

Michigan State University Combined Research and Extension Plan of Work 2022-2026

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I. Plan Overview

1. Executive Summary

INTRODUCTION

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 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. 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.

Consequently, the industry also generates a significant economic impact for the state. 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. Providing best practices guidelines and treatment recommendations in broad strokes isn't all that feasible or practical in Michigan. Research and outreach must be regionally relevant to the industry. In order to meet all of these varying needs across the state, MSU operates 14 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.

ADVANCING MICHIGAN AGRICULTURE

MSU AgBioResearch and MSU Extension have been instrumental in advancing agriculture in Michigan since the

university's beginning. In fact, MSU AgBioResearch was founded as the Michigan Agricultural Experiment Station in 1888 as part of a nationwide network of research stations specifically established to advance agriculture technology. Today, the impact of this work expands across the nation and even worldwide.

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 2019-2020 was \$122.6 million, with this report representing \$7.3 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 2019-2020 was over \$90.7 million, with this report representing \$11.6 million federal formula dollars and equivalent match.

PARTNERING BEYOND MSU

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.

MSU AgBioResearch and MSU Extension have a unique partnership with the Michigan Department of Agriculture and Rural Development (MDARD) on Project GREEN (Generating Research and Extension to meet Economic and Environmental Needs), a cooperative effort to benefit plant-based commodity industries within Michigan. Project GREEN 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.

KEY EFFORTS

Novel Coronavirus Response

During unprecedented disruptions to daily life due to the novel coronavirus global pandemic, MSU Extension remains committed to serving Michigan residents. MSU Extension has created a suite of online resources and programming, available on demand through its new Remote Learning and Resources online space (<https://www.canr.msu.edu/rlr/index>). MSU Extension had modified and transitioned traditional in-person programming to a digital space to continue to ensure individuals, families, farmers, business owners, and communities get the information they need when they need it.

The Remote Learning and Resources online space is a one-stop-shop for MSU Extension's digital offerings and educational materials related to the current circumstances. Among the resources featured on the site are:

- A listing of all MSU Extension virtual events — from family yoga sessions to lunch-and-learns for equine enthusiasts
- A collection of free educational resources for parents and caregivers to keep children engaged in learning throughout the school break
- Online learning opportunities for adults who may want to continue their own lifelong learning
- A series of resources to help individuals stay healthy and active during social distancing
- A variety of educational articles related to topics such as dealing with family stress, talking to children about novel coronavirus and managing finances

The College of Agriculture and Natural Resources along with MSU AgBioResearch also responded providing resources to ensure students and faculty were able to continue learning and conducting research in safe and healthy ways. Leadership sent out regular communications to help keep them informed. The popular field days showcasing the latest research findings successfully pivoted to online formats with high response.

MSU AgBioResearch has been able to continue much of our work due to the dedication of our faculty and staff along with strong support from MSU senior leadership. Our research centers have been open and have rapidly implemented necessary procedures to maintain the health and safety of our research staff and students working at on-campus and off-campus farms, as well as our animals and plants. We were able to establish a process to quickly review and approve research and related travel. Researchers were granted priority to projects that have immediate impact on production, especially those related to animal health, welfare and reproduction; critical plant pests like spotted wing drosophila; plant disease such as corn tar spot; plant breeding programs; as well as long-term research in both agriculture and natural resources.

Through the Food Processing and Innovation Center (FPIC), MSU Extension has also partnered with a local Lansing area healthcare provider to develop a process to use FPIC facilities to decontaminate N95 respirator masks. Having this process allows local hospitals and healthcare workers to reuse these masks, giving hospitals an added advantage in protecting themselves from the novel coronavirus.

Farm Stress Management Education

MSU Extension continues to address farm stress with behavioral health literacy programs designed to improve knowledge about signs of mental health issues, communication skills, and ability to help connect distressed people with resources among agricultural producers and stakeholders. Using online training platforms help to keep Extension professionals connected across state lines, enabling collaborative program efforts, sharing of best practices, and constructive problem-solving. MSU Extension remains a national leader in farm stress efforts for supporting Michigan's valuable agricultural economy and farming communities. To help respond to the needs of Michigan farmers and their families, MSU Extension developed three farm stress management programs:

Weathering the Storm in Agriculture: How to Cultivate a Productive Mindset shows farmers how to identify signs and symptoms of stress in themselves and their families, and teaches stress management techniques they can use in their everyday lives. This curriculum provides tools resources and information for farmers and their families to help guide them through difficult situations.

Communicating with Farmers Under Stress is designed for those who work with agricultural producers and farm families to help them learn more about managing stress and communicating with those in need. This workshop teaches agricultural industry workers how to recognize and respond to signs of mental distress with the farm families they encounter in their work.

Mending the Stress Fence is a short program delivered in 30 minutes or less and helps participants create self-awareness and provides them with tools and resources to help those in need. Topics highlighted in the three-unit course are: Identifying and Responding to Signs of Stress, Strategies for Maintaining Stress with incorporated 8 Dimensions of Wellness, Asking Open-Ended Questions, and Suicide Prevention Resources.

In addition to these programs being implemented in Michigan, the materials are available for extension educators across the nation through access to the MSU train-the-trainer course. As of 2020, MSU Extension farm stress programs are implemented in-person or online in 21 states with farm stress facilitators who are trained in the MSU programs.

Teletherapy or Online Counseling Program for Farmers Experiencing Stress

Michigan State University Extension's Farm Stress Program is now equipped to connect farmers experiencing stress and mental health issues with online counseling. Through a partnership with Pine Rest Behavioral Health, MSU Extension can link farmers with a licensed mental health therapist via teletherapy. Online counseling or teletherapy provides mental health and counseling services through the internet rather than in-person. Traditional therapy is typically conducted during face-to-face meetings in an office. Teletherapy is a counseling session that is completed through video chat between mental health care providers and clients. This advanced approach provides flexibility for people to access behavioral health supports in the comfort of their own environment.

Delayed Planting Resources

Throughout Michigan and the Midwest, the prolonged wet weather and flooding in spring 2019 put farmers in a difficult financial position. Unprecedented rainfall forced farms to delay planting and greatly adjust management practices. In the worst cases, some fields were not planted at all. MSU Extension's statewide network of agricultural educators were quick to respond to this situation by tracking growing conditions, working individually with farmers, hosting crop update sessions and writing educational articles detailing how farmers could adjust to inhospitable conditions, make difficult choices and apply for crop damage assistance. Because this issue has the potential to greatly affect farm income, educational efforts included programming dedicated to assisting farmers under stressful conditions.

More than 600 participants attended in-person MSU Extension's informational sessions discussing strategies for handling delayed planted acreage between June and August 2019. Delayed planting educational materials were also viewed online nearly 25,000 times between June and August 2019

Addressing Animal Agriculture Needs

M-AAA is a partnership among Michigan animal agriculture industries, Michigan State University College of Agriculture and Natural Resources, MSU College of Veterinary Medicine, MSU AgBioResearch and MSU Extension focused on the advancement of the Michigan animal agriculture economy. Partners include: Michigan Allied Poultry Industries, Michigan Cattlemen's Association, Michigan Farm Bureau, Michigan Horse Council, Michigan Meat Association, Michigan Milk Producers Association, Michigan Pork Producers, Michigan Sheep Breeders Association, Michigan Soybean Promotion Committee (associate member) and the Michigan Department of Agriculture and Rural Development. With competitive grant funding starting in 2015, the State of Michigan invested in M-AAA research to advance the animal agriculture industry from fiscal years 2017 to 2020.

Examining animal agriculture, alternative proteins amid climate change concerns

As meat alternatives quickly grow in appeal — especially for those 40 and under (MSU Food Literacy and Engagement Poll) — and climate change continues to be a heated topic of debate, those working in the beef industry face growing questions about how to adapt, how to be sustainable and how to address greenhouse gas concerns.

Michigan State University (MSU) is working with the industry and stakeholders to help ensure that producers, especially, are equipped to face the evolving future and the next food trends. Jason Rowntree, an associate professor of animal science at MSU and Extension educator focused on grazing and grass-finishing education, said the beef industry is unquestionably becoming more complex. “The most prominent aspect, I think, that we all can acknowledge is this entry of plant-based proteins and potentially laboratory-based proteins that are coming into the equation,” he said.

Plant-based proteins, commonly referred to as plant-based meat, are emerging as an alternative to beef. According to the MSU Food Literacy and Engagement Poll, a national survey on consumer knowledge, opinions and attitudes conducted by MSU AgBioResearch, 35% of Americans consumed plant-based meat in the past year. Cell-cultured proteins, created in a lab and derived from animal cells, aren't yet widely available. The MSU Food Literacy and Engagement Poll indicates, however, that 35% of Americans say they are likely to buy them once they are.

Among others, the belief that cattle contribute to climate change is one potential reason why consumers would choose alternative proteins over beef. Cows emit methane, a greenhouse gas that contributes to global warming. “There are a lot of conversations about climate change all over the media, and awareness is being raised about the potential impact of animal agriculture or beef production on climate change,” George Smith said. “There's been a lot of work conducted at Michigan State University that objectively asks that question.”

MSU is among those examining the beef production process and how it affects soil health at the MSU Lake City Research Center. A particular focus is analyzing how grazing systems contribute to what he calls “regenerative agriculture.” “When I talk about regenerative ag, it's that you're actually producing food in a way that's building and improving land,” he said. “That land is actually improving and regenerating versus being sustained, which can often be just another misnomer for efficiency - output over input.” Rowntree has found that taking advantage of the natural cycle created from cow's methane emissions can help offset the environmental impact.

Improving Michigan's ability to site livestock facilities

Odors from livestock production are the result of a complex set of circumstances, including location and size of the facility, species, feed storage and animal diets, type and size of manure storage, and odor control technologies. The movement and dispersion of odors are heavily dependent on meteorological factors such as wind speed and direction, as well as atmospheric stability. As livestock operations expand in Michigan due to favorable climate, population density and water resources, siting of facilities becomes critical. No livestock odor mitigation strategy exists that can replace proper siting. Having the tools to make proactive siting decisions is essential for both new and expanding facilities. The Generally Accepted Agricultural and Management Practices for Site Selection and Odor Control for New and Expanding Livestock Facilities (Siting GAAMP) has been used in Michigan since 2000. A key portion of the GAAMP since 2005 was the

Michigan Odor from Feedlots-Setback Estimation Tool (MI OFFSET), which provided an estimated odor footprint around an odor source location of interest. However, the original version had limitations, including a single average odor footprint for the entire state based on a small number of climatic observing sites and only 9 years of data. Andresen's team updated and modernized the original OFFSET scheme with a comprehensive new climatic dataset, providing detailed information that more accurately accounts for the influence of the surrounding Great Lakes on local wind and stability climatologies. Results of the new dataset were incorporated into a new web-based decision support tool, MI OFFSET 2018, which allows users to enter their specific location and odor emission information to obtain a location-specific odor footprint. Having this information to proactively identify areas that are best suited for livestock production is essential for both new and expanding facilities, and should support the growth of the Michigan livestock industry and its contribution to the state's economy.

Legume impact on animal and forage production, enteric methane and nitrous oxide emissions in Midwest grazing systems

Although U.S. agriculture only comprises 9 percent of domestic greenhouse gas emissions, the production of beef cattle is considered a large emitter and therefore a key driver of climate change. New technologies and equipment allow for scientists to measure methane emissions while cattle remain on pasture. Known as Gas Quantification Systems, this equipment can be placed in the pasture and monitor emissions on up to 25 head of cattle daily. The data can be transmitted wirelessly to an online database for real-time assessment. Michigan State University is one of a few global universities using this technology. Rowntree and his team's primary goal is to examine the impact of two legume-containing forage livestock systems, and assess their subsequent greenhouse gas emissions with the goal of identifying management tools that lower the overall beef cattle carbon footprint. Year 1 consisted of 104 days of grazing. There were no differences in forage productivity and animal performance between the two systems. In terms of forage growth, both treatments followed a similar pattern with production peaking in late June, followed by a significant decline by the end of July and beginning of August. In Year 1 of the two-year trial, Rowntree identified 20 percent lower enteric methane emission in cattle grazing a complex legume forage mixture versus a simple system composed of alfalfa grass. The results suggest that forage system management has the potential to considerably lower the carbon footprint of grazing cattle and increase environmental sustainability of beef production.

Optimizing nutritional management of sheep to improve reproductive outcomes in accelerated production systems

The seasonal supply of lamb and low flock productivity are primary barriers to growth of the North American lamb industry. Accelerated production overcomes both of these barriers by creating a consistent, year-round supply of lamb and by increasing productivity and production efficiency by decreasing the birth interval of an individual ewe from 12 to approximately 8 months. Richard Ehrhardt and others have demonstrated that accelerated production can increase productivity two to three times the national average. A primary barrier to adoption of accelerated production is poor conception and litter size from ewes mated mid-winter to mid-summer. In Ehrhardt's preliminary work, he has shown that nutritional management of ewes during the pre-conception period in the spring can have a huge impact on reproductive outcomes. This project is investigating this further by extending the period of pre-conception nutritional management back into lactation of the previous production cycle. Ehrhardt is also extending the study to evaluate the impact of pre-conception nutritional management on reproductive outcomes in both spring and fall breeding periods. The initial phase of the study involved the enrollment of 125 ewes in early lactation during February 2018. These ewes were assigned to one of five treatments with random allocation of ewes to treatment that were stratified according to breed, parity and body condition score. These ewes were weighed, and blood samples were taken as often as twice per week over the entire study period. All ewes were subjected to routine — often weekly — assessments of pregnancy status via real-time ultrasound scanning from day 18 to term. The pregnancy outcomes of the first phase of the study revealed that the nutritional treatments employed impacted both lambing percentage and conception rate, suggesting feeding strategies may further enhance lamb production and profitability in accelerated systems.

Monitoring cow performance during milking to evaluate and improve worker training, cow udder health and milk quality

On dairy farms, milking cows is obviously a critical task. It's performed two to four times daily and requires training. Employee training programs on milking procedures have been important in standardizing the procedures used on many farms. If not followed, this can result in lost revenue. This project sought to address training around two known problems that are prevalent on dairy farms: bimodal milking and over-milking. Bimodal milking occurs when cows are not properly stimulated during the pre-milk preparation or when the lag time between stimulation and attachment of the milking unit is insufficient for milk letdown to occur before the unit is applied to the teats. Over-milking occurs when milking is finished for each teat, but the unit stays on because of improper adjustment of the automatic takeoffs that stop the vacuum and remove the unit, or when employees override the automatic takeoff units. Moore and the team worked with Michigan dairy operations to:

Assess their current milk protocols, employee compliance and milking performance using VaDia vacuum recorders during milking.

Provide input on participating farms' milking protocols.

Work with owners and managers to provide suggestions on employee training to improve protocol compliance and milking performance.

Re-assess milking after changes were made based on recommendations.

Twenty-six dairy herds from across Michigan were included in the project, with the support of interns and educators working in pairs to provide support to eight to nine farms each. Farms ranged in size from 105 cows to 3,500 cows, with a total of over 19,000 cows. Herds were visited at least three times each during the project. Participation by farms was voluntary and at no cost to the project. Three MSU Extension undergraduate student interns were employed to work with MSU Extension dairy educators in three areas of the state: northern lower, Thumb area and south central, and central. Results from initial visits and analysis of milking performance data reinforced that over-milking and bimodal milking are issues on Michigan dairy farms. These results were shared directly with local Michigan farms to improve worker training and efficiency of dairy operations.

Project GREEN (Generating Research and Extension to meet Economic and Environmental Needs), a plant agriculture initiative led by Michigan State University AgBioResearch, MSU Extension and the Michigan Department of Agriculture and Rural Development, celebrated its 22st anniversary in September 2020. In partnership with industry groups and growers, researchers and outreach specialists combat plant agriculture challenges such as mounting pest and disease pressures.

Project GREEN funded 73 new and continued projects in 2019, totaling more than \$2.3 million.

In its first 20 years, Project GREEN received more than \$100 million in support from the state of Michigan and turned that into \$2.5 billion in estimated economic impact.

Every \$1 investment in Project GREEN research yields \$31.50 in economic return to Michigan.

Varietal susceptibility and chemical control of blueberry stem gall wasp in Michigan blueberries

Rufus Isaacs, a professor in the MSU Department of Entomology, is testing chemical controls and the susceptibility of blueberry varieties to stem gall wasp.

Blueberry stem gall wasp has become a damaging pest to the Michigan blueberry industry, causing yield loss and contamination risk. Researchers determined the susceptibility of different cultivars, determined ways to integrate selective insecticides into existing integrated pest management programs, and worked to validate and improve a predictive model for timing controls against gall wasp. Growers were provided with vital information needed when making planting or replanting decisions. Researchers have also determined insecticides that can help reduce gall infestations in fields, giving

growers options for existing fields that are susceptible to gall wasp. MSU Extension programming to improve growers' understanding of tactics for gall wasp control have included presentations at extension meetings, a new fact sheet and in-season announcements of gall wasp activity across the main production region.

On-farm research can solve new disease problems facing onion and celery growers

Mary Hausbeck, a University Distinguished Professor in the MSU Department of Plant, Soil and Microbial Sciences, is working to mitigate disease challenges in onions and celery.

Michigan ranked second in the U.S. for production of fresh market and processing celery in 2018, grown on 1,900 acres and valued at \$19.5 million. The state ranked seventh in the U.S. for production of summer storage onions in 2016, grown on 2,400 acres and valued at \$10.1 million. Michigan onion and celery growers typically grow both crops and have experienced loss and increased management costs due to new pathogens over the last several years. Celery crop loss from crown rot is direct, as plants are killed in the field prior to maturity. The suspected pathogen is *Fusarium*, but the currently grown varieties are considered to be resistant to the common pathogen races. *Stemphylium* leaf blight on onion causes indirect loss through premature leaf senescence, which negatively impacts bulb size, yield and storage. Researchers conducted onion field trials, which indicated an 18% yield increase when a new crop protection program was tested. This equates to a value of \$1.8 million to the state's industry. Discontinuing the use of standard fungicides (azoxystrobin and mancozeb) that used to be effective but are no longer helpful due to pathogen resistance will save the state's growers approximately \$500,000. The celery studies indicate variable results using fungicides. Michigan's growers should not invest in a costly crop protection program at this time but rather look to more tolerant cultivars.

Verifying a prototype risk model to help growers manage spotted wing drosophila in Michigan tart cherries

Nikki Rothwell, coordinator of the Northwest Michigan Horticulture Research Center, is working to develop an online risk model to help with spotted wing drosophila management.

Spotted wing drosophila (SWD) has drastically affected traditional pest management in Michigan cherry orchards. In laboratory studies, researchers have found that change in fruit color is correlated to SWD infestation in tart cherry. In response, they have developed a rudimentary risk model to help growers manage SWD. For this project, researchers are attempting to verify this model in tart cherry orchards throughout Michigan and better understand the effect of environmental conditions on SWD activity, population growth and infestation. Researchers are seeking to further refine the proposed model with environmental conditions data to guide annual recommendations. Lastly, they intend for this model to be an online assessment tool to guide SWD management for cherry growers. Michigan cherry growers were early adopters of integrated pest management. This proposed research would provide the first online risk model to assist SWD management in tart cherry.

Science Literacy and Engagement

According to a survey conducted by the Center for Food Integrity, 80 percent of U.S. consumers want to know more about their food and how it was grown but lack a direct connection to agriculture. MSU AgBioResearch is helping to bridge that gap through this initiative. Food@MSU brings attention and increases awareness of the breadth and depth of MSU's food research portfolio. Twice a year we conduct the MSU Food Literacy and Engagement Poll to gauge U.S. consumers knowledge of and behavior toward food.

To help cut through some of the conflicting information about our global food system, we also conduct Our Table conversations on various food related topics, including food safety, GMOs and food waste. In previous years, these community conversations take place around a table custom made for the initiative from fallen trees on the MSU campus. It is our goal to meet consumers where they are, and help provide the tools they need to be better informed on what to put on their plates. We have been able to shift these conversations to Zoom webinars.

2. FTE Estimates

Year	1862 Extension	1862 Research
2022	185.0	112.0
2023	180.0	110.0
2024	180.0	110.0
2025	180.0	112.0
2026	175.0	112.0

II. Merit / Peer Review Process

All researchers and other personnel funded by MSU AgBioResearch and Extension are subjected to thorough annual reviews as mandated by Michigan State University. These processes are regularly reviewed to maximize effectiveness and to enhance the opportunity for employee development. For faculty and staff with departmental affiliations, all raises are based on merit and include reviews at both the department and college levels. In recent years, these reviews have been standardized to ensure consistency and transparency both within and among our cooperating academic units.

All AgBioResearch research project plans are peer reviewed at the department and research center level on a five-year renewal cycle. The alignment with the USDA Knowledge Areas has been stressed in recent years. We have also updated our guidelines for plan preparation to increase the quality and relevance of the research. To improve the quality of the proposals submitted to competitive programs we have continued to increase our investment in our Office of Research Support. Our staff now includes 4 FTE focusing on pre-award support, 2 FTE on post-award support, and 1 FTE in program evaluation and metrics.

MSU Extension uses several continuous processes that assist in the merit and peer review process. At the county level, the public, local government officials, advisory group members, extension council members, staff members, and industry experts are involved in both the stakeholder process and review of the county and individual agents' plans. Each of MSU Extension's Institute content area work teams review the county needs, agents' plans, and research to support these programs, as well as others that may reflect emerging trends. Collectively, these plans are reviewed by MSU Extension institute and district directors who not only evaluate them, but use them in their regional and statewide presentations to describe future plans.

III. Stakeholder Input

1. Actions to Seek

On a statewide level, in 2016 MSU Extension executed an Issues Identification process, whereby an online survey and a series of statewide focus groups elicited feedback from external stakeholders. The online survey resulted in 7,180 responses from our community. Results include a ranking of statewide priorities, as well as specific programmatic feedback. There were also 52 focus groups held across Michigan, including approximately 1,200 participants, resulting in the identification of priorities by stakeholders for each MSU Extension district. The data collected from this process will enable MSU Extension and AgBioResearch to identify community needs, priorities for the future, and relevancy of existing programs to direct efforts for the next several years.

To address more local or district needs, MSU Extension has created District Advisory Groups to help in gathering input and setting priorities. Local 4-H programs will also continue to utilize county expansion and review stakeholder advisory committees to guide the direction of the local 4-H program.

MSU AgBioResearch continuously gathers stakeholder input through regular interactions with commodity groups, agricultural and natural resource organizations, partner agencies and research center advisory groups. These interactions have significant impacts on our programming decisions. Of special note are Project GREEN (Generating Research and Extension to meet Economic and Environmental Needs) and the Michigan Alliance for Animal Agriculture where stakeholders submit specific priorities and participate in the project review process.

2. Methods to Identify

The MSU Extension and AgBioResearch Issues Identification process utilizes statewide surveys and citizen focus groups to identify the major issues and opportunities in Michigan and assign a priority ranking to each. Also, through this process, additional focus groups were held targeting underrepresented audiences in MSU Extension programming, yielding input on how future program efforts can better meet the needs of these groups.

Regular interaction with the groups mentioned above: We sit on boards and committees that give us regular feedback on programs and priorities. We also strive to be accessible as needs arise.

3. Methods to Collect

Through the Issues Identification process, MSU Extension and AgBioResearch elicited feedback from stakeholders via online surveys and community focus groups, yielding both quantitative and qualitative data on programming priorities.

To address local county or district needs, local staff regularly elicit feedback from stakeholders via open meetings and advisory committee conversations.

In order to keep our stakeholders informed on our response to COVID-19, we began bi-weekly Zoom calls with stakeholders in April 2020. These meetings provide our stakeholders with the opportunity to hear directly from leaders in the College of Agriculture and Natural Resources, AgBioResearch and MSU Extension on academic, outreach and research programs as well as the opportunity for our stakeholders to ask questions and make comments. In August of 2020, these meetings shifted to monthly update meetings. We continue to have approximately 30-40 stakeholders attend these meetings. We also participate in regular calls with Michigan Department of Agriculture and Rural Development and numerous commodity and industry board meetings.

4. How Considered

MSU Extension utilizes stakeholder input in the development of work team logic models that become the framework for individual educators and specialists to align with, as well as help to identify local needs that may be specific to a certain county or district. Issues Identification survey and focus group results have been used, and will continue to be used, to develop logic models for specific program priorities.

At the local county level, staff utilize stakeholder input and feedback to determine the direction of local programming.

IV. Critical Issues

1 Water Quality and Quantity

Description:

Michigan has more than 36 million acres of land with more than 11,000 inland lakes and 36,000 miles of streams. Assuring water quality so that the state's water resources support designated uses such as drinking, recreation, and ecological health is a long-term concern. We will:

Increase participants' understanding of ecology, natural resources management and decision-making, ecosystems and processes, and contested issues

Increase participants' awareness of the impacts their actions have on water resources

Determine the best way to remove pollutants from soil and water and turn over these areas into safe, productive sites

Keep Michigan's surface and groundwater clean and make all citizens aware of why this is a critical issue

Ensure that a safe, secure and plentiful water supply is available for the state's citizens, industries, wildlife, and natural areas

Term: Long

Science Emphasis Areas

Agroclimate Science
Environmental Systems

2 Plant and Animal Production and Health

Description:

Michigan produces approximately 300 commodities, making the state second only to California in terms of crop diversity. Agriculture is one of the fastest growing sectors of the Michigan economy. Animal agriculture and its associated products -- milk, meat, wool, eggs, cheese, and butter -- also make up a significant portion of Michigan's economy. We will:

Increase farmers' success with protecting the environment, ensuring food safety, reaching new markets, and advancing agriculture through applied research
Conduct research on selecting plants and animals with desirable traits and on new methods to combat diseases and parasites
Study nutrition and animal management systems
Develop integrated crop and soil management systems to meet production and environmental goals.

Term: Long

Science Emphasis Areas

Agroclimate Science
Environmental Systems
Sustainable Agricultural Production Systems

3 Secure Food and Fiber Systems

Description:

Our expertise in biosystems engineering, food processing, and nutritional immunology is paving the way for the creation of new food products that offer Michigan residents food choices with greater health benefits. Engineering and processing advances will lead to greater cost efficiencies, enhanced food safety and security, and increased development of non-food products (e.g., biofuels, building materials). We will:

Enhance the production and profitability of small-scale agriculture projects and improve community wellness
Use educational processes to facilitate the incorporation of renewable energy into households, governmental offices, and businesses
Increase the capacity to develop forest and agricultural-based renewable resources in ecologically and economically sustainable ways.

Term: Long

Science Emphasis Areas

Agroclimate Science
Bioeconomy, Bioenergy, and Bioproducts
Environmental Systems
Food Safety
Sustainable Agricultural Production Systems

4 Human Health, Youth, and Families

Description:

Promoting well-being for Michigan's youth and families requires attending to individuals' physical, social-emotional, and behavioral health. To improve the health and safety of Michigan's adults, youth, and families, we developed broad and comprehensive research and education programs to address Michigan residents' needs. Youth development, community development, nutrition and food safety research and education, and family and parenting skills are important areas of focus. We will:

Support Michigan residents in eating healthier, being better caregivers, and preventing and managing chronic health conditions through education

Develop better models for the human health and human services sectors

Study the function of nutrients and other components related to human health

Improve management of financial resources by individuals and families through education

Prepare youth for life and work

Term: Long

Science Emphasis Areas

Education and Multicultural Alliances

Family & Consumer Sciences

Food Safety

Human Nutrition

Youth Development

5 Environmental Stewardship and Natural Resources Management

Description:

Michigan's natural resources are a fundamental asset for the state's future economic opportunities. Challenges concern how residents of the state can best benefit from its rich natural heritage without overburdening the carrying capacity of its natural systems and reducing opportunities for residents and visitors alike. Our natural resource programs improve public understanding, help landowners and communities use those assets for sustainable long-term social and economic development, and conserve natural resources for future generations. We will:

Develop tools and technology to help Michigan's natural resource-based tourism industry grow by meeting consumer demands

Determine how wildlife, fisheries, forest and natural resources areas respond to habitat management to encourage management for sustainable benefits

Term: Long

Science Emphasis Areas

Bioeconomy, Bioenergy, and Bioproducts

Environmental Systems

6 Workforce Development, Community Resource Development, and Innovation

Description:

Successful and thriving communities combine knowledgeable and engaged legislators, businesses, community groups, and residents. Agricultural producers benefit from improving their business and financial management skills, whether they raise dairy cows or grow blueberries. Marketing, distribution and other economic variables

also play a critical role in the success and profitability of the state's agriculture and natural resources industries.
We will:

Assist entrepreneurs who develop and commercialize high-value, consumer-responsive products and businesses
Research and provide education on international trade and development, economic policy, domestic and foreign policy, and community resource planning and development to help Michigan growers and producers navigate governmental regulations both here and abroad, as well as connect them with foreign buyers and markets
Assist Michigan communities in making critical policy decisions and functioning more smoothly with citizen involvement.

Term: Long

Science Emphasis Areas

Education and Multicultural Alliances

Family & Consumer Sciences

Sustainable Agricultural Production Systems