changing needs of families and child care providers during the pandemic.

Child care availability and affordability were known to be critical economic development issues in Minnesota prior to the pandemic. Identifying pandemic-related factors exacerbating the decline of child care in rural Minnesota has allowed policymakers to take steps to combat those pandemic-related issues. University research is guiding Minnesota's policies to help support daycares in rural areas and increase access to child care for working families. In the current tight labor market, policies that increase access to and quality of child care are crucial to expanding workforce participation, especially in rural Minnesota.

Critical Issue

Sustainable Energy and the Bioeconomy

Clean Energy Research Teams (CERTs)
Project Director
Catherine Dehdashti
Organization
University of Minnesota
Accession Number
7000105

CERTs brings Minnesota closer to energy efficiency and renewable energy goals

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Minnesota strives for a cleaner energy supply that is also efficient, reliable and affordable, and as such has set ambitious goals and implemented forward-thinking, nation-leading legislation. The 2021 Energy Conservation and Optimization (ECO) Act modernized the energy efficiency goals that were implemented in 2010 through Minnesota's Next Generation Energy Act, which established a statewide energy conservation goal of 1.5 percent of annual retail electric and natural gas sales. The ECO Act now allows efficient fuel switching and load management to factor into overall energy efficiency, and addresses the effect of electric vehicle adoption on electric utilities. Minnesota also requires utilities to produce 25 percent of energy using renewable resources by 2025, and legislation in 2021 authorized millions of dollars for solar on schools. Minnesota has set greenhouse gas emissions reduction goals to achieve by 2030 and is tracking behind on meeting these goals in every sector (residential, commercial, industrial and transportation), except electric generation. Thus, there is an increasing emphasis on electrifying transportation and thermal (natural gas) end uses.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The following activities of the Clean Energy Resource Teams—or CERTs— lead to the implementation of energy efficiency, renewable energy and electrification projects in Minnesota:

- Providing hands-on technical assistance to spur Minnesotans to move forward on clean energy action.
- Facilitating local, regional and statewide connections and partnerships to move clean energy forward.
- Supporting community-based clean energy projects through seed grants.
- Hosting events, conferences, presentations, workshops and tours to create learning and network building opportunities that catalyze action.
- Helping Minnesotans understand their clean energy options through educational guides and determine how best to move forward through decision tools.
- Sharing project models and examples to adapt and replicate through storytelling.

Briefly describe how your target audience benefited from your project's activities.

Minnesota continues to work toward its formal goals on energy efficiency and renewable energy and puts increasing attention on beneficial electrification through electric vehicle adoption, for example. CERTs is spurring Minnesota governmental units, small businesses, farmers and utilities to take clean energy action to contribute to these goals, with an emphasis on ensuring underserved communities are part and parcel of the work. CERTs works with Minnesota communities to facilitate partnerships, fund seed grants, host learning and networking opportunities, create educational guides and decision tools, share project models for replication, and provide technical assistance that advance clean energy projects.

In 2021, University of Minnesota Extension programming by CERTs was delivered through 28 public education events and at an additional 391 meetings and presentations hosted by others. The Clean Energy Job Board, CERTs' most popular resource, hosted 222 postings. CERTs published 159 new stories to give others a sense of what's possible, to allow them to learn from peers and to inspire them to take action. The MN Energy Stories e-newsletter reaches more than 13,000 Minnesotans.

CERTs tested new models for scaling-up sustainable energy impact, and Extension programming by CERTs achieved 36.8 billion BTUs in annual energy savings or renewable energy offsets in 2021, which is enough to power 1 million LED light bulbs annually. This includes the following impacts:

- 11 businesses, 10 farms, four churches, two nonprofits and one ethanol plant completed 19 solar and nine energy efficiency projects with clean energy financing and grants or CERTs technical assistance (14.5 billion BTUs).

- 28 residential and commercial solar installations within the jurisdictions of two cities following SolSmart certification and within two regions following solar bulk-buy promotion (7 billion BTUs).

- Seven on-site solar projects by a utility (one system), four cities, a state agency, and a school district (5.3 billion BTUs).

- 13 cities and six utilities adopted 10 electric vehicles in fleets and installed 42 electric vehicle charging ports (3.5 billion BTUs).

- 829 households in manufactured home parks and multi-family buildings reduced energy burden through the distribution of 6,045 energy-saving items, such as light bulbs and showerheads, and 39 home energy assessments were completed with similar items (3 billion BTUs).

The remaining energy savings and offsets achieved in 2021 resulted from implementation of energy efficiency, energy storage and electric vehicle projects associated with CERTs 2020 Seed Grants and energy efficiency upgrades in businesses following outreach on utility programs.

Briefly describe how the broader public benefited from your project's activities.

CERTs serves communities statewide with a focus on the following audiences: governmental units (cities, counties, schools, tribal nations), small businesses, farmers, utilities and underserved communities. Governmental units, businesses, and farmers save on their operating costs and can be seen as clean energy leaders in their communities. Utilities meet their energy savings and renewable energy goals and are exposed to innovative models and approaches to carrying out their programs. Underserved communities begin to reduce their energy burden (the amount of income spent on energy costs) and are included in energy decisions and opportunities from which they may have been historically excluded.

Applications of Acrylic Hybrid Polymers Generated with Lactide-based Macromonomers

Project Director
Steve Severtson
Organization
University of Minnesota
Accession Number
1013125

Applications of Acrylic Hybrid Polymers Generated with Lactide-based Macromonomers

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Every year the United States produces tens of billions of square meters of pressure-sensitive (PS) label products worth more than billions of dollars. PS labels are manufactured, converted, sold, and, ultimately, discarded. The chemically inert nature of polymeric materials limits their current disposal primarily to landfilling. Although some polymers can be recycled, the logistics involved in their collection and sorting is cost prohibitive. The research proposed herein aims to advance technology capable of closing the life-cycle loop on PSA, PS labels and other related polymeric consumer products through bioremediation.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

We are developing a water-based synthesis of polymer nanocomposites composed of lactide-based copolymers and cellulose nanocrystals (CNCs). We signed a non-disclosure agreement with Franklin International (Columbus, OH) during this reporting period and have begun meeting with their research staff regularly. Although our research is still in the early stages, the technology shows great promise. The work considers both cost and performance to develop a more robust water-based adhesive system appropriate for various new applications that currently use solvent-based PSA exclusively, such as building and construction, automotive manufacturing, electronics, and graphics. The unique water-based technology is less expensive,

safer, and more sustainable. The key is finding cost tradeoffs by designing the CNCs to perform multiple tasks in latex formulations (replacing existing additives). We have identified the main parameters controlling the nanocomposite adhesives' performance and have begun studies to scale up from the current small-batch experiments. The plan is to progress to laboratory emulsion polymerization and move development to pilot facilities next year.

Briefly describe how your target audience benefited from your project's activities.

The project will demonstrate a technology that allows for the retrofitting of successful disposable polymeric products to facilitate their novel remediation. It provides a means to generate products that meet both biomass content mandates and consumer demand for closed-loop life cycles and expands the market for lactide into previously untapped markets. More importantly, the project establishes a successful roadmap for closing the loop on the life cycles for a broad range of products such as plastics, coatings, adhesives, packaging films, and ink binders, establishing leadership in biobased and sustainable technologies.

In addition to the expected scientific publications and presentations, we plan to share our results directly with manufacturers at local and national meetings of technical associations for the adhesives and coatings industry (e.g., PSTC, ASC, PSTC, TAPPI). Although sustainability considerations now play a major role in new adhesive designs, resources for companies looking to develop more sustainable products are absent. Through partnerships with the USDA and the US Postal Service, the Severtson lab has served as a resource (e.g., seminars, visits and meetings) for more than a decade helping companies develop and certify recycling compatible adhesives (RCAs).

Briefly describe how the broader public benefited from your project's activities.

The research proposed herein aims to identify technology and approaches to close the life-cycle loop on PSA, PS labels, and other related consumer products. The project emphasizes water based PSA, which accounts for most of the disposable PSA market. Furthermore, it develops a roadmap for the use of renewables in everyday consumer products, helping to move away from use of components from fossil fuels.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Opportunities for training and professional development provided - My group is cooperating with several companies and a National Lab in our efforts to develop sustainable polymeric materials. Our research uses primarily emulsion polymerization requiring emulsifiers and other additives. Selecting and obtaining appropriate surfactants and additives for our work is challenging. We count on our industrial partners for help in this process. Companies supply materials such as commercial surfactants, wetting agents, biocides, and defoamers, which are difficult find because they are available for purchase in small (laboratory) quantities. Our partners also share insights on product designs such as monomer selection for a given product area. In addition, our researchers will often visit and work wit our partners at their research and production centers. This support and hands on training prepares them for careers in industry. All of our former staff members have moved on to successful careers in the chemical industry.

How results have been disseminated to communities of interest - Two recent online articles outline our work on sustainable adhesive materials. Also, once our patent applications have been filed, we intend to publish our data and present at scientific meetings. This should begin early next year.

Project or program plans to do during the next reporting period to accomplish the goals - We have accomplished most of our goals. We augmented efforts to generate adhesive systems with enahnced cohesive strength by incorporating cellulose nanocrystals. This work is quite promising. The one goal that has been somewhat neglected is the area of biodegradability. We recently began to investigate fungal decomposition of our hybrid polymers. We are attempting to integrate PSA product design and fungal degradation to enable the engineering of the entire life cycle of pressure-sensitive (PS) products. Our objective is to develop rapid techniques for identifying fungus species capable of degrading our adhesive polymers. Such tests will facilitate the development of products for various commercial applications and subsequent remediation via fungal decomposition and possibly recycling of high molecular weight components. We expect this approach can be adapted for a wide variety of disposable polymeric products, providing essential guides for future sustainability work. Furthermore, it will augment our current outreach efforts by providing expertise in the bioremediation of adhesive products, which is currently a focus area for many companies that are reaching out to us.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Every year the United States produces tens of billions of square meters of pressure-sensitive (PS) label products. Most PS labels are manufactured from components of fossil fuels and typically end up discarded in a landfill.

UMN research is advancing technologies capable of creating a more circular lifecycle for pressure-sensitive labels. The unique water-based technology is less expensive, safer and more sustainable than using components from fossil fuels. Researchers have made breakthroughs that will allow them to scale up from small-batch, lab experiments to piloting the water-based adhesives in manufacturing settings. Partnering with industry is allowing researchers to explore how a water-based adhesive system can be incorporated into various new applications that currently use solvent-based adhesives exclusively.

As companies are implementing sustainable practices and moving to eco-friendly packaging, this research is finding ways to incorporate more renewables into everyday consumer products, like plastics, coatings, adhesives, packaging films and ink binders. The research team plans to share results from the pilot studies directly with manufacturers for the adhesives and coatings industry. These findings will fill a resource gap for companies looking to develop more sustainable products and accelerate the transition to more sustainable packaging. Ultimately, replacing pressure-sensitive label products created from fossil fuels with sustainable alternatives like water-based adhesives will decrease the amount of products that are landfilled and help reduce carbon footprint of products.

Critical Issue

Water Resources and Quality

Closing Out (end date 09/07/2023)

Sustaining Minnesota's freshwater resources while producing healthy crops

Project Director

Tracy Twine

Organization

University of Minnesota

Accession Number

1016709

Sustaining Minnesota's freshwater resources while producing healthy crops

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Minnesota is one of the fastest warming states in the US. Increases in average air temperature and precipitation is already affecting natural and managed ecosystems. My project refines climate projections from global climate models at 10 mile areas to 6 mile areas and analyzes what seasonal temperatures, precipitation, water resources, and crop yields might look like by the end of the 21st century.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

My research group has used computing resources within my lab and at the Minnesota Supercomputing Institute to 'down-scale' eight global climate models from a coarser spatial resolution to a finer resolution to project the future climate of Minnesota up to 2100 for two different greenhouse gas emissions scenarios (moderate and high). I then used these projections to see what impacts there might be to corn and soybean yield and water use across the major crop growing regions of Minnesota.

Briefly describe how your target audience benefited from your project's activities.

Both scientists concerned with the future production of major US grain crops as well as climate/land surface modelers have benefited from several scientific presentations and a peer reviewed publication detailing our methods and results.

Briefly describe how the broader public benefited from your project's activities.

The public is more aware of how Minnesota's winters and summers will warm throughout the century, and how this will could have minimal impacts to crop yield if producers vary their planting dates and cultivars to adapt to a warmer, wetter climate. These results were presented to the public through several media outlets.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

We have been using our climate projections to analyze return rates of various types of heavy precipitation events for every country of the state. Results will be linked at climate.umn.edu and a peer review publication is being prepared.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

With over 10,000 lakes, Minnesota is rich in water resources, but extreme weather variability, changes in water quality, and increasing demands for water all pose threats to our water resources. Minnesota is also one of the fastest warming states in the U.S. Increases in average air temperature and precipitation are already affecting our natural and managed ecosystems and challenging our infrastructure.

UMN researchers used computing resources to refine global climate models from 10 mile areas to 6 mile areas to project the future climate of Minnesota up to the year 2100 for two different greenhouse gas emissions scenarios (moderate and high). They then used these refined climate models to assess what seasonal temperatures, precipitation, water resources and crop yields might look like by the end of the 21st century. They found that Minnesota winters could be 6.5 degrees warmer by 2100 and summers will be 7 degrees warmer than their 20th century average. Models also show that areas of the state could see significant increases in spring precipitation and significant decreases in snow depth and days with snow cover. All of these changes make for a different climate with different growing conditions than currently exist in Minnesota.

Observed climate data and climate models are used to inform infrastructure design to manage stormwater, when to plant crops, how to design railways and bridges, and how to assess risk of infectious diseases. The Minnesota State Legislature, state agency staff, communities, nonprofits and private industries across the state, are using UMN climate models to guide agricultural policies and decision-making, develop water resources management plans, and design infrastructure for Minnesota's changing climate. Researchers are also leveraging these findings to breed plants and crops that will be well-suited to Minnesota's changed weather patterns.

Water Resources and Quality

Project Director
Catherine Dehdashti
Organization
University of Minnesota
Accession Number
7000116

Soil Management Summit participants change practices on their farms and with crop consulting clients

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Soil management is important to improving soil resources and water quality. Conventional tillage practices remove more than 70 percent of crop residue, which can lead to eroding soils and loss of nutrients, such as phosphorous and nitrogen. These nutrients can migrate to rivers and lakes, causing water quality problems. By keeping the soil covered for most of the year with crop residue or cover crops, nutrient losses are reduced and provide a long-term economic benefit to the farmer. No-till, strip-till and cover crop practices allow at least 30 percent of crop residue to remain on the field which has many benefits to soil quality, nutrient retention and longterm soil productivity.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Starting in 2004, an annual Conservation Tillage Conference was designed by University of Minnesota Extension to educate the farming community about conservation tillage practices and research. The conference presents information not only on conservation tillage techniques but also on how to manage other aspects so that the full benefit of these practices can be realized. In 2014, other positive soil health practices were introduced into the agenda. These include adding cover crops, increasing the crop rotation and adding livestock to the fields. In 2020, the conference was renamed the Soil Management Summit and in 2021, 190 people attended the conference from across Minnesota and elsewhere.

Briefly describe how your target audience benefited from your project's activities.

Soil Management Summit attendees learned about nutrient/manure management, cover cropping, tillage practices and the economics of conservation practices from University of Minnesota researchers and Extension faculty. Attendees also heard directly from farmers about the experiences of those who have implemented cover crops and low-till and no-till practices on their farms. The conference gives farmers and crop consultants ample opportunity to ask questions of researchers and one another to explore how they might implement various conservation practices to improve soil health and water quality.

Results from the December 2021 Soil Management Summit showed that as a result of attending a previous conference:

- 13 percent reduced the number of tillage passes in the field and 25 percent are considering it as a result of attending the 2021 conference.
- 10 percent seeded a cover crop and 21 percent are considering it as a result of attending the 2021 conference.
- 11 percent combined manure with cover crops and 24 percent are considering it as a result of attending the 2021 conference.
- 8 percent diversified their crop rotation and 35 percent are considering it as a result of attending the 2021 conference.
- 8 percent used no-till in the field and 18 percent are considering it as a result of attending the 2021 conference.
- 8 percent used strip-till and 34 percent are considering it as a result of attending the 2021 conference.

Overall, 62 percent of past attendees used information from previous tillage/soil health conferences in their work and 87 percent will use information from the 2021 conference in their work/on their farm. With 43 percent of attendees who are farmers and 25 percent are crop consultants/agronomists, this has the potential to impact 885,000 acres.

Briefly describe how the broader public benefited from your project's activities.

Soil health management systems contribute to higher water and air quality in addition to increasing food security.

Producers applying soil health practices report greater economic returns due to overall reduced fuel, machinery, labor and fertilizer costs. Additional benefits can also be realized through better water infiltration and reduced soil crusting that result in increased crop productivity. By leaving the soil covered, there is less soil erosion and nutrients remain on the field rather than being washed or blown out of the fields. This alone can improve soil resiliency and create more consistent yields over time.

The people of Minnesota benefit from conservation tillage and cover crops in numerous ways. Reduced soil erosion results in better longterm soil quality and improved water quality. This in turn relates to reduced water treatment costs, lake and retention basin dredging costs, increased recreational values and improved aesthetic values. Better water quality also results in improved aquatic species habitat due to reductions in sediment and nutrient loading, and reduced eutrophication.

Volunteers gather to learn, scout for aquatic invasive species

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Starry stonewort is an invasive algae that was first found in Minnesota in Lake Koronis in 2015 and has since been found in 14 Minnesota lakes. Starry stonewort can grow tall and dense, forming mats on the surface that interfere with recreation and potentially displacing native plant species. It is important to monitor spread of the invasive algae so that management options can be applied. However, with so many lakes in Minnesota to monitor for aquatic invasive species (AIS) and a limited number of trained detectors, that is difficult to do.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The Aquatic Invasive Species Detectors Program, a University of Minnesota Extension volunteer program underpinned by research from the University of Minnesota's Minnesota Aquatic Invasive Species Research Center, introduces participants to AIS science, identification, and surveillance. The AIS Detectors Starry Trek event gives participants a hands-on opportunity to connect with researchers and learn to identify starry stonewort and other target aquatic invasive species. In August 2021, the AIS Detectors Program team hosted their fifth Starry Trek across Minnesota. Two hundred and six volunteers gathered at rendezvous sites throughout the state and searched a total of 281 public accesses on 222 water bodies for starry stonewort and other AIS. At each site, they took samples and used their training to set aside suspicious plants for further identification.

Briefly describe how your target audience benefited from your project's activities.

Since its start in 2016, Starry Trek volunteers have found five new populations of starry stonewort in Minnesota waters. There were no new infestations of starry stonewort to report at the 2021 event; however, there were other AIS discoveries.

In Dakota County, volunteers found a new population of Eurasian watermilfoil (*Myriophyllum spicatum*) in Thompson Lake. In Sherburne County, volunteers found live freshwater golden clam (*Corbicua fluminea*) in another inland lake, Big Lake. While dead, empty shells had previously been found in Big Lake. This is the first time a living clam has been documented in that water body (and the second documented occurrence of living Corbicula in an inland Minnesota lake). The previous year, the first case of live Corbicula in an inland Minnesota lake was discovered by a young participant that led to a MAISRC rapid response project. Starry Trek volunteers also reported numerous new observations of Chinese and banded mystery snails, further improving knowledge on the distributions of those species.

Starry Trek participants applied what they learn at the event to monitor their local waterways for invasive species. Ninety-one percent of the volunteers reported that they plan to use what they learned during the event to conduct new or additional AIS monitoring on their own time.

Briefly describe how the broader public benefited from your project's activities.

The early detection and management of AIS help to protect Minnesota's lakes and waterways. The spread of AIS can displace native species, harm fish populations, damage habitats, impair water quality and water recreation, and cost millions of dollars to manage. When waters are protected, everyone from recreationists to shoreland owners to tourism operators benefits, and not just now but for future generations.

Critical Issue

Youth Development

4-H Youth Development

Project Director

Catherine Dehdashti

Organization

University of Minnesota

Accession Number

7000017

Engaging youth in leadership through topics that invite curiosity and problem-solving

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Of the million young people living in Minnesota, 35 percent are under-engaged in enrichment experiences, according to the Minnesota Student Survey of youth in middle to upper grade levels. The survey presented enrichment as involvement in sports, clubs, arts, faith and other activities Many of these youth, of every age, gender, race, socio-economic status, religion and family type, are not fully prepared for a positive pathway.

Meanwhile, our future depends on youth who can lead. Challenges in ecology, agriculture and food will be inherited by today's youth. For example, 22 million tons of plastic enter the waters of the Great Lakes each year. Plastic pollution threatens waters, soils and animal life everywhere, from our backyards to the world's oceans.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

In 2021, Extension collaborated with the National Science Foundation's Center for Sustainable Polymers at the University of Minnesota to empower youth to tackle plastic pollution. Called the 4-H Green Superheroes of Science program, 4-H teens from diverse backgrounds teach science concepts to elementary school-aged youth. They bring attention to plastic litter and they learn to make new types of plastic from biodegradable products.

4-H Ambassador programs provide opportunities for youth to develop activities to engage their peers, promote 4-H youth development, build leadership skills, and develop meaningful relationships with adults and peers. Project-specific groups like 4-H Agriculture and Pollinator Ambassadors develop educational experiences to share knowledge in a particular topic of interest. These youth leaders gain a deeper understanding of a topic and then relay that information to peers, younger youth and community members.

Solving problems in these critical areas requires that youth understand the natural world. More than 35 new outdoor programs encouraged youth to be more active. This was a safe and fun way to engage many of the 6,000+ youth who joined 4-H during the COVID-19 pandemic when indoor gathering was less safe. From fishing to snowshoeing, to protecting natural resources, 4-H'ers learned more about the natural world, as well as the health benefits of being outdoors.

Briefly describe how your target audience benefited from your project's activities.

Evaluation of one science teen leadership opportunity, the Green Superheroes of Science program, demonstrated that youth who attend the program experience significant growth in leadership skills.

- 100 percent of leaders built leadership skills.
- 100 percent now know how to work as a team.
- 100 percent gained skills to work with younger youth.
- 86 percent grew more confident in their public speaking skills.

4-H science leaders noted a deeper understanding of environmental issues. They also learned about the difference between bioplastics and traditional plastics. This is consistent with the research on peer-to-peer teaching in that peer teachers grow in their comfort level with the teaching material.

Teen leaders set the tone for curious exploration, reinforcing how youth were doing the things scientists and engineers do. Youth engaged in science programs are more educated about science.

- 100 percent learned how to use their senses to investigate the world around them.

- 95 percent of youth are more interested in science; 81 percent are more interested in engineering.

- 96 percent can recognize how they act like a scientist in everyday life.

Briefly describe how the broader public benefited from your project's activities.

Engaging young people to learn about ecology, agriculture and food, while putting them in positions where they can teach those even younger than themselves, creates informed leaders for our future.

Project-specific Ambassadors, as well as 822 Local 4-H Ambassadors and 26 State 4-H Ambassadors, involve peers and other youth in building leadership skills and becoming civically engaged. Participants build skills with each other and share that learning with others, who then take what they've learned and apply it in their 4-H activities and beyond.

Current and future generations of all societies benefit when youth are prepared to lead on issues of global importance. 4-H in Minnesota is creating those leaders.

Training Youth Workers to Build High-quality Youth Development Programs

Project Director
Catherine Dehdashti
Organization
University of Minnesota
Accession Number
7000019

Expanding the portfolio of training for adult youth workers

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Effective youth programs need youth development professionals who are prepared for their careers, but many adults who work with and on behalf of Minnesota's young people lack training that bridges the research to practice. Youth workers experienced new challenges during the COVID-19 pandemic, and many previous models of engagement no longer fit their needs.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

University of Minnesota Extension trains youth-serving organizations and teachers of out-of-school time programs in best practices using a research-based approach. Collaboration with community partners ensures that Minnesota's youth build the skills they need to thrive.

Online training of youth workers has boomed over the pandemic. Currently, the Extension Center for Youth Development has four online e-studies: Youth Engagement Matters, Youth Work Matters, Dilemmas in Youth Work, and Social and Emotional Learning + Wellbeing.

Extension’s Youth Work Matters course is taught by experienced faculty and staff. They train individuals, teams and organizations. Training is based on research into effective youth programs and our own experience running the Minnesota 4-H program. Courses for early-career youth workers and program leaders explore the foundations, research and theories of positive youth development as they take an in-depth look at the field as a whole, how to support youth needs and their own role as a youth worker. Online course content encourages participants to learn on their own time as well as with other professionals.

The Youth Development Insight blog, founded in 2011, features educators who bridge research and practice, offering their views on what's happening in the field of youth development with an eye to evidence-based research. Extension youth development educators wrote 34 blog posts in 2021. The Center for Youth Development podcast featured a youth in agriculture series with four new podcasts in 2021.

Briefly describe how your target audience benefited from your project's activities.

Extension addressed current needs of youth workers during the pandemic through a diversified portfolio. Blogs, podcasts and online courses kept research-based content relevant and accessible during these trying times.

In 2021, 2,172 youth workers registered for the four e-studies. Evaluation results show a positive impact on participants. Over 98 percent of "Youth Engagement Matters" participants learned new strategies to engage youth in programming and learned to provide opportunities that spark the interests of young people. Participants left with tangible ways to incorporate youth engagement into a high-quality learning environment. They also deepened their knowledge of theoretical frameworks for youth engagement, specifically in better understanding the Rings of Engagement framework.

Youth Work Matters participants increased their understanding of how to weave positive youth development into their practice with youth. They also better understood how positive youth development reframes work with young people.

Participants in Dilemmas in Youth Work developed responses to dilemmas, taking into account youth needs. They understood how to generate responses to dilemmas that balance diverse and often competing considerations. They also left with resources for incorporating reflection and discussion of dilemmas in their work.

Social and Emotional Learning + Wellbeing debuted in the fall of 2021. Youth programs can support social and emotional learning (SEL) and wellbeing through equipping staff, paying attention to learning environments, designing impactful learning experiences and using data to improve practices. Overall, participants have increased their understanding of SEL and have gained strategies to infuse SEL in their youth programs. They also learned simple ways to collect and use SEL data for improvement.

The Youth Development Insight blog had 21,692 users in 2021 (a 64 percent increase) and 33,188 pageviews, a 49 percent increase. Many pageviews are from Minnesota (6,814), but the reach is global (Philippines, India, Canada, South Africa, United Kingdom, Australia, Nigeria). The podcast had 3,681 total downloads from the U.S., Europe, Canada and Africa. Posts from previous years prove to be valuable and popular today.

Briefly describe how the broader public benefited from your project's activities.

Youth work has positive youth development as its goal, and when youth are guided by well-informed staff, their experiences benefit themselves and their communities. Youth workers also benefit from education and support that help to create a field in which their career is validated and supported, and in which they have tools to use in responding to the many dilemmas they face.

The expansion of resources and access can help community partners retain youth workers so that they can continue to develop and deliver quality youth programming during and after the COVID-19 pandemic.

Type

Projects / Programs

Projects / Programs without a Critical Issue

1

OPTIMIZING EQUINE FORAGE UTILIZATION AND HEALTH

Project Director

Krishona Martinson

Organization

University of Minnesota

Accession Number

1013173

OPTIMIZING EQUINE FORAGE UTILIZATION AND HEALTH

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

All classes of adult horses require a majority of their feed be supplied from forages (hay or pasture), and most adult horses can meet their daily energy needs from forages alone. Due to the importance of forage in the horse diet, it is critical that methods to optimize forage in the ration and its impact on horse health are explored. The primary objectives of this project are to optimize equine forage utilization and health and to disseminate research-based information to horse owners and professionals.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

We continue to explore grazing forages other than perennial, cool-season grasses in horse pastures. We recently found that berseem clover, annual ryegrass, and winter rye appear to be the best-suited cover crops to extend the grazing season in horse pastures. These species tended to be nutrient-dense but were lower yielding, and the grasses tended to have an inverted Ca:P ratio. Unfortunately, herbage of purple top turnip and daikon radish was not preferred by the horses and considered unpalatable, although the cover crop species yielded well and were nutrient-dense. Additionally, we found that teff, an annual warm-season grass, could be successfully grazed by horses. When compared to a cool-season grass and alfalfa, teff had lower amounts of amino acids; however, the only difference in horse plasma amino acid was decreased threonine concentrations in horses grazing teff. Additionally, teff has lower nonstructural carbohydrate and higher fiber values compared to cool-season grass and alfalfa. When grazed by horses, blood insulin levels were lower for horses grazing teff compared to the cool-season grass in the fall and late fall. As a result, the lower nonstructural carbohydrate and higher fiber values of teff could help decrease the insulin response of horses grazing in the fall and late fall. In addition to grazing forages, feeding forages in the form of dry hay is important to explore. When feeding reduced-lignin and conventional alfalfa hay to horses, we found that both hays resulted in a similar dry matter intake (1.6% bodyweight) and time to consumption (7.6 hours). Apparent dry matter digestibility was greater for reduced lignin (64.4%) compared to non-reduced lignin alfalfa (61.7%) hay. Apparent crude protein and neutral detergent fiber digestibility did not differ between the hays, averaging 78% and 45%, respectively. Hays were similar in mean fecal particle size (0.89 mm) and mean retention time for both liquid (24 hours) and solid (27 hours) phase material. These results indicate an improvement in dry matter digestibility for reduced lignin alfalfa hay when fed to adult horses, with no change in forage consumption, fecal particle size, or retention time. In addition to feeding forages, properly storing hay is important to ensure quality is retained throughout the storage period. We explored storage losses of round-bales wrapped with twine, net wrap or B-wrap® and found that tafter 365 days in outdoor storage, dry matter losses were 7% for twine bales, 5% for net wrap bales, while B-Wrap® bales maintained dry matter. Changes in forage quality were commonly observed at ≥180 days of storage where nonstructural carbohydrates were decreased and insoluble fiber components were concentrated. Additionally, B-Wrap® bales had a higher dollar value compared to net wrap and twines bales at 180 and 270 days in storage. These results suggest that B-Wrap® was better able to shed precipitation which preserved forage quality and bale value compared to large round bales bound in net wrap and twine in long-term, outdoor storage. Finally, horse health impacts while eating hay is important to explore. Therefore, in September 2021, we launched a 2-year research project to determine the effect of hay nets on dental wear patterns in adult horses.

Briefly describe how your target audience benefited from your project's activities.

The target audience for this project is horse owners, industry professionals, and University faculty. Study results were disseminated to our audience through University of Minnesota Extension programming efforts and industry partner programs. Programming efforts included website information, e-newsletter articles, posts on social media sites, online courses, infographics, and in-person presentations at workshops and field days. Additionally, industry and University professionals were reached through society and professional meetings and conferences and peer-reviewed publications. This audience has used our research results to advance their knowledge in horses management, care, and feeding which has helped to improve overall horse welfare. Specifically, our audience now has viable options to extend the grazing season through the use of alternative forages proven safe for horses. They have a better understanding of when to use reduced lignin alfalfa in the horse ration and can make an informed decision when choosing what bale wrap is best for their hay storage system. Scientifically, these research discoveries have helped fill technical voids and have served as preliminary data spring boards for future research on related topics.

Briefly describe how the broader public benefited from your project's activities.

There has never been more public pressure on livestock owners to ensure proper care and welfare of their stock, including horses. Our research aims at optimizing horse forage utilization, which accounts for the major feedstuff (e.g. forages) in the horse ration. This information is helpful to the broader public in two main ways. First, horse owners and professionals have access to applied, cutting edge, research-based information that helps improve horse management, care, and feeding. By disseminating this information widely, horse owners are better able to make better, more informed decisions. This pleases the general public, sheds a positive light on animal husbandry practices, and helps to remove societal pressures from livestock owners. Additionally, because of our project, horse owners have access to research-based information and can help educate the general public on recommended horse husbandry practices focused on forage utilization. A more educated general public is key to gaining support and acceptance for practices commonly seen in U.S. animal agriculture production and management.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

There are no major changes or problems to report for this project. Over the course of this project, professional development opportunities have included participation in the American Forage and Grassland Annual Conference and the Equine Science Society Symposium. This project has provided training to one postdoctoral student, 4 graduate students (2 MS, 2 PhD), and 2 undergraduate students. We primarily disseminated information to horse owners and professionals through our strong online presence. Historically, we've reached (both directly and indirectly) about 5 million horse owners and professionals annually through in-person Extension programs and field days, our monthly e-newsletter, website visitors, YouTube videos, Facebook posts, infographics, podcasts, and online certificate courses. The UMN Extension Horse YouTube channel currently has over 1,000 subscribers and over 200,000 video views, the Facebook page has over21,000 followers and a 5 year average annual reach of 4 million people, over 4,000 people were signed-up for the monthly e-newsletter, and over 1,000 people have enrolled in our online courses since 2016. These diverse dissemination channels give horse owners, professionals, University colleagues, governmental officials, and the public 24/7/365 access to information. We plan to continue to collect and summarize data and publish results through scientific and Extension channels that enhance our audience's understanding of horse forage utilization. These efforts will help us continue to accomplish project goals.