Michigan (Michigan State University) Annual Report - FY2021

Report Status: Approved as of 07/08/2022

Contributing Organizations

Michigan State University

Executive Summary

Overview

Founded in 1855 as the Agricultural College of the State of Michigan, Michigan State University (MSU) has served as the model for the creation of the land-grant university system. While the challenges facing Michigan, the United States, and the world have certainly changed since then, the need for research and outreach continues perhaps even moreso in light of the COVID-19 pandemic. Today we remain dedicated to the land-grant mission of teaching, research and outreach. Educating the next generation of farmers and those working in the agricultural industry remains our highest priority and provides the motivation for all that we do. We continuously strive for excellence and are proud to be **ranked the #10 agriculture and forestry college in the world,** according to the 2021 Q.S. rankings.

Producing some **300 different types of commodities**, Michigan is second only to California in terms of its agricultural diversity and is the most diverse agricultural state with plentiful access to fresh water. These industries range from field crops such as corn, wheat and soybeans to fruits such as cherries, apples, grapes and blueberries; to dairy, livestock, honey, and fish; and vegetable crops, along with turfgrass, ornamental trees and flowering plants. The breadth and depth of Michigan agricultural enterprises require extensive research and outreach on numerous pests, diseases, invasive species and other issues in order to remain competitive and vibrant.

The food and agriculture system accounts for $104.7 billion in direct, indirect and induced economic activity per year and approximately 805,000 jobs – or 17 percent of total employment in Michigan. Helping to ensure the continued prosperity of these operations and businesses, through timely research and outreach among other things, is critical to the financial vitality of the state. Dairy and livestock comprise the two largest sectors of the farm economy in Michigan, contributing about $5 billion total impact per year. Field crops are the second largest sector of the Michigan farm economy and an important input in livestock production. Fruit production is the third largest economic sector.

Weather patterns vary tremendously across the state. **Temperatures and precipitation patterns can be markedly different** from the northern tip of the Upper Peninsula to the southern border of the Lower Peninsula. Soil types also run the gamut from sandy to rocky depending on geographic locations. Therefore, what works for a farm in Marquette may not apply to one in Benton Harbor, even if they are similar types of operations. In order to meet all of these varying needs across the state, MSU operates 15 research and extension centers throughout the state where the research is directly applicable to nearby farms. All of the centers are strategically located, equipped and staffed to address a specific segment of the Michigan agricultural and natural resource industries. The centers also help to maintain strong connections to local communities, farmers and industries at each location.

Surrounded by the Great Lakes, Michigan is also heavily **defined by water**. The water causes what's known as lake effect across Michigan and helps to moderate temperatures for modifying the growing season, creating many microclimates that allow Michigan producers to grow a wide variety of crops. Without those major bodies of fresh water, much of the state's agriculture, shipping and tourism offerings would not exist. Discovering ways to protect crops and livestock without contaminating the state's numerous waterways and rich natural resources remains a high research and outreach priority.

The mission of MSU AgBioResearch is to engage in innovative, leading-edge research that combines scientific expertise with practical experience to generate economic prosperity, sustain natural resources, and enhance the quality of life in Michigan, the nation and the world. As we often describe as "fundamental research with an intended outcome." All of our research is aimed at solving problem or creating a new opportunity. The 340 plus researchers across campus strive to maintain a balance between basic and applied research and rely heavily on the input of their constituents in identifying research priorities.

MSU AgBioResearch has faculty members from across campus, including the following colleges: Agriculture and Natural Resources; Natural Science; Engineering; Veterinary Medicine; Social Science; Communication Arts and Sciences; Arts and Letters; and Osteopathic Medicine. In addition, there are active collaborations with the College of Law and the College of Business.

MSU AgBioResearch's total budget for FY 2020-2021 was $128.4 million, with this report representing $7.25 million in federal formula funds and equivalent match.

Michigan State University Extension helps improve people's lives through an educational process that applies knowledge to critical issues, needs, and opportunities. For more than 100 years, MSU Extension faculty and staff members have been actively reaching people where they are – in their homes, farms, businesses, and communities – with research-driven education. We help people perform their jobs better, raise healthy and safe families, build stronger communities, and empower children to dream of brighter futures.

MSU Extension's total funding in 2020-2021 was over $92.8 million, with this report representing $11.6 million federal formula dollars and equivalent match.

PARTNERING BEYOND MSU

MSU AgBioResearch and MSU Extension have a unique partnership with the Michigan Department of Agriculture and Rural Development (MDARD) on Project GREEEN (Generating Research and Extension to meet Economic and Environmental Needs), a cooperative effort to benefit plant-based commodity industries within Michigan. **Project GREEEN has generated more than $2.5 billion worth of economic impact to Michigan** over the course of its 20-plus years of existence. We also partner with MDARD, Michigan Farm Bureau, and eight industry organizations on the Michigan Alliance for Animal Agriculture (M-AAA) to conduct research to advance Michigan animal agriculture. Since forming in 2014, **M-AAA has generated a $10 return on every $1 invested.** These programs provide seed grant funding that enable many of the researchers to establish primary findings and equip them to go on to receive other larger grants.

We have many collaborative grants with institutions around the country. This is particularly evident in the USDA-NIFA SCRI program.

MSU is also dedicated to creating new opportunities for our industry and growers. In recent years we have initiated programs on hops (Michigan is now the fourth largest producer in the US), malting barley, industrial hemp and new fruit crops. Currently we are developing research and Extension programs to support the developing industrial hemp business and will continue to respond as the laws and opportunities surrounding hemp evolve.

MSU's Institute of Agricultural Technology (IAT) is celebrating 125 years of providing practical agriculture training the next generation of students. While the first courses were developed for dairy management and learning to process milk and cheese, today IAT has 13 certificate programs available at 12 community college locations across the state. Demand for agricultural technicians is expected to continue to grow in the near future.

Michigan Inter-Tribal Land Grant Extension System

In 2019, Bay Mills Community College and Michigan State University began a partnership to better serve tribal nations and communities. The Michigan Inter-Tribal Land Grant Extension System (MILES) is led by Bay Mills Community College, in collaboration with MSU Extension. The goals of this partnership include enhancing agriculture production and marketing, developing leadership skills in both youth and adults, conserving natural resources, improving economic development programs, and creating stronger families through health and nutrition. MILES includes professionals from all four Michigan land-grant institutions MSU, Bay Mills Community College, Saginaw Chippewa Tribal College in Mt. Pleasant, and Keweenaw Bay Ojibwa Community College in Baraga. Through these outreach and engagement efforts, MILES strengthens tribal communities by supporting tribal sovereignty and connecting communities with the educational resources they want and need to solve community-identified problems.

Critical Issue: Environmental Stewardship and Natural Resources Management

In 2021, MSU Extension's Natural Resources and Environmental teams provided over 150 educational programs to over 10,000 participants. Over half of these events were hosted online. These educational programs cover topics such as conservation, stewardship, fisheries management, invasive species management, and solar energy.

Examining the impact of climate change on freshwater fish:

Research in the MSU Department of Fisheries and Wildlife uses maps and models to create a more sustainable future for Michigan waters and the fish that live in them.

Climate change is one of the most pressing issues in agriculture and natural resources. It could have particularly harsh consequences for fish, which are incredibly sensitive to changes in temperature.

According to a study from the Environmental Law and Policy Center, the Great Lakes basin warmed by 1.6 degrees Fahrenheit annually from 1985-2016, higher than the national annual average of 1.2 degrees Fahrenheit.

Warmer air temperature means warmer water. This, along with changes in precipitation throughout the Great Lakes basin, impacts Michigan's rivers, streams and lakes. In addition, human land use can cause damage to fisheries and the areas surrounding them.

"Michigan's diverse fisheries — warm water, cool water, cold water — attract anglers from throughout the Great Lakes region to our state," said Dana Infante, professor in the Michigan State University (MSU) Department of Fisheries and Wildlife. "If we start getting changes in the habitats that support these species, we can expect to see a loss of species, which could mean we lose fisheries."

Research in Infante's lab focuses on using maps and modeling to analyze the effects of climate change on Michigan fish. Erin Tracy, a former master's student, and Hao Yu, a current postdoctoral researcher, have conducted research to help create a more sustainable environmental and economic future for these waters and the fish that live in them.

Critical Issue: Human Health, Youth, and Families

In 2021, MSU Extension's Health and Nutrition Institute and Children and Youth Institute provided over 2,900 educational programs to over 89,000 participants. These educational programs address topics such as diabetes management, mental health, mindfulness, stress reduction, pain management, food safety, sleep hygiene, falls prevention, youth development, leadership, career exploration, and 4-H.

APPLICATION OF DIETARY OMEGA-3 FATTY ACIDS TO PRECISION MEDICINE INTERVENTIONS AGAINST AUTOIMMUNE DISEASE

Autoimmune diseases (ADs) affect over 25 million Americans, inflicting tremendous individual suffering and societal burdens. Exposure to the earth's most abundant mineral, crystalline silica (quartz), is common in individuals involved in construction, mining, farming, manufacturing and military deployment and increases their risk of developing systemic lupus erythematosus (lupus) and other ADs. Here we seek to understand the underlying mechanisms by which consumption of the omega-3 fatty acid docosahexaenoic acid (DHA) blocks silica-triggered lupus, thus yielding important new insights into how environmental toxicants trigger AD and how manipulating the lipidome through dietary fatty acid supplementation can prevent it.

This project will significantly advance mechanistic understanding of how dietary modulation of the lipidome could be used to prevent environmental triggering of inflammation and autoimmunity in the lung. This knowledge is essential to develop practical, low-cost preventative strategies to help individuals environmentally exposed to silica and potentially other toxicants to reduce the risk of lupus or other autoimmune diseases. This knowledge will also be relevant to preventing flare-ups and slowing progression of existing autoimmunity. In sum, new knowledge from this project could help decrease morbidity and mortality associated with toxicant-triggered inflammation and autoimmunity, and reduce health care costs related to lupus and other autoimmune diseases.

Managing inflammatory and autoimmune diseases today is about reducing symptoms in newly diagnosed individuals and preventing progression of established tissue damage to organs such as kidney . Existing and emerging therapeutics have multiple mechanisms of action broadly encompassing non-specific immunosuppression, lymphocyte depletion, neutralization of immune-stimulating cytokines/chemokines, and blocking Type 1 IFN- stimulated gene expression. These treatments have serious limitations: 1) unacceptable adverse effects; 2) resistance of ELT to their action; 3) inability to reverse immune-mediated damage; and 4) high cost. Individuals suffering from lupus or other inflammatory diseases can increase fish consumption or take omega-3 supplements to prevent or quell disease flares.

We also expect our studies to reveal potential benefits of ω-3 consumption pulmonary inflammatory diseases such as silicosis and COVID-19.

Critical Issue: Plant and Animal Production and Health

In 2021, MSU Extension's Animal, Consumer Horticulture, Field Crops, Fruit Crops, Ornamental Horticulture and Vegetables teams provided over 650 educational programs to over 60,000 participants. These educational programs address topics including pest management, quality assurance, management, production, and plant and animal health and wellbeing.

MSU researchers analyzing novel technique to improve Michigan wine production

Paolo Sabbatini and Ilce Medina Meza are studying how removing leaves from vine canopies early in the season can help Michigan wine producers grow high-quality grapes.

According to the National Association of American Wineries, Michigan ranks in the top 10 states for wine production, number of wineries and economic impact of the wine industry.

Viticulture is important to Michigan's economy, but the state's cool climate makes for a short growing season (May-October), which can present challenges for growers — limited fruit ripening, damage to vines, delayed fruit maturation — especially when it comes to red wine grapes.

Michigan is really a different place to grow grapes than any other place in the world," said Paolo Sabbatini, associate professor in the Michigan State University (MSU) Department of Horticulture. "However, we have the potential to produce very outstanding wines. Unfortunately, the season variability and climate challenges often limit this."

Sabbatini, along with Ilce Medina Meza, assistant professor in the MSU Department of Biosystems and Agricultural Engineering, is leading a three-year, $500,000 U.S. Department of Agriculture National Institute of Food and Agriculture (USDA NIFA) project testing alternative canopy management strategies to help Michigan wine producers grow grapes with high-quality aroma, color, bitterness and mouthfeel properties from the most important red cultivars planted in Michigan: pinot noir, cabernet and merlot.

The canopy of a grapevine is the part that's visible above ground. It includes the leaves, shoots and the trunk of the vine.

"Canopy management is how you manage the canopy structure during the summer in a way that can really speed up fruit maturation," Sabbatini said. "In Michigan, we need to be able to ripen the fruit at a lower temperature during the summer in a shorter time."

MSU animal science professor exploring environmental benefits of regenerative agriculture

Rowntree publishes study on impact of newer farming method

Michigan State University C.S. Mott Professor of Sustainable Agriculture Jason Rowntree is examining the benefits and applicability of regenerative agriculture-based livestock systems.

Regenerative agriculture is a relatively new approach to livestock farming that emphasizes the reduction of farming inputs and restoring ecosystem services such as soil carbon sequestration and improved water cycling.

"These regenerative agriculture principles suggest that modern livestock systems can be redesigned to better capitalize on animals' ecological niches as biological up-cyclers and may be necessary to fully regenerate some landscapes," wrote Rowntree in a paper recently published in *Frontiers in Sustainable Food Systems*.

"Regenerative agriculture is a newer movement in agriculture with the overarching premise of trying to improve land while simultaneously growing food – meaning its aim is improving the land, improving the ecosystem, and improving productivity with certain ecological boundaries."

MSU to study precision livestock farming adoption trends in U.S. swine industry

Animal science researcher Janice Siegford will examine how agricultural technologies can help farmers, consumers and animals.

Michigan State University (MSU) Department of Animal Science researcher Janice Siegford is leading a team of researchers and extension agents recently awarded a $1 million USDA-NIFA Agriculture and Food Research Initiative grant to study the advancement of precision farming in the U.S. swine industry.

Beginning June 2021, the group will start to explore precision livestock needs, public perceptions and the willingness of farmers, producers and consumers to pay for new technology. The end goal is to determine how new technology is viewed by the swine industry at large, with respect to what is practical and useful for farmers and consumers.

"One of the things that often occurs when researchers work with precision livestock farming is we get really fascinated by all the cool bells and whistles of the technology," Siegford said. "We sometimes lose sight of the fact that these processes have to actually go on a farm to be practically used by farmers and be something they can afford. Our focus is to really understand, from the human perspective, what is

useful and how valuable the technologies and processes are in reality."

Critical Issue: Secure Food and Fiber Systems

In 2021, MSU Extension's Agriculture Business Management and Community Food Systems teams provided over 200 programs to over 14,000 participants.

Detroit Partnership for Food, Learning and Innovation

Detroit's challenges are different than those in rural food production areas — contaminated soils, small lots, and lack of agricultural education among them. The Detroit Partnership for Food, Learning and Innovation is Michigan State University's first urban food research center, developing solutions to economic and nutritional challenges unique to urban environments. This research and Extension center grew from years of discussions with Detroit leaders and residents. This facility and the MSU Extension staff housed there will help educate people about growing healthy, nutritious food, and provide a location for a wide range of programming that will benefit the local community.

Building A Community-University Partnership for Modeling Food and Natural Resource Systems

Major progress was made in 2021 on modeling the Flint food system, with the goal of reducing food insecurity and improving access to healthy foods and sustainability of food production in Flint. A system dynamics model of the Flint food system, based on input from Flint residents, was shown to our Community Consultative Panel in Flint (comprised of food system experts), and is currently being revised based on their feedback. The model results are being written up for an academic audience and will also be shown to the community at a Food Summit which we are co-organizing with the new Flint Food Policy Council in June 2022. This will help inform community decision-making in Flint around the food system.

The system dynamics model we built this year is a key component of our food systems work in Flint. The food system experts and practitioners on our Community Consultative Panel have already benefited from discussions around the structure of the food system and how it could be shifted towards better outcomes. The Flint Food Policy Council, tasked with creating a vision for the food system in Flint, has been discussing our project results with us as well, and will be incorporating what we learned from Flint community members into their initial discussions.

Critical Issue: Water Quality and Quantity

In 2021, MSU Extension's Sea Grant team provided over 125 educational programs to over 8,500 participants in 2021.

MSU research team receives $750K USDA grant to explore ways to mitigate crop uptake of PFAS

Five Michigan State University researchers have received a $750,000 grant from the U.S. Department of Agriculture's (USDA) National Institute of Food and Agriculture (NIFA) to study crop uptake of per- and polyfluoroalkyl substances (PFAS) and how to prevent it.

The project is led by Hui Li, a professor in the Department of Plant, Soil and Microbial Sciences (PSM) who specializes in soil chemistry and the environmental occurrence and fate of emerging contaminants. The four co-principal investigators are from PSM as well.

- Stephen Boyd – a University Distinguished Professor and expert on remediation of contaminated soils.
- Ray Hammerschmidt – a professor who studies plant physiology and disease resistance.
- Kurt Steinke – an associate professor and MSU Extension specialist in soil fertility and nutrient management.
- Wei Zhang – an associate professor of environmental and soil physics who looks at the transport processes of contaminants in soil, water and plant systems.

PFAS contamination has made headlines around the country, and there is mounting concern about the effects these chemicals have on public health. In response, MSU has invested in the Center for PFAS Research and has developed several multi-institutional, nationwide partnerships to address the problem. Research is looking to quantify the exposure risk to humans and the environment, develop possible remediation strategies, and explore PFAS alternatives for industries that have relied on them.

Critical Issue: Workforce Development, Community Resource Development, and Innovation

In 2021, MSU Extension's Financial Homeownership Education, Government and Community Vitality, and Product Center teams offered over 550 educational programs to over 16,000 participants.

Resilience to Fiscal, Economic, Disaster and Public Health Shocks

The United States economy is in the midst of major economic and fiscal changes. As a consequence many communities across the country are experience economic and fiscal challenges that may increase vulnerability and reduce resilience to further economic, fiscal, natural disaster and health shocks.

The overall objective of this project is to conduct research that will:
1) Measure local economic distress; 2) identify places that are more and less resilient (identify outliers) and identify lesson learned from places that perform unexpectedly well; 3) conduct examinations of different aspects of state and local government fiscal health; 4) conduct research on natural disaster resilience, and human health/wellbeing.

The financial crisis that began in 2007-2008 resulted fiscal, economic and human stress on many households and communities throughout the country. The gradual changes occurring in the global financial system are also expected result in new stressors over time. All of these forces could potentially reduce resilience and the ability of households and communities
to the manage shocks that can and do occur. For example, Monnat (2016) argues that the opioid crisis is most severe in places that were once prosperous but are now in decline. Similarly, overall health appears to be in decline. One measure is the recent decline in average lifespans, particularly among low-educated whites.[1] Just recently the United States has
suffered from the onslaught of two major hurricanes; the degree to which households and communities are able to protect themselves and recover depends largely on wealth, human capital, and overall wellbeing. Along these lines, government services such as public safety also play a role in preserving life[2], and yet many communities struggle to fund such services.
Further, communities that struggle with eroding economies and tax bases are in a weaker position when it comes to negotiating with businesses regarding tax breaks and subsidies, and are thus more vulnerable to yielding negative net returns for the community on such arrangements.

The overall objective of this project is to assess changing household, community, and local government resilience and vulnerability, and identify approaches to increase resilience, reduce vulnerability, and improve overall quality of life in the midst of major structural changes to the U.S. and global economies. The thrust of my proposed set of activities fit within the USDA strategic goal 1: Assist rural communities to create prosperity so they are self-sustaining, repopulating, and economically thriving.
[1] See Sasson (2016).
[2] See Lim, et al. (2016).

This project has published two refereed articles. The researcher has submitted a book that is in editing (Handbook on the Economics of Disasters) to Elgar, which will become part of the prestigious Handbook of Economics series.

Merit and Scientific Peer Review Processes

Updates

None (no changes from plan of work)

Stakeholder Input

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

None (no changes from plan of work)

Methods to identify individuals and groups and brief explanation

None (no changes from plan of work)

Methods for collecting stakeholder input and brief explanation

None (no changes from plan of work)

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

MSU AgBioResearch and MSU Extension frequently partner with other Michigan entities to help drive progress. Together, we have created a statewide, cohesive plan that uses the MSU research capability and knowledge base to expand outreach. This plan fosters economic development, improved quality of life, a healthy environment, and a plentiful and secure food supply for Michigan residents.

Both organizations have long-standing traditions of working closely with Michigan commodity organizations to ensure that the research and outcomes are meeting the needs of their farmer-members, especially the emergent, pressing issues. The successes and accomplishments of these two organizations are greatly tied to close partnerships with each other, as well as state agencies, commodity groups, private industry, foundations, extramural funding agencies, such as USDA NIFA, and other stakeholders, plus outstanding legislative support. Strengthening those bonds continues to be a priority.

Highlighted Results by Project or Program

Critical Issue

Environmental Stewardship and Natural Resources Management

Closing Out (end date 09/07/2023)

Conserving river fishes and their habitats from current and future threats throughout the conterminous United States

Project Director
Dana Infante
Organization
Michigan State University
Accession Number
1016289

Conserving river fishes and their habitats from current and future threats throughout the conterminous United States

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

Distributions of stream fishes are affected by natural landscape factors operating within stream catchments such as geology, topography, catchment size, and climate. However, human uses of landscapes for activities such as agriculture and urbanization as well as other stressors like dams can alter the influence of natural factors to negatively affect numbers and types of fishes that stream habitats support. Additionally, changes in climate are exacerbating current stressors, resulting in dramatic changes to stream fish assemblages across the U.S. This project attempts to model distributions of hundreds of stream fish species across the U.S. to identify those natural landscape factors and anthropogenic stressors most influential to individual species. Outcomes of this work will aid managers in identifying fish species and habitats that may be most vulnerable to current and future stressors, and they will suggest strategies that may result in conservation of stream fish and habitats into the future.

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 the last year, we have provided species distribution models for 271 widely-distributed species to the U.S. Geological Survey for public dissemination on ScienceBase along with metrics to evaluate model precision and all data used for modeling. Additionally, we have begun efforts to model distributions of an additional 200 fish species that are rare or range-restricted; this step requires different analytical techniques than were used for 271 widely-distributed species. We also completed a study to map resilient stream fish habitat across the state of Michigan; this serves as a pilot effort for what we would propose to do nationally. We also created a database that characterizes the migratory patterns of hundreds of fish species across North America; this database will allow us to conduct analyses that better detect sensitivity of stream fish species to anthropogenic barriers such as stream and road crossings. Last, we have begun work to investigate the temporal nature of our stream fish assemblage data; by identifying watersheds with samples in historical vs. contemporary time periods, we can begin to quantify exact changes in assemblages that have occurred with human stressors, along with identifying regions of the U.S. that have changed most substantially from historical time periods.

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

Our target audience includes researchers and managers from the U.S. Geological Survey, U.S. Fish and Wildlife Service, and state natural resource management agencies across the U.S. At this time, all of the model results and data used for modeling are publicly available via ScienceBase, providing an opportunity for anybody to use our results to support conservation decision making. We have also provided specialized data deliveries to individuals and organizations requesting information, and we have given multiple presentations on our current and upcoming work in specialized webinars and in professional meetings.

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

The public benefits from this research because our results identify stream fish species that may be most vulnerable to anthropogenic stressors and changes in climate as well as well as those habitats that may vulnerable. In generating this information, we do so across the scale of the entire U.S. This approach differs from information typically generated by state natural resource management agencies operating within single states or river basins, providing national context to understand the scope of challenges to stream fishes and their habitats.

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.

No changes or problems were encountered. This year, the work of two doctoral students and one post-doctoral research associate informed our outcomes, resulting in multiple opportunities for training and professional development. In the next reporting period, we anticipate having results of 200 new species completed and will likely begin efforts to evaluate and synthesize results for all 471 species collectively.

Closing Out (end date 09/07/2023)

Developing Novel Strategies for the Control of Great Lakes Sea Lamprey based on the Manipulation of Movements and Decisions

Project Director
Clifford Wagner
Organization
Michigan State University
Accession Number
1015987

Developing Novel Strategies for the Control of Great Lakes Sea Lamprey Based on the Manipulation of Movements and Decisions

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

The sea lamprey is an ectoparasitic invasive fish that threatens the sustainability of Great Lakes fisheries. Throughout its life it relies extensively on the sense of smell - odors guide parasites to their hosts in the Great Lakes, and allow the animals to navigate back into spawning streams to reproduce at the end of their lives. Through a combination of laboratory and field experiments, we are working to develop approaches to using these odors as an innovative tool for pest management. Specifically, we are focused on understanding how the animal uses the odors to navigate and select habitats during its migrations, identifying the chemical constituents that comprise the odors it uses to navigate, and creating practices for applying the odors to achieve better sea lamprey control (e.g. to guide them into traps prior to spawning).

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 first objective of this project is to develop a model of the sea lamprey migration (out of streams to feed, back into streams to reproduce).

Result #1: There currently are no empirical estimates of survival for newly transformed sea lampreys (aka transformers) exiting natal tributaries in the Great Lakes basin, and scant descriptions of out-migration behavior. There is, however, substantial interest in ascertaining whether variation in out-migration survival can be associated with characteristics of river systems that regulate rates of mortality (e.g., distance traveled, predator abundance), and thereby the recruitment of parasites to the lakes. In a 2021 field study, we examined the timing and extent of downstream movements in 56 transformers implanted with an experimental micro-acoustic telemetry transmitter in the White River, Michigan. The field study encompassed single-thread river channel, river-wetland complexes, and a drowned river mouth lake. Transformers exhibited nocturnal movement, commencing downstream transits near nautical twilight, or ~60 min after darkness. They tended to move on nights with higher discharge, and moved more slowly in river/wetland complexes and the drowned river mouth lake vs. the single-thread channel, commensurate with changes in average water velocity, suggesting the animal drifts (vs. active swimming). Survival probabilities across habitat types were modeled with a Cormack-Jolly-Seber (CJS) mark-recapture analysis using a Bayesian framework. The results were consistent with a substantial reduction in both survival probability and detection performance in the wide and structurally complex areas of the stream (river-wetland complexes), and the drowned river mouth lake (vs the single-thread river). We performed simulation models to estimate the necessary sample size to achieve high confidence in mortality estimates, and to compare a single release site vs. staggered releases moving downstream, to compensate for the battery life. Results indicate a sample size of 250 individuals substantially improves confidence in the morality estimates, with limited benefit for larger samples, and the use of a staggered release study design. This is the first field description of out-migration movements in sea lamprey.

Result #2: How sea lamprey navigate through lower watershed river channels as they head upstream to spawn is currently unknown. If the migrants show consistent use of particular habitat types (e.g. navigating along river edges, or following the deepest channel), we may be able to target them more effectively with capture devices. In 2021 field study, we tagged 60 migrating sea lamprey with acoustic transmitters and tracked their movements with a high-resolution three-dimensional telemetry array in the White River, Michigan. We have completed data processing, error checking, and filtering. Analysis of the data is focused on ascertaining preferences of the migrants for particular movement paths and channel habitat features. Our preliminary results strongly suggest they prefer to move in the deeper parts of the channel, following meanders in the thalweg, when the river is overall shallow (1-3 m deep). We hypothesize the do so to avoid contact with nocturnal shoreline predators in relatively shallow rivers and estuaries.

The second objective of the project is to discover the chemical identify and behavioral function of the sea lamprey alarm cue.

Result #3: The sea lamprey relies extensively on a chemical alarm cue to avoid predation during its spawning migration. Alarm cues are chemical substances released from fish tissue when damaged by a predator. As the odor drifts downstream, it warns migrants of areas of predation risk, triggering anti-predator behavior including swimming around the area and accelerating to pass more quickly. The most common method used to isolate olfactory cues in aquatic organisms is behavior-guided fractionation, a stepwise iterative process that partitions an odor into fractions, typically by molecular weight, and uses a behavioral bioassay to identify the behaviorally reactive fractions. The aim of this study was to pursue the chemical constituents of the sea lamprey alarm cue using behaviorally guided fractionation. We examined the reactivity to two major fractions of the full alarm cue extract (chloroform- and water-soluble), and examined responses to 32 compounds that have been previously identified from the highly reactive water-soluble fraction, in a standard laboratory assay. We found that both the water-soluble and chloroform-soluble fractions elicited substantial avoidance responses, each exhibiting a response magnitude three-fourths of the full skin extract. When the two fractions were recombined, the full response was restored. There were six sub-fractions derived from the water-soluble fraction, from which 32 compounds were isolated and identified, representing 98**%** of the dry mass of extracted material. No individual compound nor sub-fraction evoked consistent alarm response behaviors during initial screening; however, responses were highly variable, with some replicates demonstrating clear alarm responses. Finally, to test for synergistic effects, we examined the behavioral response of sea lamprey to a mixture of the 32 identified compounds reconstituted at the ratios and quantities observed in the water-soluble fraction. The mixture failed to evoke an alarm response. Together, these results indicate that the active components of the sea lamprey alarm cue are contained in two chemically distinct fractions from skin, but likely do not include the major compounds we have isolated from the water-soluble fraction alone.

Result #4: Putrescine is an aliphatic diamine produced by animal tissue decay. It generates an odor that triggers strong, yet varying, behavioral responses in animals. This distinctive “death scent” is repulsive and elicits starkly adverse responses in some species, especially prey species. Putrescine has been identified in extractions from sea lamprey skin that contain the animal’s alarm cue, and a preliminary study in 2020 suggested the animal avoids the odor. We hypothesized that putrescine may prove an effective repellent for sea lamprey, and conducted a full-scale laboratory experiment to explore that possibility. The results of that study suggest sea lamprey do not avoid the putrescine when presented alone or with a unique molecule found in sea lamprey skin that may serve to identify the source of the putrescine. No further work is contemplated with putrescine.

The third objective of the project is to develop and test novel pest management control practices based on the use of chemical information.

Result #5: Habituation, defined here as the loss of a response to an odor cue after prolonged exposure, can cause it to become less effective when applied to control invasive species. In 2021 we completed analysis of two laboratory experiments designed to test whether 'pulsing' the odor (on/off or high/low concentration) would slow or prevent the onset of habituation to the sea lamprey's alarm cue. We discovered that high/low concentration pulsing maintained the animals response to alarm cue, suggesting it will be an effective management practice.

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

The primary audience for this work is the Great Lakes Fishery Commission (the GLFC), and its various partners and stakeholders in the United States and Canada that are engaged in the control of invasive sea lamprey. The GLFC uses scientific information to guide decisions about investments in research, and modifications to control practices that are recommended by successful development of new approaches. Consequently, this project's participants meet frequently with the GLFC and its relevant committees to convey findings, discuss future directions, and collaborate on new research initiatives. In this reporting period, team members provided briefings to the semi-annual meetings of the GLFC Barriers and Trapping task forces, on which the project leader is a member. The project leader also participates on the science advisory board for the GLFC's FishPass project, a facility that is being built to study how to achieve selective fish passage in the Great Lakes (i.e., blocking sea lamprey while allowing native fishes to pass through a fishway). Our work is being used to design and test approaches to selective blocking and removal of sea lamprey from the fishway using the alarm cue repellent.

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

We engage with the broader public via various outreach activities to promote greater understanding of how science is used to solve difficult environmental problems that society deems important, focusing on invasive species management. In the reporting period our outreach activities were reduced due to Covid-19 restrictions. Our work was disseminated to the public via magazine articles, both in print (Futures Magazine, produced by the MSU College of Agriculture and Natural Resources) and online (MSU Today, spotlighted on the MSU home page, two articles on our research and the experiences of Kandace Griffin, a Ph.D. student on the team). We also provided video, script text, and in-person interviews to support a Discovery Channel documentary production about the sea lamprey migration, and for a popular YouTube show titled "Brave Wilderness". Finally, team members provide many one-on-one outreach functions with local elected officials and the public to describe our research and its impact on creating innovative and environmentally benign approaches to sea lamprey control for the Great Lakes (typically 20-50 per year).

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.

All significant opportunities for training and development during the reporting period were in the form of direct mentorship, field and laboratory hands-on training, and via courses offered by Michigan State University. We trained four undergraduate technicians and one US Fish and Wildlife Service technician in: (1) the collection, extraction, and application of semiochemicals in field behavioral research; (2) the conduct of habitat assessment, including hydraulic measurements, in stream ecosystems; (3) proper Good Laboratory Practices and record-keeping per US EPA criteria; (4) Responsible Conduct of Research per the National Science Foundation guidelines. In addition, we trained four graduate students in experimental design and implementation in behavioral ecology.

Scientific results were disseminated in four peer-reviewed publications:

Dissanayake A, Wagner CM, Nair M. 2021. Evaluation of Health Benefits of Sea Lamprey (Petromyzon marinus) Isolates Using In Vitro Antiinflammatory and Antioxidant Assays. PLOS ONE16(11): e0259587.

Sabal MC, Boyce MS, Charpentier CL, Furey NB, Luhring TM, Martin HW, Melnychuk MC, Srygley RB, Wagner CM, Wirsing AJ, Ydenberg RC, Palkovacs EP. 2021. Predation landscapes influence migratory prey ecology and evolution. Trends in Ecology and Evolution, 36: 737-749.

Evans TM, Wagner CM, Miehls SM, Johnson NS, Haas TF, Dunlop E, Manzon RG. 2021. Before the first meal: The elusive pre-feeding juvenile stage of the sea lamprey. Journal of Great Lakes Research, 47: S580-S589.

Fissette SD, Buchinger TJ, Wagner CM, Johnson NS, Scott AM, Li W. 2021. Progress towards integrating an understanding of chemical ecology into sea lamprey control. Journal of Great Lakes Research, 47: S660-S672.

Environmental Stewardship and Natural Resources Management

Project Director

Norma Lundeen

Organization

Michigan State University

Accession Number

7001555

A guidebook for Solar Energy Planning and Zoning

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

Michigan aims to achieve economy-wide carbon neutrality by 2050 and maintain net negative greenhouse gas emissions thereafter. To ensure progress toward this goal, the state aims to achieve a 28% reduction below 1999 levels in greenhouse gas emissions by 2025. Solar power production will play a prominent role in meeting the state's greenhouse gas emission reduction goal. MSU Extension provides resources and information to utilities, local governments, and the agricultural industry to help make decisions that allow agricultural land management and conservation practices to be integrated into solar projects to ensure a continued strong agricultural presence in rural Michigan and ongoing development of solar projects.

- By 2040, more than 60% of Consumers Energy electric capacity will come from renewable sources
- Consumers Energy plans to add nearly 8,000 megawatts of solar power by 2040
- DTE Energy has set a bold goal to achieve net zero carbon emissions by 2050
- DTE Energy intends to reduce carbon emissions by 80% by 2040
- Since 2009, DTE Energy has invested $2.8 billion in wind farms and solar arrays, providing enough clean energy to power 500,000 homes

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.

Helping rural, suburban, and urban communities meet the challenge of becoming solar ready is a major focus of MSU Extension and the work of the renewable energy team. These efforts, which have become the backbone of the work championed by this team, have major impacts for local communities and the energy companies that serve them. Helping Michigan communities become solar ready, while still supporting agricultural businesses, is an area that MSU Extension has been involved in from the ground up.

With numerous factors driving the need for renewable energy, including the efforts of Consumers Energy and DTE Energy to achieve net zero carbon emissions in the future and Michigan Governor Gretchen Whitmer signing an executive order committing Michigan to be carbon-neutral by 2050, there is a need for information and awareness to be spread at a rapid pace. MSU Extension is focused on creating resources that help local communities understand these directives and provide a basis for them to structure their ordinances. One of the newest resources is the *Planning & Zoning for Solar Energy Systems: A Guide for Michigan Local Governments* guidebook.

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

This guidebook addresses the intense concern expressed by rural communities on how to preserve farmland by recommending four agricultural land management and conservation practices — pollinator habitat, conservation cover, agrivoltaics, and grazing and forage managemente– to be included in zoning ordinances. The guidebook:

- Disseminates evidence-based research along with tips and practical applications for professionals working with communities to develop solar zoning ordinances
- Furnishes examples of solar zoning for consideration by local government officials
- Equips communities without solar zoning provisions with a better understanding of solar policy implications and options
- Provides communities with policy options for integrating productive agricultural uses in solar energy systems

The guidebook was written by experts from MSU Extension, the MSU School of Planning, Design and Construction, and the University of Michigan Graham Sustainability Institute, and was refined through an extensive review conducted by a 20-person interdisciplinary team including planners, lawyers, agricultural specialists, energy experts, and state and local government officials. Since its release in 2021, the guidebook has reached a wide array of communities from across the upper Great Lakes Region, including communities in Canada. Published as a free, accessible document, the guidebook webpage has been accessed over 2,100 times and the guidebook PDF has been downloaded over 1,100 times.

“[Michigan] has aggressive goals to fight climate change, for the good of our citizens and our environment. Through this Guide and other EGLE resources, the state works to level the playing field for all municipalities and empower local governments of all sizes to advance decarbonization in their communities,” - Julie Staveland, sustainability section manager for the Michigan Department of Environment, Great Lakes, and Energy (EGLE)

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

MSU Extension works to increase farmers’ success while protecting the environment, ensuring food safety, reaching new markets, and advancing agriculture through applied research. MSU Extension serves the agriculture industry by engaging in research, education, and outreach that enhances the quality of life for people throughout Michigan.

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.

Related Links:

https://www.canr.msu.edu/resources/planning-zoning-for-solar-energy-systems-a-guide-for-michigan-local-governments

Conservation Stewards

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

In the past, resource management agencies such as the Michigan Department of Natural Resources (MDNR) or Michigan Department of Environment, Great Lakes, and Energy (MEGLE) had sole responsibility for conservation, resource management, and environmental protection programs. The amount of resource management and ecological monitoring needed throughout the state, coupled with increasingly limited financial and human resources within state agencies, means these agencies no longer have the capacity for these traditional roles. Over the years, organizations like The Nature Conservancy (TNC), Michigan Natural Features Inventory (MNFI), regional and local land conservancies, watershed councils, conservation districts, conservation and recreational organizations, universities, and local governments have emerged as

essential partners and leaders in resource management. These organizations frequently seek local volunteers to assist with their work. At the same time, a growing number of Michigan residents want to take actions that positively affect local landscapes and watersheds. Additionally, land use changes throughout the state have increased the number of small-parcel landowners who seek to understand natural resources and ecosystem processes to make informed decisions about their properties and their communities.

Many conservation and stewardship education and volunteer training programs exist throughout Michigan, coordinated through public, private, and non-governmental organizations. However, these programs tend to focus their efforts on very specific activities or locations. The Michigan Conservation Stewards Program grew out of a desire to provide coordinated training and support to empower conservation volunteers and build a network of skilled, committed conservationists that can join in local conservation activities and leadership efforts.

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 Michigan Conservation Stewards Program (CSP) helps citizens gain the knowledge and expertise to actively restore and conserve ecosystems in their own communities. CSP consists of approximately 10 weeks of instruction, combining classroom education and hands-on field experiences. In 2021, CSP moved to an online course that includes forums with targeted question sets, weekly breakout Zoom sessions, and required capstone projects. In addition, with the help of partners, CSP offered local conservation activities that could be conducted individually by participants. Local partners, including nature centers, Conservation Districts, and other natural resource-oriented organizations, are actively involved in providing these enriching experiences. These partners, in turn, receive highly knowledgeable CSP graduates as potential volunteers for their own work.

The program covers a variety of conservation topics including Michigan natural communities, conservation heritage, ecology, society and conservation, and lakes, streams, wetlands, forests, and grasslands conservation. At the end of the program, conservation stewards complete a capstone project in which they work with community partners on locally relevant projects. In 2021 these projects included development of an invasive species mapping system, a native plant seeding workshop, a wildlife demonstration garden, a local effort to remove invasive shrubs, and a fungus educational workshop for the community.

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

In 2021, the Conservation Stewards Program trained 137 volunteers with 480 hours of training. These volunteers logged 1,451 hours on their capstone projects. On an end of program survey:

- 95% agreed that they learned something they did not anticipate learning
- 87% agreed that they learned a new skill
- 80% wish to stay connected with future opportunities with Conservation Stewards
- 75% intended to continue work on their capstone project

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

In 2021, the Conservation Stewards Program resulted in 1,451 volunteer hours contributing to a total $41,000 in economic value towards conservation efforts in local communities.

MSU Extension's natural resources education programs help participants learn ecological principles, natural resource issues and the role of natural resource professionals. They also explore public policy issues related to environmental stewardship. Our programs can lead to increased income for families that retain their natural resource assets, help landowners become better stewards of their land, and protect land management opportunities for future generations. Better land stewardship benefits communities by protecting and enhancing Michigan's natural resource assets.

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

Michigan is the second most diverse state when it comes to agricultural commodities. While this diversity is beneficial to the residents of Michigan, it does present some challenges for agriculture and the development of land resources. One effort supported by MSU Extension is the utilization of land for both solar energy and pollinator habitats.

Bees are essential pollinators of many crops and are important for achieving pollination and maximum yields of many crop plants. However, honeybee colonies are experiencing staggering losses. From 2015 to 2020, beekeepers in Michigan reported an average winter colony loss rate of 28.6% per yeare– a rate 1.9% higher than the national average, and much higher than the 15% target rate that is considered sustainable. Loss of flowering forage is a factor contributing to this high rate of loss. Habitat enhancements providing diverse flowering plants can ameliorate food scarcity for honeybees, and solar projects are the perfect site for these habitat enhancements. An increase of acceptable habitats, along with the promotion of best practices for hive management, will help bolster the honeybee population in Michigan.

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.

MSU Extension works to build resources and provide information that supports pollinators and the development of pollinator habitats through programming and education for beekeepers and growers of all sizes. From using land developed for solar energy to support bee populations to assisting local beekeepers with establishing healthy hives, these programs have helped change perceptions and attitudes toward bees and beekeeping.

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

In 2021, there were over 1,200 participants in pollinator education opportunities.

A participant in one program said, “I have felt like our apiary is too small to bother the Extension office. I see that is not the case. I will continue to utilize the Extension resources more in the future.”

In post program surveys given to participants following a variety of beekeeping webinars:

- 94% of participants indicated that their knowledge increased (N=125)
- 87% indicated their skill level increased (N=125)
- 51% indicated that their learning would increase their operation’s profitability (N=125)

In a survey given after the Michigan Beekeeper’s Association Spring Conference to 230 participants who attended MSU Extension’s sessions:

- 93% indicated that their knowledge increased (N=97)
- 49% indicated that their learning would increase their operation’s profitability (N=77)
- 45% planned to make a change such as buying new equipment, implementing new practices, or managing risk (N=69)

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

The work done by MSU Extension supports the bee population in Michigan and has a positive impact on the profitability and sustainability of beekeeping operations. These efforts will continue to directly support pollinators in Michigan while also supporting sustainable efforts that maximize the pollination of Michigan-grown crops, maximizing output and yield across the state.

Solar Grazing Areas

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

Michigan aims to achieve economy-wide carbon neutrality by 2050 and maintain net negative greenhouse gas emissions thereafter. To ensure progress toward this goal, the state aims to achieve a 28% reduction below 1999 levels in greenhouse gas emissions by 2025. Solar power production will play a prominent role in meeting the state's greenhouse gas emission reduction goal. MSU Extension provides resources and information to utilities, local governments, and the agricultural industry to help make decisions that allow agricultural land management and conservation practices to be integrated into solar projects to ensure a continued strong agricultural presence in rural Michigan and ongoing development of solar projects.

- By 2040, more than 60% of Consumers Energy electric capacity will come from renewable sources
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- DTE Energy has set a bold goal to achieve net zero carbon emissions by 2050
- DTE Energy intends to reduce carbon emissions by 80% by 2040
- Since 2009, DTE Energy has invested $2.8 billion in wind farms and solar arrays, providing enough clean energy to power 500,000 homes

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.

Collectively, Michigan-based utilities DTE Energy and Consumers Energy have ambitious plans to provide more than 10,500 megawatts of solar energy by 2040. Regional electric cooperatives and municipally owned utilities are following suit with plans to expand solar energy production. The large demand for land for these solar projects directly competes with agricultural land use, creating a conflict for society.

Instead of looking at solar energy as a competitor for agriculture lands and functions, MSU Extension assists farmers and energy companies by meeting in the middle of these two industries. Being able to utilize land for solar development and grazing areas allows for both the solar and agriculture industries to prosper. Establishing vegetative ground cover for grazing is a strategy that can be employed to reduce this conflict. Using plants known to help sheep thrive will enable solar sites across the state to be grazed by sheep.

With the sheep and lamb inventory in Michigan at approximately 87,000 head and almost 50,000 head of that made up of breeding stock that requires grazing areas and management, there is an opportunity to utilize this commodity to manage the vegetation of all solar projects currently online or going online through 2024. While there are more than enough ewes to service these solar projects, the sheep inventory in the state is at grazing equilibrium. Solar projects that are suitable for grazing could spur an increase in the sheep and lamb inventory in Michigan. Because ewes can have multiple lambs, the state's sheep industry has the capacity to expand to meet this demand. Furthermore, over half of the lamb and mutton supply in the U.S. is currently imported, and with the largest livestock harvesting facility east of the Mississippi in the Detroit area, there are opportunities to replace imported meat with the increased lamb and sheep inventory.

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

MSU Extension helps local governments and farmers resolve the conflicts over agriculture and solar development in several ways, such as working with Consumers Energy engineers to incorporate sheep grazing into the designs of company-owned solar projects. Currently, five different townships have successfully resolved concerns in their zoning ordinances using this guidance.

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

MSU Extension works to increase farmers' success while protecting the environment, ensuring food safety, reaching new markets and advancing agriculture through applied research. MSU Extension serves the animal agriculture industry by engaging in research, education and outreach that enhances the quality of life for people throughout Michigan.

Critical Issue

Human Health, Youth, and Families

Community and School-based Supports for Food Security, Healthy Eating and Physical Activity

Project Director
Katherine Alaimo
Organization
Michigan State University
Accession Number
1024043

Community and School-based Supports for Food Security, Healthy Eating and Physical Activity

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

Using social ecological theory and the principals of community-based participatory research, the following objectives will be undertaken: 1) to conduct research with schools, state and community-based groups, agencies, and/or organizations on policy and environmental changes, and nutrition and physical education to determine best approaches to make it easier for children and adults to eat healthier and be physically active, and 2) to evaluate interventions for schools, neighborhoods and communities that facilitate positive education, policy and environmental change for improved nutrition and physical activity among children.

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 randomized controlled trial of community gardening, Community Activation for Prevention (CAPs), was conducted to determine whether gardening increases in fruit and vegetable consumption, physical activity, social support, and reduces age-associated weight gain, and sedentary time among a multi-ethnic, low income population of adults began in Denver, Colorado (PI: Jill Litt, University of Colorado Boulder; co-PI: Katherine Alaimo, Michigan State University). Quantitative and qualitative data analysis is ongoing. Two papers were published and one presentation was given during the reporting period. References: 1) Courtney JB, Nuss K, Lyden K, Harrall KK, Glueck DH, Villalobos A, Hamman RF, Hebert JR, Hurley TG, Leiferman J, Li K, Alaimo K, Litt JS. Comparing the activPAL software's Primary Time in Bed Algorithm against Self-Report and van der Berg's Algorithm. Measurement in Physical Education and Exercise Science, Published online December 28, 2020, 2) Gascón M, Harrall K, Beavers A*, Glueck D, Stanislawski M, Alaimo K, Villalobos A, Hebert J, Dexter K, Li K, Litt J. Feasibility of collection and analysis of microbiome data in a longitudinal randomized trial of community gardening, Future Microbiology, 2020, 3) Alaimo K, Litt, J, et al. Community gardening improves diet, physical activity, and mental wellbeing: Results of the Community Activation for Prevention Study (CAPs), a Randomized Controlled Trial of Community Gardening in Denver, presented to the Community Activation for Prevention Advisory Committee (Virtual), June 21, 2021.

Results of a study conducted in collaboration with Keep Growing Detroit, a non-profit organization that supports urban agriculture, to explore associations between garden characteristics, gardeners' involvement in various types of programming offered through a gardener support program, and the likelihood of continued garden membership in the gardener support program was published. We found that land ownership, gardeners' attending educational classes and volunteering, number of years of garden membership in the garden support program, and the garden receiving seeds and plants were associated with continued garden membership, while number of adults participating in the garden, garden size, receiving a site visit, and

gardeners participating in city-wide events were not significantly associated with continued membership. Reference: Beavers, A*, Atkinson A, Ma W, Alaimo K. Garden Characteristics and Types of Program Involvement Associated with Sustained Garden Membership in an Urban Gardening Support Program. Urban Forestry & Urban Greening, 59(4):127026, 2021.

A poster was presented at the 2021 Food and Nutrition Conference and Expo describing a program that works with undergraduate dietetics students to teach culinary skills to youth. Reference: Vaught K, Fischer D, Alaimo K. Youth Culinary Skills Program Administered by Dietetic Student Clubs. Poster presented at the 2021 Food and Nutrition Conference and Expo, October 18, 2021.

A chapter was published in *Present Knowledge In Nutrition*. Reference: Alaimo K, Chilton M, Jones A. Food Insecurity and Hunger. In *Present Knowledge In Nutrition, 11th Edition, Volume 2: Clinical and Applied Topics in Nutrition,* International Life Sciences Institute, 2020.

A grant proposal was submitted to NIFA in May 2021 to create, pilot, launch, evaluate, and propagate a tuition-free Michigan State University Extension online team-based nutrition course: Alaimo K, PI. Superpower Nutrition: Inspiring a Culture of Healthy Eating in Michigan and Beyond, 1/1/22 – 12/31/25, submitted to USDA-NIFA-AFRI: Score: High Priority; Not funded.

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

This project provides individuals, communities and schools with information and support to improve the programs, policies and environments that affect residents' abilities to be food secure, physically active, and eat healthy foods.

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

Results of these studies can support students, organizations, governments, land planners, health officials, and policy makers improve understanding of food insecurity and access to community gardening, urban agriculture, healthy food and places to be active.

Emotion Socialization Behaviors in Parents/Caregivers and Teachers: Supporting Early Healthy Development

Project Director
Holly Brophy-Herb
Organization
Michigan State University
Accession Number
1023265

Emotion Socialization Behavior in Parents, Caregivers, and Teachers: Supporting Early Healthy Development

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

The overarching goals of this project are to utilize multiple existing datasets to examine: a) adults' characteristics and attributes that are related to their emotion socialization beliefs and practices; b) associations between emotion socialization beliefs and practices and children's social-emotional and health outcomes; c) differences or consistencies in the use of emotional socialization practices across play, book sharing and mealtime contexts; and d) variations in emotion socialization beliefs, behaviors and links to children's outcomes by contextual characteristics such as culture, race and demographic risks.

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 this reporting period, we have engaged in numerous activities in pursuit of our project goals. These include the following:

1. ***Publications***

1.a The first set of papers we have published during the 2021 reporting period address goals a and b regarding adults' characteristics related to their practices and associations between adults' beliefs and practices and children's outcomes.

Torres, C. O., Brophy-Herb, H. E., McCaffery, H., *Williams, J., *Choi, H., Horodynski, M. A., Contreras, D., Kerver, J., & Lumeng, J. C. (2021). Maternal dispositional mindfulness is associated with lower child body mass index Z. *Academic Pediatrics*, 22(1), 70-75.

Perkins, H. A., Brophy-Herb, H. E., Choi, H., H., Williams, J., Dalimonte-Merckling, D.,

Mitchell, K., & Vallotton, C. (2021). Sex differences in toddlers' negative attributions to challenges: Associations with maternal emotion coaching and emotional awareness. *Social Development.*

Two papers are currently under review relative to infant and toddler teachers' mental health (pursuant to Goal A):

Brophy-Herb, H., Brincks, A., Cook, J., Stacks, A., Vallotton, C., Frosch, C., Carson, R.,

Wheeler, R., Perkins, H. & Jennings, P. (under review). *A descriptive analysis of infant/toddler teachers' stress and exhaustion and associations with sources of stress and coping strategies.*

Brophy-Herb, H. E., Stacks, A.M., Frosch, C., Brincks, A., Cook, J., Vallotton, C. D., Perkins, H., Kim, L., Carlson, R., & Jennings, P. (under review). *The Effects of a Relationship-Focused Professional Development Intervention on Infant/Toddler Teachers' Mindfulness-Based Coping.*

1.b The second set of papers concern interventions to support parenting/caregiving and positive child outcomes.

Brophy-Herb, H., Moyses, K., Shrier, C., Rymanowicz, K., Dalimonte-Merckling, D., Pilkenton, A. (2021). The Building Early Emotion Skills parenting program in face to face and virtual settings: Results of a pilot evaluation. *Journal of Community Psychology*, 49 (5), 1505-1521.

Riggs, J., L., Rosenblum, K. L., Muzik, M., Jester, J., Freeman, S., Huth-Bocks, A, Waddell, R., Alfara, E., Miller, A., Lawler, J., Erikson, N., Weatherston, D., Shah, P, Brophy-Herb, H., the Michigan Collaborative for Infant Mental Health Research. (in press) Infant mental health home visiting mitigates impact of maternal adverse childhood experiences on toddler language competence: A randomized controlled trial. *Journal of Developmental and Behavioral Pediatrics.*

Stacks, A., Jester, J. M., Wong, K., Huth-Bocks, A., Brophy-Herb, H. E., Lawler, J., Riggs, J., Ribaudo, J., Muzik, M., & Rosenblum, K. (2021). Infant mental health home visiting: intervention dosage and therapist experience interact to support improvements in maternal reflective functioning. Attachment and Human Development. Epub ahead of print.

Brophy-Herb, H. E., Stacks, A.M., Frosch, C., Brincks, A., Cook, J., Vallotton, C. D., Perkins, H., Kim, L., Carlson, R., & Jennings, P. (under review). The Effects of a Relationship-Focused Professional Development Intervention on Infant/Toddler Teachers' Mindfulness-Based Coping.

1. *Data Coding*

We have recently completed coding on three large datasets relative to our project goals. First, we completed coding of parental mind-mindedness, defined as the parent's accurate interpretation of the child's mental states, across two datasets reflecting more than 2,000 videotaped interactions. We have three manuscripts ready for submission. In the first, we report on findings that maternal mind-mindedness significantly increases for

mothers with greater parenting stress who are receiving infant mental health based home visiting services. In the second manuscript, we report on findings demonstrating associations between mothers' mind-mindedess across toddlerhood (assessed when children were 14, 24, and 36 months of age) and children's emotion regulation skills in toddlerhood. Together, findings provide important information on mind-mindedness among low-income families and links to children's regulatory outcomes. In the third manuscript, we report on the associations between two critical constructs—parental mind-mindedness and parental reflective functioning. We examined the associations among low-income mothers with significant prior history of adverse events. There is very little research on both mind-mindedness and reflective functioning in concert together. Our results show that, while related, mind-mindedness and reflective functioning are unique constructs in parents of infants and toddlers, although associations between both become more solidified over time (assessed at three time points over 12 months during toddlerhood).

In addition to our work on parental mentalization (pursuant to project goals A and B), we have completed coding of infant and toddler teachers' use of mental state language in three classroom contexts: mealtimes, play, and booksharing (goal C). We are beginning to analyze the data and look forward to examining similarities and differences in teachers' use of mental state talk across contexts as well as identifying characteristics associated with use of mental state talk.

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

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

We have identified several target audiences in this project. First, coding, data analytic, and manuscript preparation activities, described above, provide critical training experiences for student research assistants. All activities described involve both undergraduate students and graduate students. Second, project activities related to dissemination benefit the scientific field and applied practice. For example, our evaluation of the Building Early Emotion Skills program (developed with USDA NIFA funding) has been presented nationally at conferences and the evaluation results, with implications for practice, were published in a journal that draws both practitioners and researchers.

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

My team and I engage almost exclusively in community-based research. Hence, our work in interventions related to parental and child outcomes directly informs home visiting practices. Our work on infant and toddler teachers' use of mental state talk has implications for teacher professional development content. Results from the Building Early Emotion Skills evaluation has implications for the development of parenting education programs.

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 not encountered any major obstacles in our work and have not made any significant changes in our project goals or approaches.

APPLICATION OF DIETARY OMEGA-3 FATTY ACIDS TO PRECISION MEDICINE INTERVENTIONS AGAINST AUTOIMMUNE DISEASE

Project Director
James Pestka
Organization
Michigan State University
Accession Number
1020129

APPLICATION OF DIETARY OMEGA-3 FATTY ACIDS TO PRECISION MEDICINE INTERVENTIONS AGAINST AUTOIMMUNE DISEASE

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

Autoimmune diseases (ADs) affect over 25 million Americans, inflicting tremendous individual suffering and societal burdens. Exposure to the earth's most abundant mineral, crystalline silica (quartz), is common in individuals involved in construction, mining, farming, manufacturing and military deployment and increases their risk of developing systemic lupus erythematosus (lupus) and other ADs. Here we seek to understand the underlying mechanisms by which consumption of the omega-3 fatty acid docosahexaenoic acid (DHA) blocks silica-triggered lupus, thus yielding important new insights into how environmental toxicants trigger AD and how manipulating the lipidome through dietary fatty acid supplementation can prevent it.

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.

This project will significantly advance mechanistic understanding of how dietary modulation of the lipidome could be used to prevent environmental triggering of inflammation and autoimmunity in the lung. This knowledge is essential to develop practical, low-cost preventative strategies to help individuals environmentally exposed to silica and potentially other toxicants to reduce the risk of lupus or other autoimmune diseases. This knowledge will also be relevant to preventing flare-ups and slowing progression of existing autoimmunity. In sum, new knowledge from this project could help decrease morbidity and mortality associated with toxicant-triggered inflammation and autoimmunity, and reduce health care costs related to lupus and other autoimmune diseases..

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

Managing inflammatory and autoimmune diseases today is about reducing symptoms in newly diagnosed individuals and preventing progression of established tissue damage to organs such as kidneye Existing and emerging therapeutics have multiple mechanisms of action broadly encompassing non-specific immunosuppression, lymphocyte depletion, neutralization of immune-stimulating cytokines/chemokines, and blocking Type 1 IFN- stimulated gene expression. These treatments have serious limitations: **1)** unacceptable adverse effects; **2)** resistance of ELT to their action; **3)** inability to reverse immune-mediated damage; and **4)** high cost. Individuals suffering from lupus or other inflammatorty diseases can increase fish consumption or take omega-3 supplements to prevent or quell disease flares.

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

We also expect our studies to reveal potential benefits of ω-3 consumption pulmonary inflammatory diseases such as silicosis and COVID-19.

Closing Out (end date 09/07/2023)

Improving Health through the Use of Packaging

Project Director
Laura Bix
Organization
Michigan State University
Accession Number
1017305

Improving Health Through the Use of Packaging

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

Our team uses a multidisciplinary approach in an attmept to quantify the interface between people and packaging (perceptually, cognitively and physically) with the goal of improving health outcomes. Herein, we focus on objectively evaluating label design using tecniques from the field of visual cognition with the ultimate goal of providing information in ways that assist seniors in decision making when purchasing over-the-counter medications. Additionally, a great deal of the work that we are doing targets a population that is at-risk (older adults) and studies a novel way (packaging and labeling) to enable a healthy lifestyle among this population; work with at-risk populations with the intent to improve quality of life is identified to be of direct interest at NIFA. This research aligns with the mission of AgBioResearch through its broad

commitment of protecting human health and safety (USDA "Knowledge Area" 723 - "Hazards to Human Health and Safety") and promoting healthy lifestyles (USDA "Knowledge Area" 724 - "Healthy Lifestyle"). Proper use and management of medications and other products is an integral aspect of a healthy lifestyle and protecting health and safety. The research to be conducted over the life of this project will augment the important work of USDA and state experiment stations to generate holistic approaches to health and well-being.

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 mission of MSU's AgBio Research is to engage in innovative, leading edge research to generate economic prosperity, sustain natural resources and enhance the quality of life in Michigan, the nation and the world. The mission of my team is to improve health through packaging. This novel approach is in direct alignment with KA 724, Healthy Lifestyles. Specifically, we focus our efforts on a series of issues facing global health that have significant ramifications for not only health, but also for cost of care. Our work attempts to: • reduce medication error, • enhance patient adherence to medical regimens, • reduce healthcare associated infections (HAIs) and • reduce the unintentional exposure of children to medications, we also occasionally engage issues that fall outside of the healthcare system, but are (perhaps) of even greater interest to the USDA/AgBio Research mission. Work that we have and continue to engage outside of the healthcare spectrum includes efforts to: • reduce obesity and • induce appropriate consumption levels when consuming alcohol. Although packaging may not be the most obvious response to wicked problems related to the health of the population (and reduce costs associated with these problems), it has the potential to favorably impact them. Despite this fact, few researchers objectively and purposefully investigate its potential; it is for precisely this reason that it is a rich, and needed, area for careful inquiry. The project oultined herein directly aligns with USDA's desire to fund researchers working with at risk populations by promoting factors that influence a healthy lifestyle. Older adults, a group that I am specifically targeting with the proposed umbrella project, have been determined to be at disproportionate risk for adverse drug reactions (ADRs), medication errors, and healthcare associated infections relative to other sgements of the population. As such, what I am proposing to do is squarely aligned with the aforementioned goals of MSU's AgBio Research as outlined in Knowledge area 724, Healthy Lifestyles. These goals are, obviously, sweeping in nature. To demonstrate the type of work we will be doing in the next five years in support of these broad goals, I have highlighted a series of six experiments that, if funded (NIH R01), will be conducted over the next five years. These six experiments, propose to adapt a Front of Pack (FOP) labeling strategy, demonstrated as effective for food labels, for use with over-the-counter (OTC) medications in an attempt to reduce Adverse Drug Reactions (ADRs). We will empirically determine whether such a technique is effective for older adults, an at-risk population. Information deemed most critical to mitigating the likelihood of ADR will be informed by a national survey of pharmacists. Efficacy of the developed label strategies will be tested using a series of six experiments that apply methods from basic research on visual cognition (change detection, a speeded decision task, a cross-product comparison task, and eye tracking) to directly measure attention to label information and how attending to that information impacts decision making by older adults, a population identified to be at risk for adverse drug reactions (ADRs). We do so with six Specific Aims in mind: Specific Aim 1- Determine the information to be prioritized in order to reduce the likelihood of ADRs. Specific Aim 2- Investigate formatting techniques that attract attention to critical information when accessing it is not the participant's explicit goal (bottom-up attention). Specific Aim 3- Investigate formatting techniques that attract attention to critical information and promote decision making when accessing that information is the participant's explicit goal (top-down attention). Specific Aim 4-Evaluate the information required for older consumers to make an appropriate OTC choice. Specific Aim 5- Evaluate how optimized labels (based on Aims 1-3) garner attention and support appropriate OTC drug selection by older adults. Specific Aim 6- Evaluate whether the benefits of an optimized label generalize to commercial brands.

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

Despite the shut down, many training opportunities were afforded to the research team. PhD student (now graduated), Alyssa Harben, was a significant coauthor on many of the publications that were produced. Additionally, she completed a teaching certificate and served as a graduate fellow for teaching and also engaged in SoTL (both publications and presentations to learned audiences). As Alyssa prepared for her graduation, Krishnaa Venkatesan was onboarded. Krishnaa has worked with the team to learn EPrime, the software where we code the programs which run our experiments, and was integral to the creation of the stimulus materials which will be used next year (to accomplish Aims 4 and 5 of the proposed). Like Alyssa, he has enrolled in the teaching certificate program, and has spent the FS21 term working on a SoTL project that investigates the efficacy of two strategies for implementing self assessments into an online, asynchronous classroom. Lanqing Liu, another PhD that is working on the broader project, collected all the data for the final experiment of his PhD work, and (in doing so) trained undergraduate Donnie Kirkland as well as Krishnaa Venkatesan in the practical aspects of working with the public as participants. This was fortunate timing; neither Donnie nor Krishnaa had worked with human subjects due to the shutdown

and many of the Graduate students who had done this had graduated or moved away from the local area. Lanqing also successfully defended his comprehensive exam earlier in the year, and currently has a first draft of an article based on earlier work and is finalizing the analysis for the final components that will comprise his dissertation.

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

Please see previous descriptions.

With regard to the explicit specific aims listed above, in the last portion of 2021, we have been able to begin data collection again, and have completed all data analysis for Specfic Aim 3. Stimulus have been created and programming has been completed in support of Specific Aims 4 and 5. We plan to begin recruitment for these two experiments after the New Year begins.

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.

For the coming year, our goal is to collect all data affiliated with Specific Aims 4 and 5 (described above) and begin data collection on Aim 6. We would also like to see the work that Lanqing Liu has drafted submitted (if not accepted) for peer review publication.

Human Health, Youth, and Families

Project Director
Norma Lundeen
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Accession Number
7000193

4-H Special Interest Clubs

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

As Michigan and the rest of the world grappled with the ever-changing complexities of the COVID-19 pandemic, MSU Extension continued to offer young Michiganders safe and convenient ways of connecting with youth development programming, online and in hybrid formats. A majority of these offerings were 4-H SPIN clubs, which brought the 4-H experience to new and diverse audiences.

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 4-H SPIN club stands for a SPecial INterest club where five or more young people from at least two different families learn about a topic of interest together. Each club meets a minimum of six times, but not more than eight times within an eight-week period. The topics covered can be anything of interest to youth: nature, heritage arts, science, engineering, gardening, technology, and more!

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

In 2021, MSU Extension reported the following SPIN club activities:

- More than 250 clubs offered

- Over 2,500 participants engaged

- 33% of youth participants were not previous 4-H members

For one participant who took part in a SPIN reading club focused on the Harry Potter series, the experience was a bright spot amongst a dull year:

“Despite the fact that COVID had limited what she could physically do, she found that there were lots of kids going through the same experience as she was with the pandemic, and I think she felt less alone,” said the participant's mother. “Returning to Harry Potter in the midst of the pandemic was like comfort food for her. While the world seemed to suddenly be filled with people in masks and social distancing, six-foot stickers and hand sanitizer; returning to Harry Potter was just what she needed. Again, 4-H has come through for us when we needed it most.”

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

Individuals involved in 4-H programs learn life skills that prepare them for the workforce and increase their likelihood of becoming civically active. 4-H participants also demonstrate reduced high-risk behaviors such as drug use, and learn to complete tasks, solve problems, and seek help when needed. This helps ensure more young people succeed in school, attend college, and contribute to their communities. More successful young people results in greater tax revenues and consumer spending and increases the likelihood that young people will stay in, or return to, their communities.

Chronic Disease

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

Chronic diseases are among the most prevalent, costly, and preventable of all health issues. Over 60% of Michigan adults have at least one chronic condition, which results in spending 75 cents of every health care dollar to treat these conditions. Over 95% of Michigan adults report engaging in unhealthy behaviors that increase their risk of developing a chronic disease. According to the World Health Organization, if the major modifiable risk factors (e.g., inadequate physical activity, poor diet, and smoking) were eliminated, at least 80% of heart disease, stroke, type 2 diabetes, and 40% of cancers would be prevented.

According to the American Diabetes Association, almost 13% of Michigan's adult population (1,087,000 people) has been diagnosed with diabetes. Another 37% (2,741,000 residents) have prediabetes, while 259,000 have undiagnosed diabetes. Type 2 diabetes, a serious disease that can lead to complications such as heart disease, kidney disease, blindness, and amputations, can be prevented or delayed with healthy lifestyle modifications.

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.

Connecting patients to community-based education

Part of transforming healthcare is to help patients engage in prevention strategies and learn self-management activities related to maintaining and improving their health. Community-based education, especially programs that increase self-efficacy, help people enhance their daily lives and improve how they manage their chronic condition symptoms such as pain. Referrals from physicians for patients to seek health and wellness educational programs in their community can also help address social determinants of health.

Developed by MSU Extension and in use from 2014 to 2019, the Rx for Health Referral Toolkit and Pad was a paper-based tool that healthcare providers and MSU Extension educators used to increase patients’ awareness and use of MSU Extension's free and low-cost community-based health education programs. Rx for Health was designed to help healthcare providers in building or maintaining a patient-centered medical home model of care (PCMH), since PCMH designation requires that patients are referred to community and social services.

In 2020, MSU Extension began transitioning from a paper-based referral system to an electronic referral system to increase referrals. In 2021, MSU Extension launched a new way for healthcare providers to refer patients to free, online health classes offered by MSU Extension. ReferralsPlus™ is a software application that provides a secure online portal that allows providers to send referrals throughout Michigan. This referral system was formerly called "Great Lakes Health Connect." Healthcare providers can now send referrals to the MSU Extension classes through ReferralsPlus™ using the tag “MSU Extension.” Currently, patient referrals are being accepted into the following MSU Extension self-management programs for chronic disease, diabetes and chronic pain: Stress Less With Mindfulness, RELAX: Alternatives to Anger, and PATH.

Dining with Diabetes

About one in every ten Michiganders 18 or older are living with diabetes. Diabetes is more prevalent among Black, non-Hispanic adults (14.6%) compared to white, non-Hispanic adults (10.9%). MSU Extension’s Dining with Diabetes program series can help those living with the condition, those trying to prevent it, and their friends and family members who are supporting them.

Dining with Diabetes is a multi-session series conducted by MSU Extension and community health partners, where participants can explore and taste foods prepared from diabetes-friendly recipes. The Dining with Diabetes program is offered exclusively by state Cooperative Extension services in the U.S. This hands-on interactive program helps people with prediabetes, type 1 or type 2 diabetes, and members of their support systems learn cooking skills and strategies to better manage, prevent or delay diabetes and related complications. A self-paced online version of the Dining with Diabetes program is also in development, with plans to launch this virtual workshop in 2022.

Dining With Diabetes participants often report improved health habits as a result of taking the series, such as reducing portion sizes or choosing healthier recipes. As one participant stated: “I learned quite a bit. I check my sugar more often and I feel a lot better... I try to eat only healthy [and] I drink more water.”

COVID-19 Vaccine Acceptability in Tribal Communities

In 2021, MSU Extension was awarded a grant from the Extension Foundation’s national EXCITE (Extension Collaborative on Immunization Teaching and Engagement) project. The long-term goal of this funding is to strengthen immunization education with a special focus on adult vaccination hesitancy around both COVID-19 and other adult immunizations. The immediate goal is to promote the increase of COVID-19 vaccinations through relevant messaging and innovative models for community action. MSU Extension selected Tribal Nations and communities as a focus for this outreach effort in Michigan. With this focus, MSU partners with two other land-grant colleges in Michigan: Bay Mills Community College and Keweenaw Bay Ojibwa Community College.

The EXCITE project combines outreach strategies and events to increase vaccine acceptability in areas that are central to these project partners: Bay Mills Indian Community and the Keweenaw Bay Indian Community. Project staff are now implementing key strategies from a communication plan, primarily outreach via advertisements, social media, mailings, videos, newspapers, and radio. The project uses communications materials from Michigan Department of Health and Human Services, the CDC and the Urban Indian Health Institute.

EXCITE project staff presented at the Bay Mills Indian Community Powwow in August 2021 to speak to visitors about the COVID-19 vaccine and educate about the benefits of being vaccinated. In November, the Michigan EXCITE project team also coordinated a ribbon skirt workshop to share traditional knowledge about how to create ribbons skirts, why they are worn, and other teachings. At this tribal community event, the staff also shared COVID-19 vaccination education. This project continues into spring 2022 and strategies are being tailored by partners to reach tribal communities with videos, magnets, care packages, and other outreach items that promote COVID-19 vaccinations.

Sleep Education for Everyone Program (SLEEP)

The Sleep Education for Everyone Program was developed by sleep researchers, a certified sleep medicine specialist, Michigan State University (MSU) Extension educators, and older adults living in the community. In 2021, a total of six 30-minute sessions were created on the following topics: introduction to sleep and health with a focus on recommended duration guidelines; sleep hygiene best practices, Stimulus Control Therapy, mindfulness and relaxation, relationships between sleep and physical activity and sleep myths.

Six MSU Extension educators were trained to deliver SLEEP virtually in 2021, reaching a total of 114 participants. Due to its success, SLEEP became part of MSU Extension's core health programming, and in early 2022, 13 additional MSU Extension staff were trained to deliver the program in-person or virtually.

A new project is supported from a grant awarded through the MSU Family Medicine department to partner with Spectrum Health System to integrate referrals to MSU Extension-delivered SLEEP programming. This integration will make it easier for primary care providers to refer patients to SLEEP.

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

- 859 people participated in MSU Extension's disease prevention and management programs in 2021
- 114 people participated in the Sleep Education for Everyone Program (SLEEP) program in 2021
- 245 people participated in PATH programs in 2021
- 450 people in tribal communities were reached with COVID-19 vaccination education materials and cultural programming

As a result of MSU Extension's disease management, 1,668 participants learned to prevent and manage their chronic health conditions, improve communication with their healthcare provider, and increase their knowledge of healthy eating. Of participants surveyed:

- 89% of Dining with Diabetes participants are now eating smaller portions after taking the class
- 72% of Dining with Diabetes participants are now using recipes they learned from the program
- 73% of Personal Action Toward Health (PATH) program participants increased or maintained their confidence in keeping physical discomfort or pain from interfering with the things they want to do

"So many new ways to 'control' my pain. I love using the breathing, action plans and exercise. I now look at my pain differently: not something to endure or control with meds, but something I can control and reduce using a new focus." - Chronic Pain PATH Participant

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

MSU Extension helps participants connect with health care providers, increase their physical activity, improve the quality of their diets, and enhance the quality of their sleep. Encouraging these healthy behaviors helps reduce health care costs by helping prevent chronic health conditions throughout a person's life.

Cottage Food Law

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

Michigan's Cottage Food Law provides an opportunity for individuals to generate revenue by making and selling food products from their home. It is also an opportunity for entrepreneurs to try a new venture and see if operating a food business might be right for them. However, starting a new food business is always a challenge. Food safety is a concern, and there are

many conditions that must be met in order for food to be considered a “cottage food” under the law. For these reasons, MSU Extension provides a Cottage Food Law class through a partnership with the MSU Product Center and Michigan Department of Agriculture and Rural Development (MDARD).

Additionally, in 2021, MSU Extension conducted a survey of “market masters” to gain insight on the educational needs for the Cottage Food Law with respect to farmers markets, vendors, and consumers. Seventy-six responses were received from market masters representing both rural and urban areas of Michigan. Comments suggested that the biggest concerns were about confusion regarding the law and a lack of resources for vendors and consumers. To respond to this need, the Think Food Safety team developed educational brochures and supporting information to connect people to MSU Extension as a trusted resource.

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.

Encouraging the Entrepreneurial Spirit with Michigan Cottage Food Law

MSU Extension’s Cottage Food Law class provides valuable food safety information to Michigan entrepreneurs. In 2021, MSU Extension educators held 29 online Cottage Food Law classes, and a self-paced course was also made available through D2L, Michigan State University’s online learning management system. In total, MSU Extension reached 956 entrepreneurs in 2021. Due to the volume of questions received from participants, MSU Extension added a Q&A format to the programming that provided direct access to an MDARD inspector, as well as food safety educators and a product center business counselor.

The result of these webinars has led not only to the safe, successful launch of food businesses in the state, but also to changes in Michigan’s Cottage Food Law. When the law was originally written, there was only one form of payment acceptable. Through staff at MSU Extension and MDARD staying connected and sharing information, MDARD was able to hear the voice of entrepreneurs and make changes to the law. Now Michigan Cottage Food vendors can take multiple forms of payment to help meet their customers’ needs and grow their businesses.

“Thinking Food Safety” to increase awareness of illegal and online food sales

Through two years of grant funding from the Michigan Department of Agriculture and Rural Development (MDARD), MSU Extension educators have used the “Think Food Safety” campaign to educate consumers and cottage food entrepreneurs alike. The campaign uses creative, educational content to highlight safe food practices on social media, as well as educational brochures, promotional postcards, a video, a table runner, and a stake sign to be used in settings such as farmers markets.

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

As a result of participating in an MSU Extension’s food safety or food preservation program:

- 98% of people who attended Michigan’s Cottage Food Law class better understand what is necessary to run a successful cottage food business

“This program gave me knowledge to help decide if I wanted to pursue opening my own business.” - Cottage Food Law class participant

Providing vital messaging on food preservation, food safety, and cottage food law, the Think Food Safety Facebook page grew in 2021 to 2,282 followers and a total reach of 321,237.

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

Safe and properly prepared food can prevent sickness and illness, reducing healthcare costs and improving overall health and well-being. MSU Extension programs such as the cottage food law classes and Think Food Safety provide participants with the knowledge and skills that create products available for sale. Farmers markets and local food sales increasingly play a vital role in Michigan’s economic growth, while also providing residents with options for affordable, local, and safe healthy food and related products.

Dare to Serve

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

Volunteering helps young people become better leaders, increase their civic engagement, learn responsibility, gain access to scholarship opportunities, and increases college graduation rates. Providing volunteer opportunities to youth also allows them to serve their local communities. Serving one's community not only benefits the community but also encourages positive mental health for the volunteer. The impacts of COVID-19 have reduced accessibility of volunteering opportunities for youth.

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.

MSU Extension's 2021 Dare to Serve Challenge was a fun and engaging way to encourage 4-H clubs and individuals to look for ways to serve their communities. The goal was for all 83 counties in the state to complete at least one project that served local communities through volunteerism. Sixty-three of the 83 counties accomplished that goal.

Projects varied, but some examples included pop can collection, donating to hungry families, building fairy book boxes, cleaning up trash in parks or along roads and playgrounds, and placing American flags in a cemetery. Many clubs helped to prepare local fairgrounds for county fairs. Others were more personal, supporting local teens with health challenges. There were 35 individual projects and 55 club projects submitted.

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

The Dare to Serve Challenge had a huge impact in communities around the state, impacting an estimated 22,535 people. Additionally, youth reported serving larger communities of unknown size, such as everyone who used a campground or visited a fairground where a project took place.

Volunteering is a great way to improve mental health. Youth who volunteer benefit from reduced stress, depression, and increased relationships. Volunteering also gives youth access to scholarship opportunities.

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

MSU Extension 4-H programs teach youth participants life skills that prepare them for the workforce, especially for highly sought-after jobs in science, technology, engineering, and mathematics (STEM). Extension programs help children develop early literacy skills that support school readiness. Youth learn leadership and decision-making skills in 4-H that increase their likelihood of becoming civically active. 4-H participants also demonstrate reduced high-risk behaviors such as drug use, and learn to complete tasks, solve problems and seek any help they might need from peers and adults. 4-H involvement also helps participants avoid or reduce involvement with the court system. This helps ensure more young people succeed in school, attend college, and contribute to their communities. More successful young people results in greater tax revenues and consumer spending and increases the likelihood that young people will stay in, or return to, their communities.

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.

https://www.canr.msu.edu/news/michigan-4-h-direct-impacts-through-dare-to-serve-challenge

https://www.canr.msu.edu/videos/4-h-dare-to-serve

Falls Prevention

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

One in four older adults report falls each year. Falls and the fear of falling can negatively impact quality of life by causing physical, social, and emotional decline. In Michigan, as in the broader United States, falls are the primary cause of injuries and injury-related deaths among older adults. Between 2009 and 2014, deaths due to unintentional falls rose from 40.7% of all deaths in Michigan's older adults to 47%.

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.

MSU Extension offers two evidence-based falls prevention classes. Tai Chi for Arthritis and Falls Prevention is a nine-week (18 session) class that combines slow, gentle movement with deep breathing and focused intention to help participants improve strength, balance, and posture. A Matter of Balance is an eight session class that helps participants increase their physical activity, reduce their fear of falling, and remove fall hazards in the home environment.

In 2021, 311 individuals participated in MSU Extension's falls prevention education. Most of the participants were 60+ years of age (84%). Seventy-two percent of participants reported having multiple chronic conditions.

Tai Chi and falls prevention instructors often report just as rewarding an experience as the class participants themselves. As one instructor reported: "This was my first-time teaching Tai Chi in person, and it was such a great success! I had 20 participants register and over 17 of them graduated from the program. Each week, they were getting more and more confident with the forms and movements, and seeing the progression of the class was amazing. They immediately asked when we could start our next class. In particular, there was one gentleman who has Parkinson's disease in my class. He came up to me after class and told me he has seen a change in his balance from taking the program. He said, 'I may not have my feet facing the same way, but I have seen a change in my balance from taking this class'!"

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

As a result of MSU Extension's falls prevention programming, 311 participants learned to prevent falls through increased physical activity. Of participants surveyed:

- 100% of Tai Chi and A Matter of Balance participants reported feeling more comfortable increasing their physical activity as result of classes

- 98% of participants in Tai Chi for Arthritis and Falls Prevention and A Matter of Balance participants reported feeling more satisfied with life

"I have felt healing from the range of motion utilized while engaging in the Tai Chi movements since participating. The moves are so slow, deliberate and concentrated. I have shared this information with some of my friends in hopes they will also gain strength and balance using Tai Chi in their daily lives." - Tai Chi for Arthritis and Falls Prevention participant

"We are so fortunate to have this opportunity, and it is my hope that MSU Extension will continue to support our community and our seniors with these opportunities that may not otherwise be offered." - Tai Chi for Arthritis and Falls Prevention participant

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

Educational and physical activity health programs help people improve their balance, both mentally and physically, which helps significantly reduce the rate of falls experienced by older adults, increasing self-efficacy for better health. Encouraging healthy behaviors helps reduce health care costs by helping prevent chronic health conditions throughout a person's life.

Investigating Food with Science

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

MSU Extension offers high-quality, affordable and no-cost programs that help Michigan residents learn the importance of safe food and water in their everyday lives. Educational programs for the general public help participants learn how to reduce foodborne diseases and become leaders in food related industry and volunteer roles.

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.

Impacting Youth Through Investigating Food with Science

Investigating Food with Science is an educational program designed for youth ages 8 through 12 years, to explore the chemistry, nutrition, and microbiology behind food. Through this program, children learn to avoid cross-contamination by not placing fruits and vegetables with raw meat or eggs, to wash hands and cutting boards in between preparing different foods, the differences between perishable and non-perishable foods, and to use a food thermometer to ensure foods are cooked to safe temperatures. Investigating Food with Science engages youth in food science and food safety-related topics, including experiments and kid-friendly recipes.

MSU Extension developed the Investigating Food with Science program as a fun after-school activity that would engage youth online in food preparation, food safety, and hands-on science experiments. Getting youth involved in cooking and proper food safety methods can help boost confidence and lead to healthy habits throughout a lifetime. During the program, youth can ask questions and receive answers from food safety educators. By using animation to present each of these concepts, youth participants are kept engaged with the program.

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

Investigating Food with Science has reached participants from around the world, including eight different countries, 12 different states, and 42 counties in Michigan. In 2021, the program reached 742 participants total, and over 100 views on the Think Food Safety Facebook page.

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

MSU Extension's food safety programs increase knowledge and awareness of safe food handling practices among youth, encouraging healthy habits for a lifetime.

Mental Health

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

According to 2019 research by the National Alliance on Mental Illness, over 1.3 million adult Michiganders have a mental health condition, and about 38% of these individuals are not receiving care. Stress reduction and anger management programs help individuals learn how to improve their mental health and well-being.

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.

Gardening leads to improved well-being for veterans

In 2021, MSU Extension's SNAP Outreach for Veterans team shared over 40,000 USDA-funded vegetable seeds with veterans statewide. This was to promote the Supplemental Nutrition Assistance Program (SNAP), which addresses food insecurity, and to promote health and wellness through gardening within the veteran community.

Gardening provides many benefits to veterans by providing healthy food, a sense of self-reliance, and allowing people to connect with the land. Connecting with the land through gardening provides numerous therapeutic and mental health benefits such as stress relief, mental clarity, and feelings of reward. According to the United States Department of Veterans Affairs, veterans involved in gardening or horticultural therapy tend to have reduced inflammation, lower levels of stress hormones, and increased mental well-being. Veteran seed recipients shared that they loved growing produce, enjoyed working together on gardening projects, and have relished the opportunity to share their harvest with their communities.

Supporting essential workers through online lunch and learns

MSU Extension held online lunch-and-learn workshops targeted toward essential workers, caregivers, and parents. These sessions provided an outlet for learning how to increase resilience over stress through practicing mindfulness, getting quality sleep, cultivating healthy relationships, and understanding the connection between a healthy mind and healthy body. Additionally, participants learned how to create a much-anticipated space throughout the week where they could slow down and breathe, or just be at one with the present moment—restorative practices that might not otherwise have taken place.

Attendance ranged from 50 to 200 people per session. Based on participant feedback, the time spent together in this remote learning community made the difference between overcoming challenges and feeling overwhelmed and unable to navigate stress. Participants shared how valuable the experiences were to them:

“Starting the week here reminds me that all the things on life's to-do list are there, but one thing at a time and I'm learning to ask for help." - Participant

“Definitely feeling not alone is a huge part of staying mindful... knowing others are going through stress, too.” - Participant

“Going to use the mindful breaths and movements to help calm down those crazy moments at work.” - Participant

Equipping partners with suicide prevention and crisis intervention techniques

When someone is in distress, a quick and compassionate response is just as important for the person’s mental health as it is for their physical health. MSU Extension’s trained facilitators deliver the National Council for Mental Wellbeing’s Mental Health First Aid (MHFA) program to help participants learn to assist people who may be experiencing a mental health challenge or crisis.

MHFA is an evidence-based, all-day training to teach participants how to help someone who is developing or experiencing a mental health challenge or crisis. The program helps trainees identify, understand, and respond to signs of mental illness and substance use disorders. MHFA conveys to community members a positive, recovery, resiliency, and strengths-based message. Since 2017, MSU Extension has provided over 1,250 certifications in Mental Health First Aid to MSU Extension’s own employees as well as Michigan-based partner organizations. MSU Extension began offering MHFA virtually in 2020, as a two-hour self-paced course, combined with an all-day instructor-led course.

In 2021, MSU Extension reached a variety of partners, from library professionals and college advisors to an array of employees in the corporate workforce. MSU Extension’s largest partnership in 2021 was with DTE Energy’s employee health and wellness program to offer five MHFA trainings to 70 of the company’s Energize Your Life (EYL) Wellbeing Champions. The EYL Wellbeing Champions are a group of employees throughout the company who are passionate about health and are helping shape a healthier physical, mental, social, and financial culture at DTE.

The MHFA trainings instructed by MSU Extension provided the EYL Wellbeing Champions with the knowledge and tools to assist someone who may be impacted by a mental health challenge, both within and outside the workplace. One of the tools taught in the MHFA training is the ALGEE action plan. ALGEE stands for:

- Assess for risk of suicide or harm
- Listen non-judgmentally
- Give reassurance and information
- Encourage appropriate professional help
- Encourage self-help and other support strategies

After completing the MHFA course, 99% of DTE Energy trainees reported that they would likely or very likely use the ALGEE action plan to connect an adult experiencing signs and symptoms of a mental health or substance use challenge or crisis to appropriate help or resources. The MHFA-certified EYL Wellbeing Champions are a vital part of DTE Energy becoming a benchmark company in health and wellbeing. The partnership between MSU Extension and DTE Energy is ongoing and will continue with additional MHFA training for more EYL Wellbeing Champions and other groups within DTE Energy in 2022.

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

As a result of MSU Extension's social-emotional health programming, adults across Michigan learned how to reduce stress, practice mindfulness, and strengthen their families' and communities' understanding of and response to mental health crises.

- 1,018 individuals received veteran-tailored mental health resources electronically or at veteran community events
- 7,309 individuals participated in online workshops for essential workers to learn ways to manage stress
- 336 participants completed Mental Health First Aid trainings offered online in 2021

Of the participants surveyed:

- 93% reported that they were confident in having a supportive conversation with anyone about mental health or substance use challenges
- 94% reported they felt highly confident that they understood the benefits of mindfulness
- 93% reported they felt highly confident they knew how to use mindful breathing as a way to reduce stress

"The most interesting for me was realizing that I could do so much more for myself that would help me in lowering my stress." - Participant in MSU Extension mental health programming

"I enjoyed this course and got a lot out of it- both personally and professionally." - DTE Energy Mental Health First Aid Trainee

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

MSU Extension keeps people healthy and helps reduce health care costs by decreasing incidents of violence and bullying, helping participants reduce and manage stress, and teaching mindfulness techniques that can improve mental health throughout a person's life.

Opioid Misuse Prevention

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

Current trends show that Michigan is above the national average for drug overdose deaths. In 2019, Michigan had an average of five deaths per day due to opioid overdoses. The COVID-19 pandemic has intensified the impact of the opioid crisis in Michigan, with preliminary data showing increased overdose deaths and likely underreported fatalities in 2020. Higher percentages of older adults experience chronic pain or chronic conditions and thus may be more likely to be prescribed an opioid medication, increasing their risk for developing an opioid use disorder. Risk factors for opioid prescription misuse include having multiple chronic conditions, taking multiple medications, difficulties with memory, hearing, and vision, mental health issues, and physiological changes due to age. Stigma is also a significant problem for those who face substance use problems. Collaboration among organizations and community members is key to tackling the opioid epidemic.

“Opioid misuse and overdose are at an all-time high and the stigma around addiction continues to remain. Education plays a vital role in creating more awareness around substance use disorders and viewing them as a chronic conditions. Providing individuals with foundational information about addiction, treatment, and recovery is one way to support individuals’ communities as they address the opioid crisis at the local level. Opioid misuse can happen to anyone and understanding how to recognize the signs of misuse or an overdose could save someone’s life.” – Liz Williams, MSU Extension Educator

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.

Sustained Efforts of the MSU Extension State Opioid Response Team

Older adults are at a higher risk of developing chronic pain conditions, making them particularly vulnerable to opioid misuse. Between 2018 and 2021, MSU Extension’s State Opioid Response (SOR) team received two grants totaling $391,104 to help prevent opioid misuse among Michigan’s older adults (55+ years). This work focused on educating older adults on nonpharmacological approaches to pain management.

For nearly three years, a team of 20 MSU Extension staffe– health educators and program instructors — has provided educational programming to more than 3,000 older adults across Michigan. To reach a variety of participants, this project uses three methods of delivering education: face-to-face programming, virtual programming, and mailed toolkits combined with conference calls. Through these efforts, participants have developed their skills and confidence in using self-management strategies to overcome pain and manage their chronic diseases. Some of these strategies include mindfulness techniques, medication management, health literacy, and communication skill development.

In 2020, the U.S. Department of Agriculture National Institute of Food and Agriculture (Rural Health and Safety Education) awarded the SOR team a new $350,000 grant to continue and expand their successful opioid misuse prevention education to rural Michigan residents of all ages. This funding is focused on telehealth strategies and the impacts of distance education on rural adults.

For this work, MSU Extension collaborated extensively with the Michigan Department of Health and Human Services’ Office of Recovery-Oriented Systems of Care (OROSC) and the prevention networks who receive funding from OROSC. Prevention networks helped promote the programs for older adults in their regions. Many prevention network members became certified to implement opioid misuse education programs locally, helping sustain the programming past the grant period. Prior to this initiative, no other entity in Michigan was providing opioid misuse education to older adults.

The top chronic conditions experienced by program participants were arthritis (34%), hypertension (31%), diabetes (31%), high cholesterol (29%), chronic pain (28%), depression (19%), asthma/emphysema (17%), and anxiety disorder (15%). Participants in self-management classes received a locked medication box after completion, an incentive item encouraging participants to keep prescription opioids safe.

Over the course of this three-year grant, MSU Extension increased the number of instructors able to teach chronic disease/pain self-management classes for older adults by holding train-the-trainer sessions for chronic disease/pain self-management education in three locations across Michigan (Gaylord, Novi and Lansing), as well as virtually. A total of 19 new instructors participated in these sessions via in-person training and 12 attended new instructor training virtually. 100% percent of these participants completed the course and became certified to teach Chronic Disease/Pain Personal Action Toward Health (PATH) classes in support of this grant. These new instructors are now part of a team of educators that can teach older adults in Michigan about preventing substance misuse.

Achievements of MiSUPER = Michigan Substance Use, Prevention, Education and Recovery

MiSUPER (Michigan Substance Use, Prevention, Education and Recovery) is a collaborative project funded by the Substance Abuse and Mental Health Services Administration and includes MSU Extension, the MSU College of Human Medicine Department of Family Medicine, and the Health Department of Northwest Michigan. This project has gathered a team of 15 medical science faculty, public health professionals, and community-based educators. MiSUPER efforts increase awareness of opioid misuse in rural communities regarding prevention, treatment options, and recovery support so that community members and healthcare professionals can recognize signs of misuse, suggest options for evidence-based treatments, and support those in recovery.

During March 2020, with the onset of the global COVID-19 pandemic, the project was impacted by Michigan's "Stay Home, Stay Safe" orders. All planned educational outreach was quickly pivoted to a virtual format; as such the project website was expanded, adding new features such as an online calendar of events, news articles, a link to request community presentations, information on how to webinar attendees could apply for continuing education credits, seven online community resource guides, and a video series called "Stories of Hope."

The Stories of Hope video series produced by the MiSUPER project collected video testimonials from rural Michigan residents sharing their pathways to recovery. Seven stories were produced during 2021 and are on the project website as well as the Michigan State University Extension YouTube channel. In June and October 2021, members of the MiSUPER team presented virtually on the Stories of Hope project at two statewide conferences that were hosted by Michigan's Center for Rural Health.

Throughout 2021, the MiSUPER project team had a variety of project successes, including:

- The team implemented 26 community slide presentations (45-60 min) and 13 project overview presentations (10-20 min) reaching a total of 1,331 participants. Nine of these community slide presentations were in a statewide webinar format. Other community trainings were completed with closed groups that invited the MiSUPER team to their membership meetings

- In April 2021, MiSUPER project team delivered a presentation for healthcare professionals and providers that reached 159 people. Continuing education credits and attendance certificates were electronically sent to participants who requested them

- Eighteen trainings (17 community trainings and one provider presentation) used an incentive process to gather pre-, post-, and 30-day follow-up evaluations on awareness and knowledge gain

- MiSUPER ran a digital media campaign for six months (November 2020 through April 2021) in rural Michigan areas (Northern Lower Michigan and the Upper Peninsula) highlighting positive messaging regarding opioid misuse prevention, treatment, and recovery. The campaign averaged 3,000 impressions a day and had a total of 803,603 digital impressions

- The team updated the MSU Extension factsheet "Opioids in Rural Farming Communities" in June 2021, for an audience of professionals who work in rural communities, such as Michigan Department of Agriculture and Rural Development staff

- MiSUPER posted a Spanish-language article providing readers alternatives to medication for chronic pain management

- Staff created seven unique community resource guides by geographic regions of the state, based on request from community partners and participants

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

Using an opioid medication for a use other than what the provider intended, or taking the medication for longer than prescribed, can lead to misuse and other serious health consequences. Opioid use disorder (OUD) changes the structure and function of the brain. If people develop an addiction to opioids and are unable to access prescription opioids, they may seek out other harmful substances. Many people who misuse opioids or develop opioid use disorder (OUD) will need harm reduction supports, which are designed to lessen consequences. Michigan State University (MSU) Extension's opioid misuse prevention and education programming centers a message that recovery is rarely a straight line, but it is possible. Overall, MSU Extension's opioid misuse prevention education resulted in:

- 4,493 rural and older adults reached through direct educational efforts designed to prevent opioid misuse and to decrease stigma surrounding substance misuse

- 803,603 impressions through the MiSUPER (Michigan Substance Use, Prevention, Education and Recovery) digital media campaign
- 145 series of classes and 136 single-day workshops reaching older adults delivered through the State Opioid Response (SOR) project
- 31 new instructors trained in train-the-trainer sessions for SOR
- 7 people living in recovery from substance use disorder(s) shared their experiences through the Stories of Hope MiSUPER video series

After participating in a MiSUPER program or presentation offered by MSU Extension:

- 77% of participants reported improving their understanding of community resources for opioid misuse prevention, treatment, and recovery
- 75% of healthcare providers said they improved their knowledge of local resources for patients who cannot afford opioid misuse treatment
- 77% of providers reported increased comfort in discussing opioid misuse with patients and their loved ones.
- 99% of participants and 100% of providers would recommend the MiSUPER educational webinar/training to others

“For me, it was like trying to figure out a combination lock. I might get one issue addressed like my substance use, but having that one number wasn't enough to set me free. What I really needed was a more holistic approach: treatment for occupational issues, educational issues. I needed housing and transportation. And until I could get all of those variables addressed at once, I wasn't successful... [today] I love recovery because it has given me a purpose in my life and hope for the future.” - Amanda, person living in recovery in rural Michigan, Stories of Hope

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

MSU Extension keeps people healthy and helps reduce health care costs by helping prevent chronic health conditions and training providers on opioid misuse prevention.

State Fair

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

When the COVID-19 pandemic led to the cancellation of many Michigan fairs in 2020, Michigan State University Extension joined up with the Michigan State Fair (MSF) to offer Michigan youth a unique opportunity to showcase their 4-H projects and hard work. The event, the Michigan State Fair 4-H & Youth Virtual Showcase, was a huge success with hundreds of youth from across the state participating. Though both MSU Extension and the MSF returned to in-person events in 2021, both felt it important to continue offering this special virtual experience that saw so much excitement in the year before.

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 Michigan State Fair 4-H & Youth Virtual Showcase provided a virtual platform for youth across Michigan to exhibit their work in a variety of project areas and apply for $10,000 in scholarships. Utilizing the program FairEntry, youth entered photos and videos of their individual projects for evaluation. While in-person experiences offer face-to-face opportunities to highlight one's projects, the statewide virtual platform offered through the MSF partnership give youth another opportunity to obtain valuable feedback for personal development and recognition at a broader level. Due to Michigan's large geographic region, the virtual experience was the first time that many Michigan youth were able to engage in a statewide program of this nature as the opportunity to connect online eliminated previous barriers. Michigan youth aged 5-19 were encouraged to participate; 4-H membership was not required.

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

In 2021, MSU Extension and the Michigan State Fair saw another great year of engagement in the Michigan State Fair 4-H & Youth Virtual Showcase. Youth who participated in the program had the opportunity to demonstrate their mastery of skills and knowledge, receive feedback on their efforts, and obtain statewide recognition. In total:

- 382 entries were submitted across the state from 87 youth
- 35 counties had youth participating in the event
- Those who participated earned a total of $10,000 in scholarships

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

Individuals involved in 4-H programs learn life skills that prepare them for the workforce and increase their likelihood of becoming civically active. 4-H participants also demonstrate reduced high-risk behaviors such as drug use, and learn to complete tasks, solve problems, and seek help when needed. This helps ensure more young people succeed in school, attend college and contribute to their communities. More successful young people results in greater tax revenues and consumer spending and increases the likelihood that young people will stay in, or return to, their communities.

Think Food Safety

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

In 2021, MSU Extension food safety educators conducted a survey of "market masters" to gain insight on the educational needs for the Cottage Food Law with respect to farmers markets, vendors, and consumers. Seventy-six responses were received from market masters representing both rural and urban areas of Michigan. Comments suggest that the biggest concerns were about confusion regarding the law and a lack of resources by vendors and consumers. To respond to this need, the Think Food Safety team developed educational brochures and supporting information to connect people to MSU Extension as a trusted resource. Survey results also showed the importance of increased Cottage Food Law awareness through our Think Food Safety Facebook page and website.

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.

"Thinking Food Safety" to increase awareness of illegal and online food sales

Through two years of grant funding from the Michigan Department of Agriculture and Rural Development (MDARD), MSU Extension educators have used the "Think Food Safety" campaign to educate consumers and cottage food entrepreneurs alike. The campaign uses creative, educational content to highlight safe food practices on social media, as well as educational brochures, promotional postcards, a video, a table runner, and a stake sign to be used in settings such as farmers markets.

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

The Think Food Safety Facebook page grew in 2021 to 2,282 followers and a total reach of 321,237 with food preservation, food safety, and cottage food law messaging. In 2021, the team also worked on a “Think Food Safety” podcast, with the initial editions focusing on the Cottage Food Law and food licensing.

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

Think Food Safety helps vendors at farmers markets learn knowledge and skills to create products available for sale. Farmers markets and local food sales increasingly play a vital role in Michigan’s economic growth while also providing residents with options for affordable, local, and safe healthy food and related products.

Critical Issue

Plant and Animal Production and Health

Improving the management of highly productive sheep to optimize lamb production efficiency and minimize its environmental impact

Project Director
RICHARD EHRHARDT
Organization
Michigan State University
Accession Number
1026278

Progress report on improving the management of sheep

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

This project has 3 major objectives, to define the carbon footprint of US lamb production, to optimize pre breeding nutrition in prolific sheep and to investigate the use of cover crops as a lamb finishing system.

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 carbon footprint project, we have developed a life cycle analysis model of green house gas emissions (GHG) for lamb production and have collected data from 24 farms throughout the USA that vary in their production methods. We are seeking currently in the process processing this data.

For the cover crop grazing project, we have completed our 3rd year of data collection. We are analyzing the data of year 3 and compiling the results of all 3 years of this project.

For the reproduction and nutrition project, we are finishing up data analysis of plasma progesterone concentration from a series of 4 studies and are acitvely summarzing and compiling this data and working on manuscripts. We have also sent out a proposal to extend this project with 2 new major objectives.

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

For the environmental footprint project, we have presented the LCA model to the sheep industry at the annual meeting of the American Sheep Industry (ASI) Association. This has helped our producer audience understand this project better and to engage in it. We have also discussed this project on a national podcast organized by ASI with the same objectives of engaging producers in this project and educating them on this effort and on this concern in general. We are in the process of compiling our data on this project to publish a manuscript to share with our scientific audience.

For the cover crop grazing project, we have shared this project with several producer audiences in the USA and Canada and this has helped producers understand the value of cover crop grazing as a lamb finishing system. We are in the process of completiing this project for publication to share with a scientific audience.

For the reproduction and nutritiona project, we have shared the results of this project with a producer audience at several outreach events in botht the USA and Canada which has demonstrated to producers that large return on investment of improving energy intake in ewes during the pre breedig period. We are currently working on 3 manuscripts to share this work with a scientific audience.

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

We antiicipate the capacity to quantify this better as the projects progress. All this project seek to improve production efficiencies or identify ways to do that which will improve farm sustainablity and decrease the GHG foot print of food production.

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 successful in overcoming some barriers in project progress brought on by the COVID 19 pandemic but it has delayed each project significantly.

We are no longer pursuing the mastitis objective due to lack of fundign for this project.

Development and evaluation of sustainable nematode management strategies in Michigan agriculture

Project Director
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Accession Number
1022197

Development and Evaluation of Sustainable Nematode Management Strategies in Michigan Agriculture

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

I work with reducing plant parasitic nematode caused crop loses and evaluating the effect of strategies on soil health and beneficial nematode communities. Plant parasitic nematodes can cause significant economic damage. For example, Soybean Cyst Nematode is the number one yield robber of soybeans in North America. Root Knot Nematodes cause billions of dollars of losses in the USA and abroad. Growers are often not aware of the damage they cause because they are in the soil, are microscopic, and the symptoms aboveground are similar to those caused by nutrient deficiencies and water stress. Additionally, plant parasitic nematodes are difficult to control, in part because they are in the soil. Some effective strategies are no longer available because of environmental and safety concerns. Development and evaluation of new control strategies are priority. Evaluation of these strategies on soil health is also of importance, as beneficial organisms have key ecosystem functions.

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.

Nematodes that affect diverse crops are one of my primary interests. In Michigan my research has consisted of evaluating nematicides, compost, manures, cover crops, and biologicals (control through microorganisms) on the control of plant parasitic nematodes and crop yield. Their effect on free living nematodes and soil health has also been evaluated. I use a combination of field, greenhouse, and lab assays to test the efficacy different management strategies. Molecular methods have also been used in collaboration with other faculty. Trials include seven commodity groups: soybeans, corn, sugar beets, potatoes, vegetables, fruits, and ornamentals. Overall we have shown reductions of plant parasitic nematodes and increased yield with some of these methods. We have found promising sustainable practices such as designer compost. I look forward to continuing to work on nematode pest of priority such as Soybean Cyst Nematode and evaluating mechanisms and

management of SCN resistance to commercially available sources of resistance like PI88788 and Peking. We already have successful projects in this area and have obtained multiple grants to work on this topic. We are partnering with Henry Chung in the Entomology department in order to use molecular methods to further understand these topics. In addition, we would work to find solutions to diverse nematode problems in the state. Evaluation of nematode control strategies such as nematicides, fumigants, biofumigants, anaerobic soil disinfestation, biologicals, manures, composts, cover crops, and plant varieties for resistance will be conducted in collaboration with other faculty. Results will be disseminated in conjunction with extension faculty. We also currently partner with state agencies and private industry (i.e. USDA, MDARD, Bayer, Corteva, Syngenta, etc.) to address these problems, as we have received funding from all of them to support our work. Work and funding acquired at Michigan State demonstrates the ability to address the needs of growers For example: The Department of Entomology Nematology team (of which I am head) has actively completed research for every of the supporting seven commodity groups in the state of Michigan from 2017-2019. We have written and obtained more than 40 grants in order to support our work of plant parasitic nematode control and soil health. Our projects include initiatives in tree fruit, field crops (soybeans, corn, and sugar beet), potatoes, vegetables, and ornamentals. Research has been conducted in lab, greenhouse, and at field scale at research stations and the grower-collaborators fields. Research was primarily funded through research grants and chemical companies (Bayer, Monsanto, Marrone Bio Innovations, Adama, Certis, Dow-Dupont (Corteva), etc.). My research has shown successes in using techniques to control nematodes that are new to Michigan. Some examples of our work include rotation of SCN resistant varieties, cover crops, and compost and manures. Some designer-made composts are significantly reducing nematodes with greater effectiveness than many nematicides. In addition, the research includes evaluation of soil health with nematode community structure analysis. For example, in our ongoing ornamental project with Walter's Gardens, we are working toward a solution to Northern root knot nematodes in daylilies, a problem that causes nearly 20**%** loss in profit annually and have found effective management solutions. In potatoes, because of results we communicated from our 2017-2019 product trials, one of the largest potato producers in Michigan is using the products that showed greatest effectiveness. Trials have been successful, and growers are adopting the recommendations. In extension meetings and talks, 80**%** of growers say they will incorporate my recommendations and that they have learned something new. Some of the sustainable methods evaluated such as compost amendments are having the greatest impact in nematode control and increasing of soil health. Commodity groups have repeatedly told us that they are very happy with our work and growers are impressed by the fact that we are carrying out applied trials that directly meet their needs. Throughout my career I have been focused in nematode-caused crop losses and soil health and I look forwards to continuing this work in collaboration with faculty and growers.

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

Target Audiencefarmers, agriculture professionals, fellow scientists, and students • Our general objective is to find economically viable and effective solutions to important plant parasitic nematode problems in commercial crops. At the same time evaluate the effect of these management practices on yield, profitability, soil health, and beneficial nematodes • Finding alternatives to historically highly effective but environmentally risky and costly solutions such as Methyl Bromide fumigation is a priority for us. • An essential objective for us is evaluating new commercial nematicides and compare their effectiveness to established products in order to assist growers make informed research-based decisions • Compare different management practices and product effects on beneficial soil organisms, particularly free-living nematodes • Use of molecular methods to further characterize aggressive nematode populations that cause further damage than their numbers suggest and further understand the reasons for this damage differential • Soybeans: In soybeans our greatest priority is management of Soybean Cyst Nematode (SCN). Our objective is evaluation of management practices to reduce numbers and reduce breaking resistance to resistant varieties. We are and intend to continue evaluation of variety (with different sources of SCN resistance) rotations, manures/composts, cover crops, and nematicides to manage SCN. • Sugar beets: In sugar beets, our objective is to find effective solutions to managing Beet Cyst Nematode (BCN). Our trials include evaluation of nematicides, varieties, cover crops, and other management practices. We additionally intend to evaluate if BCN is successfully breeding with SCN and if their offspring can feed on both soybeans and sugar beets therefore making rotation with non-host difficult. Molecular techniques will be used for further evaluation of this in collaboration with Henry Chung. • Corn: In corn, we completed a corn survey to determine the nematodes that cause the most damage in corn in Michigan. Stunt nematode is the one that most often passed the damage threshold in the state. We aim to conduct greenhouse trials to further determine damage of stunt nematode in corn. Finding best management practices for stunt and corn needle nematode is also part of our objectives • Potatoes: In potatoes, our objectives are to find management practices to reduce root lesion nematode and verticillium wilt which together cause the potato early die disease complex. Further evaluation of composts/manures, nematicides, and cover crops to manage this important disease complex are needed. • Vegetables: Evaluation of nematicides, compost/manures, and cover crops, on the management of root lesion nematode on carrots and diverse other vegetables is our priority. In addition, northern root knot nematode is an important pest in vegetables grown in muck and finding effective management practices is part of our objectives. It is important to us to further understand the conducted vegetable survey, along with publication of its results. • Fruits: Finding methods to reduce replant problem and find ways to manage nematode problems while the plants are established in order to prevent spread of nematode vectored-

viral diseases is part of our priority • Ornamentals: In ornamentals is our objective to find and evaluate management practices of Northern Root Knot Nematode in bareroot ornamentals such as daylilies. Management practices such as dips of planting material, nematicides, bio-nematicides, compost/manures, and cover crops are and will continue to be evaluated.

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

Howland, A., Cole, E., Poley, K., and Quintanilla, M. 2022. Determining alternative management strategies for the northern root-knot nematode. Crop Protection. Journal impact factor 2.571. In preparation Núñez, L.*, Darling, E.*, Chung, H., Zasada, I. and Quintanilla, M. 2022. A Review of the Hop Cyst Nematode, Heterodera humuli. Frontiers in Plant Science. Impact factor: 4.407. In preparation Thapa, S., Cole, E., Poley, K., and Quintanilla, M. 2022. Distribution of plant parasitic nematodes in Michigan corn fields. Journal of Nematology. Journal impact factor 1.402. In preparation Darling, E., Palmisano, A., Chung, H. and Quintanilla, M. 2022. A new biological product showing promising control of the northern root knot nematode, Meloidogyne hapla, in tomatoes. Journal of Nematology. Impact factor 1.442. In preparation Parrado, L., Cole, E., and Quintanilla, M. 2022. Efficacy of integrating biological control agents with manure-based amendments for management of Pratylenchus penetrans and Verticillium dahliae in potato production. Phytopathology (tentative). Journal impact factor 4.024. In preparation Thapa, S., Cole, E., Howland, A.D., Levene, B., and Quintanilla, M. 2021. Soybean cyst nematode (Heterodera glycines) resistant variety rotation system impacts nematode population density, virulence, and yield. Crop Protection. https://doi.org/10.1016/j.cropro.2021.105864. Journal impact factor: 2.571 Cole, E., Pu, J., Chung, H., and Quintanilla, M. 2020. Impacts of manures and manure-based composts on root lesion nematodes and Verticillium dahliae in Michigan potatoes. Phytopathology. Journal impact factor: 3.264 Darling, E., Pu, J., Cole, E., Christian, R., Warner, F. W., Zasada, I., Chung, H., & Quintanilla, M. 2020. First report of the Hop Cyst Nematode, Heterodera humuli, in two counties of the Yakima Valley region, WA, USA. Plant Disease, (ja). https://doi.org/10.1094/PDIS-08-20-1769-PDN. Journal impact factor: 3.809 Dyrdahl-Young, R., Cole, E., Quintanilla Tornel, M., Weldon, R., & DiGennaro, P. 2020. Economic assessment of nematode biological control agents in a potato production model. Nematology. Journal impact factor: 1.216 Bintarti, A.F., Wilson, J., Quintanilla-Tornel, M., and Shade, A. 2020. Biogeography and diversity of multi-trophic root zone microbiomes in Michigan apple orchards: analysis of rootstock, scion, and growing region. Phytobiomes Journal. New journal so Journal impact factor yet unknown, though it belongs to APS and Phytopathology is 3.234 2022 Poster presentations Dandurand, L., Kuhl, J., Gleason, C., Zasada, I., and Quintanilla, M. 2022. Systems approach to controlling nematodes in US potato production. Potato Expo. Anaheim, California. January 5-6 2021 (n = 7) Oral presentations Quintanilla, M. 2021. Gusanos problemáticos, ¿Cómo manejar los nemátodos en la agricultura? (Problematic worms, how to manage nematodes in agriculture?) Simposio internacional de la agricultura y sustentabilidad de la Universidad Adventista de Chile. Chillan, Chile. December 1. Invited presentation Quintanilla, M. 2021. Update on nematology research in the Michigan nematology program. NE 1640 annual meeting. Gulf Shores, Alabama. September 16 Darling, E., Thapa, S., Chung, H. and Quintanilla, M. 2021. Differences in root penetration and feeding by Pratylenchus penetrans, P. neglectus, and P. crenatus on carrot. Society of Nematogists annual meeting. Gulf Shores, Alabama. September 13 Howland, A., Cole, E., and Quintanilla, M. 2021. New management practices provide promising control for the northern rootknot nematode (Meloidogyne hapla) in daylily (Hemerocallis spp.) field production. Society of Nematogists annual meeting. Gulf Shores, Alabama. September 13 Parrado, L., Cole, E., and Quintanilla, M. 2021. Potato early die: research on management alternatives and future insights. Society of Nematogists annual meeting. Gulf Shores, Alabama. September 13 Thapa, S., Cole, E., Howland, A., Levene, B., Bird, G., and Quintanilla, M. 2021. Soybean cyst nematodes (Heterodora glycines) resistant variety rotation system impacts nematode population density, virulence, and yield. Society of Nematogists annual meeting. Gulf Shores, Alabama. September 14 Poster presentations Cole, E., Perkins, J., Isaacs, R., and Quintanilla, M. 2021. Can nematodes aid in spotted wing drosophila (Drosophila suzukii) control? Society of Nematogists annual meeting. Gulf Shores, Alabama. September 14

Improving the Carbon Footprint and the Nutritive Value of Michigan Beef

Project Director
Jason Rowntree
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Accession Number
1021944

Improving the Carbon Footprint and the Nutritive Value of Michigan Beef

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

Our research works to address how management of beef cattle can influence ecological function of grasslands. We also work to quantify management's impact on beef system greenhouse gases and carbon sequestration.

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 summarized a 3 year study investigating the influence of legume addition in grazing system's influence on greenhouse gas emissions and soil health parameters. Our work indicated that a highly biodiverse mixed pasture had comparable performance and greenhouse gas emissions to that of grass and alfalfa. We also secured a large FFAR project to scale up a large suite of intensive instrumentation to assess greenhouse gas fluxes in grazing systems throughout the United States. This work will begin in 2022.

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

The target audience for this work is broad. From a producer perspective our work indicate that using biodiverse pasture swards have comparable performance and environmental impact as alfalfa. Generally biodiverse mixed pastures are less expensive to maintain and require considerably less farm equipment use, therefore lowering costs. Other audiences are beef purchasers, meat packers and restaurants. Our work of assessing greenhouse gas footprints of different grazing systems helps to inform these entities greenhouse gas reduction commitments. Finally our work has been shared with multiple government official to inform policy decisions.

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

Consumers are requesting that food products have less intensive greenhouse gas footprints. This work helps to inform on the greenhouse gas footprint of beef. We also conduct beef nutrient density work that also informs consumers on the nutritive value of the products they purchase.

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 were no problems encountered. Multiple talks to extension specialists and industry professionals were conducted. We too will host multiple educational activities to disseminate project outcomes.

Wheat variety improvement for Michigan and the Great Lakes Region

Project Director
Eric Olson
Organization
Michigan State University
Accession Number
1021594

Wheat Variety Improvement for Michigan and the Great Lakes Region

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

Wheat breeding and genetics research done at MSU will have far reaching effects regionally, nationally and globally. Varieties and germplasm developed at MSU have the potential to be grown across the Great Lakes Region. Wheat germplasm developed at MSU with improved resistance to biotic and abiotic stress will be distributed for use by national and international wheat breeding programs. In addition to providing varieties and germplasm, training will be provided for the next generation of plant breeders.

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.

1. Develop soft winter wheat varieties with high yield potential, disease resistance and quality traits. Generate wheat breeding populations Two crossing cycles will be completed annually to develop 600 populations per year focused on FHB resistance. Populations will be generated that segregate for both FHB resistance and important agronomic traits including high grain yield. Genomic Selection Each year, genomic estimated breeding values (GEBVs) for FHB resistance and grain yield will be developed for 1,900 inbred lines. A set of 500 lines with high predicted grain yield low predicted DON and FHB index will advanced and evaluated in an irrigated disease nursery. FHB Phenotyping A misted and inoculated FHB nursery will be used each year to phenotype 500 new breeding lines, 200 lines of the GS training population and 200 advanced breeding lines in replicated yield trials. Replicated Yield Testing Phenology, visual FHB resistance and plant type will be used to advance 100-200 lines to replicated yield testing at up to six locations across the Great Lakes Region. Expected Results Each year, multiple soft red and white winter wheat varieties will be released that have yield potential significantly higher than current varieties and resistance to economically significant pathogens.

2. Transfer agronomically important genes and traits from the germplasm of wheat wild relatives to cultivated wheat Evaluate wild relative germplasm for agronomically important traits.

Germplasm collections of wild diploid, tetraploid and hexaploid wheat relatives will be evaluated for resistance to Fusarium and rust pathogens of wheat Develop populations to map and transfer traits to cultivated hexaploid wheat. Wild relatives carrying target traits will be hybridized with elite cultivated wheat varieties using crossing schemes that will facilitate both mapping of the genes underlying the target traits and introgression of the traits into wheat breeding germplasm. Investigate mechanisms to facilitate transfer of genes across ploidy levels. Hybridization barriers exist between different ploidy levels that separate the gene pool of cultivated hexaploid wheat from diploid wild relatives. The formation of functional endosperm is an imprinted process dictated by parent specific and dosage specific gene expression. Mechanisms of restoring endosperm formation to interploidy hybrids will be investigated to bridge the gene pools of wild wheat relatives and cultivated hexaploid wheat. What was accomplished under these goals? Breeding Population Development • In November 2020 and March, 2021, 491 F1 crosses were made to develop new wheat breeding populations • 580 new F4 populations were generated in the greenhouse from F1 seed. Selections in Breeding Populations • Single plant selections were made in 467 F4 populations. GEBVs for grain yield, DON mycotoxin levels and Preharvest sprouting were developed for 1,900 individuals. A total of 500 selected lines were selected and planted in observation and increase plots. • 500 breeding and germplasm small plots were harvested and 250 new breeding lines are being yield tested in 2022. • 250 new genotypes were tested in preliminary yield trials in two replicates at four locations in Michigan • 112 genotypes were tested in eleven locations across the Eastern soft wheat region in advanced yield trials • 20 elite lines were tested in the Michigan commercial variety trials • One soft winter wheat line was approved for release as a variety. Other • Presentations on intensive wheat management and wheat breeding were made to over300 wheat growers and industry representatives at two events. • Two presentations to industry stakeholders

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

An undergraduate course in plant genetics was taught with an enrollment of 140 students. • Six graduate students were mentored. Three MS students graduated in 2021.

Target audiences for research conducted during the 2021 reporting period included members of academia, industry stakeholders and wheat growers in the state of Michigan. Academic organizations include collaborating wheat breeding and genetics programs across the United States as well as researchers at Michigan State University working on wheat production and management. Industry stakeholders include the Michigan Wheat Program and flour milling companies of the Michigan Millers Association.

Academic Collaborating wheat breeding programs involved yield testing and disease screening were updated on MSU wheat breeding activities and data was reported to collaborators.

Industry Members of the Michigan State Millers Association and Michigan Agri-Business Association were targeted in 2021 by project PI, Eric Olson. A talk at the annual MABA meeting highlighted results from research on wheat yield potential and variety development. At the annual MSMA meeting, milling industry stakeholders were updated on research on yield, quality and disease resistance as well as advances made in the variety development program.

Farmers Michigan wheat farmers were targeted at one virtual field day event by project PI, Eric Olson. Wheat growers were updated on wheat breeding program developments at the Michigan Wheat Program sponsored field day and growers were introduced to new wheat varieties. The outreach programs presented by Eric Olson included information sheets on new varieties in development and new varieties to be released as well as recommendations on the management of Fusarium head blight.

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

Yes

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 same activities will be carried out in the next reporting period.

Other Products

Product Type

New Germplasm

Description 'MI16R0720' is a new soft red winter wheat variety developed by Michigan State University Wheat Breeding and Genetics. This variety is ideal for production across a broad geography in Kentucky and Ohio as well as the north-central central soft red wheat producing area of Michigan. In 2021, MI16R0720 ranked at the 95th and 93rd percentile for grain yield among soft winter wheats tested in Kentucky and Ohio commercial yield trials, respectively. MI16R0720 demonstrates yield stability across a broad geography while having specific adaptation to Isabella, Gratiot and Saginaw counties in Michigan. Flowering date is one to two days earlier than average. Height is shorter than average. MI16R0720 has milling and baking quality that meets the needs of the soft wheat industry.

Product Type

New Germplasm

Description U6719-004 (Entry 538 of DNAM population, Reg. No. MP-14, NSL 536301 MAP), is a hexaploid wheat germplasm carrying YrAS2388R stripe rust resistance derived from Ae. tauschii accession TA1718 that is well-adapted to United States wheat production environments. U6719-004 (KS05HW14/3/KS05HW14/TA1718//KS05HW14) was developed using a combination of direct hybridization of TA1718 with the hard white winter wheat line KS05HW14 followed by two rounds of backcrossing and three generations of single-seed-descent. U6719-004 stripe rust resistance was characterized under controlled and natural conditions. Using gene-based markers, TA1718 and U6719-004 were confirmed to be YrAS2388R carriers. Grain yield for U6719-004 was evaluated in eleven year-by-location environments across the United States. Grain quality parameters were measured in four year-by-location environments. Compared to the recurrent wheat parent, KS05HW14 and locally adapted check varieties the Ae. tauschii introgression had little to no impact on U6719-004 grain yield or quality. The availability of U6719-004 will enable the use of YrAS2388R for stripe rust resistance breeding efforts.

Product Type

Data and Research Material

Description

In preliminary yield trials, 250 lines were tested in two replicates at Mason, SVREC, Huron and Sanilac sites in MI. In the advanced yield trial 112 lines were tested at 10 locations, in two replicates, across IL, MI and OH. The Michigan State Wheat Performance Trial consisted of 115 entries, including 20 entries from the MSU breeding program. The trial was evaluated at seven locations and three replicates. At the Isabella county and Tuscola county sites, conventional and intensive management practices were applied to all trial entries using a split-plot design. Cooperative wheat variety testing involved both public and private wheat breeding groups. Cooperative nurseries tested include the Uniform Eastern Soft Red Winter Wheat, the 5-State Nursery and the Uniform Eastern Soft White Winter Wheat nurseries. Data were generated on Fusarium head blight (FHB) disease screening nursery of ~3,000 rows. Wheat lines in replication included entries in the Michigan Wheat Performance Trials, regional cooperative breeding nurseries, advanced breeding lines and inbred lines derived in 2020. Rating was done for visual FHB severity, incidence and index. Rows were harvested and threshed to collect grain samples for assessment of Fusarium Damaged Kernels and DON mycotoxin levels. Genomic estimated breeding values (GEBVs) were developed for 1,900 inbred lines. Traits estimated included grain yield, DON mycotoxin levels and resistance to preharvest sprouting. GEBVs were used to advanced 500 lines to the observation nursery in the field and intensive greenhouse disease screening for resistance to Stripe Rust, Leaf Rust and FHB. A total of 491 crosses were made in the greenhouse to develop new breeding populations. A total of 580 breeding populations were advanced from the F1 to the F4 generation in the greenhouse. From each F4 population, 280 individuals were planted in the field to undergo visual selection and genomic selection.

Changes/Problems

{Nothing to report}

Enhancing Poultry Production Systems through Emerging Technologies and Husbandry Practices

Project Director
Janice Siegford
Organization
Michigan State University
Accession Number
1020075

Cage-Free Laying Hens: Using Computer Vision to Monitor & Impacts of Strain on Behavior and Welfare Outcomes

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

Consumer and retail demands have pushed the egg industry to adopt in more cage-free systems for laying hens, yet such systems make it harder to monitor and manage hens and result increased labor to collect eggs and care for the birds. Adapting Precision Livestock Farming (PLF) techniques to poultry production systems will further enhance the industry's capability to meet the growing demand for welfare-friendly eggs while helping mitigate labor issues. PI Siegford's efforts within the overall collaborative multistate project will further expand the concept of PLF, using automated continuous monitoring of laying hens through a combination of computer vision and wearable sensor technologies to allow producers to monitor and manage the welfare and behavior of their flocks in real time.PI Siegford also continues to examine how hens behave in cage-free systems to optimize their management and welfare.

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.

Engineering and Technology (as part of Objective 1)

Two research studies are underway using novel technological approaches. The first is a project using depth sensing technology to provide necessary data on laying hen space needs for performing wing-flapping, a dynamic and spatially intense behavior. Such information is needed to both establish realistic stocking rates and to design the structures of housing systems in ways that accommodate behaviors and comply with laws and standards surrounding animal welfare. Legislation and welfare standards related to laying hen housing often state that hens must be able to fully extend their limbs without touching the enclosure or other birds. Wing flapping, when a hen flaps her wings vigorously while standing, also involves the hen extending her wings to almost their full extent vertically and horizontally. It is therefore important to understand how much space is needed by common commercial strains of laying hens when wing flapping. However, only one study has assessed this, and that study looked at wing flapping as part of vertical movement rather than in a stationary hen. In summer and fall 2021 we developed and tested a protocol for recording hens wing flapping using depth sensing and visual light cameras to capture data on hens of a common white commercial strain as they wing flapped. Such a protocol will allow us to collect and analyze wing flapping data from hens of a variety of genetic strains and ages as well as to examine the impacts of rearing and housing conditions on wing flapping performance.

In summer 2021, funding was received to conduct an exploratory project examining use of computer vision to automatically detect hens and label their body parts to identify their orientation and location relative to other hens and to detect performance of key behaviors such as laying eggs on the litter. The project involved collecting high-resolution video of laying hens housed in cage-free commercial-style aviaries then using a range of approaches to train and test programs in these detection skills. Progress has been made in automated labeling of hens and a second set of data collection focused on identifying eggs in the litter is a next step. The ultimate goal of this project is to use information about hens and their behavior on the litter to create automated strategies for intervening when unwanted behaviors is detected to either prevent (as in the case of floor laying) or mitigate those behaviors (as in the case of hens piling to prevent subsequent smothering).

Physiological Response to Environment and Welfare (as part of Objective 2)

During the reporting periods, results were published from studies examining differences among brown and white strains of laying hens kept in cage-free commercial-style aviaries. In the first study (Ali et al., 2020) we identified how different patterns of space and resource use by white compared to brown hens led to different risks of problems such as keel fractures, foot lesions and poor plumage quality as well as to different likelihoods of problems such as laying eggs outside of nests. In the second study (Grebey et al., 2020), PhD student Tessa Grebey examined how the presence and proximity of other hens influenced dust bathing behavior in 2 white and 2 brown strains of hens. What she found was that white hens occupied the litter area in larger numbers and more of them dust bathed simultaneously. Brown hens required more space to dust bathe and also maintained more space between themselves and their neighbors while dust bathing. As space between a dust bathing hen and her neighbors decreased, brown hens were more likely to cut their dust bathing bout short while white hens decreased the amount of space they used to dust bathe but did not spend less time dust bathing.

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

Objective 1 Engineering and Technology: Both the project focused on 3D assessment of wing flapping space requirements and the computer vision project to detect key behaviors in cage free hens are still in progress, with data analysis underway in the first case and data collection in the second case. Therefore results have not yet been shared with target audiences of applied ethologists, developers of precision livestock farming, poultry industry engineers, poultry producers, or the general public.

Objective 2 Physiological Response to Environment and Welfare: Results of the risk assessment and dust bathing studies examining differences among strains of laying hens were presented at scientific meetings as well as to Michigan poultry producers in 2020 prior to their publication in peer-reviewed journals (Ali et al., 2020; Grebey et al., 2020). Subsequently, this information has also been used in discussions among members of the United Egg Producers Scientific Advisory Committee during their review and revision of cage-free guidelines in summer of 2021. Increasing the amount of information available to producers and housing equipment manufacturers and construction companies should enable future designs for cage-free systems will incorporate science about bird behavior to better match housing to biology.

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

My research under these objectives is aimed at developing a better understanding of laying hens managed in cage-free systems. The broader public demonstrates considerable concern over the welfare of production animals, including poultry, as seen through surveys and voter initiatives. Changes to allow hens more behavioral freedom by housing them in cage-free or free-range settings are widespread in the industry in response to legislation and pressure from corporations that want to please consumers. Technology can be used to both provide insight into hen biology and eventually to manage hens better at the individual level, which can help improve a bird's welfare. Knowledge of how hens behave and whether the specific strain of a bird is important can help us make better decisions about which hens to place in which systems, how to better prepare hens for life in those systems, and to manage the risks that arise in cage-free spaces. If the industry uses such information to improve bird welfare, they are more likely to be perceived positively by those who buy eggs—ensuring demand for poultry products and maintaining social license for farmers to continue farming.

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.

Engineering and Technology (as part of Objective 1)

The two research are underway using novel technological approaches to monitoring and managing cage free laying hens have provided training and professional development for 2 PhD students in animal science and 2 undergraduate students in engineering. All gained experience in on-farm data collection and in working as part of an interdisciplinary research team, which involves teaching and learning from each other to be able to work together. The PhD students have also gained experience in working with farm staff to conduct research and in analyzing data generated from computer vision methods.

Work is still underway on Objective 1, but PI Siegford has shared details about the nature of the studies with United Egg Producer's Scientific Committee and with the Michigan Allied Poultry Producer's committee dedicated to liaising with researchers at Michigan State University.

Future plans for work under Objective 1 include completing analysis on depth data collected related wing flapping, presentation of this work at a regional scientific meeting of the International Society for Applied Ethology, and submission of 1-2 manuscripts to peer-reviewed journals. Work continues to train the computer vision models to detect hens and their behaviors on litter with additional video collection and manual annotation to create reference set of video for training and testing algorithms.

Physiological Response to Environment and Welfare (as part of Objective 2)

No changes or problems

1 PhD student and 2 undergraduate students have been trained in collection of behavioral data from laying hens in aviaries. The PhD student has also had training in data analysis and interpretation, manuscript writing, and conference presentation. She has received professional development opportunities related to ethics in research, and has gained experience in mentoring and supervising personnel in the lab.

Results from Objective 2 were disseminated through 2 publications in a peer-reviewed journal (*Poultry Science*), presentation at an international scientific conference (Congress of International Society for Applied Ethology), and industry via PI Siegford's role on the United Egg Producer's Scientific Committee and meeting with the Michigan Allied Poultry Producer's committee dedicated to liaising with researchers at Michigan State University.

Future plans for this project include completing analysis on data collected related to 2) how dust bathing behavior changed in hens from their initial access to litter over time and 3) frequency and daily patterns of wing flapping behavior in the open litter area in 4 strains of hens.

Environmental and Genetic Determinants of Seed Quality and Performance

Project Director

Eric Olson

Organization

Michigan State University

Accession Number

1021335

Environmental and Genetic Determinants of Seed Quality and Performance

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

Preharvest sprouting (PHS) is an annual threat to wheat production that affects grain quality and marketability. PHS is a complex trait with interactions between grain dormancy, grain color, hormone sensitivity, and weather events between physiological and harvest maturity. The two phenotypes of PHS are vivipary, the precocious germination of grain while on the mother plant and elevated alpha-amylase activity (αAmy) which causes the enzymatic degradation of endosperm starch. PHS and αAmy are often correlated when environmental conditions induce sprouting in susceptible genotypes. However, these traits can occur independently. Late maturity amylase activity (LMA) also involves elevated levels of αAmy but differs in the causative weather events and does not involve visual sprouting. LMA is induced by temperature shock during specific developmental stages in the grain. A rapid fluctuation in temperature over a short time period triggers the production of αAmy in developing grain. Temperature fluctuations during the period of 26 to 28 days after flowering lead to LMA. Grain affected by LMA has a low falling number and high levels of αAmy but does not exhibit germination of the embryo. Previous studies conducted by MSU Wheat Breeding and Genetics on αAmy and preharvest sprouting in Michigan soft winter wheat indicate that soft winter wheat varieties adapted to Michigan and the Eastern soft wheat region may not experience LMA. Experiments conducted in 2015, 2016 and 2017 show no variation among control αAmy samples and all varieties had similar low levels of αAmy. However, it is likely that LMA-inducing conditions were not present in these years. The risk of LMA is present each year. However, reliable data can only be collected under LMA inducing conditions. In order to rate LMA and PHS each year, wheat lines must be evaluated under experimental conditions. To reduce the impact of LMA and PHS on Michigan wheat production it becomes necessary to 1) identify which varieties exhibit low LMA and PHS traits and 2) select for improved LMA and PHS in variety development.

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.

1.Understand how developmental and environmental mechanisms affect seed quality

2.Capitalize on new technologies to assess and manipulate traits to enhance seed quality

Genomic selection is being implemented to improve preharvest sprouting (PHS) in soft red and white winter wheat varieties. Visual PHS data was generated for soft red and white winter wheat including a training population (TP) of 180 genotypes, advanced yield trials (AYT) of 112 genotypes and preliminary yield trials of 250 genotypes were evaluated for visual sprouting traits in 2021. Single nucleotide polymorphisms were generated for all lines phenotyped for PHS as well as a set of 1,900 breeding program selection candidates. PHS and SNP data were used to train a Bayesian Ridge Regression model using the R package BGLR for the prediction of PHS in 1,900 breeding program selection candidates. A total of 500 F4-derived inbred lines were advanced based on genomic estimated breeding values (GEBVs) for PHS as well as DON mycotoxin and grain yield. GEBVs for PHS are used as selection criteria for advancing lines through the breeding program to variety release. 2021 marks

the third year of implementation of genomic selection for PHS resistance in soft winter wheat. Gains have been made in PHS resistance in the soft white winter wheat lines moving through the program. All of the soft white winter wheat genotypes advanced have low predicted risk of PHS.

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

In 2021, one graduate student and one post baccalaureate researcher were trained in the sampling and phenotyping of PHS.

Target audiences for research conducted during the 2021 reporting period included members of academia and wheat industry stakeholders including flour milling companies of the Michigan Millers Association as well as certified seed growers in Michigan and the Eastern US.

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

Yes

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.

In the next reporting period we will continue PHS phenotyping and training of prediction models for genomic selection of PHSresistant soft red and white winter wheat.

Product Type Data and Research Material Description Genomic selection is being implemented to improve preharvest sprouting (PHS) in soft red and white winter wheat varieties. Visual PHS data was generated for soft red and white winter wheat including a training population (TP) of 180 genotypes, advanced yield trials (AYT) of 112 genotypes and preliminary yield trials of 250 genotypes were evaluated for visual sprouting traits in 2021. Single nucleotide polymorphisms were generated for all lines phenotyped for PHS as well as a set of 1,900 breeding program selection candidates. PHS and SNP data were used to train a Bayesian Ridge Regression model using the R package BGLR for the prediction of PHS in 1,900 breeding program selection candidates. A total of 500 F4-derived inbred lines were advanced based on genomic estimated breeding values (GEBVs) for PHS as well as DON mycotoxin and grain yield. GEBVs for PHS are used as selection criteria for advancing lines through the breeding program to variety release. 2021 marks the third year of implementation of genomic selection for PHS resistance in soft winter wheat. Gains have been made in PHS resistance in the soft white winter wheat lines moving through the program. All of the soft white winter wheat genotypes advanced have low predicted risk of PHS.

Disease management of upland/muck vegetables and transplants, ginseng, and greenhouse ornamentals

Project Director
Mary Hausbeck
Organization
Michigan State University
Accession Number
1019583

Disease management of upland/muck vegetables and transplants, ginseng, and greenhouse ornamentals

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

Our target problems include the diseases incited by fungal and Oomycete plant pathogens encountered by growers of fresh market and processing vegetables and greenhouse vegetable transplants, ginseng, and greenhouse floriculture crops. Control strategies are sought that utilize conventional and/or organic methods.

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.

Fungicide efficacy trials tested biopesticides, reduced risk, experimentals, and industry standards for disease control on asparagus, onion, cucurbits, beet, ginseng, and ornamentals. Effective products, dosages, application intervals and methods, longevity of control, fungicide resistance in the pathogens were identified.

ASPARAGUS: Fungicides currently unregistered for use on asparagus were compared to chlorothalonil and tested in conjunction with forecasting program TOMCAST for effectiveness against purple spot (*Stemphylium vesicarum*). All fungicide treatments were significantly more effective than the control. The premixes of pydiflumetofen + fludioxonil (most effective) and fluxapyroxad + pyraclostrobin were more effective than the others. In the second trial, fungicides were applied according to TOMCAST until 26 Aug or 6 Oct. Plots treated with chlorothalonil through the later date had significantly less disease than plots with treatments ending earlier. Registration of new fungicides proven effective against purple spot could improve fern health and enhance the use of the TOMCAST forecasting model. Extending the fungicide program beyond August could offer additional protection in years when warm temperatures persist.

ONIONS: Fungicide field studies were conducted to develop strategies that maximize fungicide applications while protecting onions from Stemphylium leaf blight (*Stemphylium vesicarium*). For the PROGRAM trial, treatments were applied every 7-days. At the end of the trial, the untreated control plots had the least amount of green tissue and the plots treated with Bravo had a similarly reduced amount of green tissue. All of the other treatment plots had significantly more green tissue than the untreated control indicating control of Stemphylium leaf blight. For the LEAF trial, 2 fungicide programs were initiated when onion bulbs reached 1 of 5 leaf or bulb growth stages and applied at 7-day intervals until 10 Aug. The untreated control plot in the LEAF trial had the lowest amount of green tissue indicating a high level of Stemphylium leaf blight. All fungicide programs that were initiated in later growth stages also had a low amount of green tissue, similar to the untreated control. This indicates that waiting to begin a fungicide program does not result in a high level of leaf blight control. All fungicide programs were effective when applied at or before the 5-7 leaf stage.

CUCURBITS: Downy mildew (DM) influx into MI was monitored through spore traps, sentinel plots of susceptible cucurbit cultivars, and diseased sample diagnoses. Burkard volumetric spore traps were placed in 7 Michigan counties. One-half of the spore trap tape was split into lengths corresponding to a 24-hour time period, processed in a DNA extraction and multiplex qPCR assay to differentiate *P. cubensis* clade 1 and 2 and *P. humuli*. *P. cubensis* clade 2 infects cucumbers while *P. humuli* infects hop. The other half was examined using light microscopy. CDM was verified on cucumbers on 14 July. *P. cubensis* clade 1, which prefers pumpkin and squash, was detected only on October 11; infection of these crops was not observed. Thirteen fungicides and 3 disease forecasting models to time fungicide applications were evaluated for their efficacy in controlling *P. cubensis* in the field. The fungicide active ingredients oxathiapiprolin, propamocarb, cyazofamid, and fluazinam, were more effective than the other products tested. Oxathiapiprolin was the most effective. All forecasters and calendar-based treatments had significantly reduced infected foliage compared to the untreated control; DM-CAST and BLITE-CAST were the most effective forecasters. All forecasters reduced the number of applications compared to the 7-day calendar program except DM-CAST which required an extra application. Trials were conducted to determine the sensitivity of Crown Rot Disease (*Phytophthora capsici*) to fungicides and to explore genetic resistance among commercial hard squash cultivars. Five cucurbit fields were sampled in 3 Michigan counties and sensitivity to mefenoxam was evaluated using a restricted dose method using amended agar plates. Sensitivity to mefenoxam differed among farms. The highest observed amount of resistance (R) was 9.5% and intermediate resistance (IR) was 23.1%. Resistance to mefenoxam was not observed for two farms but IR resistance of 17.8 to 22.6% was noted. Commercial cultivars (12) of squash including 4 *Cucurbita moschata* type butternut and 2 *Cucurbita maxima* type were evaluated for resistance to crown rot caused by *P. capsici*. 'Dickenson', 'Buckskin', 'New England Cheddar', and 'Ultra' showed significantly less disease symptoms on the final rating date compared to the other cultivars. 'Thunder' showed fewer symptoms from *P. capsici* infection compared with 'Golden Delicious', 'Sweet Mama', 'Sunshine', and 'Delica'.

ROOT CROPS: Beet Necrotic Yellow Vein Virus (BNYVV), is a devastating, difficult to control, and persistent soil-borne disease of table beets, vectored by a fungal-like organism, *Polymyxa betae*. Utilizing the published methods and the USDA's grades and standards for table beets as a foundation, a new categorization system, with disease rating values from 0 to 5, was developed. The new disease rating system was used the effects of infection compared on 8 commercially available table beet varieties, 6 of which were genetically resistant to BNYVV infection and 2 were not. A field containing a naturally occurring inoculum of BNYVV-infected *P. betae* was used for this trial. The harvested beets were visually assessed for disease. Disease pressure across all replications was high and all varieties exhibited some level of infection. The rhizomania-susceptible varieties scored the highest mean ratings. Varieties resistant to rhizomania obtained lower scores, suggesting that genetic resistance may be a viable option for combatting rhizomania.

GINSENG: Alternaria blight is an annual threat to cultivated ginseng. Two, 15-treatment trials were applied at two 3-year-old ginseng gardens in Marathon County, WI. Treatments included registered and non-registered products. Miravis Prime was effective against one of the Alternaria species, Tanos showed effectiveness against *A. panax*, and the confidential product was effective in both experiments.

GREENHOUSE ORNAMENTALS: Isolates (394) isolates of *Botrytis. cinerea* were collected from floriculture greenhouses and evaluated for sensitivity to 8 site-specific fungicides. High resistance frequencies were observed for thiophanate-methyl, pyraclostrobin, boscalid, and iprodione. Intermediate levels of resistance frequencies were observed forfenhexamid and cyprodinil, and low levels forfludioxonil and fluopyram. Over 50% of isolates displayed resistance to at least 5 chemical classes, with 34 of those isolates harboring resistance to all 7 classes. Fungicide resistance was evenly spread among crops and regions, indicating insufficient resistance management strategies in floriculture greenhouses. Mono- and dichromatic light is commonly used to promote flowering in long-day floriculture crops. Blue, green, and red light also represses conidia formation in *Botrytis cinerea* and might help to reduce disease spread in greenhouses. However, some *B. cinerea* strains do not respond to light. Single-spore isolates collected from greenhouses were assessed for their ability to respond to a light stimulus. Most isolates had a wildtype response to light exposure producing more conidia in light than in constant darkness. So-called *blind* isolates, with statistically similar levels of conidia in constant darkness and light, generally had abnormal mycelium growth and low levels of sporulation. In the absence of *blind B. cinerea* isolates with high fecundity, fungistatic light treatments have the potential to improve disease control but monitoring for insensitivity may be needed.

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

Vegetable, ginseng, and ornamental research plots were established for this year's project research and many of these trials were sited on grower-cooperator farms. Establishing research with grower-cooperators allows the opportunity of directly communicating results to growers. Other trials were established annually at research farms such as the Southwest Michigan Research and Education Center in Benton Harbor, MI, and the Asparagus Industry Research Farm, Hart, MI, which are open to growers.

I've worked closely with extension educators and key growers in the state to advise and address their crop loss due to disease issues. Specifically, my efforts have been successful in convincing a regional processor to stop requiring the production of a highly susceptible squash cultivar from its contracted growers. I interfaced with the USDA IR-4 Project at the regional and national levels to bring forward Michigan's growers' needs/priorities for the registration of new fungicides. Our lab is responsible for the downy mildew fungicide recommendations for the Great Lakes growing area; Michigan is the #1 producer of cucumbers in the U.S. and downy mildew is the leading threat. The statewide early detection network for the airborne sporangia of the downy mildew pathogen (*Pseudoperonospora cubensis)* was run successfully across the major vegetable growing regions to alert growers when fungicide programs need to be initiated to prevent an outbreak. These monitoring/early detection efforts are funding through state and national pickling cucumber associations. Our research to improve detection of airborne *P. cubensis* sporangia by adapting qPCR-based assays to distinguish among *P. cubensis* clade I and II and *Pseudoperonospora humuli* in spore trap samples was validated in commercial fields and research plots. Pathogen alerts assist growers in initiating preventive fungicides. *P. cubensis* clade II DNA was detected in spore trap samples >2 days before disease was observed in cucumber fields, while *P. cubensis* clade I DNA wasn't detected in air samples; clade 1 infects squash and pumpkins. *P. humuli* DNA was detected early in the season. Weekly qPCR results across Michigan's cucumber production regions were communicated via the website veggies.msu.edu, extension articles, and other outreach activities.

We identified two carrot pathogens that will negatively impact growers. *Colletotrichum gloeosporioides* on carrot was reported in Brazil with no U.S. reports. *Alternaria radicina* was detected once in Michigan (2006) but was confirmed in several fields in 2021. This pathogen causes rot of stored carrots; demand for stored carrots from local processors has increased. *Alternaria carotiincultae* is morphologically identical to *A. radicina* and complicates the situation. Two grants to address these pathogens are pending.

I engage with commodity organizations for the following: Carrot Board, Asparagus Board, Carrot Board, Michigan Vegetable Council, Western Michigan Greenhouse Growers Assoc., Detroit Metro Greenhouse Growers Assoc., and Celery Research Inc. I report to each group (Board) annually with a formal presentation and a question/answer period. Some representatives of the various Boards have been directly engaged with research and extension programming as grower cooperators for field research trials and field day stops. I interact informally with growers represented by each Board through email, texting, and phone calls. I estimate that in 2021, I handled more than 200 direct inquiries from growers, field scouts, extension educators, and sales personnel for disease diagnosis and management recommendations. I saw an increase in pictures sent via text for disease diagnosis in 2021 and anticipate that this will continue in the future. I also handle some plant samples, as needed, although I prefer that MSU Diagnostic Services lead this effort. Approximately 50 plant samples were handled directly by my lab with the majority associated with cucurbit downy mildew diagnosis. As a service to key, larger squash growers, my lab processed more than 150 squash samples with symptoms of *Phytophthora capsici* infection to determine fungicide sensitivity of the pathogen. This information was provided to growers to ensure the selection of effective fungicides and provide education regarding the range of sensitivity among the different pathogen populations.

We develop and administer surveys at extension events to assess the impact of our projects with growers and industry representatives. According to responses collected pre-and post- research, a large majority (average >90%) of responding growers find our extension sessions useful and feel like they have gained knowledge about new disease management tools. For most surveys, more than half of respondents indicated that they would be adopting new recommended practices based on our research.

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

Through our disease management programs, consumers are ensured to have a steady supply of healthy fresh and processed vegetables which results in food security. Our ornamental plant pathology programs result in healthy ornamentals for the indoor and outdoor living environments. Further, by reducing the fungicides needed to limit diseases through monitoring and diagnostics of plant pathogens we contribute to a healthier environment and a reduction of pesticide residues on food.

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.

Challenges include having only two extension educators in the state for vegetables and only two for floriculture which leaves large regions of the state without coverage. As a result, growers are reaching out to Dr. Hausbeck directly. Many meetings were postponed or changed to a virtual format due to COVID. This presented some challenges in interfacing with growers, but in some instances, the virtual format allowed a broader reach. There were some general research obstacles including temporary shortages of some lab materials along with limiting undergraduate student employees to reduce lab density and COVID risk. It was also challenging interfacing with stakeholders who hold views of COVID and vaccines that differ from the scientific community.

Two new M.S. graduate students and one Ph.D. student joined Dr. Hausbeck's program. Two graduate students received their M.S. degrees and two received their Ph.D., including one who went on to serve as a post-doctoral research associate in Dr. Hausbeck's lab. Dr. Hausbeck mentored 10 graduate students, in agricultural science methods. Seven undergraduate students were mentored by graduate students, technicians and Dr. Hausbeck during this year, learning research skills for agricultural sciences.

Graduate students presented their research results in talks and posters at scientific meetings, co-authored journal articles and book chapters, and prepared extension materials. Research results were published in scientific journal articles, abstracts, extension bulletins, extension articles, magazine articles, Plant Disease Management Reports, and conference proceedings. Links to many of these publications are available online at Dr. Hausbeck's website (www.veggies.msu.edu). Research results were presented at meetings to growers, commodity groups, industry stakeholders, extension educators, legislators, other researchers and registrant companies of pesticides. Presentations included tours/field days/workshops, talks at scientific meetings, and talks at state, national, and international extension meetings. The Annual and Divisional Meetings of the American Phytopathological Society and Agriculture and Agri-Food Canada spring meeting are included among the scientific meetings that Dr. Hausbeck, her graduate students and post-docs presented at. Extension meetings included the Great Lakes Fruit, Vegetable and Farm Market Expo, Michigan Greenhouse Growers EXPO, Pickle Packers International Inc. annual meeting and various other commodity group and growers' meetings.

The goals/objectives, methods, products and expected outcomes remain unchanged from those set forth in the Project Initiation Report. These will continue to be valid for the next reporting period. Research will be ongoing to investigate alternative and novel disease management strategies for growers in MI and elsewhere. All research will be replicated and data statistically analyzed where feasible. Efficacy trials to identify new and experimental fungicides for control of diseases of vegetables, ornamentals, ginseng and hop will continue to be ongoing, including evaluating new, registered and unregistered products, biopesticides, experimentals, and reduced-risk products. Efficacy trials identify products, rates, application intervals, and application methods that maximize the effectiveness of disease control products and identify those with control failure. Besides helping growers make informed choices of disease control products, efficacy trials can support registrants adding new crops to their labels. Effective disease management recommendations will be disseminated to growers, extension personnel, industry stakeholders, and the scientific community via scientific and extension publications, presentations at scientific and extension meetings, a website (www.veggies.msu.edu, www.downymildew.msu.edu), and establishing demonstration plots on grower-cooperators' farms and extension center. Dr. Hausbeck is serving on the Scientific Committee for the 15th International Asparagus Symposium that will be held in 2022 in Spain after being postponed for two years. The current scheduling of the other international meetings that have been impacted by COVID remains to be seen.

Elucidating and controlling pathogen dispersal and disease initiation

Project Director

Frances Trail

Organization

Michigan State University

Accession Number

1019228

Elucidating and controlling pathogen dispersal and disease initation

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

Fusarium graminearum is the causal agent of head blight of wheat and barley and crown rot of corn, all of which cause devastating losses to growers in the midwest, and around the world. In the US the problem is shouldered by the growers who will lose value of their crops at upon sale if associated mycotoxin contamination is detected. We are focusing on investigating stages of the life cycle which lead to contamination: 1. Generation and dispersal of fungal propagules (mainly spores). 2. The factors that affect dispersal and the early stages of interaction with host tissue, including germination and surface interactions that lead to fungal ingress into the plant resulting in disease. 3. Development of inhibitors of sporulation and spore dispersal, as well as inhibition of disease losses.

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.

This year we have been focusing on how the fungus interacts with the plan surface to establish an infection. Our work has elucidated, for the first time, the ability of Fusarium graminearum to produce a biofilm in culture. This is one of the first 3 filamentous fungal species to be shown to produce this structure. We have also established a role for biofilms in disease. Biofilms are forms of microbes which are notoriously resistant to antimicrobials (ie antibiotics in bacteria) and therefore forms of the fungus that likely make it more difficult to control.

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

We presented our results at the 2021 American Phytopathological Society, and the 2021 Fusarium Forum sponsored by USDA Wheat and Barley Scab Initative. Both of these meetings are attended by plant pathologists, breeders and growers. In addition, in 2022, we presented a poster at the Fungal Genetics Conference sponsored by the Genetic Societ of America, and the NCCC307 meeting. Both meetings are attended by scientists researching in control of crop diseases.

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

The head blight disease is accompanied by production of several mycotoxins, including deoxynivalenol which affects the health of humans an animal following consumption of contaminated grain. Research on reduction or elimination of this disease and the lowering of the mycotoxin load in harvested crops will increase food safety and security for both US citizens and worldwide.

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.

No major changes.

Here are our citations for this year:

Shay R, Weigard A*, Trail F. 202-. Biofilm formation and structure in the filamentous fungus *Fusarium graminearum*, a plant pathogen. Microbiology Spectrum. *In press.*

*highschool student during investigation

Shay, R and Trail, F. 2022. Poster. Biofilm formation in the filamentous fungus *Fusarium graminearum*. In: Proceedings of the 31st Fungal Genetics Conference.

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Shay, R and Trail, F. 2021. Poster. Exploring the Genetics of Biofilm Development in *Fusarium graminearum*. In: Proceedings of the 2021 NFHB Forum. Virtual.

Shay, R. and Trail, F. 2021. Poster. Biofilm formation in the filamentous fungal plant pathogen *Fusarium graminearum*. In: Proceedings of Botany 2021 Virtual.

Shay, R and Trail, F. 2021. Research-on-Demand. Biofilm formation in the filamentous fungal plant pathogen *Fusarium graminearum*. In: Proceedings of Plant Health 2021 Online. Virtual,

Refining sustainable vineyard cultural practices in Michigan's variable cool climate conditions to achieve more predictable targeted yields and optimal fruit quality year after year for both juice and wine grape production

Project Director
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1018336

Refining sustainable vineyard cultural practices in Michigan's variable cool climate conditions to achieve more predictable targeted yields and optimal fruit quality year afte

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

Grape in U.S. is the most valuable crop (USDA-NASS, 2018) and total production has more than tripled in value in ten years and Michigan has been a significant contributor ranking in the top five nationally with 15,000 acres planted to grapes. The grape and wine industry in Michigan is a fast growing sector of the Michigan agricultural sector. Important numbers are: (1) Michigan ranks 5 in the USA in grape acreage (15,000 acres) and it is a major producer of juice grapes in USA; (2) there are more than 200 wineries with more emerging each year; (3) 5,000 fulltime equivalent are employed; 4) over 800,000 wine-related tourist visits every year; and (5) an estimated annual economic impact of the state's grape and wine industry of more than $800 million in spending. However, Michigan's climate presents several challenges to grape and wine producers, including (1) winter cold damage, (2) spring frost injury, and (3) variable ripening conditions that affect yield and fruit quality at harvest. Weather related disasters have occurred during the last 5 years, resulting in millions of dollars in crop losses and/or defects in product quality, reducing both the quantity of grapes at harvest and the fruit technological maturity. In fact, Michigan's climate is characterized by a short growing season (150 to 175 days) with cool-climate conditions (1200 growing degree days or GDD, base 10 C). Therefore, the wine and juice grape industry in Michigan finds a limitation to the effort of achieving quality products in a challenging environment for the physiological requirements of grapevines, too often leading to an incomplete maturation of the fruit. Under these conditions it is pivotal to achieve optimal fruit maturity every year to and quality in relation to the seasonal climate variations.

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.

As an expanding value-added crop for Michigan agriculture and an increasingly significant driver for state tourism, state viticulture requires a boost in research investment if it is to continue to grow and meet the challenges of national and international competition. The overall goal of this multi-year project, for both juice and wine grapes, is to test and recommend a series of vineyard management strategies that can hasten fruit development and maturation for improved and more consistent high quality grape production in a highly variable climate. Objectives that are more specific will be detailed in following section. The acceptance of fine Michigan wines among the pantheon of its "world class" vinifera-based competitors depends on the ability of state growers and winemakers to overcome several cultural and environmental limitations. Important high value vinifera varieties are typically harvested in Michigan well before they achieve the level of ripeness desired for premium wine production. This is almost exclusively due to two factors: 1) environmental limitations for

accumulation of sugar and aromatic compounds in the berries, and 2) small, compact clustered grape varieties with berries very tightly spaced that often lead to cluster rot complex initiated by Botrytis cinerea. Research activities have been initiated at MSU to address both problems and the efforts are currently supported by industry funding demonstrating solid interest in the issue. In 2020 and 2021, research experimental efforts were focused on determine yield ranges that could be matured over a variety of growing season types and vineyard canopy management practices, while maintaining the vine's capability to return with a full crop potential the next season.

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

During 2020 and 2021 the viticulture team worked with stakeholders, local and regional industry organizations, and utilized several online zoom-based extension meetings to provide relevant project reports and facilitate information dissemination for continued stakeholder engagement. Web-based extension materials related to the performance of several alternative grape varieties mitigating was produced and distributed, including short reports and 2) extension presentations and on-site vineyard demonstrations. Results shared with growers and extension personnel at our annual extension meetings, such as the 2019 Great Lakes Expo, 2020 Viticulture Day, 2020 online Southwest Horticultural Days, and other in-season meetings. Information was also distributed via Michigan Grape and Wine Newsletter and crop-related websites (e.g. www.grapes.msu.edu). Research presentations will also be made at scientific conferences, informal scientific meetings, and as a paper in a scientific journal.

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

The overall goal of this project, for both juice and wine grapes, was to test and recommend a series of vineyard management strategies that can hasten fruit development and maturation for improved and more consistent high quality grape production in a highly variable climate year to year. This project established management viticultural practices to obtain consistent optimal quality in Michigan. In a survey administered by the viticulture team at MSU in 2010, 82% of respondents indicated that they conduct crop thinning in their vineyards, but the target yields are not driven by fruit quality parameters but by contracts with the winery/winemaker that may or may not take these factors into account or are driven by other concerns. Moreover, target yields are not based on vine balance or overall vineyard productivity, and final grape and wine aroma composition are totally disregarded in current vineyard practices. Therefore, this study defined metrics for Michigan by addressing both the practical and the physiological aspects of vine balance issues for enhanced vine productivity, fruit, and wine quality. This research provided detailed information to the grower to make precise management decisions on crop load that are necessary a) to avoid cycling of vine productivity (analogous to alternate biennial bearing in pome fruits) and 2) to optimize juice quality for wine and juice grape under Michigan conditions. Basic information on crop management and effect on fruit maturation are available from this research activity. These are important areas of need for the juice and wine industries, with important opportunities for funding, particularly in collaborations with teams that will include molecular components. The goal of this research was to provide vineyard management strategies that can hasten fruit development and maturation for improved and more consistent high-quality juice and wine grape production in a highly variable climate. We strongly believe that this project has the potential to provide answers and significant benefits to our 420 grape growers in Michigan. The projects described above may have a variable duration from a minimum of 3 to a maximum of 5 years. The lack of precision is entirely due to the unpredictability of the seasonal variation between years and the necessity to validate the viticulture research for several growing seasons. Based on historical events, however, we feel confident that we will obtain sufficient data in a maximum of 5 years (worst case scenario) from which to extrapolate conclusions.

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 pandemic reduced immensely the opportunity for training students and professionals. Student in the viticulture certificate program, a two-year program at the Michigan State University (MSU) Institute of Agricultural Technology (IAT) during 2020-1 had the opportunity to visit the NW station experimental vineyard but no pruning or canopy management were performed by the students. Students in the Department of Horticulture enrolled in HRT336 class (Viticulture and Berry production) had the opportunity of a virtual tour of the 2 plots in the NW and SW.

Catherine Ernst
Organization
Michigan State University
Accession Number
1018153

National Animal Genome Research Program

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

Improvements in livestock production efficiency require genetically improved populations of animals with sufficient genetic diversity to allow continued improvements in economically important traits including product yield, disease resistance, efficient production, and stress tolerance, while ensuring nutritional quality and animal welfare. Technological advancements in DNA sequencing and automated recording of animal phenotypes facilitate cost-effective increases in efficiency and accuracy of genetic selection.

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.

MSU researchers contributed to this multistate project through research in pigs, cattle and horses. In general, projects evaluated aspects of gene expression regulation and genome-to-phenome prediction. Efforts in pigs included evaluation of allele-specific expression and alternative transcript splicing in crossbred pigs. Additional efforts in pigs involved assessment of DNA methylation patterns in pig tissues including immune cells and fetal tissues in order to improve knowledge of gene expression regulation. Contributions for both cattle and pigs included development of computational methods using deep learning and artificial intelligence for modeling prediction algorithms for phenotypes and genetic selection. Efforts in cattle and horses included study of animal health. Several biomarkers were evaluated for use in reducing prevalence of bovine leukemia virus in dairy herds. Molecular mechanisms controlling several equine muscle disorders were studied and included evaluation of dietary approaches for reducing symptoms.

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

The primary target audience for this project is animal genome scientists and scientists who use genomic data in other animal science disciplines. This project contributed new information to the international effort for annotating animal genomes, and contributed to developing methods for enhancing genome-to-phenome predictions.

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

This project is basic in nature so benefits to the broader public will be longer term through improvements in animal production and genetic selection. Collaborations with industry scientists and livestock producers who apply genomic data analyses facilitates adoption of new approaches for improving animal production. In addition, methods for efficiently predicting animal phenotypes (including disease prevalence) provides livestock producers with management strategies for improving animal welfare and increasing production efficiency.

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.

This project has provided opportunities for training of graduate and undergraduate students who participated in research toward completion of their degree programs, as well as postdoctoral scientists and visiting scholars. Trainees presented results of their research at university and professional society conferences. In addition to presentations, results have been published in scientific journals. Several of the project leaders gave invited presentations at industry and professional conferences. In the next reporting period we will continue evaluating gene expression regulation and developing methods for genome-to-phenome prediction. We will also publish results in scientific journals.

Closing Out (end date 09/07/2023)

Project Director
Erin Burns
Organization
Michigan State University
Accession Number
1015078

Integrating New Technologies to Manage Weeds in a Changing Climate

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

Weedy plants, as a main biotic cause of crop yield loss, have played a central role in agriculture since its beginning ten thousand years ago. However, extensive usage worldwide has imposed strong selection pressure for resistant weed populations, threatening our ability to successfully manage weed populations. Herbicide resistance is a rapidly growing worldwide problem, causing significant crop yield losses and increasing production costs. Ultimately this research will help growers adapt their cropping systems to the upcoming changes in climate and provide growers with environmental and economically sustainable solutions to maintain yields and mitigate herbicide resistance under predicted drought conditions.

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.

Project 1. Population surveys and screening are underway. We have collected over 100 populations in Michigan and screening is underway to understand the herbicide sensitivity spectrum.

Project 2. Three years of a field study has been collected, a greenhouse study has been completed, and data has been published in a thesis, one journal article, and a third is currently being written.

Water stress and weed competition are critical stressors during corn (*Zea mays* L.) development. Genetic improvements in corn have resulted in hybrids with greater abiotic stress tolerance; however, drought remains problematic. Therefore, with the expected change in precipitation throughout the Great Lakes Region, field studies were conducted in East Lansing, Michigan (2018-2020) to evaluate weed competition and water stress on drought tolerant corn performance and weed community composition. The study followed a completely randomized design with four replications. Factorial combinations consisted of hybrid (drought tolerant, DT or drought sensitive, DS), weed pressure (weed free, 50%, or no control), and precipitation (ambient or 70% reduced). Corn growth and development was measured at four growth stages. Weed species density was measured three times and biomass collected. At harvest, corn ears were harvested for yield component analysis. Data were analyzed in R using linear mixed effects, diversity indexes, and non-linear regression models. Weed density was not modified by corn hybrid. However, in July weed density was lower under reduced than ambient precipitation ($p = 0.001$). Furthermore, weed communities under reduced precipitation were more diverse in July than weed communities under ambient precipitation ($p = 0.02$). Species evenness was more uniform under reduced precipitation in July ($p = 0.009$). There was a significant main effect of weed pressure ($p < 0.0001$) and precipitation ($p = 0.007$) for corn yield. Averaged across weed pressures and precipitation, corn yield was not different between DT and DS hybrids ($p = 0.893$). Overall, corn yield was reduced by 31% under 100% weed competition compared to weed free or 50%. Results demonstrate that reduced precipitation and increasing weed pressure decreases corn yield and impacts species diversity and evenness. Ultimately, integrated weed management will need to adapt to these changes for continued success under future climate scenarios.

Water stress and weed competition are critical stressors during corn (*Zea mays* L.) development. Genetic improvements in corn have resulted in hybrids with greater tolerance to abiotic and biotic stressors; however, drought stress remains problematic. Therefore, with the expected change in precipitation throughout the Great Lakes Region, greenhouse experiments were conducted to evaluate water stress and weed competition on drought tolerant corn performance. The study followed a completely randomized design with four replications. Factorial combinations consisted of drought tolerant corn competition (presence or absence), water stress (100 or 50% volumetric water content (VWC)), and nine corn:common lambsquarters (*Chenopodium album* L.) densities. Corn and common lambsquarters growth parameters were measured 14 and 21 days after water stress initiation. To address the impact of reduced soil moisture and weed competition on corn and common lambsquarters growth parameters, photosynthetic response, and biomass; linear mixed effects and non-linear regression models were constructed in R. Common lambsquarters biomass was reduced by 46 and 50% under corn competition at two and four weeds pot-1 ($p = 0.0003, 0.0004$). However, introducing crop competition under six and nine

weeds pot-1 did not reduce common lambsquarters biomass (p = 0.90, 1.00). Averaged across weed pressures, corn biomass was 22% less when grown under 50% compared to 100% VWC (p = 0.0003). However, averaged across VWC, increasing weed competition from zero to two (p = 0.04), four (p = <0.0001), six (p = 0.0002), or nine (p = 0.0002) weeds pot-1 reduced biomass by 22, 38, 35, and 36%. Overall, water stress and common lambsquarters competition negatively affected the parameters measured in this study; however, the magnitude of reduction is stronger under drought stress than increasing weed competition when water is not limiting. Therefore, field crop growers will need to modify current integrated weed management programs to maintain yield under future climate stress.

Project 3. Three years of a field study has been collected, a greenhouse study has been completed, and data has been published in a thesis and two journal articles are currently being written.

Alfalfa acres in Michigan are declining due to reliance on corn silage as a continuous feed source, partly due to low alfalfa yield in the establishment year; however, by interseeding corn and alfalfa farmers can replace the alfalfa establishment year with corn silage, while simultaneously establishing alfalfa. A randomized split-block field study was conducted in East Lansing, Michigan over three years (2019-2021) with the goal to determine the critical period of weed control (CPWC) in the interseeded corn silage and alfalfa system with two corn hybrids with differing leaf architecture (pendulum vs. upright) and impacts on corn silage and alfalfa yield and quality. Whole plots were assigned to corn hybrids and subplots were assigned to surrogate weed (Japanese millet) duration of competition treatments. Weed-free and weedy plots were included as controls. At the end of the interseeding year, corn silage was harvested while alfalfa was harvested the following year. The CPWC, Japanese millet biological data, and corn-alfalfa quality and yield were analyzed in R. The CPWC was 303 and 369 growing degree days in corn and alfalfa, respectively. Japanese millet seed production decreased by 67% in the pendulum corn hybrid compared to the upright corn hybrid in 2020. Japanese millet seed viability decreased by 46% in the interseeded system compared to a corn monoculture system. Corn silage yield did not decrease when grown with alfalfa in both 2019 and 2020, but was negatively impacted when in competition with weeds. Extended duration of weed competition negatively impacted corn silage quality; however, did not have an effect on alfalfa first cutting quality. Identification of the CPWC, evaluation of quality parameters, and alfalfa yield in the interseeded system will hopefully increase adoption and interest in other interseeded systems that have the ability to mitigate environmental and economic issues developing in agriculture.

Interseeding alfalfa and corn silage may increase alfalfa acres that are decreasing in Michigan, provide environmental benefits, and possibly provide weed suppression. A two-year split plot field study with four replications was conducted in East Lansing, MI (2019-2020) to assess weed population dynamics in an alfalfa-corn silage interseeded system. Whole plots were assigned to one of two corn silage hybrids with different leaf architecture, pendulum (PH) or upright (UH) to assess impacts of light penetration on weed dynamics. Subplots consisted of Japanese millet, surrogate weed, presence, or absence. Japanese millet seed production was collected at the end of the season and viability assessed. The following year soil samples were collected to assess overwinter seed survival. Data were analyzed using linear mixed effect models in R. Differences in means were separated using Tukey's HSD. Japanese millet seed production differed between years (p<0.001); therefore, years were analyzed separately. In 2019, seed production did not differ between hybrid; however, in 2020, seed production decreased in the PH by 68% compared to the UH (p=0.04). Interseeding decreased weed seed viability by 46% compared to monoculture corn. Demographic data was used to create a stochastic density dependent population dynamics model in R to evaluate long-term impacts of interseeding on weed populations. Within the model, interseeding decreased Japanese millet seed production by 55% compared to the monoculture treatments in 2019. Seed production and growth rates crashed rapidly in 2020 due to lack of precipitation during weed establishment. Seed production was the most elastic parameter for the 2019 PH interseeded system. Interseeding corn and alfalfa has the ability to control weeds by limiting the number of viable seeds produced. Furthermore, management tactics that reduce seed production and overwinter seed survival will enhance weed control benefits proved from interseeding corn and alfalfa.

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

Growers were provided with the data on corn hybrid performance and herbicide efficacy under water limiting conditions, this will aid in future decisions on hybrid selection and long-term sustainability of herbicides thus minimizing the risks of developing herbicide resistance. Growers gained knowledge on the influence of drought on corn hybrid performance and herbicide efficacy under future drought conditions. The results were disseminated at two field days conducted during the summer of 2021, multiple extension winter meetings in 2021-22, at the North Central Weed Science Society of America annual meeting (Dec 2021), and the Weed Science Society of America annual meeting (March 2022).

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

Data presented as webinars and YouTube videos attended by agricultural stakeholders in Michigan and throughout the US. Giving growers sustainable methods to control weeds under future climate and herbicide resistance scenarios (outlined above) will help stabilize food security for the broader public.

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.

Four undergraduate students and three graduate students were trained to work on the projects above. In addition results of these projects have been disseminated in field days, webinars, and extension posts to agricultural clientele.

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Interpreting the effects of stressors on fish from molecular initiating events to population and community impacts; implications for risk assessment

Project Director
Cheryl Murphy
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Michigan State University
Accession Number
1014468

Interpreting the eff ects of stressors on fish from molecularinitiating events to population and community impacts;implications for risk assessment

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

This research synthesizei nformation collected at the sub-organismal level (molecular and cellular) and use this information to answer questions at a higher level oforganization such as the population or community level, using a number of quantitative methods that I will develop. Specifically, how do changes inthe physiological processes occurring within an individual translate to behavioral changes and to endpoints that can be interpreted in a ecologicalsetting? How do humankind's influences such as contaminants (many from agricultural practices), impact these relationships and aff

ectpopulations or communities of fish? Such questions are directly relevant to managing and protecting natural fish populations, a valuable naturalresource to the Great Lakes community, but also can be used for animal production,because westudy how organisms grow and reproduce normallybefore we can assess the impact of a stressor.

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.

Funded project - EPA= development of a neurobehavior adverse outcome pathway for larval fish species. We found genes that could predict behavioral impairments across 3 fish species, that could be used to predict population outcomes. The work is being published and will predict the effects of neurotoxicants of fish populations.

Funded project - GLFC - sublethal impacts of sea lamprey parasitism on lake trout ecomorphs. We found that life history of the lake trout host dictates response to sublethal sea lamprey parasitism attacks. Specifically, long lived morphotypes skipped reproduction, wheraas short lived morphotypes will not skip (but may have shortened lifespans and growth effects). We also identified a biomarker of sea lamprey parasitism that could be used as an objective measure of sea lamprey attack rates, which will help with setting sea lamprey control targets.

Founded the MSU Center for PFAS research to address widespread PFAS contamination in agricuttural and natural resources - specifically with goals to measure PFAS in different matrices, testing impacts on health of fish, wildlife, humans, modeling transport through environment into food and water and into humans, assessing and communicating risk to public and policy makers and developing remediation tehcnology and safer alternatives. We have aquired several large grants to achieve these goals.

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

Published several publication in scientific journals

Presented finding at scientific meetings.

Presented our Center's structures and goals to policy makers, general public, academia and professional societies.

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

Project activities are geared towards protecting natural and agricultural resources from stressors (contaminants, parasitism). Our findings developed new methods to assess the impact of stressors on fish, wildlife and agricultural animals.

Our new Center will serve as research and collaboration hub and will disseminate valuable information to the broader public about the impacts of PFAS contamination.

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 trained 3 graduate students, one post-doctoral research, and several undergraduates on aspects of research, publication. We taught several classes and webinars.

We accomplished much in the the past five years, and this is the final report for this project. Our new project will continue where we left off.

Controlling Mycotoxins in the Food Supply in the United States and Worldwide

Project Director

Felicia Wu

Organization

Michigan State University

Accession Number

1014542

Controlling Mycotoxins in the Food Supply in the United States and Worldwide

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

Mycotoxins are secondary metabolites of fungi that colonize our food crops, which can have toxic and carcinogenic effects to the humans and animals that consume those crops. It is not precisely known why the fungi that infect food crops produce these toxins. Various hypotheses have been put forth, such as that the mycotoxins are a virulence factor that allow the fungi to more successfully colonize crop plants, or that the fungi produce mycotoxins as a means of sequestering free radicals that the crop plants may emit in response to fungal infection. Regardless, the effects to human and animal health have been severe, and have been documented for centuries. Since the Middle Ages, humans have been affected by mycotoxicoses such as "St. Anthony's Fire" - a gangrenous disease associated with the consumption of moldy rye infected by the fungus Claviceps purpurea, which produces highly toxic ergot alkaloids (CAST 2003). However, it was not until 1960 that humans discovered that food molds produced toxins. In that year, aflatoxin was first identified and characterized - a carcinogenic mycotoxin produced by the fungi Aspergillus flavus and A. parasiticus, commonly contaminating corn, peanuts, and other nuts in warm climates worldwide. Aflatoxin was connected with the deaths of over 100,000 turkey poults that consumed contaminated peanut meal in the United Kingdom (Kensler et al. 2011). Today, it is known that aflatoxin is the most potent naturally occurring human liver carcinogen. The International Agency for Research on Cancer (IARC) has classified "Naturally occurring mixes of aflatoxins" as a Group 1 human carcinogen (IARC 1993). Additionally, aflatoxin has been associated with acute toxicity leading to liver failure and the deaths of hundreds of Kenyans (Strosnider et al. 2006), immune system dysfunction, and growth impairment in children (Khlangwiset et al. 2011). In a World Health Organization (WHO) evaluation of all the food contaminants evaluated for their contribution to human disease worldwide, aflatoxin ranked the highest among chemicals and toxins for its global burden of human disease, in terms of disability-adjusted life years, for liver cancer alone (Havelaar et al. 2015). If the other adverse health effects associated with aflatoxin consumption were included in this analysis, the global burden of human disease would be even greater. Aside from aflatoxin and ergot alkaloids, other mycotoxins of importance at the nexus of agricultural production and human health effects include fumonisin (produced by Fusarium verticillioides and F. proliferatum), deoxynivalenol (DON or vomitoxin, produced by F. graminearum and F. culmorum) and its acetylated derivatives, and ochratoxin A (produced by Penicillium verrucosum A. ochraceus, A. carbonarius). The human health effects of these mycotoxins are reviewed in Wu et al. (2014). Taken together, these mycotoxins constitute a significant economic and human health problem in Michigan, the United States, and throughout the world. In Michigan, which generally has a temperate-to-cool climate, the main mycotoxins of concern are DON (vomitoxin) in corn and small cereal grains such as wheat, barley, and oats; and ochratoxin A (OTA) in multiple foodstuffs. This is because F. graminearum and P. verrucosum, the fungi that produce these toxins, are cool-weather fungi. In the US more broadly, all of these mycotoxins cause economic loss to farmers; through contaminated food lots being rejected at grain elevators and food handlers, and through adverse health effects to livestock and poultry. Fortunately, in Michigan and the US, there is not a large burden of human disease caused by dietary mycotoxins; because the Food and Drug Administration (FDA) has set action levels for maximum allowable aflatoxin in human food and various animal feeds, and industry guidelines for other mycotoxins. Thus, instead of mycotoxin-contaminated foodstuffs entering the human food supply, they are rejected (causing economic loss to Michigan and US farmers) or sold for animal feed or alternative uses. In low- and middle-income countries, however, even if regulations for maximum allowable levels of mycotoxins in food exist, there is often little enforcement of these rules - particularly in nations where subsistence farming is common. Thus, mycotoxin consumption leads directly to human disease. Dietary mycotoxins pose the greatest risk to human populations living in warm climates (aflatoxin and fumonisin are common) who consume high amounts of corn and peanuts. This characterizes many populations in sub-Saharan Africa, Central America, and Southeast Asia. Liu and Wu (2010) found that over 100,000 liver cancer cases per year could be due to aflatoxin consumption, and that most of these cases would occur in these high-risk regions of the world. A large proportion of childhood stunting and other forms of child growth impairment could also be attributed to early childhood mycotoxin exposure (Khlangwiset et al. 2011, Chen et al. 2017). Moreover, there is evidence that if current patterns of climate change continue, mycotoxin problems could increase in Michigan, the United States, and worldwide. In particular, aflatoxin and fumonisin, warm-weather mycotoxins, are expected to increase in prevalence in crops. It is worth noting that in the last few decades, in years in which summers are unusually hot and dry, aflatoxin problems (normally confined to southern states) have spread to the Corn Belt

(Mitchell et al. 2016). This poses potentially enormous economic losses for US farmers, and similar patterns could occur worldwide. Relevant to Michigan, more extreme precipitation and drought events could predispose crops to DON contamination (Miller 2008). In industrial nations, increases in mycotoxins will primarily affect growers economically; while in low- to middle-income countries, population health could be compromised. This proposed project will focus on interventions that reduce the risk of mycotoxins and their adverse effects (economic and health) in the US and global food supply. As more thoroughly described below, the project has several objectives: 1. Objective 1: Conduct human health risk assessments of the current state of mycotoxins and their presence in the food supply, in the US and worldwide. 2. Objective 2: Evaluate the efficacy, cost-effectiveness, and feasibility of different mycotoxin control strategies in the US and in low-income settings worldwide. 3. Objective 3: Estimate the changes in concentration and geographic spread of aflatoxin contamination in the US corn crop in the near future, given predictions of climatic factors (daily temperature and precipitation) across all counties. The beneficiaries of this research will be farmers, food producers/distributors, and consumers in Michigan, the United States, and worldwide. Reducing the mycotoxin problem will improve economic return to crop growers, and will ensure a safer food supply for humanity.

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.

This proposed project will focus on interventions that reduce the risk of mycotoxins and their adverse effects (economic and health) in the US and global food supply. The project has several objectives: 1. Objective 1: Conduct human health risk assessments of the current state of mycotoxins and their presence in the food supply, in the US and worldwide. 2. Objective 2: Evaluate the efficacy, cost-effectiveness, and feasibility of different mycotoxin control strategies in the US and in low-income settings worldwide. 3. Objective 3: Estimate the changes in concentration and geographic spread of aflatoxin contamination in the US corn crop in the near future, given predictions of climatic factors (daily temperature and precipitation) across all counties. The beneficiaries of this research will be farmers, food producers/distributors, and consumers in Michigan, the United States, and worldwide. Reducing the mycotoxin problem will improve economic return to crop growers, and will ensure a safer food supply for humanity. From October 1, 2020 to September 30, 2021, we have accomplished the following under each of these objectives: 1. Objective 1: We have conducted human health risk assessments of aflatoxin-related immunomodulation, cassava cyanide related cognitive impairment in children, and aflatoxin M1 in milk worldwide. 2. Objective 2: We have evaluated the efficacy, cost-effectiveness, and feasibility of United Nations Codex Alimentarius Commission guidelines on deoxynivalenol (DON) in food on reducing DON exposure in global populations, as well as a simple wetting method to reduce cyanide in cassave; and have conducted a review of strategies to reduce aflatoxin in food worldwide. 3. Objective 3: We are preparing a paper on the projected spread of aflatoxin-related risks in corn in the United States as a function of near-term climatic conditions (maximum daily temperatures, rainfall).

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

I am grateful to have supported and trained 2 PhD students on this project during this time period, who have had the chance to learn about food safety, risk assessment, and the economics of strategies to reduce contaminants in food to protect human and animal health. My students, colleagues, and I have had the chance to present this work at several venues during the year Oct 2020 - Sept 2021, including: US Environmental Protection Agency, Entomological Society of America, Society for Risk Analysis, International Union of Pure and Applied Chemistry, and various roundtables and talks at Michigan State University.

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

We have published multiple papers and a book chapter, and our work has been featured in multiple news articles and media appearances ranging from the American Association for the Advancement of Science (AAAS) to Detroit News (WXYZ-Detroit) to MSN Lifestyle to Prevention magazine. We have also had the chance to give presentations in all the venues and conferences described above.

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.

In this next reporting period, we hope to continue our work on examining non-cancer health risks of total aflatoxins (B1, B2, G1, G2) and aflatoxin M1; as well as on strategies to reduce moisture along food supply chains to reduce microbial pathogens (including toxigenic fungi). We hope to publish on the findings of our projected spread of aflatoxin in US corn in the years 2031-2040.

Multi-state Coordinated Evaluation of Winegrape Cultivars and Clones

Project Director

Paolo Sabbatini

Organization

Michigan State University

Accession Number

1014205

Multi-state Coordinated Evaluation of Winegrape Cultivars and Clones

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

A fundamental research and extension question for a new viticultural region concerns genotype adaptation to the environmental conditions of that region. The questions posed and the answers produced may be beneficial on several levels. The most obvious is the determination that a valuable, previously non-cultured cultivar is adapted to the region. Less often appreciated is the finding that an "unknown" or "new" cultivar, breeding, or clonal selection in not adapted and costly trial and error planting and culture by industry persons can be avoided. The project titled "*NE1720 (former NE1020): Evaluation of Winegrape Cultivars and Clones*" project that started in 2007 have Michigan State University as integral part of this multistate effort. The objective of this project is to provide information on viticultural and enological performance of existing and newly released wine grape varieties in Michigan and the eastern USA. A second objective is the important extension component of this project, focused on dissemination of the research results through meetings, newsletters and ad hoc conferences in participant states.

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 2021, viticulture results were presented at the online MSUE Viticultural Days (August). Results were also presented at the 2021 Great lakes Fruit and Vegetable Expo in Grand Rapids (December). Several MI winemakers expressed an interest in collaborating with the project, and they used part of the experimental fruit for their micro-vinification trails. In 2021 data on vine performance and vine phenology were collected following the NE1020 protocols. Unfortunately, the 2013-2014 and 2014-2015 winters in the Midwest and Eastern US were impacted by the polar vortex; temperatures plunged into the sub-zero digits and the extended duration of the cold events severely affected the grapevines. Many cultivars that normally survive our winters with little to no damage were severely injured by the extreme cold. In early 2021 reports of the extent of winter injury in the NE1020 vineyards were available for the Michigan growers; we had almost 25% bud damage in *vinifera* grapes, with hybrids at 8%, and American grapes at 5%; cold-hardy grapes were not damaged. In 2021 at the NWMHRC harvest data were collected by Esmaeil Nasrollahiazar (MSUE Viticulture Educator) and his crew of volunteers. At the SW trial, the difference between damage to the cultivars were shown to winemakers and grape growers. Retraining choices for the growing season in the vinifera plot were displayed. Canopy management for improving grape quality and vine health in high wire cordon hybrids were discussed. Winery owners and crews have been contributing to the vineyard management joining Craig Cunningham's Vine-Care. The Lake Michigan College used for their enology program the experimental wines in the Southwest station to produce experimental wines.

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

Demand for wine grapes from cool-climate regions is strong and their value is high. However, cool-climate wine grapes have specific environmental requirements that limit their sustainable production in regions with challenging climates. Results of a recent survey completed by the Viticulture program at Michigan State University, along with suggestions from the stakeholders, members of the advisory committee in the Horticulture Department, reported that i) fruit quality consistency, ii) vineyard damage (fall and spring frost, mid-winter freezes) and iii) pest and disease pressure were of the most concern for building a sustainable grape industry in the east of USA. These challenges reduce yield and fruit quality per acre substantially, and several cool-climate regions are reporting profit margins far below the economic threshold identified by industry members. Low vineyard profit is driven by the low fruit technological maturity at harvest. In 2017, the Michigan wine industry was evaluated to contribute over $5.4 billion towards Michigan's economy, particularly the retail, jobs, and tourism sectors. Despite this, problems facing cool climate viticulture remain unchanged, including short and cool growing seasons.New vineyards will rely heavily on viticulture information about alternative cultivars to aid in mitigating climatic effects and in

order to obtain quality fruit. Therefore, a critical need remains to understand the vine's genetic background and physiological response of new cultivars for Michigan that could ensure a consistent viable production (quantity and quality) for the cool-climate wine industry, rapidly expanding in USA and around the world.

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

Grapes are the leading fruit crop in the U.S. and over 70% are used in wine despite little research on which varieties perform best. Many U.S. growers are interested in grape varieties that are better suited to their growing conditions, which can differ environmentally and economically from traditional European growing regions, or varieties that are more resistant to common pests and diseases. Some wine producers are interested in new varieties they can use to create new wines and expand sales. To find the best grapes for U.S. growers and wine producers, researchers at land-grant universities across the country are testing the performance of traditional varieties as well as new and neglected varieties. Information about the performance and resulting wine quality of different grape varieties will improve the economic viability of and respect for the wine industries in growing regions nationwide.

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.

As part of this collaborative project, researchers are growing different kinds of grape vines at 24 test sites all across the country. Establishing vines at a wide range of sites is helping distinguish whether genetic factors or environmental factors are influencing how the grapes perform. At each site, researchers regularly collect weather data, record vine mesasurements, such as the number of grape clusters per vine, and note the presence of any pests, predators, or diseases. After harvest, researchers analyze grape color, acidity, and other qualities. Using rigorous protocols for collecting data at each test site, researchers are ensuring the data are accurate and useful. Based on results from the test sites, researchers identified grape varieties with potential to meet the interests and needs of U.S. growers and wine producers. Researchers set up a database to store information on the characteristics of each variety and also shared their findings with the industry through newsletters, farm tours, and websites. Researchers are beginning to analyze wines made from these grapes. Results will help growers choose which grapes to grow to produce the best possible wine. This research is speeding up the development of grape varieties that are better suited for specific growing regions in the U.S. than traditional varieties. As well-tested alternatives become available, grape growers will see higher yields and lower losses, and winemakers will be able to produce new, high-quality wines that will be desirable to consumers and competitive internationally. Identifying grapes that are more resistant to pests and diseases could also help minimize environmental impacts by reducing chemical pesticide use in vineyards. As the first coordinated effort to improve wine grapes for U.S. growers, this project has created protocols, generated baseline data, and made advances that form a stable foundation for future research. The group's efforts have already fostered other projects that ar extending the impacts of the original project.

Hierarchical modeling strategies for improving dairy cattle production using genomics and phenomics data

Project Director
Robert Tempelman
Organization
Michigan State University
Accession Number
1011789

Hierarchical modeling strategies for improving dairy cattle production using genomics and phenomics data

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

Our primary focus is to develop hierarchical modeling strategies that best capture the intricacies of high dimensional genomic and phenomics data generated under heterogeneous environments. This includes developing models that account for heterogeneities over various scales, including gene, animal, environments, and even time.

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 first time ever, feed efficiency genetic evaluations are available for dairy cattle breeders in the US, in part due to developments in this project. Prediction equations using milk spectral data have also been developed for milk fatty acids and for diagnoses of pregnancy. However, with the latter we demonstrated that the ability to diagnoses pregnancy using milk spectral data has been unfortunately overhyped in the recent dairy science literature, in part due to the inability of previous researchers to properly separate out the effects of stage of lactation from pregnancy status and failing to consider how important it is to predict across environments (i.e., herds) instead of just within environments.

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

We published a paper in the Journal of Dairy Science on the prediction of fatty acid composition using milk spectral data in Michigan Holstein dairy cattle. Specifically, we identified how various regions of the mid infrared spectrum are associated with carbon number which is important since a higher ratio of long-chain to short-chain fatty acids are associated with negative energy balance and hence deleterious health effects in dairy cattle. This work should provide candidate milk mid-infrared spectrum markers researchers for health and reproductive performance in dairy cattle.

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

A highlight impact of 2021 was that our decade long work on the quantitative genetics of feed efficiency finally paid dividends when residual feed intake was included as a trait in the Net Merit$ Index for genetically ranking US dairy cows and bulls by the Council of Dairy Cattle Breeding in 2021. This means that farmers now have access to information that was generated from this research. Furthermore, the expertise developed from this project also indirectly benefited other projects in that I, along with my NCCC-170 (multi-state project on *Research Advances in Agricultural Statistics*) colleagues were honored with the 2021 Presidential Award by the American Society of Agronomy *"for dedication and service as NCCC-170 and Experiment Station Statisticians and their enduring impact on 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.

Piush Khanal was a postdoctoral research associate who worked on various aspects of the project including feed efficiency and milk spectral data associations with reproduction. He was recently hired by ST Genetics to conduct much of the same sort of research for them! Results have been published in the Journal of Dairy Science, presented at the Conference on Applied Statistics in Agriculture and Natural Resources, the American Dairy Science Association meetings, the Interbull Conference and the International Committee on Animal Recording meetings.

Plant and Animal Production and Health

Project Director
Norma Lundeen
Organization
Michigan State University
Accession Number
7001276

Bull Appraisal Program

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

The food and agriculture industry in Michigan plays a significant role in the state's economy, with Michigan's Department of Agriculture and Rural Development (MDARD) reporting that the industry contributes $104.7 billion on an annual basis. Of the over 300 commodities produced on a commercial level, the livestock industry, which includes dairy, is credited with having

the greatest portion of that economic impact at $5.12 billion dollars. With such a large industry, it is critical that livestock producers ensure meat quality and safety by implementing good production practices around management, nutrition, and animal well-being.

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 Bull Evaluation Program (BEP) is the region's premier bull appraisal program. In its 34th year, the program is a cooperative effort between the Michigan Cattlemen's Association, Michigan State University, and Plank Farm. The objectives of the program are to promote performance-evaluated beef cattle, to provide a common environment for evaluating young bulls for rate of gain, soundness, and body composition, and to aid beef producers in obtaining superior bulls that have been evaluated for growth, breeding and structural soundness, and carcass merit.

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

MSU Extension educators and specialists have worked to evaluate performance and economic data from 10 years of bulls purchased by BEP participants between 2010 and 2020. A total of 587 bulls were sold during that time frame, and a survey reveals that buyers own 1.6 bulls on average, purchased from the BEP, and that these bulls are typically used for three years. The BEP bulls were documented as having offspring with greater weights at weaning, yearling, and as finished cattle, and replacement heifers sired by BEP bulls were worth more than those not sired by BEP bulls. Over the 10 year span, BEP bull offspring were estimated to be worth over $5 million more than average bulls, and BEP-supplied genetic information has an estimated worth of more than $400,000. If the BEP did not exist, producers would have incurred more than $280,000 in additional costs in obtaining breeding bulls. Moreover, the existence of this program has saved producers $265,826 over 10 years in procuring their breeding bulls.

MSU Extension continuously provides methods for the beef cattle industry to make improvements in production efficiencies and genetics. These efforts will continue to increase the profitably of beef cattle herds in Michigan and provide a consistent evaluation system for herd bulls in beef cattle operations. Through the work of MSU Extension, Michigan will continue to lead the way in the development of superior genetics and scientific-based management decisions for the entire industry.

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

MSU Extension teaches profitable and efficient farm business and production practices as well as how to optimize processing. This education leads to better use of time, money and human capital, and helps retain and create agricultural jobs. These programs also lead to increased consumer confidence in the safety and quality of Michigan’s animal agriculture products.

Feedlot Series

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

The food and agriculture industry in Michigan plays a significant role in the state’s economy, with Michigan’s Department of Agriculture and Rural Development (MDARD) reporting that the industry contributes $104.7 billion on an annual basis. Of the over 300 commodities produced on a commercial level, the livestock industry, which includes dairy, is credited with having the greatest portion of that economic impact at $5.12 billion dollars. With such a large industry, providing educational opportunities to producers throughout the state is a perennial challenge, made all the more difficult over the past year by the COVID-19 pandemic.

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.

To address the problem of educating Michigan feedlot producers remotely during the COVID-19 pandemic, MSU Extension created the MSU Feedlot Educational Series, offering a virtual presentation in the evening once a month December through April. This schedule was selected in order to maximize opportunities for cattle feeders to find time to watch the presentations.

The MSU Feedlot Educational Series focused on providing important management information to producers in a virtual setting, expanding reach to farmers across the state. Production topics highlighted during this series included implementing a beef and dairy cattle crossbreeding strategy, both for the benefit of dairy producers and to improve the subsequent feedlot

performance of those cattle for cattle feeders, tips for successfully raising young dairy calves, financial recordkeeping for feedlot operations, alternative protein sources for expensive dry distillers' grain, and the effects of different feedlot facility designs on feedlot cattle performance. Each of the presentations was recorded so that interested producers could view them later. This effort received praise from several clients who provided feedback via email regarding the accessibility of the recorded sessions.

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

The MSU Feedlot Educational Series provided valuable information to clientele, and the information shared was impactful for Michigan cattle feeders. With the use of Zoom as a virtual platform to reach cattle feeders, the MSU Feedlot Educational Series has expanded its reach to farmers across the state, country, and internationally. Attendance during MSU Feedlot Educational Series demonstrated rapid growth, with the number of program participants continuously expanding.

- Implementation of the information shared during the MSU Extension Feedlot Series was estimated to add an additional $17-$50 of value to each animal
- 66% respondents indicated that they increased their knowledge as a result of attending the Feedlot Educational Series
- 100% of the survey results from the MSU Extension Feedlot Series indicated that the audience's knowledge of financial and economic analysis increased

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

Through the MSU Feedlot Educational Series, MSU Extension works to increase farmer success while protecting the environment, ensuring food safety, reaching new markets and advancing agriculture through applied research. MSU Extension's agriculture production efforts strive to engage those in the industry to improve management and production knowledge, which will in turn enhance animal care, food safety and modern food production methods. These research, education, and outreach opportunities enhance the quality of life for people throughout the state.

MI Ag Ideas to Grow With

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

In 2021, MSU Extension educators learned how to adapt their efforts to meet the needs of those experiencing life changes because of the COVID-19 pandemic. Traditional educational and programming efforts were shifted to methods to provide clientele with access to resources and information from their homes or office. In doing so, MSU Extension educators were able to meet the clientele where they were, by providing multiple different avenues to access important, relevant information for farmers, hobbyists, and homeowners.

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 MI Ag Ideas to Grow With virtual conference was specifically designed to meet the need for flexible programming. This unique event combined formerly in-person MSU Extension events like Ag Action Day, Branch County Farmers Day, and Southwest Michigan Horticulture Days into one cumulative weeklong virtual program. The MI Ag Ideas to Grow With conference featured a variety of educational tracks focused on livestock production, fruit and vegetable production, sustainability, soil health and irrigation, and horticulture and home gardening. A track was also offered for youth participants. This robust offering of educational programs focused on providing complete accessibility to information for MSU Extension clientele, while also opening the door to new audiences.

Though the program was developed out of a desire to provide virtual access to information and education typically delivered at MSU Extension's in-person programming, the success of the virtual platform exceeded the expectations of the planning team. One of the highlights of the MI Ag Ideas to Grow With was the ability to extend the reach of our traditional programming

by making these educational sessions available online for those not able to travel to our usual meeting locations. During the weeklong event, participants from 47 counties in Michigan attended over 980 sessions.

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

In a post program survey, some participants noted that they lived several hours away from MSU's campus and were only able to attend the MI Ag Ideas to Grow With conference because it was held virtually. The survey also indicated 67% of the attendees of the first MI Ag Ideas to Grow With virtual conference were new to MSU Extension programing, which in turn expanded the reach of Extension into more communities and homes in Michigan.

One of the goals of the MI Ag Ideas to Grow With virtual conference was to offer an array of educational programming that met the needs of different sectors of the agriculture industry. Throughout the week, 55 different education sessions were offered meeting the needs of farmers from various agricultural sectors, including hobbyists and homeowners.

Comments from participants included:

- "I am a student at Michigan Tech who is interested in soil science. I was browsing upcoming events on the SSSA website and saw you have a number of events that I was interested in. I was excited to be able to attend virtually because I currently live in Houghton, which is about 8 hours away from East Lansing, and wouldn't be able to attend in person."

- "I'm only a backyard farmer, and I know these events are geared toward commercial farmers, but I really like attending these events and learning new things that I can apply to my 'farm'."

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

MSU Extension continues to provide valuable services, programs and information for Michigan communities and families. MSU Extension agriculture and agribusiness educators serve the agriculture industry by engaging in research, education, and outreach that enhances the quality of life for people throughout the state by engaging stakeholders where they are, at their homes, classrooms, farms, and businesses. This includes providing resources and information in areas that directly impact management and production issues and decisions for those involved in these industries.

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.

With the overwhelming success of the first MI Ag Ideas to Grow With virtual conference, MSU Extension hosted the virtual conference again, as a featured event during Michigan State University's Agriculture and Natural Resources Month in March 2022, with over 80 different virtual sessions into the homes, offices, and workplaces of Michigan, again meeting people were there they are, with relevant, important information accessible for all Michigan families and communities.

Milker Training

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

With over 434,000 dairy cows and 1,200 dairy farms in Michigan, dairy is the number one agricultural commodity in the state and has a significant economic impact on communities across Michigan. Dairy farmers work tirelessly to meet the needs of their industry, giving consumers access to safe, healthy, and wholesome dairy products. To do this, those involved in the industry must be focused on quality control and the production of superior products.

Managing a dairy farm and producing dairy products has many challenges, including access to a competent and trained workforce. The trend in the industry has moved toward a bilingual workforce, with 20% of farm workers identifying as Hispanic, many of whom speak English as a second language. This adaptation in the workforce presents several communication barriers between owner-operators, management teams, and farm laborers. Access to labor and structured farm training opportunities for employees are some of the industry's biggest challenges.

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.

With the lack of trainings or resources for individual farms, and the limited options for Hispanic workers in Michigan, MSU Extension crafted individualized training opportunities for dairy farms, focused on building employee engagement, and increasing the skills of farm employees with resources and information available in both English and Spanish.

These efforts resulted in multiple training opportunities for dairy farm employees that were tailored to individual farm needs. These trainings addressed the needs of the multi-cultural workforce of Michigan's dairy industry by providing safe, culturally inclusive trainings that reinforced good milking practices and delivered knowledge and theory through a hands-on approach. In addition, MSU Extension provides milking parlor assessments during which feedback is provided on areas of improvement and specific farm needs are identified.

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

Post program surveys indicated that:

- 98% of the participants increased their knowledge of their role in the dairy industry
- 95% improved their skills
- 90% intend to use the information they learned to improve the way they perform their job
- 98% increased their knowledge regarding milking procedures
- 98% increased their knowledge regarding their impact on milk quality
- 95% increased their knowledge about somatic cells and their meaning
- 93% improved their ability to perform optimal milking procedures
- 90% plan to make changes or improvements to their job performance
- 88% plan to incorporate changes to their routine
- 100% agreed that the milker training program increased their knowledge regarding milking practices and their influence on milk quality

This program and others like it will continue to provide the dairy industry with access to relevant, important information geared toward moving the industry down the path of improvement and sustainability.

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

MSU Extension teaches profitable and efficient farm business and production practices as well as how to optimize processing. This education leads to better use of time, money, and human capital, and helps retain and create agricultural jobs. These programs also lead to increased consumer confidence in the safety and quality of Michigan's animal agriculture products.

Quality Assurance Programs

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

The food and agriculture industry in Michigan plays a significant role in the state's economy, with Michigan's Department of Agriculture and Rural Development (MDARD) reporting that the industry contributes $104.7 billion on an annual basis. Of the over 300 commodities produced on a commercial level, the livestock industry, which includes dairy, is credited with having the greatest portion of that economic impact at $5.12 billion dollars. With such a large industry, it is critical that livestock producers ensure meat quality and safety by implementing good production practices around management, nutrition, and animal well-being.

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.

Quality assurance programs are a staple for the beef and pork sectors of the animal agriculture industry. The Pork Quality Assurance (PQA) Plus program is the flagship program of the pork industry, and similarly, Beef Quality Assurance (BQA) is a program supported by the cattle industry. Both programs utilize good production practices that ensure the safety and quality of products grown and raised for consumption. Additionally, implementing the practices highlighted by these programs can help producers avoid costly production mistakes and unacceptable production defects. Certification and on-farm assessment of animal care and food safety can be required by commercial processing plants. By providing the opportunity to receive this certification, MSU Extension helps to provide market availability for the farmers involved in these industries.

MSU Extension provides comprehensive training of the advisors who implement these programs on farms and directly provides education for livestock farmers and their employees on different areas of on-farm food safety and animal care practices. On-farm assessments that accompany these certification programs allow MSU Extension educators to review production practices and assist farmers with improving their practices efficiently meet food safety standards.

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

By offering access to these important quality assurance programs, MSU Extension provides livestock farmers with a method to maintain customer confidence in the products that they are raising, helps farmers gain knowledge in proper animal care, and learn more about production practices that improve the productivity of their farm while providing economically logical management options. Additionally, certification can lead to increased profits for Michigan farmers. For example, as a result of farm certification in the BQA program, each animal sold generates approximately $200 in added value compared to selling the same animal from a non-certified farm. These quality assurance programs connect producers to a variety of educational opportunities provided by MSU Extension and create significantly more income for certified farms.

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

MSU Extension teaches profitable and efficient farm business and production practices as well as how to optimize processing. This education leads to better use of time, money and human capital, and helps retain and create agricultural jobs. These certification programs also lead to increased consumer confidence in the safety and quality of Michigan's animal agriculture products.

Vegetable Education

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

Michigan vegetable production takes place on over 3000 farms, generating cash receipts of over $500 million annually. Michigan is among the top five states in the production of asparagus, snap beans, beets, carrots, celery, cucumbers, pickles, radishes, squash, tomatoes, turnips, and pumpkins. The state's climate and soils make it possible to grow vegetables in every county. Vegetable growers are continually challenged by market demands and must work to adopt new practices that aim to reduce costs and increase quality.

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.

MSU Extension helps vegetable growers learn and incorporate new practices in a variety of ways. MSU Extension vegetable educators maximized reach across Michigan and beyond by partnering with 150 other members of the Great Lakes Vegetable Working Group (GLVWG) and Great American Media Services, publisher of Vegetable Growers News (VGN) trade magazine. Together they developed a weekly live interview show and podcast, called The Vegetable Beet, that provides education on pest management, new technology, and the latest research. A monthly column in the VGN magazine also grew out of this podcast, titled "Great Lakes Veg Connections." Articles were authored by staff from six different universities and reach a readership of 160,000 people. In 2021, the podcast garnered 265 live listeners and 2,057 downloads.

The Midwest Vegetable Production Guide is an annually-revised guide and a summary of currently suggested fertility, cultural, and pest management techniques and tools for commercial vegetable growers. This collaboration of land-grant universities from Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, and Ohio provides vegetable growers a consistent resource for sound practices. A recent agreement with Great American Media Services made this guide free to distribute and increased the distribution in Michigan by 300% with industry and Conservation District partners also ordering copies for distribution alongside Extension offices. The website houses downloadable PDFs of the printed guide, as well as a navigable and filterable web app, accessible via phones, tablets, and desktop computers. In 2021, the site recorded 11,000 visitors.

The Great Lakes Fruit, Vegetable, and Farm Market EXPO (GLEXPO) took place in Grand Rapids, Michigan in December 2021 and provided farmers an opportunity to come together to learn and share best practices through a variety of educational sessions. MSU Extension offered 14 of the 67 educational sessions at the 2021 GLEXPO on a variety of topics of interest to fruit and vegetable farmers across the state.

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

MSU Extension helps vegetable growers learn about and incorporate new practices that help them reduce the risk posed by pests, improve their efficiency through new horticultural practices, and increase revenue through improved product quality and marketing. Of those who attended an MSU Extension vegetable event, surveys revealed:

- 88% learned something new and useful to help them manage risks
- 87% reported making a change on their farm related to managing risks
- 82% learned useful information about increasing efficiency on the farm
- 67% reported making a change on their farm related to increasing efficiency

Great Lakes Fruit, Vegetable, and Farm Market EXPO

Attendance at the GLEXPO included 2,655 registrants from the Great Lakes region.

- 424 registrants who identified as mixed fruit/vegetable growers and 398 as vegetable growers
- 60% of respondents found the MSU Extension session they attended to be very useful (N=463)

"Excellent educational sessions. I was also able to meet with crop input, equipment, and irrigation supply companies on the trade show floor and discuss my needs. If it had not been for the Expo I would not have found such valuable contacts." – A program participant

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

MSU Extension facilitates flow of information to vegetable growers and the broader industry. The value of this work is widespread, and the impact can be seen from the state's soils and water all the way to the farm office and consumers' kitchens. MSU Extension works to sustain and expand Michigan's vegetable industry, aiding growers in producing safe and plentiful food for Michigan.

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.

Relevant links:

- https://www.glveg.net/listen
- https://mwveguide.org/

Virtual Breakfast Series

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

Michigan's unique fresh-water resources, climatic zones, and soil types contribute to its status as the second most diverse agricultural state in the country. Field crops grown in Michigan include corn, soybean, alfalfa/hay, and small grains, as well as important specialty row crops like sugar beets, potatoes, and dry beans. Field crops are grown on more than 16,500 of Michigan's 47,641 farms, and by the majority of commercial farmers in the state. Field crops as a whole account for approximately 32% of the market value of Michigan agricultural products, and five field crops in particular—corn, soybeans, sugar beets, potatoes, and wheat—are among the top 10 commodities produced in the state in terms of gross value.

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 2021 Virtual Breakfast Series was a weekly webinar for farmers, agribusiness personnel and others interested in agriculture. The series was conducted during the growing season with a focus on field crop pest and crop management, soil health, soil management, cover crops, and financial management. MSU campus specialists, and other guest speakers, provided brief presentations on a topic followed by a detailed weather analysis for the state, and each session concluded with a 30-minute Q&A segment. Participants were encouraged to interact with MSU Extension specialists and educators to get answers for their questions on field crop production and management topics. Each week, Restricted Use Pesticide and Certified Crop Advisor recertification credits were provided for participants. A total of 26 weekly webinars were held. The series was live streamed on Facebook for easy accessibility, and recordings were available for later viewing, with closed captioning available. These recordings were made available on the MSU Extension Field Crops website and outlets such as YouTube, Facebook, Spotify, and iTunes.

The Virtual Breakfast Series addresses the need for current information about conditions and the potential impact on field crops concerning insects, weeds, diseases, soil conditions, fertilizer usage and weather for field crops producers. Because things change fast during the growing season, this information helps producers and agribusiness professionals address possible management options associated with emerging issues and concerns.

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

The 2021 Virtual Breakfast Series reached 3,180 participants live, with over 21,000 additional views through YouTube, social media, and the MSU Extension website. Participants tuned in from all over the country, including Michigan, Wisconsin, Minnesota, Indiana, Ohio, New York, Vermont, and Texas, as well as internationally, from Canada, India, South Africa, and Nigeria.

Based on evaluation results:

- In total, participants managed or directly impacted 444,205 acres of agricultural land
- 97% of participants indicated that their knowledge increased as a result of the series
- 63% indicated that they will make management changes based on the information presented, with 80,810 total acres impacted
- The average increase in value per acre is $8.42
- The total value of increased management is $723,438.89 or $8,220.89 per farm

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

Agriculture is one of the top industries in the state of Michigan and the production of feed and fiber adds significant economic benefits to all residents. With a healthy and thriving agriculture sector, urban, suburban, and rural population centers will have improved healthy lifestyles due to a healthy, safe, and nutritious food system.

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.

Relevant links:

- https://www.canr.msu.edu/field_crops/virtual-breakfast/
- https://podcasts.apple.com/us/podcast/michigan-field-crops/id1461704431

Critical Issue

Secure Food and Fiber Systems

Environmental Fate of Chemicals of Emerging Concern: Implications to Ecosystem Services and Food Safety

Project Director
Hui Li
Organization
Michigan State University
Accession Number
1019476

Environmental Fate of Chemicals of Emerging Concern: Implications to Ecosystem Services and Food Safety

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

Chemicals of emerging concerns (CECs) enter waters and soils from agricultural practices such as irrigation with treated wastewater and land application of biosolids. These bioactive chemicals have been widely disseminated in the agricultural environment, and potentially caused negative consequences to agroecosystem services and food safety. The objectives of this

project are to (1) better understand the bioavailability of antibiotics in soils to the surrounding bacteria for promotion and preservation of antibiotic resistance, and (2) evaluate the fate, sorption and accumulation of CECs in the plant-soil-water systems.

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.

Caffeine is one of the most frequently detected compounds in treated wastewater and biosolids. In one study, we conducted hydroponic experiments to evaluate the uptake and distribution of caffeine and metabolites in two vegetables, flowering cabbage and water spinach. The results showed that 98% of caffeine lost from solution after 768 h of exposure. Caffeine was taken up by vegetables and most caffeine and metabolites were accumulated in the bottom leaves of the vegetables. At the subcellular level, caffeine and metabolites were distributed mainly in the organelles in root and stem cells, while in the leafy cells they were present dominantly in the leafy water fractions. Caffeine underwent demethylation forming xanthine and theobromine, and mineralization to release CO2. Approximately 40.2% of the initially applied caffeine was accumulated in Chinese flowering cabbage as the parent compound (28.3%) and metabolites (11.9%), and 50.9% of the added caffeine was mineralized to CO2 after 768 h of exposure. The knowledge obtained herein enhances our understanding on the uptake of CECs by vegetables and potential risks using treated wastewater for agricultural irrigation.

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

The results from this project are disseminated primarily through publications as peer-reviewed journal articles and presentations at professional conferences to scientists and policy makers. The scientists could better understand the knowledge and develop sound best management practices to mitigate food crops uptake of CECs from soils.

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

The policy makers and general public could also access the relevant reports and materials, and understand the issues in soil pollution and food safety. The research provides the knowledge for policy makers to set up regulations, and to develop potential protocols to mitigate CECs contamination in food crops. In addition, the research results are incorporated into the undergraduate and graduate curriculums to educate next generation of scientists and farmers.

Food Choice Behavior and Demand

Project Director
Vincenzina Caputo
Organization
Michigan State University
Accession Number
1013332

Food Choice Behavior and Demand

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

The constant evolution and transformation of the global food marketing system contributes to increasing diversity in food products and consumption patterns. The goal of my research program is to contribute to the knowledge of how consumers make food choices and how these choices impact the food system, supply chains, and policy. My work is comprised of two major components: 1) empirical analysis of emerging food consumption patterns and policy preferences, and 2)) methodological developments and innovations in food choice experiments and modeling. and Both foci contribute to the academic literature and debate, while my empirical work also informs policy makers, farmers, and food companies.

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 an effort to better assist agricultural producers and agribusinesses, my empirical work has focused on evaluating the market potential of emerging food products, new food technologies, and labeling programs. My main contribution in this area has been to identify the quality features that drive consumer food choices. Research outcomes helped anticipate future

market trends and informed producers, agribusinesses, and policy makers. The goal of my research project is to also contribute to the knowledge of how and to what extent economic data can be enriched with insights and concepts from other disciplines such as behavioral economics, sensory science, etc.

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

Results from my research have been disseminated through various dissemination activities including 1) professional workshops and meetings and 2) in academic journal articles. In addition to informing academia, my research also impacts policy makers, private industry, and the public. For example, my work with one of my PhD students examined consumer valuation for milk for dehorned gene-edited cows under different information regimes. Consumer concerns for animal welfare and the need for new and more "secure" production systems highlights the need of new production systems. Results from this project informs policy makers, private industry, and the public about what can be done to increase consumer awareness and ultimately acceptance of new technologies in food and animal production. Through my research I also address practical issues such as the absence of secondary data sources and the importance of using rigorous survey designs and well-crafted experiments to better inform farmers, agribusinesses, and policy makers.

My impact as a scholar goes beyond academic publications and dissemination of results to various stakeholders but also incorporates the transfer of my knowledge to students and young scholars. I consider this as a mission, which I keep related to my research program. I bring my research experience to my undergraduate classes where I teach students how to critically evaluate the marketing performance of emerging food products using a data driven approach. As an applied economist I firmly believe that economic and marketing evaluations cannot be done without accurate marketing research. I apply the same concept when training graduate students and young scholars. Thanks to my international teaching program I train MSU students as well as international students and scholars through various outlets beyond the classroom.

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

I recognize the value of service within the broader community of the university's mission, for its ability to extend the impact of research beyond scholars. In line with MSU's core value of connectivity on a local, national, and global level I have thus incorporated projects into my research that benefit stakeholders outside academia. For example, my collaborative research assisted Michigan cherry growers by providing economic consultation and outreach. We conducted an online survey on consumer preferences and demand for tart-cherries and other competitive food products. Results from this survey informed different stakeholders and perhaps will help the tart-cherry industry to better position their products in national markets. Applying my knowledge of consumer choice behavior to national and integrational contexts, my research also assists various stakeholders along the value chain to facilitate marketing and production decisions related to a) new food technologies in the United States and, b) more nutritious and safer food products in Africa.

Identification and Characterization of Main Constituents in Wheat in Relation to End-Use Quality

Project Director
Perry Ng
Organization
Michigan State University
Accession Number
1013543

Identification and characterization of main constituents in wheat in relation to end-use quality

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

There are three main foci of the project: (1) To improve and maintain wheat quality (milling and baking attributes) in MSU wheat breeding lines via (a) coordinating quality evaluation by the Michigan wheat industry of advanced lines from MSU, and (b) evaluating MSU wheat lines for acceptability for potential release. (2) To identify bio-markers of dietary fibers (DF) and

resistant starch (RS) in wheat lines and develop processing procedures for retaining these DF and RS in end-products. (3) To identify and develop hypo/non-allergenic wheat lines in collaboration with the MSU Wheat Breeding Program and to potentially develop these lines for a specific market of consumers.

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.

Our laboratory continued coordinating the wheat quality testing program of MSU advanced wheat lines for the Michigan wheat industry and evaluating the milling and baking qualities of the wheat lines. Milling and baking quality data were published and shared with the Michigan wheat industry at the Michigan State Millers' Association annual meeting in 2021.

It has been hypothesized that specific commensal microbes decrease intestinal inflammation, thereby promoting gut health. Whole grains have been increasingly gaining attention in association with intestinal commensal microbes. We developed a protocol to study the interactions among whole grains and intestinal commensal microbes and intestinal health. Human participants consumed crackers made from soft red whole grain wheat flour and soft white whole grain wheat flour as compared to control crackers made from soft white wheat flour (i.e., refined flour). Weekly fecal samples were collected from the participants and we have identified a population of responders for whom the treatment wheats had an impact on their gut microbiome alpha diversity.

Wheat is one of the "big eight" common foods responsible for allergic food reactions in the USA. Wheat protein allergens contain both gluten and non-gluten protein components. Our laboratory along with the MSU Food Allergy & Immunology Laboratory have developed a mouse-based primary screening method for testing relative allergenicity of proteins from different wheat genotypes. Allergenicities of proteins from tetraploid wheat genotypes (e.g., durum wheat) were different from those of hexaploid wheat genotypes (e.g., cookie and bread wheats). The information is essential for further identifying which group of proteins associated with which genotypes exhibit lower, or no, allergenic proteins, and thus enable wheat breeders to select varieties that are safer for the wheat-allergic population to consume.

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

Wheat breeders use the annual Wheat Quality Testing Data to make their future planting decisions, and the Michigan milling industry uses the data for anticipating what type of quality issues they will face regarding the crop harvested the same year as the Testing Data. Cereal and food scientists gained new insights about the associations of whole grains with gut health as well as wheat protein allergic effects with regard to human food safety, and they may possibly be able to incorporate the findings into their relevant food production programs.

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

The general public can continue to enjoy and be ensured of having high quality wheat products and potentially healthier and safer wheat products to consume.

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.

No changes in activities were required during the reporting period. Results were presented at the Michigan State Millers' Association Winter Meeting and the American Association of Immunologists Annual Meeting. This project provided training for two Ph.D. students and two undergraduate students. The program plans are to continue to conduct research activities to achieve the goals as outlined in the project.

Secure Food and Fiber Systems

Project Director

Norma Lundeen

Organization

Michigan State University
Accession Number
7001556

Emergency Response to Traffic Accidents Involving Livestock

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

With contributions of more than $104.7 billion annually to the state's economy, agriculture is one of Michigan's most important and productive industries. With millions of animals transported across the United States each year, traffic accidents involving livestock occur all too frequently. Many first responders are unsure of how to handle livestock, which can make for a dangerous situation for both the animals and the people responding to an accident.

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 Emergency Response to Accidents Involving Livestock (ERAIL) program is a comprehensive training and response program spearheaded by Michigan State University Extension. This program is aimed at serving Michigan's animal agriculture industry by providing resources to assist in the response to an accident involving livestock. The ERAIL program consists of training first responders (often volunteer firemen and law enforcement officers), animal haulers, and other local stakeholders on how to properly respond when animals are involved in a traffic accident, providing access to equipment that will aid in the accident response and creating a network of trained responders throughout the state.

A key goal of the ERAIL project is to provide first responders across the state with access to the tools and equipment they need to properly respond to an accident involving livestock. ERAIL Response Trailers are cargo trailers fully stocked with equipment and supplies that may be needed when responding to such an accident. Accidents of this type typically require specialized equipment not normally carried in first responder vehicles. By locating these trailers in areas of the state that typically see high levels of animal movement and are close to major highways, those responding to accidents are better able to access the type of equipment needed to make an effective and efficient response. Along with providing access to these needed resources, the ERAIL team provides training on forming local teams, properly using the equipment included in the trailers, and safety tips about animal behavior and handling for first responders.

While the ERAIL Response Trailers have been designed primarily to aid in the response to traffic accidents, these resources are suitable for many different situations involving animals. First responders, law enforcement officials, and animal control officers are encouraged to access these tools so that a proper response can be implemented, no matter what type of animal-related event requires their help.

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

The ERAIL program currently has three trailers fully stocked and deployed in Michigan, located in Otsego, Jackson, and Branch Counties. It is the intent of the ERAIL program to help deploy at least six ERAIL Response Trailers across Michigan providing access to specialized tools and equipment needed during these unfortunate events. The goal of this effort is to allow for multiple counties, through mutual aid agreements, to have access to a nearby ERAIL Response Trailer. Efforts are made to build partnership agreements between counties located adjacent to the trailer location, allowing for counties to work together using this shared resource to provide an effective and efficient response.

Additionally, the ERAIL team provides first responders, law enforcement officials, and animal control officers in the close vicinity of the established trailer with training designed specifically to educate participants on the equipment and resources housed in the ERAIL Response Trailers. Jackson, Branch, and Otsego Counties and the surrounding areas have been recent participants in this training. This training focused on how responders should use the specific equipment, identified creative ways that the equipment can be used, and provided participants the opportunity to work through typical situations that happen when responding to accidents involving animals.

It is important for teams that have access to specialized equipment to also know how to utilize the tools and resources available to them. On a post-program survey,

- 100% of the participants indicated that they gained knowledge on deploying the trailer dedicated to their specific county

- 100% also gained knowledge on using the equipment that is available to them

- 91% reported that it increased their skill set and ability to implement new and better methods for responding to accidents

- 95.5% plan to provide this training opportunity for their local organizations

MSU Extension will continue to provide training opportunities and resources in this area, focusing on training first responders, law enforcement officials, and animal control officers on how to respond effectively to transportation accidents when animals are involved, providing access to essential equipment required to mount an effective response, and creating an organized network of trained responders throughout the state. This will help minimize the risks associated with these events for those involved in the response as well as minimize the economic and animal welfare risks facing the animal agriculture industry when these types of events occur.

"I wanted to express how much I appreciate all of the work the MSU Extension Team has done for the ERAIL program in Jackson County. Prior to you reaching out to me, we didn't have resources like this within our area. Your efforts and hard work provided useful resources that will help our first responders and will provide life safety measures for both the livestock and our citizens during an actual event." - Jason Breining, Director, P.E.M Jackson County Office of Emergency Management & Homeland Security

"Without your innovative ideas, networking and persistence, this project may not have happened. You identified a need and created a way to close the gap. Without a doubt, this project set a benchmark for other communities to follow." - Jason Breining, Director, P.E.M Jackson County Office of Emergency Management & Homeland Security

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

By providing leadership for Michigan's preparedness efforts, MSU Extension focuses on finding solutions for high-risk issues that impact the animal agriculture industry. MSU Extension's Emergency Response to Accidents Involving Livestock programs focus on the safety of law enforcement officers, first responders, and the public traveling on Michigan roads and highways.

Farm Bill Program and Analyzer Tool

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

Michigan agricultural businesses are competing for market share and profits both domestically and in a world economy. Major challenges for Michigan agriculture include highly volatile prices, an aging population of active farmers, changing tax law, weather-related disasters, credit availability, and maintaining positive net margins. Uncertainty in the market continues to impact demand volatility, credit availability, and market availability. There is a fundamental need for strong financial management in order to ensure the survivability of agricultural businesses.

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 2021 production year, producers needed to select which Farm Bill program would work best for their farms. However, the choice between Price Loss Coverage (PLC) and Agricultural Risk Coverage (ARC) only focuses on one production year, and may differ from decisions made for 2019 or 2020. Making the decision more complex for producers is the importance of considering crop insurance options that tie into these Farm Bill programs.

The 2021 Farm Bill Program & Crop Insurance Decisions – What Fits Your Farm? series featured MSU Extension experts, an insurance expert, and experts from the Farm Service Agency. At these hour-and-a-half long informational meetings, producers received a refresher on the current ARC and PLC program options, learned about the current and new crop insurance options available, worked through case examples using the updated MSU Extension Farm Bill Analyzer to help make better decisions on ARC versus PLC, and discussed specific program details with experts.

Featured in the Zoom webinar sessions was the Farm Bill Analyzer. This spreadsheet analyzer provides producers with the opportunity to compare potential risk protection from Price Loss Coverage (PLC) and Agricultural Risk Coverage (ARC). Farmers enter information about their farm, including historical yields, planted acres, and anticipated yields. This information is combined with county history yield values and projected market prices and yields to offer guidance on which programs producers should select. This tool also included consideration of crop insurance policy options that might be available depending on the USDA program selected. Combined with the webinar and one-on-one producer meetings, the decision tool aided farm managers in selecting the best risk protection for their individual farms. This tool was downloaded for use 329 times.

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

272 individuals attended the 2021 Farm Bill Program and Crop Insurance Decisions – What Fits Your Farm? series. Recordings of these sessions were made available online and were viewed 86 times. In combination with the Farm Bill Analyzer tool, which was downloaded over 300 times, farmers were equipped with the tools necessary to make decisions about which Farm Bill Program was right for their farm.

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

MSU Extension works to improve farm personnel well-being and income, expand agriculture related businesses, and increase employment opportunities leading to agriculture being one of the strongest industries within Michigan.

Farm Business Decision Tools

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

Michigan agricultural businesses are competing for market share and profits both domestically and in a world economy. Major challenges for those in Michigan agriculture include highly volatile prices, an aging population of active farmers, tax law, weather-related disasters, credit availability, and maintaining positive net margins. Uncertainty in the market continues to impact demand volatility, credit availability, and market availability. Recent public and individual health concerns related to the COVID-19 pandemic have accelerated changes to the agricultural policy landscape and the development of new agricultural programs. There is a fundamental need for strong financial management in order to ensure the survivability of agricultural businesses.

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, the MSU Extension Farm Business team developed and updated several decision tools and informational factsheets. These resources aid farmers in better understanding government program options, custom work rates, land rent trends, and assessing farm plans against industry benchmarks for improved decision-making.

Budget Estimator Decision Tools

Budget estimator decision tools provided farm managers with an easy way to develop enterprise budgets. Detailed versions of the budgeting tools allow for in-depth assessment of agronomic decisions, including nutrient, fertilizer, and chemical planning, while the simplified versions allow for comparison against industry benchmarks. Industry comparisons were obtained from the FINBIN database (finbin.umn.edu), which includes Michigan farm financial data collected by the MSU TelFarm program. In total, these crop and livestock budget estimators were viewed 5,158 times with 2,794 downloads.

Custom Machine Work Cost Report

The Custom Machine Work Cost Report covers a broad range of basic field machine operations, providing summaries of custom machine rates that farms have reported they charged each other during the prior year in the Midwest region. This report had a total of 1,856 pageviews with 804 downloads.

Fertilizer Cost Comparison Decision Tools

The Fertilizer Cost Comparison Tool provides farm producers with the ability to develop nutrient plans to meet yield goals and lower possible costs. Fertilizer cost comparison tools were available for field crops, vegetables, and forages, and were downloaded 382 times in total.

Livestock Feedlot and Cow-Calf Budgeting Tools

The Feedlot and Cow-Calf tools help producers forecast their economic profitability by improving user understanding of revenue, variable and fixed costs, and profitability. The Cow-Calf and Feedlot budget tools were downloaded 383 times.

Land Rent Calculator

The Land Rent Calculator is designed to assist producers in comparing the impact of land rent payments against their farm's projected net farm income. This tool had a total of 3,051 pageviews with 786 downloads.

USDA Farmland Cash Rental Rates Report

The USDA Farmland Cash Rental Rates document is a listing of the county rental rates dating from 2010 to 2021. The information was obtained from the USDA's National Agricultural Statistics Service and is based on their survey results from producers. This report had 2,649 pageviews with 1,005 downloads.

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

With over 11,000 pageviews and over 6,000 downloads, these tools help small and large farms plan budgets, estimate costs, and determine value to improve farm management and profitability.

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

MSU Extension works to improve farm personnel well-being and income, expand agriculture related businesses, and increase employment opportunities, leading to agriculture being one of the strongest industries within Michigan.

Farm Stress Reduction

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

Mental health among farmers is a significant and growing concern in the United States. Declining commodity prices, uncertainty of impacts of weather on crop growth and animal health, variability in interest rates, higher risks of occupational injury, and dynamics in farming families are all aspects of agricultural production that generate significant stress. Farmers experience greater psychological distress and depression than the general population, which can lead to concerns over on-farm or worksite safety with an aim to prevent higher rates of injury. The suicide rate among farmers and ranchers is also higher than that of the general population and those in other occupations. Farm stress programs normalize stressors and de-stigmatize conversations for mental health seeking among farmers.

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.

Farming can be an incredibly unpredictable and dangerous occupation, and these stresses can affect farmers and their families. MSU Extension is committed to supporting agriculture professionals and their families as they make their way through tough times. By leveraging its position as a trusted organization with a history of working with producers, MSU Extension helps raise awareness of emerging mental health needs in the farming community and provides a wealth of knowledge and training tools to Michigan's local farm organization chapters, leaders, and stakeholders.

MSU farm stress educational programs vary in length and target audience. Programs are sometimes part of larger events, such as fruit and vegetable expos or statewide conferences, and at other times offered independently as standalone events. Topics covered in farm stress programming include an overview of the agricultural context related to farm stress issues, unique stressors to agriculture producers, signs and symptoms of stress and suicide, skills to communicate with a distressed farmer, and information to refer distressed producers to appropriate professional and community resources.

Aside from programming opportunities, MSU Extension educators also published a variety of online articles throughout 2021 intended to reach the agricultural community with education and support. Topics covered included the effects of stress on physical health, tips on fighting isolation during the COVID-19 pandemic, and a promotional article outlining the expansion of MSU Extension's teletherapy program to include professionals in the aquaculture industry.

Michigan farmers talk about MSU Extension's farm stress teletherapy program

Through an innovative partnership with Pine Rest Behavioral Health, MSU Extension connects farmers experiencing stress and mental health issues to referrals for professional online counseling. As a part of this program, farmers are connected with a licensed mental health therapist for confidential teletherapy services, which are counseling sessions completed through video chat between mental health care providers and clients. This approach provides flexibility for people to access behavioral health supports in the comfort of their own environment.

Teletherapy has proven to be an invaluable lifeline for many farmers experiencing stress. After a devastating tuberculosis outbreak among his herd, Jim, a Michigan cattle farmer, needed support to deal with his grief and stress. He connected with MSU Extension, who helped him engage with a grant-supported teletherapy program. In an effort to reach fellow farmers with a message of hope, Jim and his wife Kelly shared the benefits they experienced and how teletherapy helped them through tough times in a recent video interview, found on the MSU Extension Managing Farm Stress website.

National presentation reaches tribal educators and native producers

Responding to an invitation from the United States Department of Agriculture's National Institute of Food and Agriculture, MSU Extension educators worked to provide farm stress resources to national tribal Extension educators and native producers in 2021.

In March, MSU Extension shared a modified version of the Mending the Stress Fence program to the Native Waters on Arid Lands (NWAL) group. NWAL seeks to enhance the climate resiliency of agriculture on American Indian lands of the Great Basin and Southwest by building the capacity within tribal communities to develop and implement reservation-wide plans, policies, and practices to support sustainable agriculture and water management. Additional relevant data was added to the presentation for the native producers from NWAL, and engagement with participants included cultural sensitivity on the topics of farm stress, mental health and wellness, suicide awareness, and available community resources.

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

Helping Farmers Connect and Learn About Mental Health

Throughout 2021, MSU Extension continued to work together to improve farmers' understanding of their well-being as well as symptoms of stress and signs of suicide. Out of 125 participants who completed a survey on their experience with MSU Extension's Mending the Stress Fence programs,

- 98% reported improved understanding of the warning signs of suicide
- 99% reported an improved understanding of well-being
- 100% reported an increased awareness of the signs of stress

Results from program surveys indicate that farmers who meet with members of the MSU Extension farm stress team have an improved understanding of effective and helpful communication. 98% of participants reported improved confidence in how to ask open-ended questions, which can be particularly important when trying to reach out to someone undergoing a mental health crisis.

As a result of MSU Extension's farm stress programming and outreach:

- 879 farmers, farm workers, and agribusiness professionals reached through 30 different outreach opportunities in 2021
- 9,111 views on weekly Facebook "Lunch Break" live events in 2021

- 733% increase of farmers accessing teletherapy services through MSU Extension's partnership with Pine Rest Behavioral Services in 2021, compared to 2020

"Thank you, I didn't believe in the counseling program when you shared it with me, but this program gave me my life back and might have saved it in the process." – A farmer engaged with MSU Extension's farm stress team and grant-funded teletherapy program

Participants in the NWAL Mending the Stress Fence program reported gaining great value from the program, and shared the following reflections on their experiences:

"I learned that it is important to ask people directly if they are thinking of committing suicide, and I appreciated the example of how to word that question and next steps if they answer that they are thinking of suicide. Great presentation, thank you!" – 39-year-old white female participant from Nevada

"Regarding stress and how to deal with it, including things we can't control, such as weather, I believe it's sometimes easier said than done. The presentation was very good, with lots of great information. Farming has changed a great deal, it's not just planting a crop, harvesting it and selling it." – 52-year-old white male participant from the Midwest

"[T]his topic is something we are increasingly seeing in our jobs, even though we didn't think it would be." – 43-year-old white/Hispanic female participant from Montana

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

MSU Extension is committed to supporting the state's agriculture industry and the dedicated professionals that work in it. MSU Extension connects farmers and their families who are experiencing stress with a variety of tools and resources — which includes everything from grant-funded teletherapy services and farm financial analyses to educational resources and face-to-face outreach. Through these efforts, the producers and growers keeping Michigan's food supply abundant receive the support they need to keep their businesses and their families healthy.

HopChats

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

Farms and food-related businesses in Michigan experience many challenges, including volatile markets, low margins, and seasonal shifts. New and beginning farmers and food entrepreneurs may start off with very little experience in the field, but with a strong desire to be a part of the local food system. These business owners look to MSU Extension for connections to subject matter experts and counselors, technical training, information on local and regional market opportunities, food safety guidance, and more.

According to the 2010 Michigan Good Food Charter, "A new cohort of young farmers is emerging in Michigan. Immigrants and farm workers have agricultural skills and knowledge and often a desire to start new farms. Michigan communities are embracing urban agriculture. Several recent legislative actions have supported these activities, and further actions could pave the way for more good food."

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.

MSU Extension Hop Chat was a series of weekly discussions that provided timely hop production information to growers throughout the summer of 2021. These chats allowed easy communication between producers and MSU faculty, and covered topics such as weather, best management practices, hop fertility, pest and disease control, irrigation, cover crops, and more. These weekly Hop Chats were recorded on Facebook Live for registrants to view at their leisure. After each Hop Chat, MSU Extension educators published written summaries of the topics that were discussed and shared these summaries with all registrants through the Michigan State University Extension News Digest.

Registrants were from all over the United States, Canada (British Columbia, Ontario, Quebec, and Saskatchewan), Argentina, Brazil, Hungary, India, New Zealand, and Peru, demonstrating the broad appeal of this weekly online series.

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

Over 900 people attended MSU Extension Hop Chat sessions in 2021. Of those that completed the post-series evaluation,

- 70% considered it "very helpful" and 20% considered it "critically important"
- 100% gained knowledge to manage production risks (e.g. pests) and improve efficiency (e.g. nutrient management)
- 90% implemented management practices that mitigated risks (e.g. better control insects, diseases, and weeds based on MSU recommendations)
- 80% implemented management practices that improved crop quality or yield (e.g. optimized irrigation, nutrients, weed control, harvest practices)
- 90% increased awareness/use of MSU resources (staff, management guides, MSU Extension news, websites, Facebook pages, etc.)

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

Food and farming businesses form the base of Michigan's economy. When these businesses thrive and operate sustainably and equitably, everyone in the state benefits, whether it be through employment, consumption of high-quality food and farm products, or enjoying the broader effects of more money circulating in local economies.

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.

https://www.canr.msu.edu/news/michigan-hop-crop-report-for-the-week-of-june-28-2021

This series will continue in 2022: https://www.canr.msu.edu/news/join-msu-extension-and-fellow-hop-growers-for-weekly-hop-chat-series

Swine Fever Prevention

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

As pork producers deal with challenges common to agriculture, such as lack of labor, increasing input costs, and common production diseases, they are also keeping a watchful eye on African swine fever, a devastating disease spreading through China, Eastern Europe, and the Dominican Republic. This disease, while not currently present in the United States, continues to remain on the radar of producers for a multitude of reasons.

African swine fever is a production disease that will devastate a swine herd, resulting in extremely high rates of mortality in infected animals with surviving animals becoming carriers of the infectious disease. Herds that have contracted this disease are fully depopulated. Surrounding potentially susceptible farms are put under high levels of scrutiny to control the spread of the disease. As outbreaks occur in other countries, international demand increases for U.S. pork products, adding market value to Michigan-grown pigs. While increased demand generally means increased revenue, it can also cause market price fluctuations that can be difficult for producers to manage, enticing farms to expand in order to meet export demand. As infected countries recover from the disease, the export markets will likely disappear, causing lower market prices.

The 2021 African swine fever outbreak in the Dominican Republic brought the disease much closer to home. Producers, processing facilities and associated businesses understand there is no longer an ocean between their industry and this disease. The implications of an outbreak in the United States are vast and would result in an immediate shut down of all export markets for the swine industry. Recent research from Iowa State University and Universidad de la Republica, Uruguay

indicates the costs associated with an ASF outbreak are significant and require risk mitigation and safeguards to protect against the importation of the disease. If there is an outbreak, it will be critical to stop the spread of ASF quickly. This would allow the industry to regain export markets before downsizing occurs and save up to $35 billion in losses. There is also an expectation of an industry-wide shutdown when the first outbreak case occurs in the U.S., posing numerous challenges for the pork industry from farm to table. If outbreaks of disease do occur, regulations will be imposed on the industry on the movement of all swine, with state departments tasked with balancing decisions that impact disease spread and business continuity.

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.

"Prepare for the worst and hope for the best" is the motto the Secure Pork Supply Taskforce is taking as they focus on preparedness for the industry. The combined industry organizations of MSU Extension, MSU Veterinary Diagnostic Laboratory, Michigan Pork Producers Association, and Michigan Department of Agriculture and Rural Development (MDARD) are formulating a system that allows for business continuity for Michigan's pork producers, while avoiding supply chain disruption for processing units during the threat of a foreign animal disease outbreak.

The Secure Pork Supply Taskforce recognizes these challenges for Michigan's prominent pork industry and has increased their efforts for the state to be fully prepared if an event would occur. This combined industry taskforce provides a comprehensive perspective on how an outbreak would affect Michigan's pork industry. Engaging and embracing the co-leadership of MSU Extension — an organization with direct connections to pork producers, a full understanding of Michigan's diverse pork industry, and vast knowledge of disease spread and herd health — has enhanced the efforts of the entire team and made accessible numerous outreach channels and methods supporting these preparedness efforts.

The taskforce has focused on determining enhanced biosecurity practices for farms to implement if regulations are imposed for the movement of swine across and into the state. The designated system will allow producers to have their enhanced biosecurity plan validated and on-file for review if "permitted" movement is in place. By understanding and implementing these enhances protocols, farms will be better positioned to gain access to movement permits in a timely manner. Engaging in these practices will also help producers protect their herds from disease spread, decreasing the likelihood that their farm will be infected with African swine fever.

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

Michigan's pork industry is extremely diverse, with operations varying in size and type across the state. MSU Extension provides education and resources focusing on foreign animal disease information and identification and improving biosecurity practices by using a multipronged approach to reach Michigan's pork producers. Various efforts include providing written materials and information, engaging in one-on-one discuss with farmers, presenting materials in large group meeting settings, and developing virtual training tools that allow farmers and those involved in the industry to access information in a timeframe that meets their individual needs. As additional preparedness steps are determined by the state and Secure Pork Supply Taskforce, MSU Extension will continue to provide the outreach and education needed by the pork industry to ensure Michigan pork producers are prepared for the challenges associated with a foreign animal disease outbreak.

Reducing the spread of disease means identification must happen rapidly and everyone involved in the care, transportation, and processing of pigs needs to know the signs to look for and where to report their observations. Education and training materials developed by a team of Michigan State University Extension educators and specialists are available to assist with identifying the signs of this disease. Farm laborers and personnel who access farm sites regularly, those involved in transportation of pigs, and people working in processing facilities now have access to resources and information that will help them quickly identify and report any suspect animal that they may observe. This effort is crucial to quickly controlling the spread and stamping out the disease if an infection happens in Michigan or other areas of the United States.

The efforts of the Secure Pork Supply Taskforce fully enhance the preparedness of Michigan's pork industry. By engaging in educational activities, formulating enhanced biosecurity plans implemented on farms, routinely submitting data to support a high health herd status, and understanding how to quickly identify and report a suspect animal for foreign animal disease, Michigan's pork industry will be fully equipped to respond to a disease outbreak and focused on maintaining the business continuity of the industry.

"Biosecurity on hog farms has been a work in progress for many years but, when African Swine Fever (ASF) broke in China in 2018 and the Dominica Republic last year, it has risen to one of our top priorities. MSU Extension provides farmers the assistance they need in compiling the necessary information to create, verify, and submit their enhanced biosecurity plans so

they can resume business continuity during a foreign animal disease" – Mary Kelpinski, CEO Michigan Pork Producers Association

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

By providing leadership for Michigan's preparedness efforts, MSU Extension focuses on finding solutions for high-risk issues that impact the animal agriculture industry. By assisting farmers with completing preparedness efforts, MSU Extension works to avoid supply chain disruption for processing units during the threat of a foreign animal disease outbreak.

Tax Management for Farmers

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

Michigan agricultural businesses are competing for market share and profits both domestically and in a world economy. Major challenges for Michigan agriculture include highly volatile prices, aging population of active farmers, changing tax law, weather-related disasters, credit availability, and maintaining positive net margins. Uncertainty in the market continues to impact demand volatility, credit availability, and market availability. There is a fundamental need for strong financial management in order to ensure the survivability of agricultural businesses.

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.

Each year, Michigan State University Extension Farm Business Management Educators work with farms enrolled in the MSU Extension TelFarm program to improve their financial management skills and help them prepare to manage their yearly tax liabilities. The TelFarm program provides accounting and financial analysis support to farmers across the state of Michigan. TelFarm is an important tool for financial management for farm business and a real-life information source for research and education.

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

The "Prepare Your Farm for Taxes Now" webinar was offered three times over the course of 2021, totaling over 65 attendees. Participants learned how to maintain farm financial records that are useful for preparing taxes and for managing their farms. Tax fundamentals for farms were presented, as well as critical steps to ensure that their records generate accurate and complete tax returns. In addition, options and principles for setting up an effective recordkeeping system were discussed. Participants consistently reported having learned about farm recordkeeping at this webinar.

- 122 individuals participated in 2021 Year End Tax Estimates, representing 82 TelFarm program enrolled farms
- Over $1.1 million of tax savings benefit to participating farms

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

MSU Extension works to improve farm personnel well-being and income, expand agriculture related businesses, and increase employment opportunities leading to agriculture being one of the strongest industries within Michigan. Supporting agriculture and helping to improve financial stability and competitiveness has a significant economic impact on Michigan and local communities. The dollars saved through programs like these help local communities through increased purchases from local businesses from the second largest primary industry in Michigan.

Understanding Food Lables

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

The COVID-19 pandemic resulted in numerous executive orders that required people to stay home and restricted in-restaurant dining, changing the behaviors of consumers across the United States. With more people purchasing food products and preparing meals in their homes, consumers needed help to better understand the meaning of labels on the food products they purchase.

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.

Consumers have difficulty making informed choices when purchasing food because food label claims are confusing. In response, MSU Extension staff worked to develop food label claim infographics to help consumers better understand what they are buying. Infographics were created to address topics such as food product dates, introduction to food label claims, dairy, and alternative beverages. Infographics are still being developed to address topics such as animal diets, grains, and sweeteners.

To expand the reach of the infographics and meet the needs of Spanish-speaking Michiganders, seven of these food label claim infographics have been translated to Spanish.

There are multiple uses for these food label infographics. For example, when MSU Extension was approached to create a display at the Michigan State Fair, the existing seven food label claim infographics were printed as posters and utilized in this display. There was also a QR code created that was available for those who wanted to have the information available to them after their visit to the State Fair.

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

This information is readily available for health and nutrition professionals to share, and accessible for consumers who are looking to make informed decisions about their food purchases. With food purchases continuously making up a growing portion of household budgets, it is important that people have access to current, relevant, science-based information to help them make choices for their families. MSU Extension's vast network of educators, with in-depth understanding of food labels, agricultural practices, and nutritional value make them the perfect source to generate this information for consumers so that they can make informed choices.

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

MSU Extension enhances residents' access to an adequate supply of safe, affordable food to strengthen access to healthy food supplies. This leads to a healthy population, which in turn helps keep health care costs in check and our communities viable.

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.

Relevant links:

- https://www.canr.msu.edu/resources/food-product-dates
- https://www.canr.msu.edu/resources/dairy-milk-label-claims
- https://www.canr.msu.edu/resources/gmo-label-claims
- https://www.canr.msu.edu/resources/antibiotic-label-claims
- https://www.canr.msu.edu/resources/food-product-dates

- https://www.canr.msu.edu/resources/food-label-claims
- https://www.canr.msu.edu/resources/hormone-label-claims
- https://www.canr.msu.edu/resources/animal-raising-label-claims
- https://www.canr.msu.edu/resources/animal-raising-label-claims

Critical Issue

Water Quality and Quantity

Nutrient management in turfgrass systems

Project Director

Kevin Frank

Organization

Michigan State University

Accession Number

7000339

Nutrient management in turfgrass systems

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

Fertilizer applications are one of the most critical management practices in determining turfgrass health, performance, and sustainability. Turfgrass systems are continually scrutinized for the amount of fertilizer applied and the potential for nutrient leaching contaminating ground and surface water. This project addresses both the potential contamination of ground water from fertilizer applications to turfgrass and the effect of phosphorus and potassium applications based on soil testing recommendations.

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.

Progress was made towards objective 1 of measuring the impact of fertilizer applications on leaching from Kentucky bluegrass turf by applying fertilizer treatments throughout the year and measuring nutrient concentration in the turfgrass leachate. Progress was made towards objective 2 of determining the effect of phosphorus and potassium applications based on soil testing guidelines by taking soil samples to determine nutrient levels, applying fertilizer treatments based on those soil tests, and collecting data.

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

Presentations to target audiences provided information on the leaching of nitrogen from a turfgrass continually fertilized for over 20 years. The target audience benefited from understanding the impact of low and high nitrogen rate fertilizer applications on leaching from turfgrass. The audience also benefited from our research that showed few differences between soil testing recommendations for phosphorus but with respect to potassium, high annual recommended rates did not increase potassium levels in the soil.

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

The broader public benefits from the knowledge the turf managers gain from my research. Turf managers are more responsible in understanding the effect of continual fertilizer applications on leaching from turfgrass and thereby adjust their fertilizer programs to minimize the potential for ground water contamination. Turfgrass managers are also more responsible

in understanding the effect of phosphorus and potassium applications recommended from soil testing and how lower rates of both nutrients can still result in healthy turfgrass stands. The reduced nutrient rate applications further reduce the risk of ground and surface water contamination with benefits the broader public.

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.

Presentations were given to both scientific and industry audiences. Presentation on the effects of potassium and phosphorus rate applications based on soil testing guidelines was given at the Agronomy-Crop Science-Soil Science Society of America Annual Meeting, Michigan Turfgrass Field Day, and Michigan Turfgrass Conference. Presentations on long-term nutrient leaching were given at the Michigan Turfgrass Conference, Michigan Turfgrass Field Day, and the Michigan State University Turfgrass short-course.

Agrochemical Impacts On Human And Environmental Health: Mechanisms And Mitigation

Project Director
Hui Li
Organization
Michigan State University
Accession Number
1024276

Agrochemical impacts on human and environmental health: mechanisms and mitigation

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

The increasing human population has resulted in the wide application of agrochemicals for protecting crop yield and thereby helping to meet demands for increased food production. Inevitably, a portion of the applied agrochemicals, along with many anthropogenic contaminants, are lost to the surrounding environment potentially adversely affecting human and environmental health. This project is to (1) characterize abiotic and biotic processes that influence the sources, fate, transport and transformations of agrochemicals and contaminants in agricultural and natural ecosystems, (2) understand beneficial and adverse impacts from agrochemicals and anthropogenic contaminants to cells, organisms, ecosystems, and communities, and (3) quantify and mitigate human and environmental impacts of agrochemicals and anthropogenic contaminants.

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.

Human overuse and misuse of antibiotics have caused the wide dissemination of antibiotics in the environment, which has promoted the development and proliferation of antibiotic resistance genes (ARGs) in soils. Biochar (BC) with strong sorption affinity to many antibiotics is considered to sequester antibiotics and hence mitigate their impacts to bacterial communities in soils. However, little is known about whether BC-sorbed antibiotics are bioavailable and exert selective pressure on soil bacteria. In this study, we probed the bioavailability of tetracycline sorbed by BCs prepared from rice-, wheat-, maize-, and bean-straw feedstock using Escherichia coli MC4100/pTGM bioreporter strain. The results revealed that BC-sorbed tetracycline was still bioavailable to the E. coli attached to BC surfaces. Tetracycline sorbed by BCs prepared at 400 °C (BC400) demonstrated a higher bioavailability to bacteria compared to that sorbed by BCs prepared at 500 °C (BC500). Tetracycline could be sorbed primarily in the small pores of BC500 where bacteria could not access due to the size exclusion to bacteria. In contrast, tetracycline could be sorbed mainly on BC400 surfaces where bacteria could conveniently access tetracycline. Increasing the ambient humidity apparently enhanced the bioavailability of BC400-sorbed tetracycline. BC500-sorbed tetracycline exposed to varying levels of ambient humidity showed no significant changes in bioavailability, indicating that water could not effectively mobilize tetracycline from BC500 pores to surfaces where bacteria could access tetracycline. The results from this study suggest that BCs prepared at a higher pyrolysis temperature could be more effective to sequester tetracycline and mitigate the selective pressure on soil bacteria.

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

The results from this project are disseminated primarily through publications as peer-reviewed journal articles and presentations at professional conferences to scientists and policy makers. The scientists could better understand the knowledge and develop sound best management practices to mitigate food crops uptake of CECs from soils.

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

The policy makers and general public could also access the relevant reports and materials, and understand the issues in soil pollution and food safety. The research provides the knowledge for policy makers to set up regulations, and to develop potential protocols to mitigate CECs contamination in food crops. In addition, the research results are incorporated into the undergraduate and graduate curriculums to educate next generation of scientists and farmers.

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.

This project will provide many opportunities to train postdoctoral research associates and graduate students who can be benefited by improving their laboratory skills, critical thinking and problem solving. This training will also help them to advance their professional development and careers by experiment design, data analysis, manuscript writing, publishing in peer-reviewed journals, and research proposal preparation for competitive programs.

Digital Agriculture to Design and Scale Sustainable and Resilient Agricultural Systems

Project Director
Bruno Basso
Organization
Michigan State University
Accession Number
1022282

Digital Agriculture to Design and Scale Sustainable and Resilient Agricultural Systems

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

Agriculture faces the grand challenge of meeting growing demands for food, fiber and fuel under great demographic pressures and climate change, while simultaneously maintaining environmental quality. The pressure to increase yield for greater economic return often leads to harmful environmental impact and contributes to climate change. While agriculture's productivity is based on plants removing carbon dioxide from the atmosphere through photosynthesis, row crop agriculture is responsible for 5% of the greenhouse gas emissions in the US. To reduce these emissions, significant effort has been focused on changing farm management practices to maximize soil carbon. In contrast, the potential to reduce emissions has largely been neglected. This project evaluated the benefits of using digital agriculture technologies for the long-term sustainability of agricultural systems, considering the tradeoffs between profitability and environmental impacts.

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 results of the activities performed during the project helped farmers across the US Midwest better manage their N fertilizer applications rates by applying the right amount at the right place in the field and at the right time. These strategies lead to significant fertilizer reduction application (~35% less fertilizer applied on average) with consequent benefits to farmers' profitability and reduced environmental impact. The strategies used to select the right amount N fertilizer to use is based on a novel scalable method that integrates historical yield stability maps calculated from remote sensing images (Basso et al. 2019), in-season imagery and N rates from the SALUS process-based crop simulation model.

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

The project quantified the fraction of fields that have areas with stable high productivity (HS zones), stable low productivity (LS zones) and areas where yield is unstable (U).

The results showed that across the US Midwest over-fertilization occurs on approximately 25 Million acres of farmers' fields. This represents an economic loss of $750 Million to farmers and the release of 1.3 Million tons of Nitrogen to the Mississipi river and the Gulf of Messico.

The project developed a modeling software that is specifically designed to allow US farmers to evaluate various fertilizer application strategies in response to observed variability. The crop growth simulation model includes detailed calculations on nutrient, water and carbon balances of the crop system coupled with very large databases that contain information on soil, weather and remotely sensed plant reflectance. Stakeholders will be able to use the published results to better understand the risk associated with any given N rate and the potential impact of that choice on yield, profit and the environment.

From the analysis of big-data collected in this project, we have also advanced fundamental knowledge on the role of digital agriculture and big-data in optimizing input within and across agricultural fields in the US.

An improved method for in-season crop yield forecasting was developed with promising results for farmers, agencies and private company interested in crop yield forecasts.

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

This research informs stakeholders (farmers, consultants, industry, policy makers, students and the public at large) on how digital technologies in agriculture can help improve the decision-making process and leads to sustainability of food production by reducing greenhouse gas emissions and losses of agrochemical to the environment.

This research also provides broader benefits through its linkages to extension, outreach and education, showing how advances in digital agriculture and better data and analytics can improve economic and environmental performance of agricultural systems. Private companies will also benefit from the new science and results evolving from this project.

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.

No major issues were found faced during the project, beside the impossibility to meet with farmers and students in large groups of people due to COVID-19 restrictions.

During the project, students (undergraduate and graduate), post-docs and staff were trained to advance their knowledge and skills data science, agronomy, crop modeling and environmental sciences.

The study continues to make progress with the analysis and aims to expand its applications to new geographies and new crops.

Water **Quality and Quantity**

Project Director

Norma Lundeen

Organization

Michigan State University

Accession Number

7001557

Clean Boats, Clean Waters

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

Aquatic invasive species threaten the health and vitality of the Great Lakes and Michigan's inland waters by competing with beneficial native species for food and habitat, disrupting aquatic food webs, and negatively affecting water quality. Invasive species are introduced through a variety of mechanisms, including recreational boating and angling. Invasive species

prevention education targeting boaters and anglers is critical for the long-term protection of Michigan's waterways and economy.

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.

Since 2006, Clean Boats, Clean Waters has educated recreational water users in behaviors that will limit or prevent the spread of aquatic invasive species. Boater outreach is one tool used in Michigan to address invasive species issues. The Michigan Clean Boats, Clean Waters program is a joint effort between Michigan State University Extension and the Michigan Department of Environment, Great Lakes and Energy. This year, grant funding was available for the first time through the program to support local organizations. Funding for the program and this grant opportunity was provided by the Great Lakes Restoration Initiative.

The 2021 Clean Boats, Clean Waters program funded seven outreach projects across Michigan to educate boaters about aquatic invasive species prevention. The awardees included lake associations, watershed groups, local units of government, and other nonprofit organizations. Grant funds were used to communicate aquatic invasive species prevention information through outreach materials and in-person events. Projects ranged from the installation of signage at boat launches to boat and trailer cleaning stations with invasive species removal tools.

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

Clean Boats, Clean Waters builds a unified understanding of boat cleaning practices and regulations to prevent the spread of aquatic invasive species through the creation and distribution of print materials, volunteer trainings, mobile boat washing demonstrations, and mini-grants. Stewardship organizations utilize our materials, equipment, and grant funds to share invasive species information locally to address their community-specific issues related to boating and angling.

2021 Michigan Clean Boats, Clean Waters Funded Projects

- The Benzie Conservation District engaged boaters through their Aquatic Invasive Species Pathways Program in Benzie, Grand Traverse, Leelanau, and Manistee counties. Staff and volunteers conducted boat washing events at public and private launch sites throughout the boating season and are installing signage at boat access sites.

- The Black Lake Preservation Society installed boat and trailer cleaning stations with hand removal tools at three public boat access sites on Black Lake in Presque Isle County. They also hosted grand opening events at each access site to demonstrate how to use the equipment.

- The Lower Grand River Organization of Watersheds hosted three outreach events with educational materials at popular public access sites along the lower Grand River in the Grand Rapids region to engage kayakers and fisherman.

- The Michigan United Conservation Clubs shared prevention information via their Michigan Out-of-Doors magazine and membership newsletters. They also incorporated Clean Boats, Clean Waters prevention messaging in three of their 'On the Water' volunteer watershed habitat improvement project work days on the Clinton River, Manistee River, and in the Bay Mills Watershed.

- The Missaukee Conservation District partnered with the North County Cooperative Invasive Species Management Area and the Missaukee Lake Association and hosted three outreach events on Lake Missaukee and Lake Cadillac. They also distributed educational materials at local businesses and popular tourist destinations.

- The Charter Township of Oxford installed a user-operated, waterless cleaning station equipped with a weed removal tool, plug wrench, boot brush, and interpretive signage at the Stony Lake Township Park in Oakland County. They promoted the cleaning station and invasive species prevention activities via media outlets and at three outreach events hosted at township parks throughout the boating season.

- The Portage Lake Watershed Forever watershed council in Manistee County hosted aquatic invasive species education booths at community events throughout the boating season and painted their boat launch parking lot with stencils that had outreach messaging including “clean, drain, and dry.” They are also partnered with local businesses including marinas and bait shops to share educational information.

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

Protecting Michigan’s water resources is critical for our state’s future. Michigan’s diversity of water resources, including lakes, streams, groundwater, wetlands, and watersheds support a rich network of fish and wildlife populations and habitats, a vital tourism economy, a thriving agricultural sector, and provide a source of drinking water for the state’s population. There is a critical need for public understanding of Michigan’s water resources as important ecological, economic, and social assets that need to be protected and conserved, and whose use must be sustainably promoted for future generations. MSU Extension provides educational opportunities that develop the knowledge and skills needed to properly protect Michigan’s waterways.

Mortality disposal impacts on water quality

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

Impacts of the COVID-19 pandemic were widespread, and many of these were felt in the food processing industry. Staffing shortages slowed processing capabilities, creating substantial supply chain disruptions and challenges for farmers as they managed the growth of their animals alongside limited marketing opportunities. In some states, to avoid animal welfare issues, the only option for farmers was mass depopulation of entire barns of marketable swine. Thankfully, Michigan farmers, with the guidance of MSU Extension, were able to implement mitigation strategies to avoid this tragic situation. Unprepared for this type of depopulation event, states learned how to manage large quantities of animal mortalities by learning from experience.

No data existed that showed what potential impacts composting ground animal carcasses could have on groundwater when placed on bare soil. If pollutants from these organic materials leach through the soil, there could be movement of soil metals due to anoxic conditions. This is of particular concern in Michigan due to the shallow groundwater table as well as the prevalence of sandy soils.

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.

To establish the safety of composting ground animal carcasses and to generate best management practices for farmers faced with this situation, research opportunities were created to address this issue. A laboratory experiment was conducted to simulate a ‘worst-case scenario’ of mortality composting on both sandy loam and loamy sand Michigan soil. Immature mortality compost was produced and applied to the soil columns. Synthetic rainwater was applied in a schedule following a Michigan wet spring, a 25-year storm, and two sequential 10-year storms. Data collected from this project included groundwater quality information, moisture content, and manganese and iron concentrations. The findings of this project are still being reviewed by scientists and suggestions for best management practices are being compiled.

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

The efforts of MSU Extension will directly impact the ability of farmers and the state to manage large scale depopulation events with a sharp focus on environmental protection. The results of this project will allow the introduction of new mortality disposal methods. By creating more options for mortality disposal, environmental harm will decrease because solutions can be tailored to conditions surrounding the event. Furthermore, this project may provide the needed information for the Natural Resources Conservation Service (NRCS) to expand their funding opportunities for mass mortality disposal method.

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

The ability to combine scientific expertise, research capabilities, and practical experience allows MSU Extension educators and scientists to work together and generate advancements in food, health, and the environment, creating impactful data for Michigan communities. The partnership between research and outreach allows MSU Extension to share resources with clientele across the state.

Wastewater from meat processing

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

Michigan is home to many natural resources, including lakes, ponds, streams, and canals. The health of these different aquatic systems is dependent on many things, including the state's ability to manage nutrient runoff and pollution from roads, lawns, homes, businesses, and farming operations.

One concern for environmental regulators in the state is biochemical oxygen demand (BOD) and components within the wastewater that are generated by food processing businesses. Making sure these operations are utilizing the appropriate methods of treatment and disposition of the wastewater is critical in mitigating situations that could result in fish kills in surface water. As a result, all meat processors will soon need to obtain a groundwater discharge permit from the Michigan Department of Environment, Great Lakes and Energy (EGLE) and have an approved method of disposal. The permit application must include a basis of design for the wastewater treatment system, including wastewater characterization, effluent volumes, proposed storage and/or treatment system, and a sampling plan. Many meat processors will be impacted by this permit requirement, including over 170 USDA inspected meat and poultry establishments and over 300 additional retail or custom exempt facilities in the state.

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.

To develop systems that allow for food processing businesses to manage their wastewater using environmentally sustainable methods, more information was needed on the actual amount of wastewater created and its constituent contents. Researchers and MSU Extension educators worked together to design a project that will fill in these knowledge gaps with the goal of characterizing the wastewater and developing pretreatment options. This project will survey existing meat processing plants that are sending wastewater to municipalities across the state as well as those utilizing on-site treatment. Researchers will compare project results with existing industry data and design preliminary treatment solutions that protect groundwater.

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

This project will lead to a better understanding of current wastewater constituents from meat processing facilities and ultimately inform future research projects for alternative treatment systems. The project is moving forward with sampling and seeking additional funding to develop affordable BOD testing procedures for facilities.

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

Focusing on the issues that directly impact agriculture and agriculture businesses, MSU Extension continues to meet the needs of people across Michigan by identifying areas of concern and limited information, creating opportunities to address these needs and working to get solid, credible information into the hands of the people who need it.

Critical Issue

Workforce Development, Community Resource Development, and Innovation

Economic Foundations for Evaluating Consumer, Producer, and Agribusiness Decision-Making in Global Food Systems

Project Director

David Ortega Newman

Organization

Michigan State University

Accession Number

1019211

Economic Foundations for Evaluating Consumer, Producer, and Agribusiness Decision-Making in Global Food Systems

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

This project uses case studies on global consumers and domestic producers to evaluate decision-making in the global agri-food industry. This information is used to inform marketing strategies and food policies.

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.

Major activities included work on a series of US consumer studies focused on the pork and dairy industry. This work focused on the use of redundant labeling strategies in US dairy products and on consumer preferences for animal welfare-improving biotechnologies in pork products. Additionally, a study was completed assessing Chinese consumer acceptance of gene-edited food products. A US dairy industry study is currently underway which evaluates dairy producer adoption of animal welfare-improving biotechnologies.

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

Results were disseminated to peer scientists via peer-reviewed journal articles and also to industry stakeholders via industry publications and podcasts. Insights from these various activities were also disseminated to the general public via trade-press and national and international news outlet interviews (approximately 20 news interviews in the reporting period).

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

Given the effects of COVID-19 on the food industry, results and insights from this project's activities have provided the general public with timely and important information on the nature of the disruptions as well as the agricultural and food industry's response to these challenges.

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.

Graduate student research training was provided as part of this project's activities.

Throughout the next reporting period, there will be continued engagement with food and agricultural industry stakeholders to provide timely information on continued COVID19 challenges to the food and agricultural sector. Data from the US dairy producer study will be analyzed and efforts to disseminate findings from these activities will continue.

Closing Out (end date 09/07/2023)

Investigating Cross-disciplinary Communication

Project Director

Michael O'Rourke

Organization

Michigan State University

Accession Number

1016959

Investigating Cross-disciplinary Communication

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

My project addresses the challenge of communicating effectively across different worldviews when conducting complex, collaborative research. These worldviews include disciplinary worldviews inside the academy, and professional or community-based worldviews outside the academy. Differences in worldview manifest in the form of differences in core beliefs and values and differences in the technical languages spoken, and these can undermine collaborative research by making it difficult for collaborators to understand one another.

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.

On the *facilitative* side, my post-docs and I conducted 32 Toolbox workshops with various groups related in different ways to agriculture and natural resources, including eight with the National Science Foundation (NSF) Convergence Accelerator Program; six with the NSF AccelNet Program; eleven with the NSF Growing Convergence Research Program; one with the NASA WAVE DRIVE Science Center; one with the European Commission Directorate General for the Environment; and five with various groups at The Ohio State University, Binghamton University, and Michigan State University.

I continue as Director of the MSU Center for Interdisciplinarity (C4I), a research center at MSU that focuses on supporting and conducting cross-disciplinary research. I also worked with my post-docs to create a new, MSU-based service center, the Toolbox Dialogue Initiative (TDI) Center, which will become the new hub for Toolbox workshops locally, nationally, and internationally. Many of our research and facilitation efforts are focused on producing products related to my Hatch project.

On the *critical* side, I finalized and published four papers and one book, gave seven invited presentations, and received several more NSF awards to support research related to this project. The publications and presentations were as follows:

ARTICLES. Two articles on which I am a co-author that are relevant to my Hatch proposal were published in issues this past year:

- Bugin, K., Lotrecchiano, G. R., O'Rourke, M., Butler, J. (2021). Evaluating integration in collaborative cross-disciplinary FDA new drug reviews using an input-process-output model. *Journal of Clinical and Translational Science* 5: e199, 1–10. https://doi.org/10.1017/cts.2021.861

- Rinkus, M. A., Donovan, S., Hall, T. E., O'Rourke, M. (2021). Using a survey to initiate and sustain productive group dialogue in focus groups. *International Journal of Social Research Methodology*. 24(3): 327–340. https://doi.org/10.1080/13645579.2020.1786240

BOOK CHAPTERS. Two book chapters on which I am a co-author that are relevant to my Hatch proposal have appeared in the last year:

- O'Rourke, M., Fam, D. (2021). Theoretical and empirical perspectives on failure: An introduction. In D. Fam and M. O'Rourke (Eds.), *Interdisciplinary and Transdisciplinary Failures: Lessons Learned from Cautionary Tales* (pp. 1–20). London: Routledge.

- O'Rourke, M., Crowley, S., Eigenbrode, S. D., Vasko, S. E. (2021). Failure and what to do next: Lessons from the Toolbox Dialogue Initiative. In D. Fam and M. O'Rourke (Eds.), *Interdisciplinary and Transdisciplinary Failures: Lessons Learned from Cautionary Tales* (pp. 97–113). London: Routledge.

BOOK. Finally, co-edited a book published by Routledge that appeared in the reporting period:

- Fam, D., O'Rourke, M. (Eds.) (2021). *Interdisciplinary and Transdisciplinary Failures: Lessons Learned from Cautionary Tales*. London: Routledge.

PRESENTATIONS. In addition, I delivered seven invited presentations in the reporting period that relate to my Hatch proposal:

- "Introduction to the Toolbox Dialogue Initiative," University Initiatives Panel, 2021 Science of Team Science Conference, Virginia Tech University, Online, June 2021

- "Creating Common Ground for Interdisciplinary Teams," Keynote lecture, Team Research Symposium, University of New Mexico, Virtual, April 2021

- "Facilitating Convergence Through Dialogue: The Toolbox Dialogue Method," Keynote lecture, Convergence Symposium, Dartmouth College, Online, February 2021

- "Interdisciplinary Environmental Science," ESP 800, Michigan State University, Online, January 2021

- "The Challenge of Building Transdisciplinary Research Teams," Workshop on Transdisciplinarity, University of Ghent, Belgium, Online, December 2020

- "Warming Up to the 'F' word: Failure in Interdisciplinary and Transdisciplinary Research," with D. Fam, Sustainable Communities Transdisciplinary Areas of Excellence Seminar, Binghamton University, Online, December 2020

- "Is There Any Hope for Interdisciplinarity?", Department of Philosophy Colloquium, University of Utah, Online, October 2020

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

During the reporting period (October 1, 2020 - September 30, 2021), my work involved both facilitation and critique as outlined in my non-technical summary. On the facilitative side, the audiences reached by our work include international development officers, international scientists, interdisciplinary researchers, the Directorate General of the Environment of the European Commission, PIs and teams sponsored by three National Science Foundation programs (AccelNet, Convergence Accelerator, and Growing Convergence Research), PIs and teams sponsored by one NASA program (Heliophysics DRIVE Science Center), faculty and administrative staff at MSU, and participants in several academic conferences. Our primary work involved running Toolbox workshops. My post-docs and I led 32 Toolbox workshops, serving roughly 350 people and supporting research development and capacity building in a number of federal programs and universities.

On the critical side, the audiences for my work include scholars of interdisciplinarity and transdisciplinarity, natural resource and agricultural researchers conducting interdisciplinary projects, scholars interested in interdisciplinary research methods, and interdisciplinary environmental science graduate students. I finalized and published four papers and one book, delivered seven presentations, and received several more NSF awards to support research on this project. The publications represent

contributions to the literature that will help theorists, researchers, and practitioners conduct cross-disciplinary research more efficiently and effectively. For example, the work on *failure* is meant to provide specific case studies that can help cross-disciplinary researchers and practitioners avoid the challenges and failures that have beset others.

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

The broader public benefits indirectly and directly from work on this project. By helping to build research capacity and thus make research on complex global challenges more efficient and effective, this project contributes indirectly to research-based responses to these challenges and so helps improve the quality of life on a global scale. More directly, the broader public has profited and will continue to profit from participation in transdisciplinary Toolbox workshops, i.e., Toolbox workshops that involve participants from inside and outside the academy. Now that we have brought TDI Center online, we anticipate delivering more Toolbox workshops to communities and other groups that are at least partially based outside academic institutions.

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 have been no major changes or problems encountered in approach.

What opportunities for training and professional development has the project provided?

I have worked with Dr. Marisa Rinkus, a Ph.D. in human dimensions of natural resources. Dr. Rinkus is hired on funds from a different source, but she has been engaged in work that is related to my Hatch proposal. I have also worked with Dr. Edgar Cardenas, who has been a key part of collaborations with various people in AgBioResearch, and Dr. Chet McLeskey, who has conducted Responsible Conduct of Research workshops for the College of Agriculture and Natural Resources at MSU. Together, the four of us helped to initiate a new service center at MSU, the Toolbox Dialogue Initiative (TDI) Center, and they are not Associate Directors of this center. This represents a significant increase in salary and in professional profile, and this is an outcome of the Hatch-supported Toolbox work they have done with me over the years. In addition, the Toolbox workshops delivered during courses supplied training opportunities in interdisciplinary communication for students, teachers, and other meeting participants.

How have the results been disseminated to communities of interest?

Our published manuscripts have appeared in venues read by philosophers, scientists, and interdisciplinary and transdisciplinary researchers and theorists. We have presented on various aspects of the Toolbox approach to very interested audiences around the world. The Toolbox workshops were disseminated directly to communities of interest, including a number of communities interested in agricultural and natural resource issues.

What do you plan to do during the next reporting period to accomplish the goals?

On the facilitative side, we will continue to conduct Toolbox workshops, collecting data for process evaluation. We will continue to work with NSF and NASA programs, and will grow the portfolio of Toolbox partners through the activities of TDI Center. Further, we plan to maintain our workload on campus, expanding the services we provide local transdisciplinary collaborations.

We plan to continue working on cross-disciplinary communication in the coming year, which will result in additional manuscripts that are related to the critical goals described above. I plan to commence work on a research monograph that focuses on crossdisciplinary integration.

Closing Out (end date 09/07/2023)

Building A Community-University Partnership for Modeling Food and Natural Resource Systems

Project Director

Laura Schmitt-Olabisi

Organization

Michigan State University

Accession Number

1015990

Building A Community-University Partnership for Modeling Food and Natural Resource Systems

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

We will work with community members in Flint and Detroit to build computer models of the food system in those cities. We will use these models to find out how to move the food system towards better human health, protection of the environment, and equity. We will also design materials for residents of Flint and Detroit to learn about systems thinking and modeling, so that they can use these tools to analyze other problems. These tools will also be made available online, for leaders and decision-makers from other cities to use.

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.

Major progress was made in 2021 on modeling the Flint food system, with the goal of reducing food insecurity and improving access to healthy foods and sustainability of food production in Flint. A system dynamics model of the Flint food system, based on input from Flint residents, was shown to our Community Consultative Panel in Flint (comprised of food system experts), and is currently being revised based on their feedback. The model results are being written up for an academic audience and will also be shown to the community at a Food Summit which we are co-organizing with the new Flint Food Policy Council in June 2022. This will help inform community decision-making in Flint around the food system.

We published an academic article based on similar food security work from Detroit: Metta K, L Olabisi, R Wallace. 2021. A system dynamics approach to examining household food insecurity. *Journal of Agriculture, Food Systems, and Community Development* **10**(2): 455–472. While this is intended for a technical audience, peer reviewed publications increase confidence in the model we built, which we will continue to use with stakeholders.

In 2021, I co-designed and taught in a virtual participatory modeling field school (https://modeling.engage.msu.edu/) which engaged academics and practitioners from around the country in learning about participatory modeling techniques for application in their own communities. Approximately 80 participants enrolled.

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

The system dynamics model we built this year is a key component of our food systems work in Flint. The food system experts and practitioners on our Community Consultative Panel have already benefited from discussions around the structure of the food system and how it could be shifted towards better outcomes. The Flint Food Policy Council, tasked with creating a vision for the food system in Flint, has been discussing our project results with us as well, and will be incorporating what we learned from Flint community members into their initial discussions.

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

As mentioned above, practitioners and academics from around the country have benefited from learning through our participatory modeling field school, and the publication on modeling Detroit food security.

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.

During the next reporting period, I plan to apply for additional funding through the Robert Wood Johnson Foundation to fund a broader food system modeling effort in Detroit.

Workforce Development, Community Resource Development, and Innovation

Project Director
Norma Lundeen
Organization
Michigan State University
Accession Number
7001277

American Rescue Plan Act Workshops

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

The American Rescue Plan Act (ARPA) of 2021 established the $350 billion Coronavirus State and Local Fiscal Recovery Fund, $150 billion of which was earmarked for distribution to local and tribal governments. This federal stimulus creates a unique opportunity to make critical investments in infrastructure, facilities, and services to reshape Michigan communities. Regional impacts of stimulus spending will vary, but those governments that spend to build capacity and infrastructure in line with other regional investments will likely see the greatest return on investment.

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 September and October 2021, members of the Michigan Association of Regions (MAR) and MSU Extension hosted local and tribal government officials to explore Coronavirus Local Fiscal Recovery Fund spending opportunities in a regional context. The 14 regional workshops covered:

- ARPA Coronavirus Local Fiscal Recovery Fund basic rules
- Best practices and early examples of ARPA spending
- Practical considerations for contracts, accounting, and project management
- Group discussions related to regional collaboration
- Leveraging other state and federal funding and priorities

As a follow-up to the ARPA workshop series, a website was developed to host a recording of the lecture portion of the program, the presentation handout, and lists of community needs for each region. This website was shared with participants, local government officials, and over 100 nonprofit leaders.

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

This statewide workshop series had over 750 participants from many of Michigan's nearly 1,900 units of government.

On a post program survey completed by 169 participants:

- 78% of respondents rated the workshop as “very valuable” or “valuable”
- 46% were elected officials, 24% local government staff, 15% appointed officials, 8% representatives of nonprofit organizations, and 8% from other organizations including regional governments and economic development consultants
- 80% gained confidence in their ability to fulfill their role in the community
- 83% felt more prepared to help their local unit of government manage ARPA funds
- 57% are more likely to pursue regional collaboration efforts
- 63% have new ideas on how to match local and regional priorities with state and federal funding initiatives

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

MSU Extension programs engage participants in learning best practices in planning, community development, zoning, placemaking, design, land division, public engagement, environmental protection and sustainability. The application of knowledge and skills gained from MSU Extension programs builds stronger civic infrastructure and successful communities of every size.

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.

Relevant links

- https://sites.google.com/msu.edu/arpameetings
- https://www.canr.msu.edu/news/michigan-workshops-on-american-rescue-plan-act-arpa-coronavirus-local-fiscal-recovery-fund

Citizen Planner

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

Many Michigan communities face high turnover rates among elected and appointed officials and routinely have individuals serving without adequate training in local governance, finance, planning, zoning, or placemaking. Without these fundamental skills, communities cannot fully benefit from training on more advanced concepts that inform key land use policy and regulation issues in Michigan.

Local land use decision-makers are on the front line of new development and redevelopment in their communities. How well they do their job has a great impact on the future of their community and the use of public funds. Poor land use decisions can result in lawsuits, land being used contrary to zoning ordinances, or lost economic development. Millions of dollars are spent by Michigan taxpayers and insurance companies defending against lawsuits or paying damages resulting from poor land use decisions.

Most local land use decision-makers have no formal training. They learn on the job and may not have uniform skills, but courts expect local officials to know the rudiments of all applicable laws. MSU Extension's Citizen Planner Program is a proven solution to these issues.

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.

MSU Extension's Citizen Planner Program provides a unique program to learn the fundamentals of planning and zoning. Thousands of Michigan residents have graduated from the MSU Extension Citizen Planner Program since 1999. In 2021, 91 people participated in the Citizen Planner Program via Zoom and 206 individuals completed the self-paced Citizen Planner Online (CPO) program. Citizen Planner is a 6-week program with approximately 18 hours of instruction led by MSU Extension educators. CPO is an online, self-paced version of the program that takes approximately 15 hours to complete.

The Citizen Planner Program covers a broad range of topics including planning, zoning, zoning board of appeals, citizen engagement, ethics, development patterns, effective board meetings, and more. Lectures and activities set in a fictitious place known as Spartyville offer students an opportunity to work with nuanced legal principles around planning and zoning. Interactive planning and zoning scenarios help participants apply subject matter and build confidence.

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

2021 Citizen Planner graduates had the following to say about the course:

- "This course was MAGNIFICENT!"
- "Great class - recommend for any public official."
- "The staff was great and the format was super convenient."
- "All the instructors were very knowledgeable and kept the course moving."

2021 Citizen Planner graduates indicated how they will use what they learned:

- "To help plan for the redevelopment of our Downtown space"
- "Make better decisions as a board member. Knowledge/facts more than opinions"
- "During discussion on Planning Related items brought to the Board"
- "Share what I learned with my Planning Commission"
- "Try to incorporate a more Innovative Planning and Zoning approach"
- "It will really help as we work through our solar ordinance and upcoming master plan update"

In 2021, nine individuals went on to become a Master Citizen Planner (MCP). The MCP credential is recognized around the state as a sign of excellence. To obtain the MCP credential a person must graduate from Citizen Planner, pass an exam, and complete a 20-minute capstone project presentation. After the first year, MCPs are required to obtain six hours of continuing

education to retain their MCP credential.

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

MSU Extension's land use programs engage participants in learning best practices in planning, community development, zoning, placemaking, design, land division, public engagement, environmental protection and sustainability. The application of knowledge and skills gained from MSU Extension land use programs builds stronger civic infrastructure and successful communities of every size.

Connecting Entrepreneurial Communities

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

There is a need for more sustainable economic growth in communities all over Michigan, particularly rural, low to moderate income communities, and underserved populations.

MSU Extension provides networking and professional development opportunities for community stakeholders that improve their capacity to support local entrepreneurs. This leads to strengthening local economies within Michigan.

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.

Connecting Entrepreneurial Communities Conference

The Connecting Entrepreneurial Communities (CEC) program was created to educate local community members on the value of entrepreneurship and to create an environment conducive to entrepreneurial growth. A key part of this program is the annual CEC Conference, a community development initiative that brings together entrepreneurs, business leaders, economic development professionals, and decision makers to strengthen and broaden regional entrepreneurial networks.

Due to COVID-19, MSU Extension pivoted to a virtual conference which provided an opportunity to collaborate with Extension services in other states. MSU Extension provided leadership to seven other Extension systems (Missouri, Nebraska, South Dakota, North Dakota, Minnesota, Pennsylvania, and New Hampshire) as they came together to plan this week-long virtual conference.

Octoberfest

In October 2021, due to COVID-19, MSU Extension provided a virtual 'Lunch and Learn' program, modeled after the CEC Conference, called Octoberfest. This program was open to all, but geared toward community development professionals, Chamber of Commerce staff, Downtown Development Authorities, economic planners, government employees, and others with an interest in supporting entrepreneurial communities.

CEC Octoberfest included 8 breakout sessions held twice a week throughout October, on topics such as community engagement, imaging, resiliency, designing to prevent crime, co-creating change, economic development, collaboration, and tribal partnerships.

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

Connecting Entrepreneurial Communities Conference

- 314 individuals participated from 28 states, with high concentrations from Missouri (93), Nebraska (56), Michigan (55), Minnesota (35), South Dakota (16), and North Dakota (15)

- 37 sessions were offered during the week

- Each day concluded with a 'Community Connections' session where attendees could reflect on what they learned and network with others

- Based on the results of the post-conference survey,
  - 100% indicated they would attend the conference again in the future if offered

  - 97% can apply the ideas or skills they learned in conference sessions within their communities

  - 92% made new connections with peers that can help them bring these practices to their communities

Octoberfest

- 99 individuals from over 15 states participated in this weeklong event

- Based on the results of a post-program survey,
  - 100% said the educational sessions were engaging

  - 86% agreed that the content presented was replicable in their community

  - 93% thought the conference was a good value

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

MSU Extension provides educational and networking opportunities for community stakeholders that enhance opportunities for entrepreneurs in their communities. This results in more localized programs and services to support entrepreneurship growth in Michigan and fuel the economy.

Product Center

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

Value-added agriculture and food processing are driven by the needs of both the producer and consumer. Producers need to reduce costs and increase income for a viable and profitable operation. At the same time, consumers are increasingly supporting locally produced, value-added agricultural products. This increased demand for locally produced foods has led to more farmers investing in value-added activities and direct marketing.

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 MSU Extension Product Center helps producers meet the expectations of consumers by accelerating innovation and growth for businesses, industries, and entrepreneurs in the food, agriculture, and natural resources sectors of the Michigan economy. The Product Center assists clients with business development, financial planning, product development, service development, and marketing needs through counseling and education. The Product Center partners with the MSU Center for Regional Food Systems, the Michigan Good Food Fund, USDA Rural Development, and the Michigan Department of Agriculture and Rural Development.

The Product Center offers new and growing businesses counseling services in concept development, business planning, navigating regulations, and accessing the supply chain. Clients are connected to specialized services offered by campus staff and faculty, such as product classification and process authority review, nutritional labeling, food science, food processing and safety, and packaging assistance.

In partnership with the Product Center, the Food Processing and Innovation Center (FPIC) is Michigan's leading independent commercial food development, processing, packaging, and research facility. Businesses of all sizes rent the state-of-the-art facility featuring the latest in processing and packaging technology to create and commercialize new food and drink product lines for the marketplace. The FPIC provides customized processing options to meet the needs of existing food businesses and larger-scale startups in Michigan, the Great Lakes region and beyond. Products made in the FPIC are FDA and USDA compliant.

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

Overall, the Product Center had the following impacts in 2021:

- 805 clients were served
- Clients received a total of 4,458 contact hours
- 15 new businesses were started
- 404 new jobs were created
- $42,759,097 in total capital formation
- $21,092,180 in total sales growth
- 66 new licenses were obtained
- 57 new products were launched

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

The Product Center provides low-cost assistance to new and developing food and agricultural entrepreneurs that leads to job creation, increases in sales and investment, a stronger economy, and more sustainable communities.

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.

Relevant links:

- https://www.canr.msu.edu/news/amazing-myanmar-asian-cuisine-launches-new-line-of-grocery-meals
- https://www.canr.msu.edu/news/msu-product-center-helps-michigan-food-entrepreneurs-survive-and-thrive-throughout-pandemic

- Food Processing and Innovation Center
- About - Food Processing and Innovation Center
- Innovation and Growth - Alumni & Friends
- MSU Extension Develops Decontamination Method to Reuse N95 Masks

Type	Projects / Programs
Projects / Programs without a Critical Issue	**0**

Not Provided