# 2015 Michigan State University Combined Research and Extension Annual Report of Accomplishments and Results

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## I. Report Overview

### 1. Executive Summary

The need for targeted research and outreach in the areas of agriculture and natural resources has arguably never been higher than it is today. With emerging threats such as antibiotic resistance, bovine tuberculosis, invasive pests and avian influenza, agriculture producers are faced with a plethora of on-farm issues, many of which have human health implications. This, at a time, when the growing world population is projected to exceed 9 billion by 2050 and requiring our global food supply to double within that same timespan.

Michigan State University (MSU) AgBioResearch (ABR) scientists and MSU Extension (MSUE) specialists are valued for providing science-based knowledge in an effort to improve food and quality of life, as well as generate economic viability and sustainable practices. They are committed to helping to find solutions to meet growing food demands with fewer resources.

ABR conducts leading-edge research that combines scientific expertise with an understanding of real-world problems in the key areas of **FOOD**, **ENERGY** and the **ENVIRONMENT**. The research strives to find viable, workable solutions in many diverse areas from entomology and packaging to microbiology and nutrition. The multidisciplinary projects are led by more than 300 scientists from the following MSU colleges:

- Agriculture and Natural Resources
- Natural Science
- Veterinary Medicine
- Engineering
- Social Sciences
- Arts and Letters
- Communication Arts and Sciences

An integral part of the pioneer land-grant university, **ABR maintains a balance between basic and applied research and relies heavily on constituent and stakeholder input from the agricultural and natural resources industries** to identify priorities. An emphasis is placed on integrated and multidisciplinary endeavors with programs continually evaluated for relevance and progress to meet the changing needs of both the agriculture and natural resources industries. The accomplishments and discoveries outlined in this report are reflective of some of the reasons why ABR (founded as the Michigan Agricultural Experiment Station) continues as one of the most successful entities of its kind 125 years after its formation.

Also a vital component of the land grant mission, Michigan State University Extension (MSUE) disseminates the research knowledge to people in an effort to improve lives through an educational process that **applies knowledge to critical issues, needs and opportunities**. One of the hallmarks of MSUE is its willingness and ability to adapt programming to meet the needs of Michigan residents, communities and businesses.  Community needs are addressed through four Institutes:

- Preparing Michigan's Children & Youth for the Future
- Enhance Michigan's First Green Industry: Agriculture and Agribusiness
- Improve Health and Nutrition for Michigan Residents
- Greening Michigan: Leveraging Natural and Human Assets for Prosperity

In the 2014-2015 federal year, these Institutes directly served 149,342 adults and 203,450 youth through workshops, trainings, and one-on-one consultations. Over 1 million people were provided information indirectly through web sites, hot-lines, public events with information booths and brochures, and eXtension.

The **food and agriculture industry in Michigan is estimated to contribute more than $100 billion to the state's economy (direct, indirect and induced) and accounts for more than an estimated 923,000 jobs**. Food and agriculture represent about 22 percent of the workforce in Michigan. With more than 300 commodities, 55,000 farms and 10 million acres of farmland, Michigan also has one of the most diverse agricultural industries in the nation. The state ranks second in the U.S. in terms of its crop diversity from fruit, vegetables and graincrops to ornamental trees, livestock and fish.

Michigan farmers, ABR scientists and MSUE educators continue to be asked to accomplish more with less. Conversely, **challenges with pests, plant diseases, processing logistics, shifting climates and the need for consumer education have become increasingly complex and more demanding**. Leveraged and external funding is more important and more competitive to secure than ever before. ABR scientists and MSUE educators continue to demonstrate flexibility, innovation and a perseverance that equips them to respond to these challenges.

**Every dollar the state invested in ABR and MSUE in 2014-15 resulted in an additional $2.59 in federal funds and external contracts, grants and other revenues to serve Michigan residents.** During that fiscal year, ABR secured $92.1 million in external contracts and grants from such federal agencies as the U.S. Department of Agriculture (USDA), National Science Foundation (NSF) and the U.S. Agency for International Development.

In the FY2014-2015, **the state's $56.6 million investment in ABR and MSUE generated more than $1 billion for Michigan residents**. The state's investment also allows ABR to secure external, competitive funds - further leveraging state dollars while creating opportunities to make discoveries that advance Michigan agriculture and sustain our natural resources.

The success and accomplishments of ABR and MSUE are fueled by **close partnerships with each other, as well as linkages to state agencies, commodity groups and other stakeholders, and outstanding legislative support.** This collaboration is crucial as researchers and outreach specialists continue to tackle and address issues that rarely respect geographical borders such as food safety, invasive species and plant and animal diseases.

**Key Extension Total Inputs and Outputs for FY 2015**

- 1,006 staff representing 675.5 FTEs with 125 FTEs funded through 3BC
- 83 counties covered with educational programing and outreach
- 203,450 youth participated in MSU Extension programs
- 149,342 adults participated in workshops and formal trainings
- 14,630 adult volunteers assisted 4-H programming
- 4,859 youth volunteers assisted 4-H programming

**Key Extension Outputs for FY 2015 by Institute and Work Team**:

**Institute for Agriculture and Agribusiness**

- 35,840 adults educated by Animal and Plant Production/Environmental Quality
- 10,483 adults educated by Business Management

**Institute for Children and Youth**

- 203,450 youth received experiential education in 4-H
- 6,083 adults trained by Academic Success
- 2,882 adults trained by Capacity Building
- 749 adults trained by Career Education/Work Force Preparation
- 1,655 adults trained by Leadership & Civic Engagement

**Institute for Greening Michigan**

- 1,686 adults educated by Sustaining Community Prosperity
- 3,410 adults educated by Natural Resources Stewardship
- 3,060 adults educated by Government and Public Policy
- 5,477 adults educated by Financial and Homeownership Education
- 6,112 adults educated by Community Food Systems
- 6,628 adults educated by Seagrant

**Institute for Health and Nutrition**

- 1,520 adults trained by Disease Prevention and Management
- 7,329 adults trained by Food Safety
- 52,304 adults trained by Nutrition and Physical Activity
- 3,332 adults trained by Social and Emotional Health

**Key Extension Accomplishments for FY 2015 by Institute and Work Team**:

- Hosted 100 Farm Bill informational meetings for more than 8,000 producers.
- Attracted 2,313 youth to participate in Ag Innovators Experience challenges, enhancing their interest in and knowledge about science and agriculture careers.
- Drew more than 350 participants to the first Great Lakes Hops and Barley Conference.
- Helped struggling Michiganders avoid home foreclosure through sound financial and homeownserhip education.
- Helped leverage $2.7 million in funding for farm-to-fork food organizations.
- Expanded the offerings of the IPM (integrated Pest Management) Academy through online education.
- Taught nearly 1,000 people correct food preservation processes and techniques.
- Matched 270 at-risk youth with caring adult mentors and another 200 with mentors focused on STEM (science, technology, engineering and math).
- Helped avoid an outbreak of avian influenza by providing biosecurity education to 4-H families.
- Prepared youth for postsecondary education through pre-college programs such as educational camps.
- Taught parents and caregivers techniques to assure school readiness.
- Helped more than 84,000 residents improve nutrition and physical activity through Supplemental Nutrition Assistance Program (SNAP) education.
- Broke down cultural and language barriers to deliver nutrition education to more than 8,500 underserved people.

• Through the MSU Product Center, helped entrepreneurs create more than $8.2 million in total capital formation, including more than $7 million of owner investment in Michigan businesses.

**Key areas for MSU AgBioResearch in FY15:**

**Preventing Childhood Obesity**: More than one-third of adults and one in six children in the United States are obese, according to the Centers for Disease Control and Prevention. Obesity is linked to a multitude of health problems, such as heart disease, stroke, diabetes and many types of cancer. Estimates of the annual medical cost of obesity in the United States top $147 billion. Individuals who come from low socioeconomic backgrounds may be more likely to struggle with their weight for several reasons, including a lack of access to nutrition information. Kami Silk, the associate dean of research for the College of Communication Arts and Sciences at Michigan State University (MSU), is examining the beginning stages of life. She is studying the relationship between obesity in infants and their mothers' access to information on appropriate feeding practices. Working with Mildred Horodynski, a professor in the MSU College of Nursing and an expert on childhood nutrition, Silk has created the Tools for Teen Moms project. The initiative is aimed at 80 low-income first-time teen moms.

**The Same for Less: Genetic science the key to better feed efficiency in dairy cattle:** As the eighth largest dairy-producing state in the country*, Michigan is home to more than 400,000 dairy cows spread across farms with herds numbering less than 100 up to thousands. Feeding such a large number of animals is a challenging task. With each animal eating approximately $5 in feed every day, Michigan dairy farmers spend over $730 million each year to keep their herds well-nourished and to produce enough milk to meet consumer demand. Michael VandeHaar, Michigan State University (MSU) AgBioResearch livestock nutritionist, and his colleagues are working to bring that cost down by combining genomics and nutrition science to breed cows that require less food to produce the same volume of milk.

**Adapting human medical technology to predict plant diseases:** Developing technology to ensure that growers have the capability to fight the next devistating blight epidemic has been the subject of ongoing research at Michigan State University (MSU) and in agriculture and natural resources programs around the country. Now, MSU researchers from human medicine, plant genetics and plant pathology have joined forces to adapt the latest technology for tracking and predicting the next major plant epidemic. "We aim to provide point-of-contact plant disease diagnosis, which will facilitate rapid disease management decisions to minimize crop losses and improve grower profitability," said Martin Chilvers, assistant professor in the MSU Department of Plant, Soil and Microbial Sciences. "The data we collect will also aid in longer term management solutions. For the general public and globally, this will translate into increased food security."

**Developing alternative approach to assess stream health:** The 2011 EPA Biological Assessment revealed that nearly 42 percent of U.S. streams are in "poor" biological condition, which is measured by the health of native fish and invertebrate populations. Only 53 percent were determined to be in "fair" or "good" condition. The remaining 5 percent have not been assessed. Using data to make better decisions, Pouyan Nejadhashemi and his research group have developed models that factor in aquatic life, soil, land use, climate change, erosion, plant growth and many other variables. Historically, models have done a poor job at considering several variables concurrently, leaving researchers to make generalizations based on relatively small amounts of data.

**Investigating algae's full potential as an efficient renewable energy source:** Blue-green algae may look unappealing in nature, settling on the surface of swamps and other bodies of water. But it could be one of the catalysts for developing the bioeconomy of the 21st century, including renewable energy sources that fuel the future. The algae, also known as cyanobacteria, use photosynthesis to convert light energy from the sun into the chemical energy needed for growth and function. Scientists at Michigan State University (MSU) are learning more about the photosynthetic process from these abundant organisms -- with an eye on efficiency. Cheryl Kerfeld, the John A. Hannah Distinguished Professor of Structural Bioengineering and an AgBioResearch scientist, and her team of researchers have been studying a

process by which cyanobacteria protect themselves from too much light.

**Understanding insect response to popular insecticide in effort to develop new compounds**: Developed in the 1980s, insecticide-treated bed nets are estimated to be twice as effective as non-treated nets in preventing malaria, a deadly mosquito-borne disease that kills more than 600,000 people in Africa and around the world each year. Some studies have shown a protection rate as high as 70 percent compared with no nets. Michigan State University (MSU) entomologist Ke Dong, who operates the MSU Insect Toxicology and Neurobiology Laboratory, has been studying various aspects of the one class of insecticides approved for use on mosquito bed nets -- pyrethroids. The work has been ongoing for the past two decades with continous funding from the National Institutes of Health (NIH). She wants to understand the mechanism by which these compounds control various insects, including malaria-carrying mosquitoes. This large class of synthetic insecticides is derived from pyrethrum, a compound extracted from dried chrysanthemum flowers.

**Curtailing environmental harm through efforts in conservation criminology:** Interdisciplinary research is a cornerstone of innovation at Michigan State University (MSU). The opportunities for faculty members to partner with colleagues across the various MSU colleges are plentiful -- and encouraged. Input from experts in many fields will be crucial to developing solutions to the world's most pressing challenges. With topics such as climate change dominating news headlines and the political sphere, MSU and other research institutions will be asked to provide leadership and answers. Meredith Gore, an associate professor in the MSU Department of Fisheries and Wildlife, is one of the researchers leading the charge. In an effort to curtail environmental harm, Gore has been working in the area of conservation criminology, a joint effort between the university's Department of Fisheries and Wildlife and the School of Criminal Justice. Her educational background is in anthropology and natural resource policy, but human behavior has always been a significant interest.

These stories are excerpts from our 2015 Annual Report. For more on these stories and many of the other exciting research from our scientists, please visit:
http://agbioresearch.msu.edu/publications/annual_report

**Total Actual Amount of professional FTEs/SYs for this State**

| Year: 2015 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| Plan | 178.8 | 0.0 | 64.0 | 0.0 |
| Actual | 250.6 | 0.0 | 71.0 | 0.0 |

## II. Merit Review Process

### 1. The Merit Review Process that was Employed for this year

- Internal University Panel
- External University Panel
- External Non-University Panel
- Expert Peer Review

### 2. Brief Explanation

ABR and MSUE goals must remain fluid and flexible in order to meet the constant changes in the agriculture and natural resource industries. Research goals are **continually evaluated for relevance and impact at local, state and regional levels**. Strategic priorities address the research needs of the Michigan agriculture and natural resources industries, but are also linked to national and global goals and initiatives.

Through strategic planning with ABR-affiliated colleges, MSUE staff and key stakeholder groups, priority areas are reviewed annually. **This process involves industry experts, university faculty, MSUE and ABR advisory council members and research center advisory committee members, as well as scientific review by peers (local, national and international)**. MSUE uses several continuous processes that assist in setting priorities and evaluating program goals and plans. At the local level, the interested public, government officials, advisory group members and industry experts are involved in broader stakeholder processes as well as the review of individual educator plans. These goals and plans are also reviewed by state leaders and industry experts for quality and relevance and by the ABR and MSUE directors, who not only evaluate them, but use them in regional and statewide presentations to explain future plans.

**Jointly, ABR and MSUE address issues of concern in communities with research and teaching by using a network of citizen advisory groups at the local and state levels.** Thirteen district MSUE councils identify and prioritize issues, seek collaborations and resources and communicate to others the importance of MSUE educational programming. Citizen Advisory Councils help establish research priorities at the 13 outlying ABR centers and 18 on-campus facilities. The MSUE-ABR Council serves as liaison among district councils, research center advisory groups and state agencies and organizations.

## III. Stakeholder Input

### 1. Actions taken to seek stakeholder input that encouraged their participation

- Use of media to announce public meetings and listening sessions
- Targeted invitation to traditional stakeholder groups
- Targeted invitation to non-traditional stakeholder groups
- Targeted invitation to traditional stakeholder individuals
- Targeted invitation to non-traditional stakeholder individuals
- Targeted invitation to selected individuals from general public
- Survey of traditional stakeholder groups
- Survey of traditional stakeholder individuals
- Survey of the general public
- Survey of selected individuals from the general public
- Other (Conferences and meetings, social media)

**Brief explanation.**

A variety of strategies and approaches were used in the past year to encourage stakeholder participation for a number of key activities and undertakings. ABR and MSUE continue to **develop the framework for new, industry-supported partnerships**:

• **Michigan Alliance for Animal Agriculture (M-AAA) is a new partnership between the MSU College of Agriculture and Natural Resources, ABR, MSUE and Michigan animal**

**agriculture commodity organizations started in 2014 to advance** animal agriculture. The Michigan food and agriculture system annually contributes about $100 billion to the state's economy and provides nearly 1 million jobs. About 37 percent of the agricultural products sold are attributed to the animal agriculture sector. M-AAA focuses on advancing the state's animal agriculture economy by supporting applied research and outreach efforts that address key issues identified by the industry.

• **Project GREEEN (Generating Research and Extension to meet Economic and Environmental Needs) commits to funding outreach and research programs that align with the plant-based agricultural priorities of growers and entrepreneurs throughout the state**. This cooperative effort between ABR, MSUE, the Michigan Department of Agriculture and Rural Development and grower-led commodity organizations supports Michigan's growing plant-agriculture industry by providing targeted research and Extension programming in the face of evolving challenges.

ABR and MSUE participated in several **trade shows to engage with growers and producers and help business owners learn profitable and efficient business and production practices** by planning programs that benefit agriculture and agribusiness. The Great Lakes Fruit, Vegetable and Farm Market Expo is an excellent example:

• MSUE and ABR educators serve as leaders of the programming committee that creates up to 70 educational sessions over a three-day period.
• The event attracts more than 4,000 growers and agriculture professionals annually from 42 states and eight Canadian provinces.

The **MSU Product Center is emblematic of the way ABR and MSUE work to invest in people - one-on-one with entrepreneurs to supply objective, evidence-based methods for starting and growing businesses**. Its client base in food and agriculture businesses has grown by 18 percent. Product Center professionals conducted 6,000 counseling sessions with 625 clients. This led to:

• 61 new venture launches.
• More than $8.2 million in total capital formation, including more than $7 million of owner investment in Michigan businesses.
• 175 jobs created or retained.

In addition, the **Product Center is working diligently to establish the Food Processing Innovations Lab, which will help midsized companies develop new and improved products by allowing them to establish a commercial production line to test new procedures**. It will also help prepare students for the workforce by giving them unmatched hands-on experiences in food science.

**MSUE encourages growth in a sustainable and prosperous Michigan food and agriculture system** by training industry and agency professionals to keep their skillsets current with proven science.

• Thanks to a grant from DuPont Pioneer, staff worked with their counterparts from the University of Wisconsin to train Pioneer agronomists to determine best practices to improve soil health, such as planting cover crops and reducing tillage and compaction.
• To date, more than 80 agronomists in Michigan, Ohio, Indiana and Iowa have been trained. The feedback tells us agronomists value this model because it allows them to work with growers on

improving soil health and better advise them on practice changes that will increase soil health.

• Using that same model, we also trained 90 people with the U.S. Department of Agriculture Natural Resource Conservation Service and Michigan Conservation District.

• Our educators created an on-line training program for Pioneer Seed that staff members can use when they consult with growers.

**ABR and MSUE partner with state agencies and growers to battle invasive pests**. For several years, we have led the charge to fight spotted wing drosophila and brown marmorated stink bug, two insects that threaten Michigan fruit production. Through these partnerships, we have been able to monitor these pests, in hopes of controlling and eliminating these invasive species.

**Fourteen district advisory groups helped in collecting local stakeholder input and assist in the development of priorities**. A major part of the MSUE planning process includes the integration of needs and priorities identified by stakeholders in Institute Work Team Plans of Work. While stakeholder input is an ongoing process with advisory groups as described above, two major stakeholder initiatives were conducted jointly by ABR and MSUE in 2015. Information from these processes were used as community input at the beginning of the planning process to not only integrate the information in the upcoming plans, but also used as a measuring stick to give feedback to stakeholders after the implementation of these new and modified plans. One initiative involved a statewide survey of more than 5,000 people who identified both needs and priorities for communities. The report can be found at: http://reporting.anr.msu.edu/issueid/statequant.pdf. The second initiative involved 40 focus groups in the 14 Districts that involved **1,391** community members that identified up to ten priorities for their regional area. Work Teams examined the results from these two Needs and Priorities processes for relevancy and, when appropriate, incorporated the information into their 2017 Work Team Plans. Both quantitative and qualitative information from this process was helpful in identifying new areas and audiences to target, areas that have support for sustaining, and, in rare cases, dropped.

Further, numerous individual meetings were held with staff, stakeholder advisory groups and the ABR-MSUE State Council related to the development of MSUE institute areas and their focus. Meetings were also held with the Michigan Association of Counties, the Michigan Townships Association and state legislators. In addition, MSUE and ABR continue to strengthen its collaboration with the North Central Region to identify common issues among stakeholder input, pool resources and improve multi-state efforts.

**2(A). A brief statement of the process that was used by the recipient institution to identify individuals and groups stakeholders and to collect input from them**

**1. Method to identify individuals and groups**

- Use Advisory Committees
- Use Internal Focus Groups
- Use External Focus Groups
- Open Listening Sessions
- Needs Assessments
- Use Surveys

**Brief explanation.**

In order to conduct leading-edge research that results in practical solutions, ABR and MSUE rely on input from an **extremely broad and long list of stakeholders and partners**. Such feedback is generated by representatives in the following industries:

- Agricultural
- Food and food processing
- Natural resources
- Bioeconomy industries
- State residents
- Non-profit organizations
- Businesses
- Governmental organizations
- Universities

An emphasis is placed on keeping key internal and external stakeholders (e.g., agricultural producers, commodity groups, food processors and the tourism, fisheries and forestry industries), legislative contacts and the interested public abreast of issues, and **using a blend of traditional and online platforms to reach individuals and groups and collect input from them**. The MSU Extension and AgBioResearch partnered to "Sharpening their Focus" in community needs. In last quarter of 2015 and first quarter of 2016, statewide data collection through focus groups and survey provided important stakeholder input. The previous statewide effort for issue identification and needs assessment was conducted in 2011 and at that time was called Advanced Michigan. Community-based discussions in all Michigan counties, involving local advisory committees, the MSUE-ABR councils and others are held to discern what issues and opportunities stakeholders believe should be addressed related to research and programming. **Resident focus groups are used to identify issues and opportunities in Michigan and assign a priority.** Community groups, commodity and producer groups and other state and local partners are periodically asked what issues and opportunities should be explored and addressed.

**2(B). A brief statement of the process that was used by the recipient institution to identify individuals and groups who are stakeholders and to collect input from them**

**1. Methods for collecting Stakeholder Input**

- Meeting with traditional Stakeholder groups
- Survey of traditional Stakeholder groups
- Meeting with traditional Stakeholder individuals
- Survey of traditional Stakeholder individuals
- Meeting with the general public (open meeting advertised to all)
- Survey of the general public
- Meeting with invited selected individuals from the general public
- Survey of selected individuals from the general public

**Brief explanation.**

Stakeholder input provides the foundation for the research and educational programs developed by ABR and MSUE. Stakeholders help decide the future direction for ABR through programs such as Project GREEEN, the Michigan Alliance for Animal Agriculture (M-AAA) and commodity advisory teams. There are **extensive conversations and visits that also take place throughout the year with local, state and federal officials and commodity group and industry representatives** from the agricultural, natural resources and renewable energy industries.
For MSUE, town hall meetings, individual meetings, feedback via email, blogs and a statewide online survey established information for District Advisory groups (called District Councils) to consider and to further inform MSU Extension, including the priorities that should be set under each of the Institutes.

For ABR, multiple meetings were held with commodity groups, legislators and key stakeholders representing the key agricultural sectors as work continued with the consolidation of management and operations for various research centers and units. In addition to these traditional, long-standing venues, an **ad hoc committee comprised of faculty members and commodity group stakeholders was established to conduct a comprehensive review of ABR centers** and to provide recommendations on how to best move forward in implementing needed changes.

**3. A statement of how the input will be considered**

- In the Budget Process
- To Identify Emerging Issues
- Redirect Extension Programs
- Redirect Research Programs
- In the Staff Hiring Process
- In the Action Plans
- To Set Priorities

**Brief explanation.**

Due to stakeholder input, ABR has focused more sharply on renewable energy and bio-based products that can help boost the Michigan economy, including fuels, chemicals, neutraceuticals and food products; the environment; land use issues; and biotechnology. Water research and food safety are also issues that are receiving increased attention and funding resources, as evidenced by the recent launches of the MetroFoodPlus Initiative and the MSU Global Water Initiative. From an operational perspective, ABR has used stakeholder input to guide its decision making process around the consolidation and restructuring of its 13 ABR centers and 18 on-campus centers.

MSUE utilizes stakeholder (via focus groups and state survey) input in forming the four institute's educational goals and the 25 work groups that guide them and implement programs. The input has been useful in setting priorities and focusing on more with fewer resources.

**Brief Explanation of what you learned from your Stakeholders**

The following are a few of the takeaways ABR and MSUE learned from its stakeholders:

- Food safety and security and a safe and secure water supply are critical priority areas for research activities.
- Residents want safe an plentiful food and water supplies.
- Newer technology is necessary to continue to build and maintain strong partnerships both internally and externally.
- Research and information dissemination efforts are critical to the success of the $100 billion food and agriculture industry in Michigan.
- Youth need help connecting to agricultural jobs and the general public would benefit from agricultural literacy programs that help connect farm-to-fork, and other food production-to-institution systems.
- Solutions and innovations will be even more critical in the future for residents in Michigan, the nation and the world.
- Genetic research needs to be a critical area of focus.

## IV. Expenditure Summary

| 1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS) | | | |
|---|---|---|---|
| Extension | | Research | |
| Smith-Lever 3b & 3c | 1890 Extension | Hatch | Evans-Allen |
| 9228770 | 0 | 6505840 | 0 |

| 2. Totaled Actual dollars from Planned Programs Inputs | | | | |
|---|---|---|---|---|
| | Extension | | Research | |
| | Smith-Lever 3b & 3c | 1890 Extension | Hatch | Evans-Allen |
| Actual Formula | 10384691 | 0 | 6412500 | 0 |
| Actual Matching | 10384691 | 0 | 6584605 | 0 |
| Actual All Other | 0 | 0 | 23141298 | 0 |
| Total Actual Expended | 20769382 | 0 | 36138403 | 0 |

| 3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous | | | | |
|---|---|---|---|---|
| Carryover | 2601978 | 0 | 0 | 0 |

# V. Planned Program Table of Content

## V(A). Planned Program (Summary)

**Program # 1**

**1. Name of the Planned Program**

Human Health, Environment, Family, Youth, Society and Community

☑ Reporting on this Program

**V(B). Program Knowledge Area(s)**

1. Program Knowledge Areas and Percentage

| KA Code | Knowledge Area | %1862 Extension | %1890 Extension | %1862 Research | %1890 Research |
|---|---|---|---|---|---|
| 608 | Community Resource Planning and Development | 10% | | 12% | |
| 702 | Requirements and Function of Nutrients and Other Food Components | 0% | | 4% | |
| 703 | Nutrition Education and Behavior | 10% | | 3% | |
| 711 | Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources | 0% | | 8% | |
| 712 | Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins | 0% | | 7% | |
| 721 | Insects and Other Pests Affecting Humans | 0% | | 2% | |
| 723 | Hazards to Human Health and Safety | 0% | | 12% | |
| 724 | Healthy Lifestyle | 30% | | 12% | |
| 801 | Individual and Family Resource Management | 10% | | 0% | |
| 802 | Human Development and Family Well-Being | 10% | | 10% | |
| 803 | Sociological and Technological Change Affecting Individuals, Families, and Communities | 0% | | 10% | |
| 805 | Community Institutions, Health, and Social Services | 0% | | 12% | |
| 806 | Youth Development | 30% | | 8% | |
| | **Total** | 100% | | 100% | |

## V(C). Planned Program (Inputs)

**1. Actual amount of FTE/SYs expended this Program**

| Year: 2015 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| **Plan** | 99.3 | 0.0 | 11.0 | 0.0 |

| | | | | |
|---|---|---|---|---|
| **Actual Paid** | 138.6 | 0.0 | 9.0 | 0.0 |
| **Actual Volunteer** | 86.5 | 0.0 | 0.0 | 0.0 |

**2. Actual dollars expended in this Program (includes Carryover Funds from previous years)**

| Extension | | Research | |
|---|---|---|---|
| **Smith-Lever 3b & 3c** | **1890 Extension** | **Hatch** | **Evans-Allen** |
| 5442804 | 0 | 833625 | 0 |
| **1862 Matching** | **1890 Matching** | **1862 Matching** | **1890 Matching** |
| 5442804 | 0 | 855999 | 0 |
| **1862 All Other** | **1890 All Other** | **1862 All Other** | **1890 All Other** |
| 0 | 0 | 3008369 | 0 |

## V(D). Planned Program (Activity)

### 1. Brief description of the Activity

Research programs to:

• Develop a better understanding of public benefits for policy development in recreation and tourism resource management.
• Increase understanding about how environmental pollutants, especially ozone and endocrine disruptors affect human health.
• Establish new programs and policies to help young people move successfully from foster care to independent living after they are too old for foster care.
• Analyze the relationships among social support, public policy and family characteristics and how they affect the function and well-being of rural low-income families.
• Increase understanding and develop more effective environmental management systems.
• Develop better models for the human health and human services sectors.
• Identify the nutritional determinants of allergic immune disorders.
• Develop an understanding of how n-3 polyunsaturated fatty acids affect human health and disease, especially cardiovascular disease and inflammation. ....

Educational programs to:

• Teach how to choose healthful food, physically active lifestyles and behaviors consistent with dietary guidelines.
• Teach consumers to keep their food safe by offering programs on food safety, home food preservation and healthy, hygienic food-handling practices.
• Teach people living with chronic medical conditions to manage their condition effectively.
• Teach financial literacy and prepare individuals to manage their finances in anticipation of retirement.
• Teach caregivers and parents how to prepare children for school.
• Increase access to affordable, high-quality childcare.
• Prepare communities for the health care, housing and transportation needs of seniors.
• Educate citizens and public officials about funding methods, service provision and intergovernmental cooperation.
• Provide counties and municipalities with technical assistance related to intergovernmental contracting,

consolidating services and financial and strategic planning.
- Assist government officials in leadership, conflict management, communication and engaging the public in policy development.
- Prepare youth with knowledge and skills needed for life and employment.
- Enhance the physical, social, emotional and cognitive health and well-being of youth.

**2. Brief description of the target audience**

Michigan private citizens, state agencies, farmers, food processors, commodity groups and agricultural industry representatives are targets of research programs. Individuals of all ages and life stages are targeted for healthy lifestyle and food-safety education programs. Human development and family well-being programs target parents and caregivers of preschool children, people living with chronic medical conditions and senior citizens. Community institutions, health and social services programs target citizens and public/government officials. Youth age 9 to 18 are targets of youth development programs.

**3. How was eXtension used?**

All field educators are encouraged to be involved in eXtension through both Ask and Expert and Communities of Practice (CoP). A total of 37.8 fte's were involved in this area of human health and youth development with 17.2 fte's funded through 3bc. Examples are:
**ECOP Chronic Disease Prevention and Management National Action Team**
Assisted with in development of the ECOP Health Implementation team implemented Creating Healthy Communities webinars for eXtension.
**Social Networking In Youth Programs**
Social media can be very overwhelming to youth programming. MSUE developed and posted a webinar to address the following:

- Learn about Social Networking in Youth Programs
- Explore the different social media options programs can use
- Learn how to easily manage social media profiles

The webinar can be viewed at: https://learn.extension.org/events/2016#.VOZDtSwerfc.

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

| 2015 | Direct Contacts Adults | Indirect Contacts Adults | Direct Contacts Youth | Indirect Contacts Youth |
|---|---|---|---|---|
| **Actual** | 75584 | 226752 | 75371 | 150742 |

**2. Number of Patent Applications Submitted (Standard Research Output)**

**Patent Applications Submitted**

| | |
|---|---|
| Year: | 2015 |
| Actual: | 2 |

**Patents listed**
MICL02354, Improvement of Meat Quality, Safety, and Nutritional Values Using Advanced Meat Processing Techniques, Serial Number 14/326,853 ; MICL02257, Hierarchical Genetic and Environmental Regulation of M. tuberculosis Complex Persistence, Serial Number 62/156,733

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

| 2015 | Extension | Research | Total |
|---|---|---|---|
| Actual | 2 | 34 | 0 |

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Number of research programs on human health, environment, family, youth, society and community.

| Year | Actual |
|---|---|
| 2015 | 33 |

**Output #2**

**Output Measure**

- Number of adult participants trained in healthy lifestyles.

| Year | Actual |
|---|---|
| 2015 | 51418 |

**Output #3**

**Output Measure**

- Number of youth participants trained in healthy lifestyles.

| Year | Actual |
|---|---|
| 2015 | 62712 |

**Output #4**

**Output Measure**

- Number of youth participants trained in life skills.

| Year | Actual |
|---|---|
| 2015 | 12221 |

**Output #5**

**Output Measure**

- Number of adult participants trained in family resource management.

| Year | Actual |
|---|---|
| 2015 | 3113 |

**Output #6**

**Output Measure**

- Number of youth that gain knowledge in how to respond to one's own social-emotional needs and the social-emotional needs of others

| Year | Actual |
|---|---|
| 2015 | 434 |

**Output #7**

**Output Measure**

- Number of adult participants trained in youth development.

| Year | Actual |
|---|---|
| 2015 | 18650 |

**Output #8**

**Output Measure**

- Number of adult participants trained in home ownership education and foreclosure counseling

| Year | Actual |
|---|---|
| 2015 | 2403 |

**Output #9**

**Output Measure**

- Number of youth participants trained in financial literacy and money management.

| Year | Actual |
|---|---|
| 2015 | 976 |

**Output #10**

**Output Measure**

- Number of adults trained in human development and family well-being.

| Year | Actual |
|---|---|

2015 5344

**V(G). State Defined Outcomes**

## V. State Defined Outcomes Table of Content

| O. No. | OUTCOME NAME |
|---|---|
| 1 | Number of research programs to determine the relationship between family meals/lifestyle factors, education/food choices, general health and environmental influences, physical activity and general health. |
| 2 | Number of research programs to understand how environmental pollutants, especially ozone and endocrine disruptors, affect human health. |
| 3 | Number of research programs to develop better models for the human health and human services sector. |
| 4 | Number of adult participants with increased knowledge about healthy lifestyles. |
| 5 | Number of youth participants with increased knowledge about healthy lifestyles. |
| 6 | Number of adult participants with increased knowledge of human development and family well-being. |
| 7 | Number of youth participants with increased knowledge of life skills. |
| 8 | Number of adult participants with increased knowledge of youth development. |
| 9 | Number of research programs to develop more effective environmental/natural resources management systems. |
| 10 | Number of adult participants with increased knowledge of family resource management. |
| 11 | Number of research programs that study the function of nutrients and other components related to human health. |
| 12 | Number of youth that change in their ability to respond to one's own social-emotional needs and the social-emotional needs of others |
| 13 | Number of adult participants with increased knowledge in home ownership education and foreclosure counseling |
| 14 | Number of youth participants that increase knowledge in financial literacy and money management. |

## Outcome #1

### 1. Outcome Measures

Number of research programs to determine the relationship between family meals/lifestyle factors, education/food choices, general health and environmental influences, physical activity and general health.

### 2. Associated Institution Types

- 1862 Extension
- 1862 Research

### 3a. Outcome Type:

Change in Action Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2015 | 8 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
While about 175 different types of foods have been documented to trigger an allergic reaction in sensitized subjects, 90% of food allergies are due to 8 major food types: Chicken egg, cow's milk, soybean, wheat, peanut, tree nuts, fish and shellfish. Notably, as reviewed recently, improved methods for predicting allergenicity of food proteins are critically needed. A promising approach is to test if a dietary protein might induce allergic reactions in a validated food allergy mouse model. However, a validated mouse model of food allergy is not available at present to evaluate allergenicity of novel foods.

**What has been done**
Research to: improve human, animal and plant health; understand the relationship between cancer and diet; assess allergenic potential of food; understand inflammation and the development of diabetic retinopathy; explain how diet, obesity and inflammation impact colon cancer risks; understand how diet and environment impact liver disease and heart health; understand how incentives work to impact social norms and behavior.

**Results**
We have established the efficacy, toxicity and blood brain barrier permeability of bioactive ingredeints in Withania somnifra
fruit as a botanical drug to treat and prevent Alzheimer's disease. This technology, licensed by a Michigan company, is being
evaluated to determine clinical efficacy in AD pateints. We determined the functional food qulaity of fenugreek spice and
reported its bioactive constituents with antiinflammatory, antioxidant and tumor cell proliferation inhibitory activities. This

research article, published in the journal Food Chemistry, has already been read or downloaded by more than 1114 times as
indicated the usage data by Science Direct.

Food allergies are the leading cause of life-threatening allergic reactions with incompletely understood mechanisms. We
previously reported a novel mouse model of near-fatal hazelnut (HN) allergy that involves transdermal sensitization followed
by oral elicitation of allergic reactions. Here we studied the cardiac mast cell and cardiac tissue responses during oral nut
induced allergic reaction in this mouse model.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 703 | Nutrition Education and Behavior |
| 724 | Healthy Lifestyle |
| 802 | Human Development and Family Well-Being |
| 806 | Youth Development |

**Outcome #2**

**1. Outcome Measures**

Number of research programs to understand how environmental pollutants, especially ozone and endocrine disruptors, affect human health.

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 2 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Nitrogen availability is critical for crop production yet excess nitrogen poses a significant environmental threat. The threat to
groundwater and surface waters is well recognized and understood; the threat to air quality is more poorly recognized but no less real. Nitrogen trace gases can significantly affect regional / global climate over long time scales, as can other trace gases such as methane. Agricultural landscapes may play a critical role in global balances of these greenhouse gases, and the

inclusion of perennial biofuel crops in the landscape may represent a mitigation option.

**What has been done**
Research to: understand greenhouse gas and carbon sequestration in regards to agriculture landscapes; evaluate pregnancy outcomes related to food and environmental factors.

**Results**
We have made measurements of the radiatively important trace gases nitrous oxide (N2O) and methane (CH4 ) at biweekly to monthly intervals through the year at the KBS Long-term Ecological Research site. These measurements are included in an on-going assessment of the overall impact of farming activities on atmospheric chemistry. The global warming potentials (GWPs) of 11 different cropped and natural ecosystems are calculated using information on soil carbon sequestration, fertilizer, lime, fuel inputs, and the production of N2O and consumption of CH4 in these systems. N2O production continues to be the largest single source of GWP in all annual crop ecosystems, followed by nitrogen fertilizer manufacturing when nitrogen fertilizer is used.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 723 | Hazards to Human Health and Safety |
| 805 | Community Institutions, Health, and Social Services |

**Outcome #3**

**1. Outcome Measures**

Number of research programs to develop better models for the human health and human services sector.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 9 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Despite being called "invisible" children of a parent with a mental illness are numerous and at

significant developmental risk. One of five Americans has a serious mental illness and 25 to 40 percent of them are parents. Children with a parent with a mental illness have a higher risk for acquiring a mental illness. The children know little about mental illness and recovery despite asserting that their lives are affected by adjusting from one moment or one day at a time to the level of parental symptoms. Many of the children report believing that they are at fault for the parents' illness. They may endure times of separation from their parent with a mental illness. They are more likely to enter kinship care or foster care.

**What has been done**

Research to: transition young people who age out of foster care; develop healthcare packaging that is easier to access, particularly for aging consumers and people with disabilities; develop models for preventive and early intervention strategies for children living with a family member with a serious illness;examine the relationship between the number of foster home placements for youth and the number of community connections as emancipated adults;examine the relationships between emotion-related socialization behaviors and infants', toddlers' and preschoolers self-regulation and social-emotional competencies; and to develop models and family-based interventions that advance the well-being of National Guard soldiers and their families post-deployment to a combat zone; work to make breast cancer risk reduction messages more accessible to diverse groups.

**Results**

Researchers are working to build and test a new evidence-based psychoeducation for approximately 20 youth who have a parent with a mental illness. To accomplish this objective, researchers will: Develop a manualized intervention program of psychoeducation for youth with a parent with a mental illness. Develop a scale with acceptable
psychometric properties (validity, reliability) to measure youth knowledge of mental illness and recovery. Evaluate the YES program per youth outcomes of increased pre to post intervention knowledge of mental illness and recovery per scores on the Knowledge of Mental Illness and Recovery scale (K-MIR). Evaluate the YES program for youth outcomes of increased pre to post intervention coping skills per the Adolescent Coping and Problem Experiences Scale (A-COPE). Refine the program across three administrations of the YES intervention with 6-8 youth per each group (N = 18 to 24 youth, or approximately 20). Train Guidance Center staff in order to increase their ability to deliver the program. Develop and implement a plan to include the YES program as a mainstream public mental health service of the Guidance Center.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 608 | Community Resource Planning and Development |
| 802 | Human Development and Family Well-Being |
| 803 | Sociological and Technological Change Affecting Individuals, Families, and Communities |
| 805 | Community Institutions, Health, and Social Services |
| 806 | Youth Development |

## Outcome #4

### 1. Outcome Measures

Number of adult participants with increased knowledge about healthy lifestyles.

### 2. Associated Institution Types

- 1862 Extension

### 3a. Outcome Type:

Change in Knowledge Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2015 | 49386 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
An example in this area, preventing diabetes in Michigan residents. More than 2.6 million adults in Michigan are prediabetic, and only 7.3 percent have been informed of this important fact. Prediabetes is considered a risk factor for Type 2 diabetes, with a high risk of conversion to diabetes within five years.

**What has been done**
MSU Extension?s National Diabetes Prevention Program received full recognition in May 2015 by the Centers for Disease Control and Prevention as a Diabetes Prevention Recognition Program, proven to change participants? lifestyles to prevent Type 2 diabetes.

**Results**
As a result of a National Diabetes Prevention Program delivered by MSU Extension: 100% of participants said that they became aware of techniques to stay motivated to make healthy lifestyle changes. 98% of participants said they learned how to eat healthy away from home. 92% of participants were monitoring their food intake. 90% of participants were physically active.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 724 | Healthy Lifestyle |

## Outcome #5

### 1. Outcome Measures

Number of youth participants with increased knowledge about healthy lifestyles.

### 2. Associated Institution Types

- 1862 Extension

### 3a. Outcome Type:

Change in Knowledge Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2015 | 55186 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
For example, children and youth are at-risk in becoming obese and developing chronic diseases as adults unless they change their diets and physical activities.

**What has been done**
MSU Extension integrated work from the Health and Nutrition Institute with Children and Youth Institute (4-H) to create programs that emphasized healthy nutrition and physical activities.

**Results**
Evaluation results found:

- 32% of the youth increased their fruit intake
- 31% of the youth decreased their sugary drinks intake
- 34% of the youth increased vegetable intake
- 36% of the youth increased whole grain intake
- 30% of the youth increased time spent in physical activity
- 33% of the youth increased frequency of food safety practices

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 724 | Healthy Lifestyle |
| 806 | Youth Development |

**Outcome #6**

**1. Outcome Measures**

Number of adult participants with increased knowledge of human development and family well-being.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 4702 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
One example, Providing caring adult role models for youth

Issue

Young people need caring adults in their lives who can provide guidance, listen to them, and support their goals and aspirations. While many youth find these individuals on their own, not all are so lucky. To help fill the void for those without a nurturing adult in their lives, MSU Extension offers formal youth mentoring programs in 10 Michigan counties.

**What has been done**
Through these programs and the time committed by nearly 85 caring mentors, 270 Michigan youth were each matched with an encouraging adult who served as a personal coach, cheerleader and friend. These positive adult relationships help youth feel they have an ally in their corner - someone they can turn to for advice and support.

**Results**
As a result of these MSU Extension mentoring programs: 97% of surveyed mentees felt they had mentors that cared about them and 90% said their mentors made them feel special. 79% of surveyed mentees felt their mentors helped them make better decisions and 64% talked to their mentors when they had a problem or concern. 60% of surveyed mentees were doing better in school, thanks to their mentors' help.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 802 | Human Development and Family Well-Being |
| 806 | Youth Development |

**Outcome #7**

**1. Outcome Measures**

Number of youth participants with increased knowledge of life skills.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 11586 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
An example in this area, developing a love for literacy and learning

Early childhood literacy is critically important to an individual's future success. Up until third grade, children are learning to read, after that, children read to learn making learning increasingly difficult for those who struggle with literacy. Studies show that children who fail to meet fourth-grade proficiency standards are four times more likely to drop out of school in the future than those who met reading standards.

**What has been done**
MSU Extension is helping prepare young Michiganders for reading success ? and future success by teaching parents and caregivers skills to improve early childhood literacy. By educating adults about daily ways they can incorporate literacy activities, such as reading or singing songs, MSU Extension is helping infants, toddlers and young children develop a love for reading and language at an early age.

**Results**
As a result of MSU Extension early literacy efforts:

More than 30,000 books were distributed to nearly 27,500 children living in low-income situations in 65 Michigan counties, providing them with reading tools they can practice with on a daily basis. Further, 181 parents and caregivers received early childhood literacy education, with 95% of surveyed respondents indicating they increased their knowledge of techniques that help young

children learn and promote school readiness.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 724 | Healthy Lifestyle |
| 802 | Human Development and Family Well-Being |
| 806 | Youth Development |

**Outcome #8**

**1. Outcome Measures**

Number of adult participants with increased knowledge of youth development.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 15368 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
The success of Michigan's youngest generation is of utmost importance as they are the future of the Great Lakes state. Because the early childhood years are the building blocks for future success, the first people to influence a child is his or her parents and caregivers that play a critical role in the proper development and later academic achievement of Michigan's youth. Ensuring these children are ready for school both socially and academically that will provide long-term benefits to individuals, communities and the state as a whole.

**What has been done**
To help parents and caregivers achieve this important goal, MSU Extension provides a variety of early childhood education programs and resources. As a result, parents and caregivers are equipped with the tools and knowledge necessary to enhance children?s school readiness and become their best resources and advocates. MSU Extension delivered 73 workshops and 31 educational series to more than 2,100 participants.

**Results**
Evaluation results of 1,713 adults (59%) found:

- 85% indicated an increase in knowledge regarding basic concepts of early childhood development
- 90% indicated an increase in knowledge of techniques that help young children learn and promote school readiness
- 80% indicated an increase in knowledge of how to keep children safe (physically, emotionally, and socially)

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 802 | Human Development and Family Well-Being |
| 806 | Youth Development |

**Outcome #9**

**1. Outcome Measures**

Number of research programs to develop more effective environmental/natural resources management systems.

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 11 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
The need to develop economically and environmentally sound approaches to address environmental and natural resources challenges is increasingly important. Policies, practices and science-based knowledge must constantly evolve to promote stewardship and sustainability in light of new opportunities for increased productivity, resource-saving technologies and threats to biodiversity. Research is needed to ensure that practices and policies have a strong, science based foundation.

Waste treatment is one of the most pressing challenges to the sustainability of agroindustries. Agroindustrial wastes, such as those generated from bioenergy or food processing, can contain

high concentrations of carbon or nutrients that can adversely impact ecosystems if discharged to surface waters or can cause metal and nitrate contamination of groundwaters if applied to fields. Even land application of treated wastes, such as wastewater treatment plant biosolids, can introduce pollutants, such as pharmaceuticals or personal care products, into agricultural ecosystems and the human food chain.

**What has been done**

Research to: better understand public benefits for policy development in recreation and tourism resource management; identify sustainable ways to enhance human well-being while reducing stresses on the environment; and to better understand the current spread, historical distribution and future disease risk of Lyme disease to inform effective citizen-focused information campaigns; understand large scale biodiversity in human dominated landscapes.

**Results**

Small scale studies on the uptake and phytometabolism of triclcarban and triclosan from biosolids and irrigated wastewater were conducted. Results are pending, but will provide valuable insight into whether wastewater should be used for irrigation. Additionally, a tropical wetland in Costa Rica was maintained and monitored for treatment of anaerobic digestate. Growth of five tropical emergent plants and five tropical floating plants were monitored to improve planting recommendations. Thirdly, a combination wetland-bioretention system on
MSU campus was monitored and recommendations for optimization and maintenance were developed.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 608 | Community Resource Planning and Development |
| 723 | Hazards to Human Health and Safety |
| 803 | Sociological and Technological Change Affecting Individuals, Families, and Communities |

**Outcome #10**

**1. Outcome Measures**

Number of adult participants with increased knowledge of family resource management.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|

2015 2814

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Struggling Michiganders receive needed money management education
More than 300,000 Michigan residents are unemployed, and many report trouble sustaining a daily living due to job loss, decreased income, rising food prices and lack of credit. Michigan is only as strong as its residents, and with an unemployment rate above 7 percent, the state struggles to attract new businesses, losing the brightest minds to other states.

**What has been done**
MSU Extension has experts across Michigan that help people in all categories of financial literacy and money management. Through this education and outreach, MSU Extension creates stronger and more sustainable individuals, households, organizations and communities.

**Results**
Of the 712 survey respondents who took Money Management education offered by MSU Extension in 2014, 64 percent had an annual income of less than $17,900. While the experience of asking for financial help is difficult, 97 percent said they would recommend MSU Extension to others with a similar need. Of survey respondents reporting:

92% said they now knew how to reach retirement goals.
91% said they now knew how to write out spending plans.
89% reported they now knew how to save money regularly and pay down debt.
88% reported they now knew how to keep track of spending and income.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 801 | Individual and Family Resource Management |

## Outcome #11

### 1. Outcome Measures

Number of research programs that study the function of nutrients and other components related to human health.

### 2. Associated Institution Types

- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 3 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Processed meats have received negative publicity due to their typically high fat and high sodium contents, which have been linked to adverse effects on human health. In addition, consumption of Listeria contaminated process meats was linked to a massive multistate outbreak including many fatalities, miscarriages or stillbirths. In case of poultry products, incidence of poultryborne salmonellosis and campylobacteriosis has remained relatively unchanged despite of various intervention strategies at farms and processing plants.

**What has been done**
Research to: identify more effective, efficient and greener, plant-based processes to produce pharmaceuticals; to determine the effect of selected nutrients and food components on the development of allergic airway diseases; and understand genetic and environmental components of M. tuberculosis persistence.

**Results**
Poultry meat has been attributed to one of major sources for bacterial foodborne illness, especially salmonellosis and campylobacteriosis. Two potential reasons for the high foodborne illness could be: 1) ineffective bacterial control strategy on farms and at processing plants, and 2) inaccurate sampling methods leading to false negative results when pathogens are physically present on the carcasses. In our research, bacterial populations of broiler skin were quantified by swabbing or stomaching for 10 times and by grinding the resulting skin (swabbed or stomached). Results indicated that less than 35% of
total bacteria seemed loosely associated in the skin, whereas more than 65% looked tightly associated which were not recovered by stomaching or swabbing. The unique outcome of this study is to indicate that major portions of tightly-associated bacteria were remained even after 10 swabbings or 10 stomachings but recovered after grinding the skin. As a result, more reliable detection methods such as sample grinding are required to detect loosely- and tightly-associated bacteria on poultry
carcasses. The sampling techniques and subsequent results in this research can impact on preventing any false negative results and unknown introduction of pathogens during food processing. The research for bacteria decontamintion on broiler carcasses using hot water dipping, trisodiun phophate dipping, and brusing is being conducted now.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 702 | Requirements and Function of Nutrients and Other Food Components |
| 723 | Hazards to Human Health and Safety |

## Outcome #12

### 1. Outcome Measures

Number of youth that change in their ability to respond to one's own social-emotional needs and the social-emotional needs of others

### 2. Associated Institution Types

- 1862 Extension

### 3a. Outcome Type:

Change in Knowledge Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2015 | 391 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Creating safe environments and relationships through bullying prevention
Young people who are the target of bullying and harassment behaviors are at higher risk for physical injury and emotional distress including anxiety, depression and suicidal thoughts. According to a 2014 report from the Centers for Disease Control and Prevention, more than 18 percent of Michigan youth in grades 9 and 12 had been bullied electronically, and more than 25 percent were bullied on school property. Other studies indicate that these behaviors are more common within middle school settings.

**What has been done**
The MSU Extension Be SAFE: Safe, Affirming and Fair Environments initiative helps communities reduce and prevent bullying behaviors. During 2014, more than 700 people; including educators, youth and family workers, parents and young people; were involved in Be SAFE efforts across the state.

**Results**
Participants reported:

Community workshops: 97% developed new skills for interrupting bullying behaviors and for supporting kids who are targeted.

Parent-caregiver workshops: 97% had a greater understanding about bullying issues happening in kids? lives.

Webinars: 100% had a greater understanding of distinctions between bullying and sexual harassment, as well as intervention strategies.

Youth settings: 66% of youth noticed positive changes in their settings as a result of what they learned.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 724 | Healthy Lifestyle |
| 802 | Human Development and Family Well-Being |
| 806 | Youth Development |

**Outcome #13**

**1. Outcome Measures**

Number of adult participants with increased knowledge in home ownership education and foreclosure counseling

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 2257 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Many Michigan families are finding it difficult to make ends meet and sustain daily living. Some of the reasons for this are job loss, decreased income, increased mortgage or rent costs, rising food prices and lack of affordable credit. In order for communities to prosper it is important that individuals and families review their assets and liabilities and develop a plan to change their financial habits for a more sustainable existence. When individuals and families in our communities are financially healthy, it creates an environment for sustained community prosperity.

**What has been done**
One example, Michigan State University Extension's Financial and Homeownership Education team delivers foreclosure prevention and intervention education and counseling by MSHDA and Department of Housing and Urban Development (HUD) certified housing counselors. These counselors work directly with Michigan residents, providing one-on-one information and options in addition to foreclosure. All counseling notes and outcomes were reported into Home Counselor Online (HCO), an online database created by Fannie Mae and used by foreclosure counselors.

During 2015, fourteen FHE counselors assisted clients in 27 Michigan counties to resolve mortgage and tax delinquency issues. Between January 1, 2015 and December 31, 2015, 1005 participants received educational information through phone consultation and triage services. From that total, 248 participants from 210 total households were assisted with mortgage and property tax delinquency and default counseling by educators and instructors certified counseling staff.

**Results**
Of the 210 total households who received foreclosure counseling services in 2015, over half (n=110) of households are still receiving services from Michigan State University Extension counselors, so their outcomes are unknown at this time. This includes:

One quarter of households (n=29) are still receiving counseling services. Three quarters of the households (n=81) are waiting to hear back from their service provider. Ten percent of the 210 total households (n=22) withdrew from counseling in 2015 and less than six percent (n=12) had their workout requests denied so their outcomes are also unknown.

The following results are from the remaining clients that continued receiving counseling services and have achieved housing outcomes (n=66). Seventy-eight percent of the households achieving housing outcomes (n=52) were able to keep their current home and get back on track with their mortgage. Of those 52 total households, approximately one-third (n=16) were able to bring their mortgage current and a little over half (n=28) received Step Forward Michigan funds to avoid mortgage and/or tax foreclosure.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 801 | Individual and Family Resource Management |

**Outcome #14**

**1. Outcome Measures**

Number of youth participants that increase knowledge in financial literacy and money management.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 781 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Youth need a basic understanding of financial management, need to plan with financial skills, and apply to everyday life. These skills are also used when youth are treasurers of clubs and as part of live stock or market animal education programs.

**What has been done**
Youth participated in saving and budgeting simulations through the Credit Union League partner program, Mad City Money, and Spartan Dollars and Cents. Series of financial literacy trainings were held across the state. 4-H members also learned financial literacy skills as part of their officer roles training to be treasurers and as part of livestock or market animal education programs (Animal Dollars & Cents). There were in-school programs to help youth learn how to write checks and balance check books. Community financial resource fairs, Money Smart week themed program week, and larger MSU or 4-H events (such as Grandparents University, 4-H Exploration Days) featured money management sessions. Trainings were held around the state for adult audiences to use the National Endowment for Financial Education High School Financial Planning Program curriculum. Many youth experienced financial literacy components as part of a career education or workforce preparation series of education.

**Results**
Evaluations found:
- Of those participants surveyed (n=216), 55% indicated an increase in knowledge of their understanding of how to track the money they earn and the money they spend (how to create a budget).
- Of those participants surveyed (n=215), 40% of youth indicated an increase in knowledge of their understanding the importance of starting to save early in life.
- Of those surveyed (n=182), 56% of youth participants stated that they feel confident they know how to create a written savings & spending plan as a result of attending a 4-H money management session.
- Of those surveyed (n=117), 64% of youth participants planned to pay their bills on time as a result of participating in the 4-H money management program.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 801 | Individual and Family Resource Management |
| 806 | Youth Development |

## V(H). Planned Program (External Factors)

### External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

### Brief Explanation

During the 2014-2015 fiscal year, ABR and MSUE was able to continue rebuilding some of its resources after several years of either flat or funding cuts at both the state and federal levels. ABR was able to **fill voids in its research and support teams by hiring quality, skilled people for a variety of positions ranging from farm managers and grant coordinators to faculty and research technicians**. **Much needed equipment and infrastructure updates were also conducted at many on-campus and outlying research facilities**, helping to keep operations to full capacity. In 2014, ABR and Project GREEEN funds helped bridge operating budget gaps at five of the 13 outlying research centers, enabling the repairs of equipment and several buildings. Together, the organizations look to re-invigorate the MSUE presence at the 13 outlying research centers throughout the state.

The **ongoing economic challenges** faced by Michigan continue to affect this planned program area. Consequences have included fewer new hires, delaying the award of new financial obligations, reducing levels of continued funding, and renegotiating or reducing the current scope of assistance through formula funds or block grants. Specifically, a 15 percent decreases in state funding FY2011-2012 coupled with a flat federal funding line for the following two years resulted in the elimination of 72 Extension educator positions across 83 counties, 22 academic and faculty positions on campus and 15 support staff. Administrative positions were reduced from 45 to 19 FTEs. Impacts on ABR came largely in the form of reductions in research infrastructure support. Investments in facility maintenance and equipment were postponed in an effort to avoid eliminating more than 45 research positions (faculty, support staff and graduate assistants) and one research facility had to be closed in light of the reductions. There were also fewer funds to seed research on emerging issues.

## V(I). Planned Program (Evaluation Studies)

### Evaluation Results

#### Research

As Hatch dollars are base funding for faculty salaries, there is a built-in evaluation mechanism through annual reviews of overall performance, research productivity and the leveraging of additional research dollars. In addition, many of the research projects have an evaluative element that is required by state and federal-level funding sources that provides

documentation related to project assumptions, goals and outcomes. This information is used to determine the overall success of the research initiatives; their contribution to providing practical, real-world solutions and resources to address challenges and problems; and whether continuation funding and/or new dollars are appropriate and necessary as funds are available.

**MSU Extension examples for Human Health, Environment, Family, Youth, Society and Community**

**Comida Saludables, Familias Saludables (Healthy Foods, Healthy Families)**

Issue

The Hispanic community represents 4.8% of the population in Michigan (U.S. Bureau of the Census, 2014). Based on the Census of 2010, the counties with the highest distribution of Latinos in Michigan are Oceana, Van Buren, Kent, Ottawa, Saginaw, Ingham and Lenawee counties. Historically, MSUE's Spanish-speaking staff translated nutrition education curriculum materials verbatim. This resulted in the need for a linguistically and culturally appropriate nutrition curriculum for MSUE.

Response

- **Eight** bilingual SNAP-Ed paraprofessionals were identified in Wayne, Oakland, Kent, and Lenawee counties for the first phase of the program pilot.
- The need to hire additional bilingual paraprofessionals was identified, which resulted in the hiring of **two** SNAP-Ed paraprofessionals working out of Kent, Ottawa, and Lenawee counties. Still, there is a need to hire more paraprofessionals to meet the needs of the Hispanic/Latino communities in the other counties mentioned above.
- **Staff Training.** Both face to face and virtual training was provided during the year for each paraprofessional member.
- 316 Hispanic adults were served

Results

Outcome evaluation results evidenced the effectiveness of MSUE programming in improving healthy eating habits among Latinos/Hispanics.

- 83% maintained or increased the fruit consumption; 9% increased fruit intake
- 82% maintained or increased the vegetable intake; 33% increased vegetables intake
- 78% (202 of 258) of participants showed improvement in one or more food resource management practice (i.e. plan meals, compare prices, does not run out of food or uses grocery lists).
    - 44% (114 of 258) more often planned meals in advance.
    - 40% (104 of 258) more often compared prices when shopping.
    - 32% (80 of 248) less often ran out of food before the end of the month.
    - 38% (98 of 255) more often used a list for grocery shopping.

**Arab American Project (Arabic Language)**

Issue

Michigan is home to the 2nd largest Arab population in the U.S. behind California (Arab American Institute Foundation, [AAIF] 2013). Arab Americans reside in 82 out of the 83 counties in Michigan, but more than 80% of Michigan's Arab American population resides in Wayne (39%), Oakland (26%) and Macomb (17%) counties (AAIF, 2013). The barrier to participating in nutrition education programs included the availability of culturally appropriate foods and nutrition education. Food is the center of family activity and family is a very strong value in the Arab American communities (including Refugees).

Response

In FY14, MSUE identified the need to culturally adapt our nutrition education materials to meet the needs of the Arabic-speaking communities and to equip staff with the necessary materials for programming. During FY15 MSUE engaged the SNAP-Ed Arabic-speaking paraprofessionals to assist with the identification and the design of materials necessary to meet the needs of the community. Some of the FY15 MSUE achievements are:

- **Documents in Arabic**. MSUE's SNAP-Ed reporting and evaluation tools were translated into Arabic.
- **Cookbook**. MSUE's Eating Right is Basic cookbook was translated into Arabic. This adaption included culturally appropriate ingredients to highlight custom practices and food staples for the Arab American communities. Continued efforts for the Arabic cookbook will include the completion of the design and the piloting phase. MSUE plans to conduct focus group with Arabic-speaking populations in the Southeast region, to assess its cultural and linguistic relevance. Feedback collected from participants will warrant if necessary changes are needed. Providing relevant Arabic nutrition education materials will help increase our reach and relevance within Michigan's Arab populations.
- The graphic designing of the cookbook began and is in the continuation process. Below is a preview of the cookbook.

- **Example of partners' satisfaction with the program.** In Macomb County, MSUE partnered with the Chaldean American Ladies of Charity for recently relocated refugees. The participants enrolled in an MSUE nutrition education series that was adapted to meet their cultural and language needs. MSUE provided an on-hands learning experience through food demonstrations and physical activity.

- Samar Yousif, Program Coordinator for the Elderly Refugee Program at Chaldean American Ladies of Charity, provided feedback to MSUE.

Results

Outcome evaluation results of a sample of Arabic Refugees that participated in series programming evidenced that MSUE educational programs were effective in improving healthy eating habits among Refugees.

- 73% maintained or increased the fruit consumption; 5% increased fruit intake
- 80% maintained or increased the vegetable intake; 40% increased vegetables intake
- 72% (43 of 60) of participants showed improvement in one or more food resource management practice (i.e. plan meals, compare prices, does not run out of food or uses grocery lists).
    - 47% (27 of 58) more often planned meals in advance
    - 32% (19 of 60) more often compared prices when shopping.
    - 32% (18 of 56) less often ran out of food before the end of the month.
    - 34% (19 of 56) more often used a list for grocery shopping.

**Building responsible and informed Michigan residents**

Issue

Though today's youth learn a great deal about the democratic process at the federal level, very little time is spent on the legislative system at the local level - with few resources spent learning about state and regional legislative processes. Despite this, local and state politics play a pivotal role in everyday life, and an understanding of these systems is critical to building active and engaged agents of positive change.

Response

To address this issue, MSU Extension offers programs and resources to help young people

know and understand the policymaking process from the ground up. Through programs such as 4-H Capitol Experience, which this year gave 100 youth a hands-on look at the state Legislature, and 4-H Citizenship Academy, which in 2015 provided 38 young people with an in-depth look at local county and tribal governments, youth develop knowledge of how legislative systems operate and learn skills to influence public policy. After participating in these programs:
Results
95% of surveyed Capitol Experience participants feel prepared to work toward change in their communities, compared to just 60% before the event. Further, 75% of Citizenship Academy participants were willing to work in government jobs and 50% were interested in running for public office.

Another MSU Extension example for youth and Human Health, Environment, Family, Youth, Society and Community

**Creating culturally competent children**
Issue
Today's world is more interconnected than ever - colleagues, competitors or classmates on one side of the globe can join effortlessly with those a world away via the Internet or phone. This connectedness places a growing importance on the need for youth to have both an understanding of their place in the world and an appreciation for diverse cultures.
Response
MSU Extension is helping youth develop these important skills by providing cultural competency enhancing experiences such as the Michigan 4-H China Art Exchange. Through this program, youth from China and Michigan create and exchange works of art that tell a story. These "visual letters" allow youth to communicate with each other despite language barriers. While developing the pieces, youth also take part in lessons about Chinese life and culture, enhancing the experience and their understanding about another culture.
Results
In 2015, survey results found: 100% reported knowing and appreciating both their culture and the culture of others. 100% reported an increased awareness that there are similarities between themselves and Chinese children. 88% reported an increased respect for others who may be different from themselves.

Another MSU Extension example for youth and Human Health, Environment, Family, Youth, Society and Community

**Michigan 4-H makes a difference in post-secondary education enrollment**
Issue
Studies show individuals with college degrees earn more over the course of their lifetimes and enjoy lower unemployment rates than those without post-secondary degrees. With more college graduates, Michigan benefits greatly - through higher taxable earnings, more disposable income and lower rates of unemployment - and produces a more skilled and educated workforce.
Response
Helping to prepare the next generation of college graduates in Michigan is Michigan 4-H. Through its wide range of programs, Michigan 4-H promotes personal growth, career exploration and goal-setting. In addition, its designated pre-college programs - including 4-H Exploration Days, 4-H Great Lakes & Natural Resources Camp (GLNRC) and Michigan 4-H Youth Conservation Council (M4-HYCC) - prepare youth for post-secondary education by helping build important life skills, increase college aspirations and improve college readiness.

Results

- 61% of 2014 Michigan 4-H seniors enrolled in post-secondary education, compared to 45% of their same-age peers.
- 4-H alumni are more likely to go to college than their same-age peers in 90% of Michigan counties.
- College enrollment rates of youth in 4-H pre-college programs is even higher, with 68% of 4-H Exploration Days, 71% of GLNRC and 78% of M4-HYCC seniors enrolling.

Another example of MSU Extension for Human Health, Environment, Family, Youth, Society and Community

**Delivering research-based processes to home kitchens**

Issue

Consuming home-canned foods that have not been preserved properly increases the risk of foodborne illness or death. Outdated recipes and procedures result in unsafe canning techniques and increased risk of botulism. Surveys from the National Center for Home Food Preservation have reflected that many home food preservers use outdated and unsafe food preservation practices, most of which have been learned from family or friends. Home food preservers in Michigan communities receive high-quality, research-based education using U.S. Department of Agriculture guidelines for safe food preservation. MSU Extension food preservation workshops teach Michigan residents how to safely handle and preserve food and use canning equipment.

Response

In 2015, more than 900 people participated in the workshop, either through face-to-face or online education. A survey of participants reported:

- 98% will use correct processing times to preserve low- and high-acid foods safely.
- 97% will use correct processing methods to preserve low- and high-acid foods safely.
- 96% will follow research-based and tested recipes for home food preservation.
- 90% know how to properly use a pressure canner to preserve food.

Another example from MSU Extension

**Delivering culturally relevant nutrition education**

Issue

Language and cultural barriers must be overcome to deliver effective nutrition education to Michigan's diverse communities. Hispanics represent more than 4 percent of Michigan's population, and in 2011, more than 26 percent of Michigan Hispanic households experienced food insecurity as compared to the U.S. average of 14.5 percent. Michigan is home to more than 1 million residents who are deaf or hard of hearing, with the majority living in Wayne and Oakland counties. Deaf adults are more likely to be obese because of lack of knowledge of health care and available preventative medicine interventions. Additionally, Michigan has the nation's second-highest Arab population, and a recent study found that more than 56 percent of Arab Americans age 30 and older were considered overweight.

Response

MSU Extension is investing efforts to break these cultural barriers, delivering nutrition education to 8,500 underserved and vulnerable communities, including:

Results

Hosting culturally appropriate nutrition and physical activity education events for seasonal and migrant workers at migrant Head Start centers during summer 2015. Adapting the Eating Right Is Basic cookbook to be culturally relevant to the Arabic community.

Transitioning the Eat Healthy, Be Active program to be available virtually for people who are deaf or hard of hearing.

Another MSU Extension example
**Improving nutrition and physical activity in Michigan**
Issue
Limited income and poor nutrition affect a person's quality of life and can increase healthcare costs. Michigan has the 10th highest obesity rate in the U.S. Of those enrolled in state food assistance programs, about two-thirds of adults and youth are overweight or obese, with more than 30 percent of youth considered obese.
Response
Nutrition education programs teach necessary skills to buy and prepare nutritious foods on a budget, and ways to increase daily physical activity. MSU Extension delivers affordable, evidence-based education to serve the needs of adults, youth and families in urban and rural communities. MSU Extension nutrition education programs reached over 84,000 Michigan adults and youth in 2015.
Results
Participants reported the following changes: 93% of teachers reported that their students demonstrated an increased awareness of the importance of good nutrition. 75% of adult participants showed improvement in one or more nutrition practices, such as making healthy food choices, planning meals in advance and reading food labels. 50% of adults adopted healthy eating habits by increasing their daily vegetable consumption. 42% of adults adopted healthy eating habits by increasing their daily fruits consumption. 32% of adults improved their weekly strengthening and stretching activities.

**Key Items of Evaluation**

- Preparing Michigan's Children & Youth for the Future
  - 1599 youth participants trained in career exploration:
    - 53.2% of youth surveyed indicated that they were more aware of the various careers that are available in fields that have connected to their interests, skills, and experiences, as a result of participating in a career exploration program.
    - 50% of youth surveyed indicated an increased awareness of knowing the specific education, skills, and characteristics needed to be successful in a career they have explored as a result of participating in our career exploration programming.
    - As a result of participating in career exploration programming, 49.2% of youth surveyed indicated that they had identified the steps necessary for them to reach their career goals.
- Improve Health and Nutrition for Michigan Residents
  - Utilizing a linguistically and culturally appropriate education program resulted in positive impact in the lives of people across Spanish-speaking communities across the state of Michigan. Impact was noted in the following EFNEP core areas: Diet Quality, Nutrition Practices, Food Resource Management, Food Safety, and Physical Activity.
    - **Dietary Intake (73 participants with pre and post dietary data):**
    - **53%** of the adults completing the series demonstrate adoption of healthy eating practices by reporting an increase in fruit consumption during a typical day.
    - **41%** of the adults completing the series demonstrate adoption of healthy eating practices by reporting an increase in vegetable consumption during a typical day.
    - **24%** of the adults completing the series demonstrate adoption of healthy eating practices by reporting a positive change in whole grain consumption during a typical day (e.g., change from never to seldom, seldom to sometimes, sometimes to most times, and

most times to always)

- **Nutrition Practices**
- **88%** of participants showed improvement in one or more nutrition practices (i.e. plan meals in advance, make healthy food choices, prepare food without adding salt, read nutrition labels, or reported that their children ate breakfast) ( 68 of 77 participants).
- **Food Resource Management**
- **84%** of **adults** completing the series demonstrate improvement in one or more food resource management practices (i.e. plan means, compare prices when shopping, less often ran out of food, or often used a list of grocery shopping) (65 of 77 participants).
- **Food Safety**
- **52%** of the adults completing the series demonstrate improvement in one or more food safety practices (i.e. thawing and storing foods correctly) (39 of 75 participants).
- **Physical Activity**
- **43%** of adults completing the series demonstrate adoption of increased time spent in physical activity by reporting a positive change in the time spent physically active on a weekly basis (e.g., changes from sedentary to moderate physical activity, or active).

**The air we breathe:**

Linked to increases in heart disease, respiratory disease, lung cancer and a host of other health complications, air pollution plays a role in 3.7 million premature deaths each year, according to 2012 data from the World Health Organization. Contrary to the popular portrayal, however, the effects of air pollution are not limited to urban environments. Michigan State University (MSU) AgBioResearch toxicologist Jack Harkema is studying the impacts of air pollution on rural populations.

Air pollution is a mixture of elevated concentrations of potentially harmful gaseous chemicals, like ozone and nitrogen dioxide, and very small particles (particulate matter or particulates) that result from emissions from both human sources, like motor vehicles or industrial smoke stacks, and natural sources, like wildfires or volcanoes. If inhaled these pollutants may cause injury to our lungs or other organs like our heart and blood vessels.

Airborne particulates are defined according to their size into three basic categories: coarse, fine and ultrafine. Fine particles range in size from 2.5 to 0.1 microns in diameter, and ultrafine particles are less than a tenth of a micron in diameter. Both are invisible to the naked eye and even the largest size of fine particles are still 30 times less than the diameter of a human hair. The larger coarse particles with diameters greater than 2.5 microns and smaller than 10 microns are common to rural atmospheres. Fine and ultrafine particles are commonly emitted by automobiles, power plants and industries, while coarse particles are more likely to originate from organic compounds commonly found in the earth's crust.

"In agricultural settings, you see some of the highest airborne concentrations of particulate matter due to dusty conditions generated by common agricultural practices," said Harkema, university distinguished professor in the MSU College of Veterinary Medicine and the Institute for Integrative Toxicology. "A lot of people think air pollution is just an urban issue, but we now know that it causes real problems in rural settings, too."

Harkema's work in this area blossomed in 2011, when an $8 million grant from the U.S. Environmental Protection Agency (EPA) established the Great Lakes Air Center for Integrated Environmental Research (GLACIER). Combining the multidisciplinary expertise of researchers from MSU, the University of Michigan, Ohio State University and the University of Maryland, GLACIER is one of four EPA Clean Air Research Centers established to study the health impacts of air pollutants. Each center has a distinctive focus within this research area. GLACIER focuses on understanding the health effects of air pollutant mixtures, especially in susceptible populations like those suffering from chronic cardiovascular,

respiratory or metabolic conditions.
Though much of their work has focused on urban air pollution -- primarily in communities in and around Detroit -- recent research has shifted to rural environments.
More on this story:
http://agbioresearch.msu.edu/news/the_air_we_breathe_studying_the_impact_of_air_pollution_in_ru

## V(A). Planned Program (Summary)

**Program # 2**

**1. Name of the Planned Program**

Soil, Water and Natural Resources

☑ Reporting on this Program

**V(B). Program Knowledge Area(s)**

1. Program Knowledge Areas and Percentage

| KA Code | Knowledge Area | %1862 Extension | %1890 Extension | %1862 Research | %1890 Research |
|---|---|---|---|---|---|
| 101 | Appraisal of Soil Resources | 0% | | 5% | |
| 102 | Soil, Plant, Water, Nutrient Relationships | 55% | | 12% | |
| 111 | Conservation and Efficient Use of Water | 5% | | 12% | |
| 112 | Watershed Protection and Management | 5% | | 10% | |
| 123 | Management and Sustainability of Forest Resources | 5% | | 5% | |
| 131 | Alternative Uses of Land | 0% | | 6% | |
| 132 | Weather and Climate | 0% | | 10% | |
| 133 | Pollution Prevention and Mitigation | 5% | | 12% | |
| 134 | Outdoor Recreation | 0% | | 1% | |
| 135 | Aquatic and Terrestrial Wildlife | 0% | | 12% | |
| 216 | Integrated Pest Management Systems | 15% | | 15% | |
| 806 | Youth Development | 10% | | 0% | |
| | **Total** | 100% | | 100% | |

## V(C). Planned Program (Inputs)

**1. Actual amount of FTE/SYs expended this Program**

| Year: 2015 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| **Plan** | 12.9 | 0.0 | 11.0 | 0.0 |
| **Actual Paid** | 20.1 | 0.0 | 14.0 | 0.0 |
| **Actual Volunteer** | 78.2 | 0.0 | 0.0 | 0.0 |

**2. Actual dollars expended in this Program (includes Carryover Funds from previous years)**

| Extension | | Research | |
|---|---|---|---|
| **Smith-Lever 3b & 3c** | **1890 Extension** | **Hatch** | **Evans-Allen** |
| 904663 | 0 | 1282500 | 0 |
| **1862 Matching** | **1890 Matching** | **1862 Matching** | **1890 Matching** |
| 904663 | 0 | 1316921 | 0 |
| **1862 All Other** | **1890 All Other** | **1862 All Other** | **1890 All Other** |
| 0 | 0 | 4628259 | 0 |

## V(D). Planned Program (Activity)

### 1. Brief description of the Activity

Research programs and Extension activities to:

- Develop new land use models for Michigan communities.
- Offer education to planners, elected officials and citizens on how these new models will reduce sprawl and ensure that the desirable outcomes will become reality.
- Create new remediation strategies to clean up polluted soil and water. These strategies will be environmentally friendly, economically feasible and easy to implement with proper training.
- Discover new knowledge about the composition, organization and fluctuations of microbial populations in the soils.
- Develop a user-friendly computer program for nutrient management for Michigan crop and livestock producers to improve the management of fertilizer and manure nutrients on cropland to protect water resources and boost crop productivity.
- Develop management techniques for potato and vegetable growers that includes cover crops.
- Develop new nitrogen application recommendations for turf managers.
- Develop a management system for Michigan inland lakes that does not involve sampling the lakes.
- Develop Total Maximum Daily Load (TMDL) assessment tools for evaluation of Michigan watersheds.
- Determine how wildlife responds to ecosystem management decisions in forest and agricultural systems
- •Develop fish population/community computer models for species important to Michigan. These models will be used to evaluate different fishery management strategies.
- Develop web-based tools and models for natural resources managers so knowledge can be shared quickly and easily.
- Develop computer models to assess how habitat management affects species important to Michigan, including white-tailed deer, salmon, trout and perch.
- Promote and support value-added processing of forest products, including wood products, biofuels, maple syrup and other nontimber products.
- Identify, prevent and control exotic invasive pests and diseases of forests.
- Conduct educational programs to help farmers improve nutrient management and other practices to maintain and improve quality of groundwater and surface water.
- Conduct educational programs with riparians and lake users to enhance their understanding of watershed management and inland lakes water quality issues.
- Work with state agencies and local communities to encourage protection of community groundwater supplies through wellhead protection programs.
- Educate and train health officials, consultants, engineers and riparians to improve onsite and decentralized wastewater treatment and design.

**2. Brief description of the target audience**

Michigan farmers, natural resource managers, private citizens, agriculture and natural resources industry representatives, state agencies, riparians and foresters.

**3. How was eXtension used?**

All field educators are encouraged to be involved in eXtension through both Ask and Expert and Communities of Practice (CoP). A total of 11.5 fte's were involved in this area of plant soil with 5,7 fte's funded through 3bc. An example is one natural resources Educator that was assigned and answered nine questions on the following topics.

- iron bacteria in drinking water well
- sump pumps
- treating drainfield weed intrusion with copper sulfate
- pond weeds
- alternatives to septic systems
- bacterial rust in drinking water
- two for water testing
- Michigan Green Schools Program

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

| 2015 | Direct Contacts Adults | Indirect Contacts Adults | Direct Contacts Youth | Indirect Contacts Youth |
|---|---|---|---|---|
| **Actual** | 14656 | 43968 | 41693 | 83386 |

**2. Number of Patent Applications Submitted (Standard Research Output)**

**Patent Applications Submitted**

| | |
|---|---|
| Year: | 2015 |
| Actual: | 1 |

**Patents listed**

MICL02306, Development and Applicaton of Pheromones for Control of Aquatic Invasive Species, Serial Number 61/828,001

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

| 2015 | Extension | Research | Total |
|---|---|---|---|
| **Actual** | 2 | 32 | 0 |

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Number of research programs on soil, water and natural resources.

| Year | Actual |
|---|---|
| 2015 | 52 |

**Output #2**

**Output Measure**

- Number of adult participants trained in soil, plant, water and nutrient relationships.

| Year | Actual |
|---|---|
| 2015 | 4618 |

**Output #3**

**Output Measure**

- Number of adult participants trained in how human activities impact on ecosystems.

| Year | Actual |
|---|---|
| 2015 | 10038 |

**Output #4**

**Output Measure**

- Number of youth participants trained in how human activities impact on ecosystems.

| Year | Actual |
|---|---|
| 2015 | 41693 |

**V(G). State Defined Outcomes**

## V. State Defined Outcomes Table of Content

| O. No. | OUTCOME NAME |
|---|---|
| 1 | Number of research programs to discover new knowledge about the composition, organization and fluctuations of microbial populations in the soils. |
| 2 | Number of adult participants with increased knowledge of how human activities impact ecosystem. |
| 3 | Number of research programs to determine how wildlife responds to ecosystem management decisions in natural resource and agricultural systems. |
| 4 | Number of adult participants with increased knowledge of soil, plant, water and nutrient relationships. |
| 5 | Number of research programs that deal with fish population dynamics and the management of Great Lakes fisheries. |
| 6 | Number of research programs that deal with the security, stewardship and management of Michigan's water resources. |
| 7 | Number of research programs that analyze key soil characteristics to better assess their agricultural and environmental contribution, including crop yield. |
| 8 | Number of research programs that explore the occurrence, transport and fate/effect of organic contaminants, chemicals, pesticides, pharmaceuticals and particulates in soils. |
| 9 | Number of research programs to develop new land use models for Michigan communities. |
| 10 | Number of youth that increase their knowledge in how human activities impact on ecosystems. |

## Outcome #1

### 1. Outcome Measures

Number of research programs to discover new knowledge about the composition, organization and fluctuations of microbial populations in the soils.

### 2. Associated Institution Types

- 1862 Research

### 3a. Outcome Type:

Change in Condition Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2015 | 2 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Soil harbors the greatest undiscovered microbial diversity. This diversity recycles Earth's nutrients and helps maintain our atmosphere. This research is aimed at discovering some of that diversity, especially novel microbes that degrade chlorinated pollutants such as PCBs, chlorinated solvents and pesticides; microbes that have unique freezing protection mechanisms, and microbes that affect nitrogen availability for plant growth.

**What has been done**
Research to: understand temporal and spatial control of gene expression during development of soil bacteria; and develop new technologies to control soil-borne diseases.

**Results**
Because soil microbes drive many of the processes underpinning ecosystem services provided by soils, understanding how cropping systems affect soil microbial communities is important for productive and sustainable management. We characterized and compared soil microbial communities under four potential cellulosic biomass crops (corn, switchgrass, mixed prairie grasses, and restored prairie) in two spatial experimental designs - side by side plots where plant communities were in their second year since establishment (i.e., intensive sites) and regionally distributed fields where plant communities had been in place for at least 10 years (i.e., extensive sites). We assessed microbial community structure and composition
using lipid analysis, pyrosequencing of rRNA genes (targeting fungi, bacteria, archaea and lower eukaryotes), and targetedmetagenomics
of nifH genes. For the more recently established intensive sites, soil type was more important than plant community in determining microbial community structure, while plant community was the more important driver of soil microbial communities for the older extensive sites where microbial communities under corn were clearly differentiated from
those under switchgrass and restored prairie.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 101 | Appraisal of Soil Resources |
| 102 | Soil, Plant, Water, Nutrient Relationships |

**Outcome #2**

**1. Outcome Measures**

Number of adult participants with increased knowledge of how human activities impact ecosystem.

Not Reporting on this Outcome Measure

**Outcome #3**

**1. Outcome Measures**

Number of research programs to determine how wildlife responds to ecosystem management decisions in natural resource and agricultural systems.

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 6 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Wildlife resources contribute greatly to the bio-economy of Michigan, the US and the rest of the developed world. Yet, several significant and on-going demographic changes will dramatically affect the institution of wildlife management: the social landscape is becoming more diverse ethnically and racially, and suburban sprawl continues to grow into rural environments. Although wildlife in suburban-ex-urban settings has been a continual stewardship concern to wildlife professionals, only recently has the level of stakeholder interest in the issues and scrutiny of management become acute. Left unchecked in an increasingly suburbanized landscape, human-wildlife conflicts likely will become an insurmountable drain on agency personnel and financial resources. A potentially even more heinous effect, however, is that public perceptions of wildlife may transition from one of being a valued resource to one of pest . If this occurs, societal support will dwindle for wildlife conservation generally.

**What has been done**
Research to: understand the mechanisms of wildlife dynamics on landscape mosaics; develop a better understanding of wildlife-habitat relationships as influenced by natural and managed wildlife habitat disturbances; and uncover systematically informative morphological and molecular characteristics related to arthropods in order to revise classifications and test evolutionary hypotheses; understand wildlife responses to habitat management; and improve wildlife management.

**Results**
A change in knowledge and practice occurred in regards to management of white-tailed deer in suburban environments. Initial research results suggested localized approaches to conflict management would be more effective than broad-brushed approaches previous used by the Michigan Department of Natural Resources (MDNR). Maps, depicting isoclines of tolerance for deer were produced and reported to stakeholders. Insights into the characteristics of human communities with conflicts were described quantitatively and qualitatively in terms of landscape features, demographics, affluence, as well as the extent and quality of interactions with white-tailed deer. Knowledge transfer occurred through presentations to the MDNR Wildlife Division at their annual division meeting and in consultation with local area managers. Presentations at the annual conference of the Michigan Township Supervisors Association provided preliminary results to local governance.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 123 | Management and Sustainability of Forest Resources |
| 135 | Aquatic and Terrestrial Wildlife |

**Outcome #4**

**1. Outcome Measures**

Number of adult participants with increased knowledge of soil, plant, water and nutrient relationships.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 3936 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
One example, Michigan State University Extension's Smart Gardening Initiative is designed to meet gardeners at their own level of learning.

**What has been done**
MSUE conducted a day-long Smart Gardening Conference that allowed participants to dig deeper for greater levels of learning. Focusing on major environmental themes such as Smart Plants, Smart Soils and Smart Lawns, the 2015 conference hosted presenters on beneficial insects and pollinators, Smart vegetable gardening, lowering inputs and environmental landscape design.

**Results**
226 participants attended the conference from 37 counties and out-of-state. Conference surveys showed significant adoption/implementation rates of smart practices (higher than any year prior).

1) A survey monkey post-series evaluation was done. 100% of students ranked every session/topic as either ?exceeded expectations? or ?met expectations.?

2) Averaging all responses, 76% of respondents implemented Smart Gardening (sustainable) practices in their gardens as a result of the program. (152 practices were adopted)

3) Participants are asked if they have shared the Smart Gardening messages with others and 65% of the ten practices were shared. Interesting to note that only 43% of the class said they took a soil test but 100% said they shared that message with someone else.

4) 100% said they would recommend the program to others

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 102 | Soil, Plant, Water, Nutrient Relationships |

**Outcome #5**

**1. Outcome Measures**

Number of research programs that deal with fish population dynamics and the management of Great Lakes fisheries.

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|

2015 6

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**

Humans affect aquatic ecosystems at a variety of levels, and across a wide range of spatial and temporal scales. The impact of human activities on aquatic ecosystems is often to reduce their productivity of "desirable" species, and to reduce the ability of the system to withstand additional perturbations. Applied research is needed to identify the consequences of specific actions (e.g., land use changes, lakeshore development, dam removal) and the mechanisms bringing about change. Basic research is needed to formulate models capable of synthesizing this information. Research linking fish populations to their habitat is essential for better managing our fishery resources in the face of increasing demand by the citizens of Michigan. As the fishery management profession has matured, it has become increasingly apparent that habitat management (often in partnership with terrestrial land managers) is needed to maintain productive aquatic ecosystems capable of providing sustained societal benefits and food resources.

**What has been done**

Research to: investigate areas of uncertainty for Great Lakes fishery management, particularly sea lamprey control and salmon stocking; determine how fish population dynamics are affected by the physical, chemical and biological environment; investigate how human activities bring about changes in aquatic habitats; develop models capable of predicting response of fish to habitat alteration; investigate the environmental effects on fish genetic diversity.

**Results**

Currently, quantitative data pertaining to the use of chemotherapeutant prophylactics are lacking for lake sturgeon beyond the egg period. Researchers quantified and compared survival of young-of-year lake sturgeon as a function of different chemotherapeutant prophylactics. They showed that survival of young-of-year lake sturgeon differed as a function of different chemotherapeutant prophylaxis treatments.

Research results empower managers and stakeholders to protect sensitive thermal habitats, sustain thermal buffering mechanisms (e.g., groundwater inputs, grassland and forest watersheds and riparian zones), and implement appropriate harvest regulations to conserve resilient, productive salmon fisheries in a warming climate.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 112 | Watershed Protection and Management |
| 134 | Outdoor Recreation |
| 135 | Aquatic and Terrestrial Wildlife |

## Outcome #6

### 1. Outcome Measures

Number of research programs that deal with the security, stewardship and management of Michigan's water resources.

### 2. Associated Institution Types

- 1862 Research

### 3a. Outcome Type:

Change in Action Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2015 | 14 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
With growing concern about the connection between health and the marine environment, there is a corresponding emphasis on large freshwater lake ecosystems and human health. The Great Lakes serve as a highway for international maritime commerce and support a $1 billion per year recreational and commercial fishing industry. They also supply drinking water for more than 15 million people. Holding about 20 percent of the world's fresh surface water, the degradation of the Great Lakes ecosystem through chemical and biological contamination presents an enormous challenge for the future.

The invasive sea lamprey remains the most significant source of mortality for many large fishes of the Great Lakes and represents one of the greatest impediments to the restoration of the native food web and the many economic opportunities and ecosystem functions it provides to human society. The financial cost of applying pesticides to sea lamprey-producing streams across the Great Lakes basin is substantial, averaging $10-18 million per year and requiring the application of as much as 70,000 kg of lampricide. These costs constrain the contrl program to treatment of no more than approx. 100 streams per year of
the 485 known infested streams (21%), and likely underlie the programs failure to achieve suppression targets

**What has been done**
Research to: enhance the current water resources management structure through the ecosystems approach, development of a system to help create sustainable water resource management, understand how anthropogenic actions can affect food web structure and function, address critical questions that have relevance to specific problems in Michigan inland lake and Great Lakes integrity; help develop dynamic, interactive computer interfaces in resource-based recreation management; construct and evaluate a knowledge management system in resource-based recreation management; develop a landscape-based ecosystem management framework

that integrates landscape ecology with natural resource policy and management; determine why sport fish populations, fish assemblages and lake food webs, and their response to perturbation vary among lakes; determine if pheromones can be used to control sea lamprey in streams, with a view to developing a viable new control strategy; to improve design of engineered phytoecosystems for treatment of wastewaters and stormwaters; assess the value of ecosystem services from inland waterways; and understand sustainable water use of both natural and agriculture systems

**Results**

Researchers continue to build are large 17-state water quality and geospatial database (LAGOS) on 50,000 lakes that are greater than
4 ha. During this past year, we have created a database that we have started to analyze for water quality relationships to land use, climate, and other landscape features around lakes. The database currently includes over 9,000 lakes in our 17-state study area for which we have water quality data, and 50,000 lakes for which we have geographic information science data, including information on lake watersheds and regions including: land use and cover, geology, climate, atmospheric deposition, hydrology, road and dam density, and freshwater connectivity metrics.

During the current reporting period major activities were focused on the analysis of fish telemetry data from three years of monitoring of at-large migrating sea lamprey in Lake Huron (i.e., Changes in Knowledge). (1) Researchers completed several analyses 3-dimensional sea lamprey movement data in cooperation with Dr. Eliezer Gurarie of the University of Maryland. In particular, researchers(a) identified the nature of offshore-to-inshore navigation via bathymetric tracking in sea lamprey, a novel finding; (b) mapped 3-D movements of sea lampreys as they search in the vicinity of spawning river plumes, integrating animal movement paths with a 3-D hydrodynamic model of the river plume in collaboration with Dr. Phanikumar Mantha (MSU); (c) Dr. Trevor Meckley successfully defended his Ph.D. dissertation based on these findings; and, (d) four manuscripts are in prepartion for submission

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 102 | Soil, Plant, Water, Nutrient Relationships |
| 111 | Conservation and Efficient Use of Water |
| 112 | Watershed Protection and Management |
| 133 | Pollution Prevention and Mitigation |

**Outcome #7**

**1. Outcome Measures**

Number of research programs that analyze key soil characteristics to better assess their agricultural and environmental contribution, including crop yield.

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 6 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Soils simply do not contain adequate nutrients to support the sheer quantity of plant growth required from today's agricultural production systems. Sufficient nutrients supplied from either organic or inorganic sources are required to maximize crop growth and attain crop yields able to support the world's population. Globally, nitrogen fertilizer usage has increased 10-fold since the mid-20th century resulting in both positive and negative repercussions. Although agricultural and foreign policy changes have contributed to the rising costs of natural gas and urea over the last 5-7 years, the escalating price of crude oil has primarily driven the hike in fertilizer prices. Even though commodity prices have correspondingly increased 60% over the last two years, input costs are projected to remain on an upward climb. This combination of factors has pushed fertilizer costs to a tipping point
where producers are carefully reconsidering their fertilizer sources and rates based on crop response and price per unit of nutrient. Simultaneous to the fertilizer and crop price increases, yields across many crops have substantially increased over the last decade and have resulted in increased nutrient requirements. Developing efficient soil and nutrient management practices that maximize the genetic potential of Michigan cropping systems, improves the profitability for Michigan producers, and promotes nutrient stewardship amongst all production systems will be essential to the sustainable management of our natural
resources.

**What has been done**
Research to: study herbivore suppression of cyanobacteria and total phytoplankton biomass; effectiveness of nitrogen rates on soil quality and plant nutrition; study the characteristics of high content soil blends used in athletic fields and golf putting greens and how the properties of these soils change with time and use; and to explore diversification with cover crops to enhance nutrient cycling efficiency and rhizosphere traits for resilient, productive row crop systems.

**Results**
Several field research trials were established and completed under objective 1. Data show that growers may need to apply additional N to maximize economic return for sugar production but greater attention needs to be paid toward N timing in conjunction with N rate. Unless growers fertilizer at 160 N, few differences exist at rates between 40 and 160. Currently evaluating the role of late season N application to increase corn nitrogen use efficiency. Attempting to delineate whether early season leaf firing from delayed N application results in yield loss despite the impact of late season N applications

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 101 | Appraisal of Soil Resources |
| 102 | Soil, Plant, Water, Nutrient Relationships |
| 111 | Conservation and Efficient Use of Water |
| 133 | Pollution Prevention and Mitigation |

## Outcome #8

### 1. Outcome Measures

Number of research programs that explore the occurrence, transport and fate/effect of organic contaminants, chemicals, pesticides, pharmaceuticals and particulates in soils.

### 2. Associated Institution Types

- 1862 Research

### 3a. Outcome Type:

Change in Knowledge Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2015 | 8 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Michigan's 37 million acres of land support the plants and animals that provide our shelter, food and fiber. The land provides us with minerals and foods for our industry and our businesses. At the same time, human activities are generating and releasing large amounts of pollutants -- including pesticides, antibiotics and dioxins, and other industrial emissions -- that may end up in the soil. Research to investigate the fate and effect of these pollutants is critical to sustaining soil viability and health, and minimizing consequences to human health.

**What has been done**
Research to: investigate the transport of a group of engineered nanomaterials in the soil and water environments and develop an understanding of their interactions with other elements; evaluate the occurrence and human health risks of historic pesticide contamination of agricultural soils; understand the mechanisms by which chronic estrogen exposure brings about reproductive failure; determine the mechanistic functions and contributions of soil humus and clays to the immobilization of pesticides and POPs found in soils; evaluate the occurrence of antibiotics in animal farms and their mobility; to control and convert rural waste to resources; and to understand adaption for ecosystem responses.

**Results**

Land application of animal manure/sewage sludge and irrigation with reclaimed water in agricultural production result in the dissemination of pharmaceuticals in agroecosystems, which can be taken up and accumulate in vegetable crops. In this study, the accumulation and transportation of six pharmaceuticals caffeine, carbamazepine, lamotrigine, trimethoprim, monensin sodium and tylosin in lettuce were examined using hydroponic experimental settings. The uptake of target
pharmaceuticals by mature lettuce was measured from 0 to 144 h. The results revealed that for caffeine and carbamazepine greater pharmaceutical concentrations were found in lettuce shoots than that in roots. Lamotrigine, trimethoprim, monensin sodium and tylosin appeared to more accumulate in lettuce roots than in shoots. Sorption by vegetable tissues from nutrient solution showed that lettuce roots sorbed more lamotrigine and trimethoprim than caffeine and carbamazepine, monensin sodium and tylosin. These results demonstrated that lamotrigine and trimethoprim, with relatively strong affinity for plant root constituents, tend to accumulate in lettuce roots rather than in shoots. Conversely, caffeine and carbamazepine were observed to significantly transport to lettuce shoots with water transpiration flow, which could be due to their weak sorption by root constituents. Monensin sodium and tylosin also demonstrated a weak affinity to lettuce root constituents, but manifested a great accumulation in lettuce roots.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 101 | Appraisal of Soil Resources |
| 102 | Soil, Plant, Water, Nutrient Relationships |
| 111 | Conservation and Efficient Use of Water |
| 112 | Watershed Protection and Management |
| 132 | Weather and Climate |
| 133 | Pollution Prevention and Mitigation |
| 216 | Integrated Pest Management Systems |

**Outcome #9**

**1. Outcome Measures**

Number of research programs to develop new land use models for Michigan communities.

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|

2015 5

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
What we do to our land is intimately tied to our drinking water quality, wildlife habitat, potential for flooding, our recreational open space and tourism, and many other quality of life issues. For example, urbanization of the rural landscape is claiming some of the country's richest farmland and creating challenges for areas where rural and urban interests collide. Some recipients indicate the, by 2020, farmers will only have enough land to meet the nation's domestic food needs.

**What has been done**
Research to: better understand how regional and continental processes affect local processes; increase management capacities among agencies to better integrate biological and human dimensions of management in dealing with wicked problems, such as wildlife health; and to help develop sustainable agro-ecosystems that protect public health, environmental quality and promote efficient and profitable resource use.

**Results**
Water, food and land are tightly coupled in such way that food security assessment requires a better understanding of the nexus of the three. This research from past year has revealed how climate change, especially precipitation pattern shift, affects both vegetation and water use efficiency at different spatial scales and agricultural systems (cropping and grazing lands). Further, there is a debate on the causes of environmental degradation, especially regarding climate roles in degradation assessment. This research also examined anthropogenic and climatic contributions to vegetation productivity and concluded
that climate change results in long-term, large scale change while human activities often result in drastic but limited in space degradation or vegetation production. Research efforts will continue in order to fully understand the nexus of land use and land cover change, climate and ecosystem services such as agricultural productivities.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 102 | Soil, Plant, Water, Nutrient Relationships |
| 112 | Watershed Protection and Management |
| 123 | Management and Sustainability of Forest Resources |
| 131 | Alternative Uses of Land |
| 135 | Aquatic and Terrestrial Wildlife |

## Outcome #10

### 1. Outcome Measures

Number of youth that increase their knowledge in how human activities impact on ecosystems.

### 2. Associated Institution Types

- 1862 Extension

### 3a. Outcome Type:

Change in Knowledge Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2015 | 35439 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Creating environmental caretakers and conservationists. Known as the Great Lakes State, Michigan is celebrated for its great outdoors. From sunny lakeshores to rustic forests, these natural resources are one of Michigan's premier assets. Whether utilized for recreation or commerce, Michigan?s environmental resources play a key role in the life of every Michigander. They are critically important to protect and preserve.
To build a future generation of environmental stewards, MSU Extension offers many environmental education programs. These programs teach youth the science and ecology behind Michigan?s environmental assets while helping them develop an awareness of their role in protecting these resources.

**What has been done**
Programs include the Great Lakes Education Program (GLEP) and the 4-H Great Lakes & Natural Resources Camp (GLNRC). GLEP is a classroom, vessel-based and shoreside program that focuses on the Great Lake's biological, chemical, physical and cultural aspects. GLNRC is a residential camp that teaches ecological concepts such as coastal ecology, fisheries management, limnology, invasive species management and forestry.

**Results**
GLEP reached more than 1,500 youth in Macomb and Wayne counties, with 93% indicating they feel more knowledgeable about the Great Lakes. For example, 67 teens from 37 counties participated, with 88% reporting the experience increased their interest in natural resources and the environment.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 102 | Soil, Plant, Water, Nutrient Relationships |
| 111 | Conservation and Efficient Use of Water |
| 112 | Watershed Protection and Management |
| 123 | Management and Sustainability of Forest Resources |
| 131 | Alternative Uses of Land |
| 132 | Weather and Climate |
| 133 | Pollution Prevention and Mitigation |
| 806 | Youth Development |

## V(H). Planned Program (External Factors)

### External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

### Brief Explanation

During the 2014-2015 fiscal year, ABR and MSUE was able to continue rebuilding some of its resources after several years of either flat or funding cuts at both the state and federal levels. ABR was able to **fill voids in its research and support teams by hiring quality, skilled people for a variety of positions ranging from farm managers and grant coordinators to faculty and research technicians**. **Much needed equipment and infrastructure updates were also conducted at many on-campus and outlying research facilities**, helping to keep operations to full capacity. In 2014, ABR and Project GREEEN funds helped bridge operating budget gaps at five of the 13 outlying research centers, enabling the repairs of equipment and several buildings. Together, the organizations look to re-invigorate the MSUE presence at the 13 outlying research centers throughout the state.

The **ongoing economic challenges** faced by Michigan continue to affect this planned program area. Consequences have included fewer new hires, delaying the award of new financial obligations, reducing levels of continued funding, and renegotiating or reducing the current scope of assistance through formula funds or block grants. Specifically, a 15 percent decreases in state funding FY2011-2012 coupled with a flat federal funding line for the following two years resulted in the elimination of 72 Extension educator positions across 83 counties, 22 academic and faculty positions on campus and 15 support staff. Administrative positions were reduced from 45 to 19 FTEs. Impacts on ABR came largely in the form of reductions in research infrastructure support. Investments in facility maintenance and equipment were postponed in an effort to avoid eliminating more than 45

research positions (faculty, support staff and graduate assistants) and one research facility had to be closed in light of the reductions. There were also fewer funds to seed research on emerging issues.

E**xtreme weather events** have also caused extensive hardship to the agriculture industry. The period between November 2013 and February 2014 was the coldest in Michigan since 1911 and among the five coldest periods on record in the state. And the winter of 2013-14 brought a series of bitterly cold air masses rolled down from the Arctic, through Canada and into Michigan. The spring 2012 ranks among the most destructive weather periods in Michigan fruit production history, with crop losses valued at more than $500 million. Peach production suffered a 95 percent loss; tart cherry, a 90 percent crop loss; apple production, an 88 percent loss; and grapes, an 85 percent loss. The summer 2012 brought the worst drought in Michigan since 1988 with many crops suffering substantial losses.

Together, MSUE and ABR continue to serve as the primary research and development arm for the agriculture and food industries in Michigan, valued at more than $100 billion annually.

## V(I). Planned Program (Evaluation Studies)

### Evaluation Results

As Hatch dollars are base funding for faculty salaries, there is a built-in evaluation mechanism through annual reviews of overall performance, research productivity and the leveraging of additional research dollars. In addition, many of the research projects have an evaluative element that is required by state and federal-level funding sources that provides documentation related to project assumptions, goals and outcomes. This information is used to determine the overall success of the research initiatives; their contribution to providing practical, real-world solutions and resources to address challenges and problems; and whether continuation funding and/or new dollars are appropriate and necessary as funds are available.
MSU Extension- Assisting biologists using citizen scientists
Michigan Sea Grant Extension has a long history of assisting the Great Lakes sport fishing industry. Educators gather industry information through surveys, offer fisheries workshops and recruit anglers to be citizen scientists. Today, Michigan's recreational fisheries industries are valued in excess of $4 billion annually. The Great Lakes salmon stocking program began in 1966 and for years, anglers and biologists lived by a simple equation: more fish stocked equals more fish caught. But when chinook salmon catches dropped off, biologists realized they had come close to the limit of salmon the lakes could support.
Response
Thanks to a citizen science project led by Michigan Sea Grant Extension, anglers now share critical information on their catches. Salmon ambassador volunteers track each chinook salmon they catch and report whether it was a wild or stocked fish. Understanding how stocked fish contribute to the catch helps managers make informed decisions regarding the future of salmon stocking in lakes Michigan and Huron.
Results
In 2014, 125 anglers signed up to be salmon ambassadors.Volunteers recorded data on 3,460 salmon. Ports around Lake Michigan reported 57 to 75% of caught chinook salmon were wild, while volunteers in northern Lake Huron reported 82% were wild.

MSU Extension- Celebrating 25 years of advancing Great Lakes literacy
Issue

Michigan is the Great Lakes State, yet Great Lakes literacy among both youth and adults is low and physical access to the lakes is a challenge for many Michigan residents. Michigan Sea Grant Extension is a leader in Great Lakes literacy and science education, helping to create a network of educators and informed citizens who share their knowledge of and commitment to Great Lakes stewardship with others.

Response

The Great Lakes Education Program has provided classroom and vessel-based education for K12 students in southeastern Michigan since 1991. More than 85,000 students and 15,000 adults have participated - many experiencing the Great Lakes for the first time. The program includes classroom lessons and an entire day in the field. In 2014 alone, the Great Lakes Education Program involved schools from four counties and 26 school districts and included 3,470 students, 116 teachers, 476 adult chaperones and 42 volunteer educators, who donated 725 hours toward program delivery valued at $16,348.

Results

Student evaluations demonstrate a high confidence in science knowledge and an affinity for science after taking part in the program. Teacher evaluations show: 93% feel a greater responsibility for the Great Lakes, 74% include more Great Lakes content in their classrooms, and 21% engage their students in Great Lakes stewardship activities.

**Key Items of Evaluation**

- Enhance Michigan's First Green Industry: Agriculture and Agribusiness
  - 35.840 adults were trained on environmental quality
  - 12,068 of acres adopting practices to reduce nutrient, pesticide or sediment use or runoff.
  - 44 new farms adopting practices to reduce nutrient, pesticide or sediment use or runoff
  - 4,976 sustainable landscape practices adopted
  - 3,383 new acres under irrigation management
  -
- Greening Michigan: Leveraging Natural and Human Assets for Prosperity
  - 3,410 adults trained in natural resources stewardship
  - 79.5% of 302 adults influenced changes in public policy.

For MSU AgBioResearch in FY15 it was a big year for soil. Piggy backing on the United Nations Food and Agriculture Organization's 2015 International Year of Soil and our Center for Global Connections hosting a conversation around the UN topic, we dedicated an entire publication to the topic. That publication can be found at:
http://agbioresearch.msu.edu/publications/2015_international_year_of_soils
Here is an excerpt on one of our researchers, James Tiedje:

**Getting the scoop on soil**

When discussing soil research at MSU, it is impossible to mention the university's immense contributions to the field without recognizing James Tiedje, a University Distinguished Professor and the director of the MSU Center for Microbial Ecology. For more than four decades, Tiedje has been unlocking soil's secrets with the development of new technologies and analysis techniques, broadening the scope of understanding for scientists everywhere.

Throughout his career, Tiedje has seen paradigm shifts in soil studies, starting with the advent of personal computers. They allowed researchers to do modeling work much easier and made it simple to scale up mathematical models derived from experiments. Today Tiedje sequences DNA from soil with the same technology used in human medicine. MSU researchers, including Tiedje, led the largest soil DNA sequencing e™ffort to date,

collaborating with scientists at the U.S. Department of Energy Joint Genome Institute and Lawrence Berkeley National Laboratory.

"In the '90s, it would take us almost four years to sequence one gene in a microbe," Tiedje said. "Now we can sequence billions of base pairs a day. The sequencing capacity is tremendous, but the hard part is data analysis because storing and examining that amount of data requires high-performance computers. Our team has developed methods of breaking the data into more interpretable components, suitable for computers here at Michigan State."

Tiedje calls soil microbiology the greatest frontier in all of biology because it is the most complex, diverse and unknown. Over nearly 3 billion years, microbial evolution has resulted in extremely high genetic diversity in soils. Sequencing e™fforts have decoded some of the mysteries, but scientists are just scratching the surface of identifying and understanding soil microbes and their impacts on agricultural production, the environment, biotechnology and medicine.

"No one knows how many species of bacteria there are," Tiedje said. "Any particular gram of soil has about 1 billion bacteria, but no more than 0.1 percent of those microbes would be previously known."

DNA technology is being used in several of Tiedje's current projects, including one that is part of the Great Lakes Bioenergy Research Center. It is one of only three national centers funded by the U.S. Department of Energy that focuses on biofuels research, led by the University of Wisconsin-Madison in partnership with MSU. One of its research groups focuses on the rhizosphere, the area of soil around plant roots, which is home to large microbial communities.

Just as humans have microbes that live with us and aid our health, plants also have a microbiome that supports their health and productivity. It improves nutrient access, prevents disease and may provide other benefits not yet discovered. Tiedje's group is using new high-capacity DNA sequencing to learn how the plant's microbiome can contribute to cost-e‹ffective and sustainable biofuel production. In addition to pinpointing its eff‹ect on promoting healthy vegetation, experts are studying how soil plays a part in climate change. A group of MSU researchers is part of a consortium studying warming sites in Alaska and Oklahoma, looking into the soil microbes' response to an increase in temperature.

"There's so much carbon in the permafrost in the Arctic and some of the permafrost is melting, so the microbes take over and convert that carbon to carbon dioxide and, in wet areas, to methane," Tiedje said. "Our major goals are to learn about the temperature sensitivity of microbes using these DNA approaches, and whether their activity has an amplifying or moderating e‹ffect on the projected rate of climate warming."

Soil microbiologists, including those at MSU, have found microbes that can degrade many environmental pollutants. Tiedje's team is well known for the discovery of bacteria that dechlorinate environmental contaminants, important because many environmental pollutants contain chlorine. This microbial dechlorination process is now implemented in the cleanup of some contaminated groundwater and soil. This process, Tiedje said, is one example of the great microbial diversity that resides in soil.

"'Soil health' is a general term reflecting the chemical, physical and biological properties that result in effi’cient food production and optimum ecosystem services, such as ensuring good water quality and element cycling," Tiedje said. "A very important part of soil health is the microbial community, now often termed the microbiome. The new DNA-based methods allow us much more insight into the unknown world. Plants and microbiomes have been living together ever since the first plants evolved, and it makes sense that they have developed to work in harmony. Keeping soil healthy includes ensuring and improving upon that harmony."

## V(A). Planned Program (Summary)

**Program # 3**

**1. Name of the Planned Program**

Plant Sciences

☑ Reporting on this Program

**V(B). Program Knowledge Area(s)**

1. Program Knowledge Areas and Percentage

| KA Code | Knowledge Area | %1862 Extension | %1890 Extension | %1862 Research | %1890 Research |
|---|---|---|---|---|---|
| 201 | Plant Genome, Genetics, and Genetic Mechanisms | 100% | | 17% | |
| 202 | Plant Genetic Resources | 0% | | 5% | |
| 203 | Plant Biological Efficiency and Abiotic Stresses Affecting Plants | 0% | | 9% | |
| 204 | Plant Product Quality and Utility (Preharvest) | 0% | | 5% | |
| 205 | Plant Management Systems | 0% | | 10% | |
| 206 | Basic Plant Biology | 0% | | 10% | |
| 211 | Insects, Mites, and Other Arthropods Affecting Plants | 0% | | 13% | |
| 212 | Pathogens and Nematodes Affecting Plants | 0% | | 11% | |
| 215 | Biological Control of Pests Affecting Plants | 0% | | 5% | |
| 216 | Integrated Pest Management Systems | 0% | | 13% | |
| 806 | Youth Development | 0% | | 2% | |
| | **Total** | 100% | | 100% | |

## V(C). Planned Program (Inputs)

**1. Actual amount of FTE/SYs expended this Program**

| Year: 2015 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| **Plan** | 27.4 | 0.0 | 19.0 | 0.0 |
| **Actual Paid** | 35.9 | 0.0 | 24.0 | 0.0 |
| **Actual Volunteer** | 0.0 | 0.0 | 0.0 | 0.0 |

**2. Actual dollars expended in this Program (includes Carryover Funds from previous years)**

| Extension | | Research | |
|---|---|---|---|
| **Smith-Lever 3b & 3c** | **1890 Extension** | **Hatch** | **Evans-Allen** |
| 1615255 | 0 | 2116125 | 0 |
| **1862 Matching** | **1890 Matching** | **1862 Matching** | **1890 Matching** |
| 1615255 | 0 | 2172919 | 0 |
| **1862 All Other** | **1890 All Other** | **1862 All Other** | **1890 All Other** |
| 0 | 0 | 7636628 | 0 |

## V(D). Planned Program (Activity)

### 1. Brief description of the Activity

Research programs to:

• Develop improved varieties of dry beans, tart and sweet cherries, potatoes, wheat, rice, soybeans, oats, barley, canola, turfgrass, apples, strawberries, blueberries, floriculture crops, chestnuts, vegetable crops, and conifers for Michigan growers.
• Continue to identify genes and genetic pathways that control plant response to environmental stresses and develop techniques to insert these pathways into at-risk plants.
• Identify and isolate novel genes, markers and genetic pathways that can benefit crops important to Michigan agriculture through higher yields, improved quality, and better insect and disease resistance.
• Identify and isolate novel genes, enzymes and other phytochemicals that may have benefits for human health and determine how these beneficial compounds can be made available to people.
• Develop integrated management strategies and provide education programs for producers of fruit, field, vegetable, floriculture, Christmas tree and forestry crops that use the lowest possible inputs of resources and improve yield and quality, while minimizing environmental effects, such as leaching and run-off.
• Develop cultural, management and insect and disease control strategies for crops that meet USDA certified organic standards so Michigan growers can take advantage of this growing market, if they choose to do so.
• Continue to develop biological controls for pest insects and diseases to minimize effects on the environment.
• Continue variety trials for crops important to Michigan, including wheat, corn, soybeans and forages.

Extension actitivities to:

• Conduct educational programs to help farm producers control weeds and more effectively manage high-cost fertilizer inputs while optimizing crop production.
• Develop plant disease prediction models.
• Conduct educational programs to help plant producers control disease caused by pathogens and nematodes and teach integrated pest management methods.
• Provide green industry professionals and homeowners with scientifically sound information to enable them to safely and effectively manage their turf, landscapes and gardens, improving efficiency of resources and controlling pests, while reducing pesticide and fertilizer use.
• Train Native American adults in sustainable agriculture.

### 2. Brief description of the target audience

Michigan growers (traditional and organic), commodity groups, agriculture and natural resources industry representatives (including herbicide, pesticide and insecticide suppliers), green industry/landscape/turf professionals, state agricultural agencies, Native American growers and the interested public.

**3. How was eXtension used?**

All field educators are encouraged to be involved in eXtension through both Ask and Expert and Communities of Practice (CoP). A total of 17.5 fte's were involved in this area of plants with 8.34 fte's funded through 3bc. An example from Ask an Expert is:
Question: What kind of plant is this?
Hello there. We moved into this house over the winter and inherited all sorts of plants. We're trying to figure out how to get them all ready for winter, so trying to identify those we don't know. This one might be in the mint family? It or some kind of herb of that sort. Thank you for your help!
Answer: I think you are on the right track- it looks like is in the mint family- more specifically the genus Pycnanthemum or Mountain mints. I am not sure of the species, however.

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

| 2015 | Direct Contacts Adults | Indirect Contacts Adults | Direct Contacts Youth | Indirect Contacts Youth |
|---|---|---|---|---|
| **Actual** | 24805 | 74415 | 11074 | 22148 |

**2. Number of Patent Applications Submitted (Standard Research Output)**

**Patent Applications Submitted**

| | |
|---|---|
| Year: | 2015 |
| Actual: | 19 |

**Patents listed**
MICL02133, The convergence and activation of abiotic and biotic stress signaling in plants, Serial Number 14/384,094; MICL02391, Evaluating the Specificity/Structure of Enzymes from a Taxus Plant, Serial Number 14/408,515; MICL02121, Molecular Genetic approaches to Improving Crop Production Efficiency, serial numbers 14/544,193, 14/544,194 , 14/544,192; MICL02141, Molecular Insights Into Geobacter Biofilms, Serial Number 14/705,766; MICL01810, Genetic Improvement of Strawberries and Blueberries, Serial Number 20142700, 20142702; MICL01654, Genetic Improvement of Bean (Phaseolus vulgaris L.) for Yield, Pest Resistance and Food Value, Serial Numbers 201500009, 201500008, 15-8734, 15-8735 ; MICL02357, Regulation of Lipid Metabolism in Plants and Algae, Serial Numbers 62/058,985, 14/598.953 ; MICL02368, Understanding Spatial and Temporal Variability of Crop Yield, Water and Nutrient Fluxes by Integrating Precision Agriculture with Crop Modeling, Serial Number 62/087,924; MICL02421, The Physiology and Biochemistry of Herbicide Action, Selectivity, and Degradation, Serial Number 62/129,124; MICL02364, Dynamic Environmental Photosynthetic Phenotyping for Mapping Responses of Crop Plants to Environmental Fluctuations, Serial numbers 62/154,405, 14/404,338; MICL02315, Exploring Sporulation and Spore Dispersal in Fungal Pathogens, Serial Number PCT/US2015/034543.

### 3. Publications (Standard General Output Measure)

**Number of Peer Reviewed Publications**

| 2015 | Extension | Research | Total |
|---|---|---|---|
| Actual | 2 | 56 | 0 |

### V(F). State Defined Outputs

**Output Target**

**Output #1**

**Output Measure**

- Number of research projects on plant sciences.

| Year | Actual |
|---|---|
| 2015 | 87 |

**Output #2**

**Output Measure**

- Number of adult participants trained in plant management systems.

| Year | Actual |
|---|---|
| 2015 | 22837 |

**Output #3**

**Output Measure**

- Number of youth participants trained in plant management systems.

| Year | Actual |
|---|---|
| 2015 | 11074 |

**Output #4**

**Output Measure**

- Number of adult participants trained in integrated pest management (IPM).

| Year | Actual |
|---|---|
| 2015 | 1968 |

**V(G). State Defined Outcomes**

## V. State Defined Outcomes Table of Content

| O. No. | OUTCOME NAME |
|---|---|
| 1 | Number of adult participants with increased knowledge of integrated pest management (IPM). |
| 2 | Number of research programs to develop insect and disease control and/or cultural and management strategies for organic crops. |
| 3 | Number of research programs to develop biological controls for pest insects and diseases to minimize any effects on the environment. |
| 4 | Number of research programs to develop integrated management strategies for fruit, field, vegetable, floriculture and forestry crops that use the lowest amounts of nutrients possible and improve yield and quality. |
| 5 | Number of research programs to identify and isolate novel genes, markers and genetic pathways that can benefit crops important to Michigan agriculture through higher yields, improved quality, and better insect and disease resistance. |
| 6 | Number of research programs to identify genes and genetic pathways that control plant response to environmental stresses and develop techniques to insert these pathways into at-risk plants. |
| 7 | Number of research programs to develop improved varieties of economically important crops for Michigan and the region. |
| 8 | Number of adult participants with increased knowledge of plant management systems. |
| 9 | Number of research programs to develop weed control methodologies, protocols and practices. |
| 10 | Number of research programs to develop controls for pathogens and nematodes affecting plants. |
| 11 | Number of research programs to develop production protocols and environmental and cultural strategies for the floriculture/nursery industry. |
| 12 | Number of youth participants with increased knowledge of plant management systems. |
| 13 | Number of research programs to develop more effective post-harvest protocols and practices to minimize loss and enhance quality. |

## Outcome #1

### 1. Outcome Measures

Number of adult participants with increased knowledge of integrated pest management (IPM).

### 2. Associated Institution Types

- 1862 Extension

### 3a. Outcome Type:

Change in Knowledge Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2015 | 1824 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Michigan's unique fresh water resources, climatic zones and soil types contribute to its status as the third most diverse agricultural region in the U.S. Although best known for its thriving specialty fruit, vegetable, and floriculture industries, field crops comprise the largest cropping sector in Michigan in terms of acreage, farms, farmers, and income. Farmers need research-based knowledge to address the needs of producers across Michigan, including strategies for managing production risks and advancement of efficient farming practices that enhance productivity while protecting soil and water resources.

**What has been done**
Michigan State University Extension has been offering a series of free, on-demand integrated pest management webinars since July 2013. Viewers are able to request up to five re-certification credits towards their pesticide applicators license in the state of Michigan. Over time, a number of webinars have been added and there are currently 17 webinars available (listed below starting with the most recent):
- MDARD Nursery Program Update
- Summer 2015 Nursery Update
- Becoming an Insect Investigator
- Top Diseases and Insects in Nursery Crops
- Growing Bee-Friendly Plants in the Greenhouse
- Tactics for Vegetable Disease Management
- Hop IPM
- What's Wrong with My Vegetable Plants?
- Chestnut IPM
- Introduction to Integrated Pest Management
- Integrated Pest Management Resources
- Entomology 101

- Plant Pathology 101
- Soil Science 101
- Plant Science 101
- Pesticides 101
- Insect Scouting in Fruit Crops

**Results**

Viewers are routed through Survey Monkey before and after viewing webinars to collect demographic and impact data, this data is summarized annually. Between 8/23/14 and 10/2/15, there were 1,968 webinar sessions viewed. Viewers reported an acreage impact of 1,553,199 acres. Approximately 30% identified as growers, 8.5% as crop consultants, 33.6% as landscapers, 11.2% as agriculture educators, 2.5% pesticide distributors, 6.6% students, 22.7% recreational gardeners, 0.3% as policy makers and 5.7% were members of the general public. Thirty-seven viewers applied for Michigan pesticide.

- Introduction to IPM (n=72)

Viewers representing 8,935 acres reported that following the webinar they better understood the history of IPM (91.8%), the guiding tenants of IPM (75.34%), the benefits of adopting IPM practices (87.7%) and where to find resources related to the adoption of IPM (76.7%).

- Plant Pathology 101 (n=72)

Viewers representing 31,572 acres reported that following the webinar they better understood the economic impacts of plant pathogens (84.9%), the cause of plant disease (89.0%), the historical significance of plant pathogens (65.8%) and methods of disease suppression (83.6%).

- Entomology 101 (n=69)

Viewers representing 14,193 acres reported that following the webinar they felt they had an improved understanding of the potential negative impacts of pest insects on ag (72.9%), the positive roles of insects in the environment (71.4%), insect morphology, the importance of accurate identification (78.6%), calculation of growing degree days (46.5%) and utilizing MSU resources (66.2%).

- IPM Resources at MSU (n=51)

Viewers representing 104,263 acres reported that following the webinar they better understood the benefits of adopting IPM practices (71.1%) and where to find resources related to the adoption of IPM (100%).

- Hop IPM (n=48)

Viewers representing 4,510 acres reported that following the webinar they felt they had an improved ability to identify insect pests (80.6%), scout regularly (80.6%), utilize pest thresholds (58.3%), support beneficial insects (72.2%) and utilize MSUE resources to help make management decisions (72.2%).

- Scouting in Fruit Crops (n=39)

Viewers representing 8,326 acres reported that following the webinar they better understood the

importance of scouting (92.5%), how to develop scouting programs (72.5%), how to assess pest damage (77.5%) and available monitoring tools and techniques (77.5%).

- Chestnut IPM (n=34)

Viewers representing 4,861 acres reported that following the webinar they felt they had an improved ability to identify insect pests (91.7%), scout regularly (70.8%), rotate pesticides to prevent resistance (62.5%), utilize MSUE resources to help make management decisions (58.3%), and be more aware of potential invasive pests and their impact (75%).

- What Wrong with my Vegetable Plant? (n=27)

Viewers representing 5,736 acres reported that following the webinar they better understood the difference between plant diseases and disorders (96.3%), pH effect on nutrient availability (81.5%), tissue testing (59.3%), where to find IPM resources (85.2%). Users also indicated their intent to adopt use of the Master Gardener hotline (56.5%), Find an Expert (65.2%), the Diagnostic Lab (34.8%) and nutrient testing facilities at MSU (34.8).

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 205 | Plant Management Systems |
| 216 | Integrated Pest Management Systems |

**Outcome #2**

**1. Outcome Measures**

Number of research programs to develop insect and disease control and/or cultural and management strategies for organic crops.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 2 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

American organic farmers represent only 1 percent of total U.S. farms, with 14,540 farms out of 2.2 million, and 4.1 million acres of land out of 922 million, with organic farms in all 50 states. Despite their smaller numbers, the sector grew by 8 percent in 2010, dramatically outpacing the food industry as a whole which grew at less than 1 percent in 2010. Overall, the industry has grown from $3.6 billion in 1997 to $29 billion in 2010, demonstrating that the organic sector will continue to play a contributing role in revitalizing America's economy through diversity in agriculture. Given this, research to help these producers increase production and marketing efficiencies and control pests with methods that conform to organic standards is critical.

**What has been done**

Research to: optimize the production and use of thermophilic compost and vermicompost as important tools for organic and sustainable production and management of vegetable transplants and high tunnels for year round vegetable production and marketing on rural and urban farms; and to develop a methodology for quantifying multi-trophic crop/pest beneficial interactions.

**Results**

Our prototype attract and kill device appears suitable for use on Japanese beetles and Oriental fruit moth but less so for codling moth. Our prototype SSCDs system was upgraded to a new system and coverage appears consistent with the previous system. The new system may be able to significantly slow tree development in the Spring providing growers with a new way to prevent frost damage. Reductions in leaf litter carrying apple scab inoculum did not translate into reduced scab incidence.Brown marmorated stinkbug sentinel eggs were not heavily utilized by predators or parasites but several species of parasitoids were collected in 2014 and 2015.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 205 | Plant Management Systems |
| 211 | Insects, Mites, and Other Arthropods Affecting Plants |
| 212 | Pathogens and Nematodes Affecting Plants |
| 215 | Biological Control of Pests Affecting Plants |
| 216 | Integrated Pest Management Systems |

**Outcome #3**

**1. Outcome Measures**

Number of research programs to develop biological controls for pest insects and diseases to minimize any effects on the environment.

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2015 | 18 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Biological control is the use of living organisms to suppress pest populations, making them less damaging than they would be otherwise. Biological control can be used against all types of pests, such as vertebrates, plant pathogens, weeds and insects. Insects that were of little economic importance can become damaging pests. When a non-toxic control method is used, natural enemies are more likely to survive and reduce the numbers and damage of potential pest species

**What has been done**
Research to: develop and deliver Integrated Pest Management strategies for insects in Michigan vegetable crops; develop stable, sustainable management strategies for vegetable insect pests; determine the effectiveness of currently registered and experimental products for control of insect pests in small fruit crops; improve control of moth pests by pheromone disruption; increase knowledge about mode of actions or effects of pests and diseases on honey bees to achieve better control and to gain increased honey production and more effective pollination of agricultural crops; to develop biological and cultural tactics based on vegetation management; to increase knowledge about the plant defense genetics; and to use new pest controls for tree fruit production

**Results**
In 2014 the primary focus of my research and extension effort changed abruptly when the greenhouse and nursery industries were suddenly expected to be able to grow plants without using neonicotinoid insecticides. This mandate came from some of the largest retail stores. Retail stores account for 80% of all greenhouse and nursery sales by Michigan growers. An Emergency GREEEN grant, a specialty crop block grant (supported by the Michigan Greenhouse Growers and the Michigan
Nursery and Landscape Association), and a grant from the Horticultural Research Institute have funded research by my lab in 2014 and 2015 to: (1) determine when the last foliar sprays can be applied to flower crops before shipping without posing a risk to pollinators after they are purchased and planted in the yard, (2) if imidacloprid is applied as a soil drench to potted flowers at the standard time of 5 weeks before shipping, will it harm pollinators after the plants are purchased at garden centers, and (3) will the standard practice of using imidacloprid as a soil drench in July to protect linden trees from Japanese beetle harm pollinators the following spring when the trees bloom. The safety of these flower treatments were tested by
caging the treated plants and controls in individual screen tents, each with a colony of bumble bees. Bumble bees were counted weekly throughout the growing season. After two field seasons, the results of these experiments suggest that: (1) applying an imidacloprid drench to flowering plants that are attractive to bees in spring of the same year that they are shipped and sold could be harmful to pollinators unless the flowering period is over when they are sold (which would apply to some trees and shrubs); (2) drenching woody plants in the summer after they are done flowering will not be harmful to bumble bees
the following year; and (3) spraying annual or perennial flowers with amidacloprid or other insecticides could be harmful to pollinators if the insecticides are sprayed at a interval of 2 weeks or less before shipping. However, if they are sprayed at 3 weeks or more before shipping, no harmful is expected on flowers by the time the plants are purchased and planted. I am

coorganizing the 'Protecting Pollinators in the Ornamental Landscape'conference, scheduled for October 12 - 14, 2015. We have raised $20,000 in funding for the conference to bring in some outstanding speakers, including Dr. Dave Goulson (author of the recent review paper in Science Magazine- 'Bee declines driven by combined stress from parasites, pesticides, and lack of flowers'), Nigel Raine (Endowed chair of pollinator ecology at University of Guelph), and our own Rufus Isaacs. Information is available at the conference website: http://www.ornamentalpollinators.org/

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 205 | Plant Management Systems |
| 212 | Pathogens and Nematodes Affecting Plants |
| 215 | Biological Control of Pests Affecting Plants |
| 216 | Integrated Pest Management Systems |

**Outcome #4**

**1. Outcome Measures**

Number of research programs to develop integrated management strategies for fruit, field, vegetable, floriculture and forestry crops that use the lowest amounts of nutrients possible and improve yield and quality.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 14 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Growers' livelihoods depend on production systems that are healthy and sustainable -- environmentally, ecologically and economically. Farmers in Michigan grow a diversity of crops second only to California, a state almost three times the size of Michigan. This world-class diversity necessitates a unique mixture of research and Extension programs to meet the needs of the state's growers, who produce more than 200 commercially grown commodities

**What has been done**

Research to: identify and characterize phloem-associated lipids and lipid-binding proteins and identify their role in plant development and pathogen defense response; optimize protocols for honeycrisp storage in air and in controlled atmospheres; utilize and integrate physiological, genetic and horticultural approaches for understanding and improving Great Lakes region high value fruit production; decrease reliance on conventional crop protection practices by using low environmental impact fungicides in combination with host resistance; and to improve row crop nitrogen management to optimize economic returns and reduce environmental impacts

**Results**

We collected approximately 1300 seed from directed crosses in spring 2015 using 20 parental combinations of peach and nectarine. Seed yield was less than normal due to extended cold temperatures during bloom. Seedling are being grown and evaluated for desirable charactistics useful for the commercial peach industry. In collaboration with the RosBreed Project, 40 peach and nectarine elites and potential crossing parents were tested by PCR for 2 DNA loci (G1XapF, G6XapF) associated
with bacterial spot resistance / susceptibility by Washington State University (P. Sandefur & C. Peace). Results from this test were correlated with field ratings of fruit and leaf disease ratings, and were used to help select parents for future crosses and chose best elite candidates from the seedling populations. A set of another 50 peach elites and potential parents are currently being analyzed by Clemson University for the same DNA loci, also as part of the RosBreed Project. 2015 was a good year to evaluate tree and fruit bud hardiness, and bacterial spot resistance of potential new varieties. 12 elite peach
selections from the breeding program were established at grower cooperator test sites for expanded testing. We have identified 4 advanced elite peach selections from the MSU breeding program for potential patenting and nursery propagation / expansion. These will be sent to the Clean Plant Center Northwest for fruit trees in Prosser Washington for virus testing in January 2016.

New knowledge on the effects of tillage on several vegetables was generated from research trials. This year, we found that potential benefits of reduced tillage for moisture retention were minimal due to plentiful rainfall. In addition, both sweet corn and cucumber crops under strip tillage (ST) with rye residue appeared to have reduced stands and early vigor compared to full-width tillage (FWT). In cucumbers, cool wet conditions hindered crop growth and exacerbated herbicide injury. Injury was lower in ST plots with rye residue compared to FWT. In snap beans, cool wet conditions combined with
rye-vetch residue resulted in seed corn maggot damage; damage was more prevalent in FWT compared to ST presumably because cover crop residue was incorporated into the seed zone under FWT, but left on the soil surface under ST.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 203 | Plant Biological Efficiency and Abiotic Stresses Affecting Plants |
| 204 | Plant Product Quality and Utility (Preharvest) |
| 205 | Plant Management Systems |
| 206 | Basic Plant Biology |

## Outcome #5

### 1. Outcome Measures

Number of research programs to identify and isolate novel genes, markers and genetic pathways that can benefit crops important to Michigan agriculture through higher yields, improved quality, and better insect and disease resistance.

### 2. Associated Institution Types

- 1862 Research

### 3a. Outcome Type:

Change in Condition Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2015 | 18 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
As the world population increases and the demand for food and fuel relies more heavily on agricultural products, efficient methods of plant transformation will be required. Although conventional breeding will fulfill a part of this need, these techniques are limited to the gene pool of the species involved. In contrast, the tools of genetic engineering significantly expand the resources that can be used for variety improvement. Further, current transformation techniques are not applicable to all plant species.

**What has been done**
Research to: identify molecular markers for traits that are important in highbush blueberries; identify high-yielding oat, barley and canola cultivars for Michigan; provide guidance on disease control and crop health to the Christmas tree and chestnut industries; determine the biochemical mechanisms involved in turfgrass disease control; develop production methods to increase net returns to Michigan berry producers; elucidate molecular and biochemical mechanisms of plant resistance to arthropod herbivores; determination of how to better control for fungal and bacterial diseases of plants; and to develop improved analytical methods for the profiling of metabolites to assist in comprehensive measurements of biomarkers related to plant and animal health.

**Results**
We generated about 2,400 blueberry and 1,200 strawberry hybrids that will be field planted for selection this coming spring. We also made 8 new selections of strawberries and five of blueberry that will go into advanced trial in 2015. We are released two new day-neutral cultivars intended for the Midwestern and Northeastern USA, Ontario and Quebec, and the Pacific Northwest - Redstart (MSU 67) and Wasatch (MSU 68). They will be the first day-neutral cultivar released outside of California in over 30 years. Redstart and Wasatch have proven to have a very long production season beginning in mid-June. They fruited up to 13 weeks in Mt. Vernon,

Washington, and 8 weeks at Benton Harbor, Michigan. Their fruit are generally larger and better flavored than 'Seascape', comparable in firmness, but not as strongly colored. Their yields have been higher than Albion, with a comparable to slightly sweeter flavor; however, they are not quite as firm and are smaller fruited.

Using rice as the foundation species, we have provided annotation for Poaceae species to permit cross-species analyses and data-mining thereby providing a computational resource for Poaceae researchers to data-mine their species of interest, the majority of which lack robust annotation and research tools. As researchers rely heavily on transitive annotation methods and due to the "gold standard" sequence and annotation, coupled with the high degree of sequence conservation among the Poaceae, the rice genome has and will continue to have a pivotal role in informing researchers the function of genes within
this agriculturally important clade. For this project, we support a rich annotation resource for rice and other Poaceae species through a set of databases and webpages (http://rice.plantbiology.msu.edu/).

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 201 | Plant Genome, Genetics, and Genetic Mechanisms |
| 202 | Plant Genetic Resources |
| 203 | Plant Biological Efficiency and Abiotic Stresses Affecting Plants |
| 205 | Plant Management Systems |
| 206 | Basic Plant Biology |

**Outcome #6**

**1. Outcome Measures**

Number of research programs to identify genes and genetic pathways that control plant response to environmental stresses and develop techniques to insert these pathways into at-risk plants.

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 8 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Research on plant resistance to environmental stress is essential to sustainable agriculture. Determining how to develop or enhance resistance is a critical research area. Before plant varieties that are insect- or disease-resistant can be developed, scientists have to find a source of plant resistance and then determine how to cross-breed plants or isolate the responsible genes and then move them from one plant to another.

**What has been done**

Research to: better understand disease resistance signaling in plants; determine foliage thresholds based on the assimilation and storage of carbon; improve the efficiency of crop production through increased understanding of the genetics controlling plant growth and development; determine the effects of stress on plant metabolism; and to understand the genetic mechanism by which plants tolerate environmental stresses.

**Results**

This year we have continued to characterize the function and structure of secretory organelles. Of particular relevance, we have identified components of the machinery responsible for the production of cell wall polysaccharides that influence cell growth and expansion as well as plant productivity. Specifically, we have identified and characterized two Arabidopsis pectin methyltransferases, named CGR3 and CGR2, and evaluated the effect of loss-of-function mutants and over-expression lines of CGR2 and CGR3 in planta. Pectin is a critical cell wall polymer that is secreted in a highly methyl-esterified form, but the components of the molecular machinery responsible for the methylesterification are largely unknown. We demonstrated that both proteins are Golgi localized and active in the Golgi lumen. Loss of both enzymes caused defects in plant growth and development, in support of critical but overlapping functional roles of these proteins. Qualitative and quantitative cell-wall analytical assays of the double knockout mutant demonstrated reduced levels of pectin methylesterification in the cell wall, coupled with decreased microsomal pectin methyltransferase activity. Conversely, CGR2 and CGR3 over-expression lines have markedly opposite phenotypes to the double knockout mutant, with increased cell-wall methylesterification levels and microsomal pectin methyltransferase activity. These results indicate that CGR2 and CGR3 are critical enzymes involved in pectin methylesterification

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 201 | Plant Genome, Genetics, and Genetic Mechanisms |
| 202 | Plant Genetic Resources |
| 203 | Plant Biological Efficiency and Abiotic Stresses Affecting Plants |
| 206 | Basic Plant Biology |
| 216 | Integrated Pest Management Systems |

## Outcome #7

### 1. Outcome Measures

Number of research programs to develop improved varieties of economically important crops for Michigan and the region.

### 2. Associated Institution Types

- 1862 Research

### 3a. Outcome Type:

Change in Condition Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2015 | 12 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Agriculture is Michigan's No. 2 industry. The state's agrifood system accounts for $71.3 billion in total economic activity and 600,000 jobs. Michigan is also one of the most diverse agricultural industries in the United States, growing more than 200 commodities. As the world population increases and demand for food and fuel relies more heavily on agricultural products, efficient methods of plant transformation will be required. Developing improved crop varieties is critical to sustaining an economically viable agriculture industry.

**What has been done**
Research to: identify the genes critical for the replication and repair of chloroplast DNA; understand the patterns of evolution of flora forms that contributes to the reproduction and persistence of Michigan plants; increase the environmental and economic sustainability of small fruit production through management of diseases in Michigan; understand the central plant metabolism and transport in plant systems well enough to rationally manage and engineer them for human benefit; develop a data-driven protocol for culture of juice grape cultivars as well as fruit plant canopies and management systems that fit into these advances to achieve maximum efficiency; and to discover genes that are co-expressed with genes known for amino acid biosynthetic and catabolic enzymes.

**Results**
We continued our analysis of how different (existing) management practices affect species composition and productivity in perennial grasslands likely to serve as cellulosic biomass sources of biofuels. We finalized the analysis, submitted and published a paper comparing effects of planted species diversity on above ground production in switchgrass and prairie plantings (Dickson and Gross 2015). We completed a 3 year field experiment designed to examine how harvest time and frequency impacted biomass production and species composition in mixed species grasslands. The harvest frequency experiment was conducted in two sites planted at the

same time to a native prairie species mix that are part of the Great Lakes Bioenergy Research Center (GLBRC) scale-up experiments at the Kellogg Biological Station (KBS). One site has become dominated by C4 grasses and has lower overall plant diversity and forbs are uncommon; the other has a more diverse assemblage and with forbs and C3 grasses making up a greater proportion of community composition. We also initiated a study of how nitrogen impacts the plant-mycorrhizal interactions in bioenergy crops (Panicum virgatum and Miscanthus) and in May 2015 established a new experiment (jointly funded by the GLBRC (KL Gross) and a USDA-NIFA grant to Sarah Emery) to compare the effects of N-addition and drought on mycorrhizal community composition and growth of two varieties of Panicum virgatum, that are used widely in the upper Midwest as potential bioenergy stocks. This experiment is established at the LTER BioEnergy plots and will continue for another year. We also completed a comparison of physiological, morphological traits among 11 cultivars of P. virgatum established at the KBS GLBRC intensive plots and will use these data to determine how the relation to biomass. This work will be used to develop and frame proposals to be submitted in 2015-16 on how to establish species and variety mixtures that will provide high biomass and support other ecosystem services in bioenergy plantings.

In corn in 2015, western bean cutworm flight was moderate in a few places in central Michigan and the Upper Peninsula, and very low elsewhere. A recommendation was made to treat fields (including dry beans, the alternate host besides corn) in the areas with the highest cumulative trap catches, resulting in a few fields being sprayed for larvae. However, flights continue and ratings of damage in 2015 are not yet available to determine if the recommendation was correct, as harvest has not started. In extension programming, the Handy Bt Trait Table, the regional extension bulletin which provides information on the
specific proteins, pest spectrum, and refuge requirements for commercially available Bt traits in corn, was significantly updated and reformatted in winter 2015. The table is provided gratis upon request for use and/or republication by other universities and agribusinesses, and posted electronically. Also in 2015, a separate trait table for the southern cotton-growing region - which has different refuge requirements - was developed in cooperation with a colleague from Texas A&M. This document was also provided gratis and posted electronically. Another pest in corn, the western corn rootworm, was targeted for early detection of unexplained damage to Bt corn (potential resistance). In the spring, the PI was the lead author of, and a signatory to, a document submitted to EPA in response to the Agency's proposal to improve corn rootworm resistance management. The paper was developed by public sector entomologists in the eastern Corn Belt. It highlighted the differences in landscape, agronomic practices, and rootworm populations in the eastern versus western Corn Belt, and argued for a
stricter management recommendation (i.e. crop rotation) for potential cases of resistance in the east.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 201 | Plant Genome, Genetics, and Genetic Mechanisms |
| 202 | Plant Genetic Resources |
| 203 | Plant Biological Efficiency and Abiotic Stresses Affecting Plants |
| 204 | Plant Product Quality and Utility (Preharvest) |
| 205 | Plant Management Systems |
| 206 | Basic Plant Biology |

**Outcome #8**

**1. Outcome Measures**

Number of adult participants with increased knowledge of plant management systems.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 19479 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
One example, protecting vegetable yields in western Michigan. MSU Extension educators monitored soil moisture on a weekly basis on three western Michigan vegetable farms to demonstrate sensor technology and help growers assess their irrigation schedule. Monitored crops included bell peppers, asparagus and carrots ‒ different crops requiring different irrigation intensity. Peppers were grown on raised beds with plastic and were drip irrigated daily for three hours. Carrots for processing were grown on bare soil.

**What has been done**
Vegetables require irrigation whenever conditions are dry from the time they are sown in April or May to September. Asparagus is a deep-rooted perennial, typically irrigated during July and August. None of the growers had used soil moisture sensors before. All looked at the weekly data and felt it influenced their decisions. The biggest barriers to adoption were equipment cost and lack of expertise using equipment and software.

**Results**
Soil moisture sensors helped time irrigation to protect yield for vegetables on 109 acres worth roughly $509,000 in gross value.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 205 | Plant Management Systems |

## Outcome #9

### 1. Outcome Measures

Number of research programs to develop weed control methodologies, protocols and practices.

### 2. Associated Institution Types

- 1862 Research

### 3a. Outcome Type:

Change in Action Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2015 | 3 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Weed control is an essential part of all crop production systems. Weeds reduce yields by competing with crops for water, nutrients and sunlight. Weeds may also reduce profits by hindering harvest operations, lowering crop quality and producing chemicals harmful to crop plants. Weeds left uncontrolled may harbor insects and diseases and produce seed or rootstocks that infest fields and affect future crops. Weeds are a major source of yield loss for growers in Michigan and in the North Central Region. It is estimated that losses due to weeds left uncontrolled exceed $7.5 billion in the United States.

**What has been done**
Research to: help define management strategies that address shifts in weed populations; understand the degree to which weeds affect crop establishment and production in traditional and emerging cropping systems; identify effective practices for weed control in annual and perennial horticultural crops; determine the mode of action and basis for selectivity and fate of new or potentially new herbicides for weed control in Michigan; and identify the fundamental factors in cultural and chemical weed control, weed composition and weed life cycles.

**Results**
Preemergence herbicides were used alone and in combinations on perennial fruit and vegetable crops to increase the weed control spectrum and avoid development of weed resistance to herbicides. In apples, the combination of sulfentrazone plus carfentrazone plus terbacil provided excellent control of wild carrot for over 8 weeks. Terbacil plus norflurazon controlled wild carrot for 12 weeks. Isoxaben plus pendimethalin provided 8 weeks control of white campion and perennial sowthistle. The combination of oxyfluorfen plus penoxsulam controlled alfalfa, birdsfoot trefoil and curly dock. In grape, sulfentrazone plus carfentrazone plus oryzalin and sulfentrazone plus

carfentrazone plus indaziflam provided excellent control of field bindweed for 12 weeks. In asparagus, terbacil plus sulfentrazone provided complete control of wild carrot, horseweed, and wild radish for 8 weeks. Norflurazon plus metribuzin and flumioxazin plus terbacil provided excellent control of all weeds for 8 weeks. Combination of residual herbicides with different modes of action in perennial crops has improved control of persistent weeds and will increase crop yields and decrease weed and pest control expenses. Good weed control may result in a 10% increase in asparagus yield, with a total annual increase in return to Michigan growers of $2-4 million.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 205 | Plant Management Systems |
| 216 | Integrated Pest Management Systems |

**Outcome #10**

**1. Outcome Measures**

Number of research programs to develop controls for pathogens and nematodes affecting plants.

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 4 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Nematodes are among the parasites that attack numerous economically important plants, substantially reducing their yield potential by destroying their root system. Pathogen epidemics are a constant problem for agriculture and are known to influence natural ecosystems, especially when alien pathogens successfully invade new areas.

**What has been done**
Research to: examine methods and problems associated with controlling disease in agriculture; gain a strategic understanding of the complexity of nematode problems and necessary disciplinary interactions; develop new, safer methods of insect control by using baculovirus biotechnology to either improve the insecticidal properties of baculoviruses or as a tool for designing safer chemical insecticides; to develop, assess and deliver effective IPM programs in cherry, apple, peach and some row crop conventional and organic commodities in the Upper

Midwest; and to employ ecological and evolutionary perspectives to understand the dynamics of plant disease

**Results**

This past year's work has focused primarily on avoiding MRL violations by assessing pesticide residue degradations near harvest in apples and cherries, as well as determining biopesticide efficacy on late season invasive species. These MRL studies were conducted with Danitol, Delegate, Exirel, and Imidan on cherries and conducted with Assail, Danitol, Delegate, Exirel, and Imidan on apples. As done in previous years, we assessed the residue degradation of key chemistries from a
single treatment; however, this year we also initiated a study to assess the degradation of key pesticides after they have been applied multiple times. This latter study more closely resembles grower practices and will give us a better picture of pesticide degradation in real grower fields. Our work in biopesticides this past year has been motivated by their potential for late season use in conventional tree fruit production as a means to avoid MRL violations. The largest threat to growers late season is newly emerged invasive species: the Brown Marmorated Stink Bug (BMSB) and the Spotted Wing Drosophila (SWD). This growing season we performed a field study to assess the efficacy of two novel biopesticides, Venerate and Grandevo (Marrone Bio), compared to a commonly used conventional pesticide, Imidan (Gowan). We have also begun laboratory bioassays to assess the efficacy of Venerate, Grandevo, Pyganic (MGK Company), Surround (NovaSource), and Mycotrol O (Bioworks, Inc.) on BMSB and SWD. Finally, the Arthropod Pesticide Resistance Database has received an increasing number of visitors of which more than half are new on a monthly basis. The database itself is also growing: roughly 3300 new cases of resistance have been reported
worldwide during the past year, sourced from more than 50 scientific articles. Each case of resistance in the database contains critical information such as the species involved, active ingredient of resistance, the origin of the resistance (field or lab selected), and location of resistance including country, state/province, city, and latitude and longitude coordinates, if published. Each case entry also houses information pertaining to the bioassay used to determine resistance, including doses,life stage of the arthropod, method, and date of test. The information contained in the database is accessible to anyone with internet access, and new cases can be submitted by authorized users. A user may become authorized by applying online,
and cases that users submit must go through a peer-reviewed submission process before they are published to the database.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 205 | Plant Management Systems |
| 206 | Basic Plant Biology |
| 212 | Pathogens and Nematodes Affecting Plants |
| 215 | Biological Control of Pests Affecting Plants |
| 216 | Integrated Pest Management Systems |

**Outcome #11**

**1. Outcome Measures**

Number of research programs to develop production protocols and environmental and cultural strategies for the floriculture/nursery industry.

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 7 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
The wholesale value of floriculture crops produced in Michigan is more than $400 million annually. Michigan's 625 commercial floriculture companies showed an estimated value of $402.7 million, with over half of them reporting wholesale sales of more than $100,000. Total greenhouse cover is about 50 million square feet, with an additional 3,600+ acres of open ground for floriculture production. Research in this area is critical to keeping this industry viable and profitable.

**What has been done**
Research to: improve control over quality loss in horticultural produce; evaluate turfgrass species and mixes for their adaptation to athletic field turf and to assess the effects of cultural practices;improve the environmental sustainability of the Michigan landscape tree industry by optimizing water and nutrient inputs and determining the utility and potential impacts of organic fertilizers;
investigate nitrogen fate in turfgrass; evaluate several perennial semi-aquatic or aquatic plants for use in the phytoremediation of nursery runoff water; and to develop protocols that growers and retailers can use to produce and profitably sell perennials as new floriculture crops while enhancing sustainability.

**Results**
Young ornamental plants and vegetable transplants are typically produced in greenhouses from January through March, when the days are short and dark, and outdoor temperatures are low. During this time, commercial greenhouse growers consume a significant amount of energy to heat and provide supplemental lighting in greenhouses. Variations in weather (for example, an extended period of cloudy weather) can yield crops with atypical growth characteristics, which makes it a challenge to schedule crops for specific market dates. This year, our research focused on the use of light-emitting diodes (LEDs) in environmentally controlled facilities that transmitted

sun light (i.e., greenhouses) or in which light was completely provided by electric lighting (i.e., vertical farms). Our objective was to produce high-quality, uniform plants in a predictable and more energy-efficient manner.
One thrust of research was to evaluate various low-intensity lighting treatments from LEDs to control flowering of photoperiodic ornamental crops grown in greenhouses. We learned that blue light alone, or when added to red and far-red light, did not influence flowering. In addition, white light created long days for short-day plants but only for some long-day plants. This suggests that inexpensive white LEDs can be used to delay flowering of economically important short-day crops such as chrysanthemum and poinsettia. However, white LEDs are sometimes not effective when trying to promote flowering of long-day crops such as petunia

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 204 | Plant Product Quality and Utility (Preharvest) |
| 205 | Plant Management Systems |

**Outcome #12**

**1. Outcome Measures**

Number of youth participants with increased knowledge of plant management systems.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 9853 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Building leaders in agricultural production and ingenuity. Due to our rapidly growing population, the need to produce more food becomes critical. With a finite amount of land and resources on which to produce this food, advancements in food production must come from new and innovative agricultural practices that allow farmers to produce more with less.

**What has been done**
To help prepare a capable future workforce interested in tackling this issue, the 4-H Ag Innovators Experience was created. A national program, the 4-H Ag Innovators Experience trains teen leaders on simulated agricultural problems. 2,313 youth participating in Ag Innovators Experience

challenges, enhancing their interest in and knowledge about science and agriculture careers.

**Results**
MSU Extension results: 43 youth were trained as teen leaders in the Ag Innovators Experience. These youth developed expertise in program concepts while delivering 59 challenges across the state and developing important leadership skills. Two participants took part in an urban challenge and won a national video contest about their experience.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 205 | Plant Management Systems |
| 206 | Basic Plant Biology |
| 806 | Youth Development |

**Outcome #13**

**1. Outcome Measures**

Number of research programs to develop more effective post-harvest protocols and practices to minimize loss and enhance quality.

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 4 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Farmers and food sellers have been concerned about losses since agriculture began. Yet the problem of how much food is lost after harvest to processing, spoilage, insects and rodents or to other factors takes on greater importance as world food demand grows. Cutting postharvest losses could add a sizable quantity to the global food supply and reduce the need to intensify production in the future. Estimates of total postharvest food loss are controversial and range widely, generally from about 10 percent to as high as 40 percent

**What has been done**
Research to: Improve orchard and vineyard postharvest technologies and postharvest recovery of sugars and pectic polysaccharides from plants; 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; determine storage regimens for Honeycrisp and other apples prone to CA injury.

**Results**

Michigan's climate is characterized by a short growing season (150 to 175 days) with cool-climate conditions (1200 ± 300 growing degree days or GDD, base 10 C). Yield and quality are often limited by several factors, namely spring freeze (50% chance of spring frost as late as May 15), early fall frost, high humidity and rainfall during the harvest season. 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. During 2015, research activities were focused on crop manipulation of juice grapes (Concord and Niagara, Vitis labruscana Bailey) and wine grapes (Cabernet Franc and Riesling) in collaboration with Michigan growers and Welch's National Grape Cooperative and The Michigan Grape and Wine Council. Grapevines producing juice products remain the predominant land area for grapes in Michigan (over 12,000 acres); Concord (10,000 acres) annually producing an average of 65,000 tons of grapes with a farm-gate value of about $20 million. Research effort was dedicated to determine the crop range that could be matured over a variety of growing season types, while maintaining the vine's capability to return with a full crop potential the next season. Several presentations about the results of the 2015 crop load management projects and their potential future development were made during extension and research meetings.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 205 | Plant Management Systems |

**V(H). Planned Program (External Factors)**

**External factors which affected outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

**Brief Explanation**

During the 2014-2015 fiscal year, ABR and MSUE was able to continue rebuilding some of its resources after several years of either flat or funding cuts at both the state and federal levels. ABR was able to **fill voids in its research and support teams by hiring quality, skilled people for a variety of positions ranging from farm managers and grant coordinators to faculty and research technicians**. **Much needed equipment and infrastructure updates were also conducted at many on-campus and outlying research facilities**, helping to keep operations to full capacity. In 2014, ABR and Project GREEEN

funds helped bridge operating budget gaps at five of the 13 outlying research centers, enabling the repairs of equipment and several buildings. Together, the organizations look to re-invigorate the MSUE presence at the 13 outlying research centers throughout the state.

The **ongoing economic challenges** faced by Michigan continue to affect this planned program area. Consequences have included fewer new hires, delaying the award of new financial obligations, reducing levels of continued funding, and renegotiating or reducing the current scope of assistance through formula funds or block grants. Specifically, a 15 percent decreases in state funding FY2011-2012 coupled with a flat federal funding line for the following two years resulted in the elimination of 72 Extension educator positions across 83 counties, 22 academic and faculty positions on campus and 15 support staff. Administrative positions were reduced from 45 to 19 FTEs. Impacts on ABR came largely in the form of reductions in research infrastructure support. Investments in facility maintenance and equipment were postponed in an effort to avoid eliminating more than 45 research positions (faculty, support staff and graduate assistants) and one research facility had to be closed in light of the reductions. There were also fewer funds to seed research on emerging issues.

E**xtreme weather events** have also caused extensive hardship to the agriculture industry. The period between November 2013 and February 2014 was the coldest in Michigan since 1911 and among the five coldest periods on record in the state. And the winter of 2013-14 brought a series of bitterly cold air masses rolled down from the Arctic, through Canada and into Michigan. The spring 2012 ranks among the most destructive weather periods in Michigan fruit production history, with crop losses valued at more than $500 million. Peach production suffered a 95 percent loss; tart cherry, a 90 percent crop loss; apple production, an 88 percent loss; and grapes, an 85 percent loss. The summer 2012 brought the worst drought in Michigan since 1988 with many crops suffering substantial losses.

Together, MSUE and ABR continue to serve as the primary research and development arm for the agriculture and food industries in Michigan, valued at more than $100 billion annually.

## V(I). Planned Program (Evaluation Studies)

### Evaluation Results

As Hatch dollars are base funding for faculty salaries, there is a built-in evaluation mechanism through annual reviews of overall performance, research productivity and the leveraging of additional research dollars. In addition, many of the research projects have an evaluative element that is required by state and federal-level funding sources that provides documentation related to project assumptions, goals and outcomes. This information is used to determine the overall success of the research initiatives; their contribution to providing practical, real-world solutions and resources to address challenges and problems; and whether continuation funding and/or new dollars are appropriate and necessary as funds are available.
MSU Extension- other examples for plant management systems.
Producing high-yield soybeans on irrigated soils
Issue
Irrigation has not consistently increased soybean yields. In fact, non-irrigated yields have equaled or exceeded irrigated yields in some cases. The Michigan Soybean Promotion Committee (MSPC) has identified irrigated soybean production as a high priority.

Response
MSU Extension led a cooperative effort to plan, promote, conduct and evaluate a high-profile, multi-state educational program held in conjunction with Purdue University Extension, the MSPC and the Indiana Soybean Alliance. More than 160 soybean producers and agronomists from Indiana and Michigan participated in the program. Key soybean producers, industry representatives and Extension personnel met at the conclusion of the program to identify educational needs required to improve irrigated soybean production. Two topics were identified: white mold management and irrigation water management.
Results
A follow-up multi-state program was planned, promoted and conducted in 2015 to address these issues.75% of the participants utilized or implemented the new information they learned in 2014. 52% of the participants actually earned additional money by implementing the new information. The average amount of additional income was $13.15 per acre. The total financial impact of the program was $93,010 in 2014 alone.

**Shielding fruit industry against tiny fly that is big trouble**
Issue
Michigan's fruit industry boasts more than 22,000 acres devoted to small fruit production; blueberries account for a whopping 20,900 of those. Valued at $118.5 million, the blueberry industry has helped Michigan gain a reputation as a top producer of one of the world's most popular fruits.
Response
In 2010, MSU researchers confirmed the presence of a pest that threatened the future of this industry: spotted wing drosophila (SWD). Since its arrival in the eastern U.S., growers of most berry crops have spent millions of dollars managing the invasive pest. SWD cuts its way into fruit while it's still intact on the tree, creating a scenario where larvae could be inside fruit at harvest, compromising fruit quality.
Results
Rufus Isaacs, MSU professor of entomology, has been leading a grower-centered response to the threat of SWD in Michigan. In partnership with several MSU AgBioResearch scientists and MSU Extension specialists, Isaacs has: supplied Michigan growers with information on the most effective insecticides, sprayers and nonchemical controls to limit SWD and committed to continue identifying biological controls and biopesticides, and to developing additional control methods, and brought growers and consultants together for hands-on demonstrations and presentations on the latest research and management techniques.
Another MSU Extension example of Plant Sciences
**Brewing new businesses through Great Lakes Hop and Barley Conference**
Issue
The inaugural Great Lakes Hop and Barley Conference (GLHBC) took place in Grand Rapids Michigan, drawing more than 350 participants. MSU Extension, MSU AgBioResearch and the Michigan Brewers Guild coordinated the event.
Response
The GLHBC consisted of three concurrent sessions: the Hop Introductory Track, the Hop Advanced Track, and the Barley and Malt Track. The conference drew attendees from Alabama, Illinois, Indiana, Iowa, Maryland, Nebraska, New York, Ohio, Washington and Wisconsin and from Ontario, Canada. Male attendees represented 82 percent of the audience; females represented 18 percent. Attendees estimated their agricultural land impact to be 2,397 acres and the estimated farm gate value of agriculture-related products to be $276,000.
Results

- 91% of participants in the Hop Introductory Track session said they plan to use MSU Integrated Pest Management (IPM) resources.
- 100% of participants in the Barley and Malt Track session said they will be using MSU Malting Barley online resources, along with 91% planning to use the MSU Malting Barley Variety Trial Data.
- 84% of participants in the Hop Advanced Track session plan to use MSU IPM online resources.

**Key Items of Evaluation**

- Enhance Michigan's First Green Industry: Agriculture and Agribusiness
  - 24,805 adults trained in plant management and food production
    - 353,902 acres adopting practices to increase yield, improve quality, or decrease inputs
    - 7,645 farms adopting practices to increase yield, improve quality, or decrease inputs
    - 156 farms adopting tools or technology to increase yield, improve quality, or decrease inputs

One key area for AgBioResearch in FY15 is innovation in the Plant Sciences area:

**A social network for plant science**

**David Kramer's** laboratory is reminiscent of a start-up business, a convergence of diverse minds and skills with the same end goal -- to improve plant science. His group is looking to solve some of the worldwide challenges related to human population growth and the need for more food. Achieving that lofty objective requires innovation.

Kramer, the John A. Hannah Distinguished Professor in Photosynthesis and Bioenergetics, leads a team of scientists, engineers and software developers in a project called PhotosynQ that is changing the way farmers and researchers think about collaboration.

About 10 years ago, as a faculty member at Washington State University, Kramer had an idea. "We were talking with some people from Botswana, Africa, where there is a very arid climate," the Michigan State University (MSU) AgBioResearch scientist said. "We had some non-invasive ways of seeing how the plants were doing, but the instruments you need to do that cost tens of thousands of dollars. That may be more than the entire budget of their institution. At that time, I had been developing instruments for probing photosynthesis for quite some time. I thought, 'Wow. Wouldn't it be great to get these things to everybody?'"

Growing better crops using new management strategies relies heavily on how researchers approach information collection and analysis, particularly with small-scale farming. Kramer indicated that there is a ready market for affordable equipment that allows growers to make predictions about their crops. The idea of producing such a device is one thing; making it happen is quite another. Once he arrived at MSU, Kramer hired PhotosynQ co-lead **Greg Austic**, an expert on new approaches to open-source and community-based solutions. Together they assembled a team to harness new technology that has increased the speed of product development and deployment while decreasing the cost.

For more on this story, please visit:
http://agbioresearch.msu.edu/news/a_social_network_for_plant_science

## V(A). Planned Program (Summary)

**Program # 4**

**1. Name of the Planned Program**

Economics, Marketing and Policy

☑ Reporting on this Program

**V(B). Program Knowledge Area(s)**

1. Program Knowledge Areas and Percentage

| KA Code | Knowledge Area | %1862 Extension | %1890 Extension | %1862 Research | %1890 Research |
|---|---|---|---|---|---|
| 601 | Economics of Agricultural Production and Farm Management | 40% | | 12% | |
| 602 | Business Management, Finance, and Taxation | 30% | | 10% | |
| 603 | Market Economics | 0% | | 8% | |
| 604 | Marketing and Distribution Practices | 0% | | 9% | |
| 605 | Natural Resource and Environmental Economics | 0% | | 14% | |
| 606 | International Trade and Development | 0% | | 11% | |
| 608 | Community Resource Planning and Development | 20% | | 10% | |
| 609 | Economic Theory and Methods | 0% | | 12% | |
| 610 | Domestic Policy Analysis | 0% | | 9% | |
| 611 | Foreign Policy and Programs | 0% | | 5% | |
| 806 | Youth Development | 10% | | 0% | |
| | **Total** | 100% | | 100% | |

## V(C). Planned Program (Inputs)

**1. Actual amount of FTE/SYs expended this Program**

| Year: 2015 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| **Plan** | 24.7 | 0.0 | 6.5 | 0.0 |
| **Actual Paid** | 33.4 | 0.0 | 0.0 | 0.0 |
| **Actual Volunteer** | 0.0 | 0.0 | 0.0 | 0.0 |

**2. Actual dollars expended in this Program (includes Carryover Funds from previous years)**

| Extension | | Research | |
|---|---|---|---|
| **Smith-Lever 3b & 3c** | **1890 Extension** | **Hatch** | **Evans-Allen** |
| 1487416 | 0 | 833625 | 0 |
| **1862 Matching** | **1890 Matching** | **1862 Matching** | **1890 Matching** |
| 1487416 | 0 | 855999 | 0 |
| **1862 All Other** | **1890 All Other** | **1862 All Other** | **1890 All Other** |
| 0 | 0 | 3008369 | 0 |

## V(D). Planned Program (Activity)

### 1. Brief description of the Activity

Research programs to:

- Identify current and emerging key public policy issues on trade, environmental, agricultural and food issues important to Michigan and analyze responses.
- Conduct research and education to improve the operations, business and financial management skills of Michigan producers so they can make decisions that are more sound financially and environmentally.
- Evaluate the competitiveness and marketing strategies of Michigan farm markets, greenhouses and other green industry retailers.
- Develop a framework to understand and analyze domestic and international trade policies and assess their impact on Michigan.
- Evaluate how Michigan citizens use the Internet when searching for information about a vacation destination or planning a vacation.
- Determine rationale for farmland preservation choices and how changes will affect the Michigan tax base.
- Develop models to estimate the demand for and value of recreational fisheries and wildlife resources.
- Identify and evaluate the policy, technology and marketing issues faced by Michigan organic growers and develop responses.

Extension program activities to:

- Teach financial management skills, business organization, estate planning, management information systems, strategic management, alternative sustainable production and marketing systems to agriculture and natural resources producers and businesses.
- Assist agencies, organizations, local governmental units and individuals in pursuing a cultural economic development strategy.
- Offer business retention and expansion support.
- Help people recognize, understand and appreciate multicultural differences.
- Provide entrepreneurship education to a broad audience, including individuals, business owners, youth and communities.
- Offer communities consultative, diagnostic and educational assistance in planning and zoning to meet community land use goals.

### 2. Brief description of the target audience

Agriculture and natural resources producers and industry representatives; tourism industry

representatives; state agency representatives; private citizens; school administrators; local, state and federal elected officials and policymakers.

**3. How was eXtension used?**

All field educators are encouraged to be involved in eXtension through both Ask and Expert and Communities of Practice (CoP). A total of 11.3 fte's were involved in this area of plant soil with 6.6 fte's funded through 3bc. An example of an eXtension collaboration:
**How to Develop Educational Farm Tour Programs Like Breakfast On The Farm.** A national webinar via eXtension on Jan 29,2015 by MSU Extension professionals Ted Ferris and Nancy Thelen. This webinar covered what it takes to implement educational farm tours like Michigan's Breakfast on the Farm program. In addition, exit survey results from participants were presented to show the impact such educational farm tours have on the public. The Michigan State University Extension Breakfast on the Farm (BOTF) program began in 2009 in Clinton County and since then has been held in many counties throughout the state, attracting over 61,000 participants. BOTF gives consumers and farm neighbors a first-hand look at modern food production, and the farm families who work hard to produce a safe, wholesome food supply for Michigan communities and the world. Consumers want to know that farmers will do the right thing. So they greatly appreciate the opportunity that BOTF provides to tour modern farms. Since farm tours provide transparency, they build trust. BOTF events in Michigan have had a tremendous impact on the public and neighbors attending these events. They learn how farmers are caring for animals, safe guarding food products such as milk, beef and grains, and caring for the environment as they manage their businesses to make a living. Survey results from 2,964 participants attending 18 dairy farm tours in 2010-2012 show BOTF events attract a non-farm audience, with 44% making their first visit to a dairy farm in the past 20 years (first-time visitors) and 21% having made only 1 or 2 prior visits. Most visitors grew up in urban (34%) or rural areas not near farms (28%), while 31 and 39% live in urban and rural areas not near farms, respectively. The percentage of participants with Positive or Very Positive impressions about four management areas on dairy farms increased from the 60's to about 95% for ALL respondents. Further, public trust is improved. For first-time visitors, 86% either Agree or Strongly Agree with the statement "As a result of today's tour, my trust in milk as a safe food has increased", with 81% of ALL respondents either Agreeing or Strongly Agreeing. To the statement, "As a result of today's tour, my trust in dairy farmers as a source of information about food production has increased", 91% of the first-time visitors either Agree or Strongly Agree. The majority of the public is unfamiliar with modern food production and likely have difficulty sorting through information they receive from various sources about food production methods. Educational farm tours provide the public an opportunity to learn first-hand, ask questions of farmers and other professionals and give feedback about modern food production. Results suggest that the time and money spent on educational farm tours, such as Breakfast on the Farm, are well worth it. Local Michigan milk sales are expected to increase as a result of this public awareness and marketing effort.

## V(E). Planned Program (Outputs)

**1. Standard output measures**

| 2015 | Direct Contacts Adults | Indirect Contacts Adults | Direct Contacts Youth | Indirect Contacts Youth |
|---|---|---|---|---|
| **Actual** | 20657 | 61971 | 1182 | 2364 |

**2. Number of Patent Applications Submitted (Standard Research Output)**

**Patent Applications Submitted**

| | |
|---|---|
| Year: | 2015 |
| Actual: | 1 |

**Patents listed**
MICL02276, Designing Sustainable Bioenergy Systems, Serial number 14/579,377

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

| 2015 | Extension | Research | Total |
|---|---|---|---|
| **Actual** | 2 | 17 | 0 |

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Number of research programs on economics, marketing and policy.

| Year | Actual |
|---|---|
| 2015 | 34 |

**Output #2**

**Output Measure**

- Number of adult participants trained in economics of agricultural production and farm management.

| Year | Actual |
|---|---|
| 2015 | 10483 |

**Output #3**

**Output Measure**

- Number of adult participants trained in business management and finance.

| Year | Actual |
|---|---|
| 2015 | 3410 |

**Output #4**

**Output Measure**

- Number of adult participants trained in community resource planning and development.

| Year | Actual |
|---|---|
| 2015 | 6764 |

**Output #5**

**Output Measure**

- Number of youth participants trained in entrepreneurship.

| Year | Actual |
|---|---|
| 2015 | 1182 |

### V(G). State Defined Outcomes

## V. State Defined Outcomes Table of Content

| O. No. | OUTCOME NAME |
|---|---|
| 1 | Number of adult participants with increased knowledge in economics of agricultural production and farm management. |
| 2 | Number of adult participants with increased knowledge in business management, finance and taxation. |
| 3 | Number of adult participants with increased knowledge in community resource planning and development. |
| 4 | Number of research programs to identify current and emerging key public policy issues on trade, environmental, agricultural and food issues important to Michigan and analyze responses. |
| 5 | Number of research programs to improve the operations, business and financial management skills for Michigan producers so they can make decisions that are more sound financially and environmentally. |
| 6 | Number of research programs to evaluate the competitiveness and marketing strategies and human resources management practices of Michigan farm markets, greenhouses and other green industry retailers. |
| 7 | Number of research programs to develop a framework to understand and analyze domestic and international trade policies and assess their impact on Michigan. |
| 8 | Number of research programs to develop models to estimate the demand for and value of recreational fisheries and wildlife resources. |
| 9 | Number of youth with increased knowledge in entrepreneurship. |

## Outcome #1

### 1. Outcome Measures

Number of adult participants with increased knowledge in economics of agricultural production and farm management.

### 2. Associated Institution Types

- 1862 Extension

### 3a. Outcome Type:

Change in Knowledge Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2015 | 9584 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Helping farmers navigate farm bill programs. The 2014 farm bill contained new farm programs that require farmers to make complicated business decisions. To help producers make the best decision for their farms, MSU Extension collaborated with the Michigan Farm Service Agency (FSA) to develop educational programming. Because of the complexity of the bill's commodity, noninsured crop disaster assistance programs and crop insurance programs, this collaboration is essential to provide accurate information to producers.

**What has been done**
While the FSA can provide information on U.S. Department of Agriculture programs, it cannot advise producers about program choices. Close collaboration between MSU Extension and the FSA helps producers work through the best program choices for their operations. This approach provides an easy-to-access source of information for producers through meetings and an MSU Extension website dedicated to continuing farm bill education.

**Results**
MSU Extension worked with FSA and farm and commodity organizations to host 100 regional informational meetings for nearly 7,976 producers in the past year, representing a majority of the farm acreage in Michigan. The new commodity and crop insurance programs were designed specifically for the lower market conditions that are developing. Better informed producer decisions will improve farm financial success during the 2014-2018 period.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 601 | Economics of Agricultural Production and Farm Management |
| 602 | Business Management, Finance, and Taxation |

**Outcome #2**

**1. Outcome Measures**

Number of adult participants with increased knowledge in business management, finance and taxation.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 2836 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
One example in this area is Grass Fed Beef production in Michigan is a growing industry, there are smaller producers (less than 20 head) that have been selling and marketing grass fed beef for several years, and there is very few places for them to get credible information on the subject.

**What has been done**
MSUE has started to provide beef producers with data that does not exist anywhere else in the country. MSU is one of the few Universities that is actively researching Grass Finished Beef Production. In 2015 MSUE focused on having more cooperative farms to start producing a grassfed beef product.

**Results**
In early 2015 producers were surveyed and the highlighted results include: 8 of the 17 targeted farms (47%) have now produced and marketed a grassfed beef animals (we feel good about this number because during 2014 - 2015 the price of beef cattle skyrocketed and some of the participants could not cashflow the cost of buying cattle); these 8 farms have produced a total of 38 head of GF cattle, when combined with the Lake City and Chatham Research Farms output we have produced over 200 head of GF cattle for the Northwest MI. market. These cattle carcasses have all been weighed and carcass quality graded by our team of four once they were slaughtered and the quality results have been impressive as the average have graded in the High Select grade, which is just a slight step below the Low Choice grade which is the grain feed beef industry target goal. This is exactly where we hoped they would grade.

From the butchers, to the food wholesale buyers, to the chefs and the consumers we have received excellent reviews. For example, one Amish butcher that received four heifers from one of our SARE cooperative farms said, ?Before I butchered these cattle I had a bad opinion of grassfed beef meat quality. You guys at MSU have shown me there can be quality beef

produced in a grassfed way." A chef in Traverse City said ".... the grassfed coming from the MSU project is some of the BEST I have had in close to 30 years in the business ... the taste, texture and flavor of your work is something that I hope continues on for many years to come". The producers that have marketed thus far have received a 25 - 30% premium for their cattle above the market price by marketing them as grass fed beef. One major food wholesaler in NW MI. has increased their annual purchases of grassfed beef carcasses from our project from 40 per year to 70 per year. A 75% increase and they are very happy with the response from their retail buyers. To showcase the growth and significance of grassfed beef production in the U.S., and to highlight the grassfed beef research conduct by MSU, the grassfed beef team orchestrated the 2015 Grassfed Exchange Conference held in Mt. Pleasant, MI. Over 275 attendees from 23 States and Canada attended the event. Michigan attendees made up 57 of this total. Our team published a 33 page MSU Lake City Ag Bioresearch Center Beef Report that was distributed to everyone that attended. The Lake City tour showcased our research on cattle, pasture grazing, It highlighted our latest research and findings on grass-fed beef, on pasture forage, fencing, watery systems on pasture and utilizing cover crops for grazing.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 601 | Economics of Agricultural Production and Farm Management |
| 602 | Business Management, Finance, and Taxation |

**Outcome #3**

**1. Outcome Measures**

Number of adult participants with increased knowledge in community resource planning and development.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 5961 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Empowering landowners interested in oil and gas leases. Since 2010, Michigan has seen a major increase in oil and gas companies contacting landowners offering to lease their mineral rights. A lease is a legal document that can last for many years. Landowners must know their rights and opportunities involving leases.

**What has been done**
To assist landowners in this sometimes confusing process, MSU Extension has hosted 66 public meeting workshops that focus on oil and gas lease contracts, with total attendance of 7,643 since June 2015. The program helps owners understand lease contract terms and conditions, the rules and statutes that oil and gas companies must follow, and options to negotiate lease terms. It teaches owners specific contract changes to allow them to meet financial and land usage goals.

**Results**
Following the public meeting workshops that focused on oil and gas lease contracts, participants reported: Lease bonuses had increased by 68% or $34.89 per acre, and royalties had increased by 22.4% or $12,600 per year. Post-production cost was reduced by 66% or $49,599 per year. The average cropland acres per farm was 323 resulting in a one-time lease negotiation gain of $11,263 per farm in bonus payments.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 608 | Community Resource Planning and Development |

**Outcome #4**

**1. Outcome Measures**

Number of research programs to identify current and emerging key public policy issues on trade, environmental, agricultural and food issues important to Michigan and analyze responses.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 18 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Public policy has taken on considerable importance to the future of agriculture. The farmer's historic struggle was with the forces of nature and the marketplace, and government policy played a minor role. Government policy at all levels now is a major player in agriculture, especially related to agriculture as an important economic asset - the sustainability of a productive agricultural sector balanced with the preservation of environmental quality and the importance of

prime farmland with respect to the continued viability of the rural economy and of rural lifestyles.

In general, Michigan is becoming warmer (1 degree warmer on average in the past 120 years) and wetter (a 10 to 15 percent increase in precipitation over the same period). And the growing season has lengthened by about 1.5 weeks in the past 30 years, resulting overall in new challenges and opportunities for the state's agriculture industry.

**What has been done**

Research to: develop a dynamic model to analyze the long-run impacts of renewable energy development on fossil fuel supply; provide a more comprehensive understanding of tourist preferences for tourism management and development; provide information that can contribute to better design and better use incentive-based conservation; develop rural Latino communities in Michigan; develop environmentally benign bioprocesses to effectively utilize various renewable resources; visually characterize changes in food and agricultural systems examine the implications of sustainability principles for U.S. agriculture; elucidate the role of economics and law on environmental management; develop, extend and apply economic and ecological theory to analyze economic and ecological trade-offs associated with ecological problems; and to better understand impacts of climate change on crops;  sustainable bioenergy systems; telecoupling food security and land use; and integrated farm-based refining for chemical and bio-fuel production.

**Results**

Progress has been made on understanding how standards form a major part of the social infrastructure that underpins social institutions in a manner analagous to that of physical infrastructure. Moreover, concentration in the agrifood sector as well as the growth of global supply chains have tended to integrate agrifood standards with those of other industries to a considerable degree. For example, the rising use of information technologies and the standards embedded in software (e.g., algorithms) and hardware are becoming integrated with standards for farm operations, transport of farm products, food processing and
food retailing. Even as these standards allow an increase in the circulation of capital, they have the potential to channel innovation into certain pathways and not others. Given concerns of climate change and agricultural sustainability, this narrowing of the path of innovation could prove problematic.

Researchers tested a new approach with the Van Buren County Drain Commissioner to use financial incentives to encourage farmers to adopt conservation practices. County drain commissioners in Michigan are mandated to build and maintain infrastructure to drain water away from land to enable productive uses. Until now, there has not been a link between farmers' assessments (the bill they must pay for drain maintenance) and whether or not they incorporate conservation practices on their land. The pilot project in Van Buren County tested such an approach, to general satisfaction of the Van Buren County Drain commissioners and farmers in the pilot project area. In a presentation at the Michigan Association of County Drain Commissioners Annual Winter Meeting in February, 2015, researchers presented this pilot project and conducted a clicker survey to gauge audience reactions. The majority of
drain commissioners and drain office staff n the room indicated that they would be interested in testing such an approach in their county. Additional testing is underway to expand the approach.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|

| | |
|---|---|
| 601 | Economics of Agricultural Production and Farm Management |
| 605 | Natural Resource and Environmental Economics |
| 608 | Community Resource Planning and Development |
| 610 | Domestic Policy Analysis |

**Outcome #5**

**1. Outcome Measures**

Number of research programs to improve the operations, business and financial management skills for Michigan producers so they can make decisions that are more sound financially and environmentally.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 9 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Recognizing, measuring, and managing risk is part of every-day practice for participants in the food system. Farmers and ranchers are subject to yield uncertainty caused by weather, pests, disease, and natural disasters. Price uncertainty, combined with biological lags between planting/investment decisions and harvest, imposes additional risks on producers. Food manufacturers and retailers face risks from higher input prices, emerging new technologies which alter the competitive
landscape, and shifting consumer demand and price patterns. Consumers face risks of rising real food prices and resulting food insecurity, especially in developing countries but also among low income households in developed countries. All food system participants are exposed to the risk of changes in government policies which can alter the operation and performance of the system. Current trends in food system risks are not encouraging. Global warming appears to be adding to production
uncertainties, perhaps increasing the frequency of natural disasters such as drought, flooding, hurricanes, etc. An effective response may call for major adjustments in production practices, marketing channels, and the spatial location of agricultural production. Moreover, since the global food price crisis of 2007/2008 there appears to have been a structural shift in world commodity markets causing prices to become both higher on average and more unstable. Increases in biofuel production, and uncertainty about the policy environment that has led to them, are

additional new sources of risk. Food insecurity, especially for the poor, continues to pose major risks worldwide. Improvements in strategies and mechanisms for managing food system risks can benefit participants and pave the way for more effective and efficient policy responses.

**What has been done**

Research to: explore, analyze and evaluate the dynamics and economic impact of entrepreneurial activity within the context of MI and global agrifood systems; further the understanding of coupled human and natural systems and sustainability; more broadly develop conceptual and analytically frameworks for understanding, assessing and empirically studying effective innovation in the agriculture, food and natural resource sectors; examine the causes and consequences of Michigan state and local government fiscal challenges; to discern the relationship between entrepreneurship and the Michigan agrifood sector; to develop sustainable energy and business systems; understand agricultural production economics in an environmentally conscious manner; to improve the quality of natural resource management.

**Results**

A project evaluating role of small-scale informal cross-border maize trade on spatial price transmission and market risk in Southern Africa was completed (paper published). Results showed that markets connected by small-scale informal trade were better integrated, more efficient and less risky than markets that only have large-scale trade subject to significant government oversight and regulation. Results have important implications for the encouragement and regulation of small-scale
informal trade sectors. Another project developed a conceptual model of farmers' production decisions in the context of dual output marketing channels (government and private sector) when output prices at harvest time and the availability of one of the marketing channels are unknown at planting time (paper published). It then applied the model to the case of Zambia using nationally-representative household-level panel survey data to estimate the marginal effects of the Food Reserve Agency
(FRA), the government parastatal strategic food reserve/maize marketing board, on smallholder fertilizer use and crop production. Results suggested that increases in the FRA farmgate maize price raise farmer maize price expectations, which induces a production response. Smallholders respond to an increase in the FRA price by both intensifying and extensifying their maize production. On average, a 1% increase in the FRA price is associated with a 0.14% increase in smallholders' fertilizer application rate on maize and 0.06% increases in their maize area planted and maize quantity harvested. We find no
evidence to support the claim that the increase in maize production stimulated by FRA policies comes at the expense of other crops. A third project focused on the risky dairy participation decisions of smallholder farmers in Kenya (paper published).

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 601 | Economics of Agricultural Production and Farm Management |
| 602 | Business Management, Finance, and Taxation |
| 604 | Marketing and Distribution Practices |

## Outcome #6

### 1. Outcome Measures

Number of research programs to evaluate the competitiveness and marketing strategies and human resources management practices of Michigan farm markets, greenhouses and other green industry retailers.

### 2. Associated Institution Types

- 1862 Extension
- 1862 Research

### 3a. Outcome Type:

Change in Action Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2015 | 1 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Management of personnel and human resources has changed over the past three decades, partially due to increasing employment legislation, education issues, employee awareness and changes in demographics. As competitors strive to win the war for talent, effective human resource management is necessary to gain true competitive advantage in the marketplace.

**What has been done**
Research to: study issues related to the management of human resources and "green" business practices in commercial recreation and tourism; profile and characterize consumers and markets for eco-friendly products.

**Results**
? A USDA funded project involving wine tourism in the northern United States. Initiatives include profiling tasting room visitors, understanding collaboration in the wine industry and wine tourism consumer behavior.
? A Sea Grant funded Integrated Assessment involving the coastal areas of Michigan's Thumb region. The region is working collaboratively to find new ways of using its resources to attract tourists after the collapse of the Chinook Salmon fishery in Lake Huron.
? A project funded by Oakland County Parks that examines how various park attractions can contribute to a more sustainable community. The focus of the project thus far has been on attractions such as farmer's markets, a greenhouse complex, nature-based education programs, a proposed off-road vehicle park and a heritage sports center.
? An impact assessment of the Grameen Foundation's Community Knowledge Worker (CKW) program in Uganda. The program aims to reduce poverty among Ugandan farmers by equipping model farmers with smart phones equipped with a database of agricultural information. These

model farmers (CKWs) then act as liason's between their neighbors and
information about improved agricultural practices as well as market and weather conditions.
? A project funded by the International Joint Commission to explore the impact of lower water levels in the Upper Great Lakes (as a result of climate change). The focus of Dan's research was on identifying sustainability indicators and providing a contextual narrative for coastal tourism and recreational boating in the Great Lakes.
? An annual forecast study of the Michigan tourism industry delivered to industry leaders, and media sources.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 602 | Business Management, Finance, and Taxation |
| 603 | Market Economics |
| 604 | Marketing and Distribution Practices |
| 608 | Community Resource Planning and Development |
| 609 | Economic Theory and Methods |

**Outcome #7**

**1. Outcome Measures**

Number of research programs to develop a framework to understand and analyze domestic and international trade policies and assess their impact on Michigan.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 5 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
The ability to understand the economic, cultural and political factors of domestic and international trade policies in order to determine the likely changes in these policies and their consequent market is essential to a competitive, sustainable Michigan economy. Research in this arena will provide information and resources that are critical to Michigan businesses, either directly or indirectly, as the balance of power within the marketplace shifts. As globalization of food industries continues, an assessment of such power requires analysis of world trends and the

institutional structures that govern national and international actions.

**What has been done**
Research to: provide economic analysis of agricultural production technologies and management practices related to the many agricultural enterprises important to Michigan farmers; better understand the supply chains of various horticultural products; and identify ethical issues in agriculture; and increase innovation, entrepreneurship and sustainability in MI and globally in agri-food and value chains; and global partnership for food security and economic growth.

**Results**
Changes in U.S. domestic agricultural programs were analyzed and implications for decision-making for Michigan agricultural producers were analyzed and identified.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 601 | Economics of Agricultural Production and Farm Management |
| 605 | Natural Resource and Environmental Economics |
| 606 | International Trade and Development |
| 610 | Domestic Policy Analysis |
| 611 | Foreign Policy and Programs |

**Outcome #8**

**1. Outcome Measures**

Number of research programs to develop models to estimate the demand for and value of recreational fisheries and wildlife resources.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 1 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
The implications of embracing alternative governance models, particularly collaborative governance, in resource management and larger sustainability initiatives will be a central focus.

The contributions of Michigan's natural resources to the State's economic health are widely cited. Land, water, forest resources, fish and wildlife and associated habitat, and ecosystem functions and services are but a few of the critical resources that play a significant role in numerous sectors of Michigan's economy. While discussions of sustaining a sufficient quantity of these critical resources are common, debate has tended to focus on how much of the resource can or should be used in total, with less direct attention to questions raised by competition for the resource. While resource users express concerns about the quality and quantity of the state's natural resources, state policy has not kept pace with the resource competition and resource degradation concerns, nor the restoration and regeneration needs, evidenced by the state's natural resource issues. One example lies in Michigan's statutory framework for managing water use within the context of the Great Lakes - St. Lawrence River Basin Water Resources Compact (the Compact). While Michigan's program provides for monitoring large extractions of water resources, it does not account for return flows of water withdrawn into affected watersheds or large clusters of small, individual withdrawals. Nor has its proposed process for managing competition and conflict been tested. Innate inconsistencies between the state's common law for water use and state statutes developed in 2008 will create additional challenges for water resource management in Michigan. Reconciling the statute and common law as water scarcity arises in some watersheds will prove challenging, and involvement of large-quantity water users (and others) in decisions about how scarce water resources will be allocated is envisioned by statutes as a way to ameliorate such conflicts. However, water users in Michigan have little experience in collaborative governance and resource management, and challenges are inevitable.

**What has been done**
Research to: assess levels of water use among various users in Michigan and estimate impacts of economic and environmental changes on water use rates and water competition

**Results**
Survey data collection was completed in September 2015 and data analysis continues. Recommendations were developed by Water User Group subcommitttee (which Norris chaired) of state water use advisory council and included in final council report released December 2014. Recommendations addressed ways in which to better meet the state's programmatic requirements and the needs of water users in implementation of the state's water use program

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 603 | Market Economics |
| 605 | Natural Resource and Environmental Economics |

**Outcome #9**

**1. Outcome Measures**

Number of youth with increased knowledge in entrepreneurship.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 1003 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Today's youth are faced with an ever-changing economic environment which has an impact on their current and future employment opportunities. Through recent career and workforce preparation programming done in communities across the state, Educators are finding that many youth and their parents are not aware of the numerous post-secondary education opportunities that exist. As experts in career exploration and workforce preparation programming, MSU Extension Educators continue to experience clientele who do not understand the connections between life, academics, and their 4-H youth development experiences. We also continue to encounter incidences of schools cutting counseling and career education staff so that young people and their families are not getting the networking, linkages, and experiences they need through K-12 education to understand how to explore careers and plan for their post-secondary education, training, jobs, and careers.

**What has been done**
MSU Extension implemented programs in 59 Michigan counties and Indiana with 55 workshops and events addressing entrepreneurship programming. Participants included 70 adults that engaged in learning about entrepreneurship and how to teach young people to think about, and be more entrepreneurial as a part of their 4-H experiences.

**Results**
Evaluation data found: 65% of youth participants indicated an increase in understanding of what it?s really like to own your own business as a result of participating in a 4-H entrepreneurship program. And 75% of youth participants indicated an increase in understanding of the parts of a business plan as a result of participating in a 4-H entrepreneurship program. 63% of youth participants indicated an increase in understanding of the concept of break-even analysis. 92 % (68% agreed, 24% strongly agreed) of youth participants indicated they learned about how entrepreneurial skills could be used in any career. 60% (28% agree, 32% strongly agree) of youth participants indicated they plan to start their own business.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 608 | Community Resource Planning and Development |
| 806 | Youth Development |

## V(H). Planned Program (External Factors)

### External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

### Brief Explanation

During the 2014-2015 fiscal year, ABR and MSUE was able to continue rebuilding some of its resources after several years of either flat or funding cuts at both the state and federal levels. ABR was able to **fill voids in its research and support teams by hiring quality, skilled people for a variety of positions ranging from farm managers and grant coordinators to faculty and research technicians**. **Much needed equipment and infrastructure updates were also conducted at many on-campus and outlying research facilities**, helping to keep operations to full capacity. In 2014, ABR and Project GREEEN funds helped bridge operating budget gaps at five of the 13 outlying research centers, enabling the repairs of equipment and several buildings. Together, the organizations look to re-invigorate the MSUE presence at the 13 outlying research centers throughout the state.

The **ongoing economic challenges** faced by Michigan continue to affect this planned program area. Consequences have included fewer new hires, delaying the award of new financial obligations, reducing levels of continued funding, and renegotiating or reducing the current scope of assistance through formula funds or block grants. Specifically, a 15 percent decreases in state funding FY2011-2012 coupled with a flat federal funding line for the following two years resulted in the elimination of 72 Extension educator positions across 83 counties, 22 academic and faculty positions on campus and 15 support staff. Administrative positions were reduced from 45 to 19 FTEs. Impacts on ABR came largely in the form of reductions in research infrastructure support. Investments in facility maintenance and equipment were postponed in an effort to avoid eliminating more than 45 research positions (faculty, support staff and graduate assistants) and one research facility had to be closed in light of the reductions. There were also fewer funds to seed research on emerging issues.

E**xtreme weather events** have also caused extensive hardship to the agriculture industry. The period between November 2013 and February 2014 was the coldest in Michigan since 1911 and among the five coldest periods on record in the state. And the winter of 2013-14 brought a series of bitterly cold air masses rolled down from the Arctic, through Canada and into Michigan. The spring 2012 ranks among the most destructive weather periods in Michigan fruit production history, with crop losses valued at more than $500 million. Peach production suffered a 95 percent loss; tart cherry, a 90 percent crop loss; apple production, an 88 percent loss; and grapes, an 85 percent loss. The summer 2012 brought the worst drought in Michigan since 1988 with many crops suffering substantial losses.

Together, MSUE and ABR continue to serve as the primary research and development arm for the agriculture and food industries in Michigan, valued at more than $100 billion annually.

## V(I). Planned Program (Evaluation Studies)

## Evaluation Results

As Hatch dollars are base funding for faculty salaries, there is a built-in evaluation mechanism through annual reviews of overall performance, research productivity and the leveraging of additional research dollars. In addition, many of the research projects have an evaluative element that is required by state and federal-level funding sources that provides documentation related to project assumptions, goals and outcomes. This information is used to determine the overall success of the research initiatives; their contribution to providing practical, real-world solutions and resources to address challenges and problems; and whether continuation funding and/or new dollars are appropriate and necessary as funds are available.
MSU Extension examples
**Showing farmers the benefits and savings of energy audits**
Issue
MSU studies have shown, on average, a 46 percent reduction in energy expenses when energy audit-recommended energy conservation practices have been implemented. Power companies and the federal government are targeting farmers in an unprecedented way to entice them to implement energy conservation practices. Utilities offer substantial rebates and the federal government offers grants and low-interest loans to implement recommended energy conservation practices. An energy audit is the gateway for farmers to access rebates, grants and loans to implement audit-recommended energy conservation practices.
Response
MSU Extension, Consumers Energy and DTE Energy sponsored a series of workshops during January 2015 at three different sites across Michigan, designed to help row crop, poultry, swine, livestock and dairy farmers learn how to use an energy audit to develop an energy management strategy.
Results
100% of the farmers said they had a better understanding of the need for an energy audit. An overwhelming majority of farmers indicated that their knowledge of funding opportunities through utilities, REAP and EQIP had increased. Five farmers indicated they intend to conduct an energy audit on their farms within the next three months, one said within the next six months, and three said within the next 12 months.

Another MSU Extension example of Economics, Marketing and Policy.
**Making farm to fork a reality.**
Issue
Whether you call it farm to fork, farm to institution or just good old-fashioned business development, MSU Extension is helping forge sustainable and growing local food systems, through connecting farmers and consumers. While "more local food" is a popular mantra, MSU Extension has the expertise, talent and local ties to bring important stakeholders together, make small farm and food businesses more profitable, and increase the local foods in Michigan organizations, homes and businesses.
Response
MSU Extension educators focused on local food businesses and community food systems

leverage their knowledge of the food chain, local food resource needs and business and community connections to create local food hubs, strengthen their local food systems and forge connections between local growers and organizations interested in adding more Michigan-made products to their schools, cafeterias and restaurants.

Results

In 2015, MSU Extension evaluated key partners in food and farming business development and found:

- $2.7 million in funding for food organizations leveraged through working with MSU Extension.
- 82% said they had increased knowledge of sustainable agriculture.
- 74% said they received valuable business concepts and tools.
- 67% said they were made aware of increased market options.

**Key Items of Evaluation**

- Enhance Michigan's First Green Industry: Agriculture and Agribusiness
  - 10,483 farmers trained on business management
    - 752 farms adopting practices or tools that manage risks
    - 22,119 acres adopting practices or tools that manage risks
    - 80 new Enviroweather users
    - 386 farm businesses changed in purchasing habits
- Greening Michigan: Leveraging Natural and Human Assets for Prosperity
  - 6,112 adults trained on food systems
    - 293 new and/or strengthened relationships with farmers, producers or distributors as a result of our local food purchasing work or through our FoodCorps Program
    - 5.510 students served through the Food Corps, Farm-to-School and school garden programs.
    - 56 new Michigan foods/healthy recipes added to school menus.

**Of note for MSU AgBioResearch in FY15:**

**<u>Studying monetary incentive programs and their impact on social norms</u>**

Why do some view protecting natural resources as an important part of their cultural identity, even without financial incentives? What happens to other reasons for environmental protection when financial incentives are introduced? What are the long-term impacts on the social system when the incentive money runs out? These are questions that Michigan State University (MSU) AgBioResearch scientists Maria Lapinski, John Kerr and Jinhua Zhao want to answer.

"We come at this project in very different ways, so we've had to develop an interdisciplinary model that encompasses a number of variables," Kerr said. "The turning point of the project was a three-day retreat, where the team tried to take a look at finding a way to serve all of our interests. That's when we began developing a model that takes the social, economic and environmental factors into account."

Lapinski, a communication scientist in the Department of Communication, and Kerr, a researcher with a focus on economics from the Department of Community Sustainability, have been working on a project in Sanjiangyuan, China, a region in the Qinghai Province on the Tibetan Plateau. Alongside Jinhua Zhao, an MSU AgBioResearch scientist and researcher in the Department of Agricultural, Food and Resource Economics, they are studying how financial incentive programs influence behavior and social norms.

The location of the project was determined when Zhao introduced Lapinski and Kerr to Lu

Zhi, a professor of conservation biology at Peking University in China. Zhi is the founder of the Shan Shui Conservation Center and a world-renowned giant panda and snow leopard researcher. Sanjiangyuan will soon be a part of China's payment for ecosystems services program. It is ecologically important because it holds the headwaters of Asia's three largest rivers: the Yellow, the Yangtze and the Mekong.

Close to 1 million people inhabit the region, with roughly 90 percent being ethnic Tibetans and having a strong tie with Tibetan Buddhism. Interviews conducted by the project team found that inhabitants have depended on herding sheep and yaks for years, which, along with their cultural beliefs, has created a desire to live harmoniously with nature. This was found in the first phase of the project, which included interviews with 80 nomadic herders.

"These payments for ecosystems services happen all over the world, including right here in Michigan," Lapinski said. "What we know from financial research is that once you start incentivizing certain behavior with money, it can change the way people think about that behavior. We know that money can erode psychological motivation and attitudes, but we know less about how money can change the whole social system and what we call social norms."

Phase two of the project involves household surveys that yield quantitative data, such as measures of social norms and responses to hypothetical scenarios, as well as income and education levels. The data will represent how social norms, coupled with financial incentives, affect conservation behaviors, with a particular focus on grazing management and protection against illegal hunting. Data is being collected currently.

For more on this story:
http://agbioresearch.msu.edu/news/studying_monetary_incentive_programs_and_their_impact_on_social_norms

## V(A). Planned Program (Summary)

**Program # 5**

**1. Name of the Planned Program**

Animal Production and Protection

☑ Reporting on this Program

**V(B). Program Knowledge Area(s)**

1. Program Knowledge Areas and Percentage

| KA Code | Knowledge Area | %1862 Extension | %1890 Extension | %1862 Research | %1890 Research |
|---|---|---|---|---|---|
| 301 | Reproductive Performance of Animals | 100% | | 10% | |
| 302 | Nutrient Utilization in Animals | 0% | | 10% | |
| 303 | Genetic Improvement of Animals | 0% | | 10% | |
| 304 | Animal Genome | 0% | | 10% | |
| 305 | Animal Physiological Processes | 0% | | 10% | |
| 307 | Animal Management Systems | 0% | | 13% | |
| 308 | Improved Animal Products (Before Harvest) | 0% | | 1% | |
| 311 | Animal Diseases | 0% | | 15% | |
| 314 | Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals | 0% | | 2% | |
| 315 | Animal Welfare/Well-Being and Protection | 0% | | 11% | |
| 605 | Natural Resource and Environmental Economics | 0% | | 8% | |
| | **Total** | 100% | | 100% | |

## V(C). Planned Program (Inputs)

**1. Actual amount of FTE/SYs expended this Program**

| Year: 2015 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| **Plan** | 11.6 | 0.0 | 9.5 | 0.0 |
| **Actual Paid** | 17.1 | 0.0 | 10.0 | 0.0 |
| **Actual Volunteer** | 0.0 | 0.0 | 0.0 | 0.0 |

**2. Actual dollars expended in this Program (includes Carryover Funds from previous years)**

| Extension | | Research | |
|---|---|---|---|
| **Smith-Lever 3b & 3c** | **1890 Extension** | **Hatch** | **Evans-Allen** |
| 739547 | 0 | 833625 | 0 |
| **1862 Matching** | **1890 Matching** | **1862 Matching** | **1890 Matching** |
| 739547 | 0 | 855999 | 0 |
| **1862 All Other** | **1890 All Other** | **1862 All Other** | **1890 All Other** |
| 0 | 0 | 3008369 | 0 |

## V(D). Planned Program (Activity)

### 1. Brief description of the Activity

Research programs to:

- Understand the processes that control/influence reproduction at the molecular and genetic level.
- Develop and test new cropping, grazing and feeding strategies for food animals.
- Develop and evaluate management/training strategies for race horses to reduce injuries.
- Add to the understanding of various food animal genomes by improving and integrating genetic maps.
- Understanding of the genetic and molecular processes that control/influence the immune system in food animals to create new disease detection and tracking technologies.
- Develop and evaluate new tools and strategies to detect, prevent and control emerging and reemerging livestock and poultry diseases.
- Understanding of the environmental fate and biological effects of vaccines, steroids and other drugs fed to animals.

Extension activities to:

- Assist beef producers with implementing the mandatory electronic identification system and demonstrate methods to use the system to sharpen management skills.
- Provide livestock producers with knowledge and skills to develop and maintain herd-health systems.
- Provide animal industry with up-to-date animal health information.
- Improve farm-specific environmental stewardship related to manure management, including developing whole-farm nutrient management plans, manure value, land use and neighbor relations.

### 2. Brief description of the target audience

Michigan animal producers, agriculture and natural resources industry representatives, animal pharmaceutical industry, animal welfare organizations, state agency representatives, state and local elected officials and the interested public.

### 3. How was eXtension used?

All field educators are encouraged to be involved in eXtension through both Ask and Expert and Communities of Practice (CoP). A total of 6 fte's were involved in this area of plant soil with 3.5 fte's funded through 3bc. An example from Ask an Expert is:
Question: If a horse eats moldy hay and developed a respiratory problem will he get better after the moldy hay is stopped?
Answer: Not necessarily. Unfortunately, the damage may be permanent, although typically manageable, through outdoor housing, limiting exposure to dust and mold, and careful selection of feed. Certain drugs

can also be used to alleviate symptoms should they worsen.

### V(E). Planned Program (Outputs)

### 1. Standard output measures

| 2015 | Direct Contacts Adults | Indirect Contacts Adults | Direct Contacts Youth | Indirect Contacts Youth |
|---|---|---|---|---|
| Actual | 2861 | 8583 | 63557 | 127114 |

### 2. Number of Patent Applications Submitted (Standard Research Output)

**Patent Applications Submitted**

Year: 2015
Actual: 2

**Patents listed**
MICL02127, Generation of Bovine Pluripotent Stem Cells Using Fertilization, Somatic Cell Nuclear Transfer, and Transcription Factors, Serial numbers 62/024,279, 62/064,227

### 3. Publications (Standard General Output Measure)

**Number of Peer Reviewed Publications**

| 2015 | Extension | Research | Total |
|---|---|---|---|
| Actual | 2 | 24 | 0 |

### V(F). State Defined Outputs

**Output Target**

**Output #1**

**Output Measure**

- Number of research programs on animal production and protection.

| Year | Actual |
|---|---|
| 2015 | 35 |

**Output #2**

**Output Measure**

- Number of adult participants trained in animal management systems.

| Year | Actual |
|---|---|

| | |
|---|---|
| 2015 | 2861 |

**Output #3**

**Output Measure**

- Number of youth participants trained in animal management systems.

| Year | Actual |
|---|---|
| 2015 | 63557 |

**Output #4**

**Output Measure**

- Number of adult participants trained in animal diseases.
  Not reporting on this Output for this Annual Report

**V(G). State Defined Outcomes**

## V. State Defined Outcomes Table of Content

| O. No. | OUTCOME NAME |
|---|---|
| 1 | Number of adult participants with increased knowledge about animal management systems. |
| 2 | Number of youth participants with increased knowledge about animal management systems. |
| 3 | Number of adult participants with increased knowledge of animal diseases. |
| 4 | Number of research programs to understand the processes that control/influence reproduction at the molecular and genetic level. |
| 5 | Number of research programs to add to the understanding of various food animal genomes by improving and integrating genetic maps. |
| 6 | Number of research programs to develop and evaluate new tools and strategies to detect, prevent and control emerging and reemerging livestock and poultry diseases. |
| 7 | Number of research programs to understand the environmental fate and biological effects of vaccines, steroids and other substances fed to animals. |
| 8 | Number of research programs to develop and evaluate management/training strategies for horses to reduce injuries. |
| 9 | Number of research programs to add to the understanding of animal behavior and welfare. |
| 10 | Number of research programs to test new cropping, grazing and feeding strategies for food animals. |

**Outcome #1**

**1. Outcome Measures**

Number of adult participants with increased knowledge about animal management systems.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 2481 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
The economic impact of livestock and dairy products account for 37% of the total economic impact of Michigan's agricultural products. According to the Michigan Department of Agriculture and Rural Development, agricultural commodities produced annually on Michigan farms contribute a total of $13.0 billion. Livestock products, including dairy, contribute $4.73 billion. Michigan's diverse livestock industry is a significant component of the state?s agricultural industry. Producers need knowledge and skills to be successful producers and farms, especially new beginning farms and businesses.

**What has been done**
One example is 2015 Beginning Farmer Webinar Series - Getting started with manure management and mortality management on small livestock farms. The focus of this specific Beginning Farmer webinar was to help educate beginning farmers or small livestock farmers about manure management (storing, handling and land application) and proper methods of handling livestock mortalities.

**Results**
Evaluation results found:

Of the participants who viewed the live webinar, 39% are not currently raising livestock, 33& are interested in raising livestock, 22% are raising poultry, 17% are raising beef cattle, 11% are raising sheep/goats, 5% are raising a mix of livestock species and the remaining 5% work with livestock producers (i.e. Educators, Conservation District/NRCS Technicians/Staff, Advisors, etc.) - viewers could select multiple answers. Respondents indicated that the training:

(50%) - Helped in developing a new manure management plan for the farm.

(50%) - Helped in adjusting or changing current manure management plan.
(23%) - Helped in developing a new mortality management plan for the farm.
(18%) - Helped in adjusting or changing my current mortality management for the farm.
(9%) - Helped in reducing or eliminating runoff to surface waters or leaching to groundwater.

Lastly participants were asked what part of the webinar did they find most useful (able to choose multiple answers): 91% choose manure storage and handling options on small farms, 50% choose mortality management methods, 36% choose "Why is manure management important on small farms?", 27% choose land application of manure on small farms, 24% choose "What is a small farm?", 9% choose "Why are we concerned about mortality management?" and 9% choose the Questions and Answers.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 307 | Animal Management Systems |
| 311 | Animal Diseases |

**Outcome #2**

**1. Outcome Measures**

Number of youth participants with increased knowledge about animal management systems.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 61788 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Preparing the next generation of dairy farmers. As the leading segment of Michigan agriculture, dairy contributes more than $14 billion to the state?s economy annually. MSU Extension programs work with youth to ensure this critical economic sector continues to grow and thrive. To help ensure the strength and longevity of dairy production, and to prepare young dairy farmers for success, MSU Extension offers youth interested in the dairy sector a continuum of learning opportunities.

**What has been done**

These opportunities range from instructive events such as the Michigan 4-H Dairy Conference and the 4-H/MMPA Milk Marketing Tour, to educational contests such as 4-H Youth Dairy Days and numerous judging competitions. These experiences, along with county 4-H dairy science projects, educate youth about the dairy industry and prepare them for careers in this important sector. Nearly 2,750 4-H youth participated in dairy science projects in 58 counties.

**Results**
Evaluation results found: 89% of the more than 220 potential dairy professionals who took part in 4-H Youth Dairy Days reported they felt more knowledgeable about dairy science. 98% of the more than 50 youth who attended the Michigan 4-H Dairy Conference said they plan to apply the knowledge and skills they learned.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 307 | Animal Management Systems |
| 311 | Animal Diseases |

**Outcome #3**

**1. Outcome Measures**

Number of adult participants with increased knowledge of animal diseases.

Not Reporting on this Outcome Measure

**Outcome #4**

**1. Outcome Measures**

Number of research programs to understand the processes that control/influence reproduction at the molecular and genetic level.

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 8 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Unless you are a strict vegetarian or lactose intolerant, chances are that dairy and beef products make up half of your diet. According to the U.S. Department of Agriculture, almost 40 percent of the average American diet is dairy, and beef makes up 10 percent. This makes these products an integral part of our lifestyle and our economy, this sustained productivity and animal health are critical issues to the cattle industry.

**What has been done**
Research to: understand the impact of animal agriculture on the modern society; develop new methods to improve fertility and reproductive efficiency in livestock; investigate potential effects of exposure to environmental contaminants in humans and animals, with an emphasis on reproductive performance; develop a local/regional pasture-based beef production system encompassing the entire beef production chain; and to assess the impact of Ovsynch on conception rates of lactating dairy cows.

**Results**
We discovered that inter-strain germinal vesicle transfer (iGVT) between C57BL/6 and DBA/2 mouse strains, followed by IVM/IVF and embryo transfer yields female progeny that are severely growth restricted relative to both intra-strain control GV transfers (cGVT) and IVM/IVF controls of the equivalent genotype.

Completed statistical analyses of ART outcomes for 650,000 women. Results demonstrated total FSH dose used during ovarian stimulation protocols was inversely related to live birth rate. This finding provided rationale to conduct similar studies in cattle to determine the mechanisms whereby high FSH doses may negatively impact embryo survival.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 301 | Reproductive Performance of Animals |
| 303 | Genetic Improvement of Animals |
| 304 | Animal Genome |
| 305 | Animal Physiological Processes |
| 314 | Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals |

## Outcome #5

### 1. Outcome Measures

Number of research programs to add to the understanding of various food animal genomes by improving and integrating genetic maps.

### 2. Associated Institution Types

- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 1 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Genetic maps are an integral part of several statistical models that are commonly used to find disease genes. A better understanding of these maps will allow for the development of increasingly accurate models that will provide researchers and producers with reliable estimates in a practical amount of time and will greatly enhance disease prevention and treatment efforts.

**What has been done**
Research to: develop a new set of tools and reagents to study autologous cell therapy using a new large animal model.

**Results**
Researchers have characterized the gene expression of key transcription factors in bovine preimplantation embryos. They have also spend considerable time optimizing the culture conditions for the derivation of bovine and canine embrynic stem cells, a manuscript is in preparation.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 304 | Animal Genome |
| 305 | Animal Physiological Processes |

**Outcome #6**

**1. Outcome Measures**

Number of research programs to develop and evaluate new tools and strategies to detect, prevent and control emerging and reemerging livestock and poultry diseases.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 10 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
There are increasing public concerns about antimicrobial use in animals and the development, persistence, accumulation and dissemination of resistance in enteric bacteria of livestock origin and its implications for human health. These concerns have lead regulatory organizations around the world to promulgate rules to protect public health by either reducing the number and/or formulations of antimicrobial drugs available for use in food animal agriculture (e.g., the ban of antimicrobial growth promoters in the European Union) or by tightening the approval and monitoring processes for new antimicrobial drugs intended for food animal use (e.g., FDA's Guidance for Industry #152 in the United States). Furthermore, the availability of currently efficacious therapeutic antibiotics may be curtailed, as evidenced by the FDA proposed ban on all extralabel use of cephalosporins in food
animals in 2008. The future costs to animal agriculture (and potentially to consumers and other stakeholders) will be tremendous if certain classes or uses of antibiotics are no longer available. The use of antibiotics for treatment and prevention of bacterial infections in beef and dairy cattle is essential for sustaining profitability in these two sectors, for producing safe and wholesome food for consumers, and for ensuring the maximum welfare of the animals. Discovering and sharing proven, responsible and prudent ways to make better use of both existing and new antibiotics - with minimal risk to human health - will
not only reduce the costs associated with antibiotic resistance, but also promote a profitable and sustainable agriculture in the future. Additionally, the development of safe and efficacious alternatives to antibiotic treatments may help slow accumulation and dissemination of antimicrobial resistance in food animals.

**What has been done**
Research to: derive useful information on emerging infectious diseases; develop new interventions to reduce antimicrobial resistance when treating animals with antimicrobial drugs and develop a new non-antibiotic treatment option for mastitis in dairy cows; dissect the mechanism of representative members of enzymes; determine if discontinuing the use of milk replacer medicated with antibiotics results in increased antimicrobial susceptibility in enteric organisms; to elucidate the molecular mechanisms that control phenotypic variation in economically important pig production and meat quality traits; and understand the role of bovine leukemia virus (BLV)
infection on progression of clinical Johnes disease.

**Results**

On-going analysis will further determine if quantities of total coliforms and resistant coliforms are associated with stage of production, diet/location, treatment history, or seasonality in dairy cows. Analysis of CFUs per gram of feces is complicated because the data are not normal distributed and a large proportion of samples have zero counts. Several samples with zero counts are likely not truly zero but are between zero and the detection limit of ~240 CFUs/g feces. Hence, we are investigating using count models and potentially imputing CFUs for samples with <240 CFUs. The models are exceedingly complicated because we need to account for repeated sampling (~26) per cow over a year, and we are continuing working on these model. Understanding the variation in susceptibility patterns of fecal coliforms in dairy cows will assist in the design of potential interventions to reduce levels and patterns of antimicrobial resistance in cull cows entering the food chain. We have already discovered that cows that are in the dry period, have a lower risk of having ceftiofur-resistant coliforms detected in their feces as compared to cows that are in other stages of production.

Another study was initiated in May of 2015 to determine the prevalence and distribution of White Nose Syndrome in big brown bats in Michigan, using samples from over 1,000 bats collected in 2014 and early 2015. An initial finding has been the detection of a previously unreported fungus in a sample of wing membrane from a big brown bat.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 303 | Genetic Improvement of Animals |
| 305 | Animal Physiological Processes |
| 308 | Improved Animal Products (Before Harvest) |
| 311 | Animal Diseases |
| 315 | Animal Welfare/Well-Being and Protection |

**Outcome #7**

**1. Outcome Measures**

Number of research programs to understand the environmental fate and biological effects of vaccines, steroids and other substances fed to animals.

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 1 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Livestock production has been recently characterized by the assertion that production systems are changing more rapidly than animal populations can adjust by natural selection. Future changes would appear to be only just as dramatic, given emerging issues such as those, for example, driven by climate change and biofuel energy policies. Hence, it seems vitally important that the germplasm pool for all current and potentially economically important livestock species be sufficiently diverse to accommodate these and other unforeseen changes. Heterogeneities of effects on the responses of interest (like milk or meat production) exist on many different scales, beginning at the gene, then the animal, finally the environment level, and intersect with heterogeneities potentially existing at several other levels (e.g., different times or developmental stages). Quantitative genetic evaluation systems that facilitate the proper assessment of these phenomena should be developed in order to ensure that genetic diversity of livestock in the United States sufficiently great and fluid to optimize production of animal products across a wide range of environments and management conditions.

**What has been done**
Research to: develop models that better reflect the heterogeneity in effects of causal variants and their associations with high density
genetic markers across the genome

**Results**
One development this past year is that our group has developed computationally efficient strategies (based on the expectation maximization algorithm) for providing robust tests for helping discover which genetic markers have significant associations with economically important traits in so-called "genome wide association" (GWA) studies. We believe that these robust tests represent a substantial improvement over current strategies which are based on rather inflexible assumptions about the distribution of these genetic marker effects.

Researchers were able to develop a hierarchical modleing strategy whereby we established that the genetic variance and, consequently, heritability of feed efficiency in dairy cattle is highly heterogenous across herds.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 307 | Animal Management Systems |
| 314 | Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals |
| 315 | Animal Welfare/Well-Being and Protection |

## Outcome #8

### 1. Outcome Measures

Number of research programs to develop and evaluate management/training strategies for horses to reduce injuries.

### 2. Associated Institution Types

- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 2 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Due to improvements in nutrition, management and health care, horses are living longer, more useful lives. It's not uncommon to find horses and ponies living well into their 20s and 30s. Although genetics play a determining role in longevity, providing proper care and nutrition plays a key role in horses' health, performance and overall well-being.

**What has been done**
Research to: investigate ways to manipulate bone density and strength through mechanical loading to help prevent injuries to performance horses and increase the longevity of livestock; identify ways to manipulate the equine diet to optimize skeletal health and improve the overall welfare of horses; and to define the role that EHV-5 plays in the development of spontaneous equine multinodular pulmonary fibrosis.

**Results**
Research from our laboratory has confirmed only moderate possible anti-inflammatory benefits from orally supplementing omega-3 fatty acids, despite widespread belief that such supplementation can decrease lameness in performance horses. Based on a cost to benefit ratio, our research does not support the use of such supplementation in most horses but can likely justify the use of such when cost is not a factor in the case that it might have a small benefit.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 307 | Animal Management Systems |
| 315 | Animal Welfare/Well-Being and Protection |

## Outcome #9

### 1. Outcome Measures

Number of research programs to add to the understanding of animal behavior and welfare.

### 2. Associated Institution Types

- 1862 Research

### 3a. Outcome Type:

Change in Knowledge Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2015 | 6 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Our society has placed increased emphasis on the welfare of research and exhibit animals. U.S. law now requires attending to exercise requirements for dogs and the psychological well-being of non-human primates. Animal welfare without knowledge is impossible. Animal behavior researchers look at the behavior and well-being of animals in lab and field. Good animal welfare requires solid science that informs and directs policies and practices related to disease prevention and veterinary treatment, appropriate shelter, management, nutrition, humane handling and humane slaughter.

**What has been done**
Research to: maintain and improve skeletal health in livestock and companion animals; identify management practices and environmental conditions, particularly for young animals, that allow expression of positive natural behaviors while improving animal welfare in the context of environmentally sustainable production systems; and to examine ethical issues in agriculture.

**Results**
One of the most significant health issue for fed cattle in the US is lameness and is viewed as a major welfare issue in animal agriculture. Lameness tends to be more problematic for cattle housed in facilities with slatted floors. The objective of this preliminary study was to evaluate the effectiveness of rubber covered slatted floors for reduction of lameness, tail injury incidence, and improvement of overall performance. Angus-based steers (250 to 300 kg) were assigned randomly to pens with non-covered concrete slats (NC; n = 4 pens) or concrete slats covered with rubber (RC; n = 4 pens). Each pen contained 7 steers at a stocking density of 6.9 m2/steer. Cattle were on feed for 110 to 131 d. Locomotion scores, tail lesions, left carpal joint circumference, and hoof dimensions were recorded. Average daily gain, feed conversion efficiency, cleanliness, and carcass traits were collected and reported in a companion abstract. Hide cleanliness was graded on a scale of 0 to 9, with 0 being less than 5%

soiled and 9 being completely soiled. Locomotion scores were recorded on a 0 to 3 scale, where 0 was a normal gait and 3 was severely lame. Tail tip injury was recorded on a scale of 0 to 3, where 0 had no visible lesions and 3 had open wounds. Locomotion scores, left carpal joint circumference, and tail lesions did not differ between treatments. The toe length of cattle housed on the RC was longer than NC (77.3 vs. 84.0; P < 0.01). A trend for sharper angle of the hoof was observed
for cattle on NC compared with RC (55.5 vs. 52.5; P < 0.16). A positive correlation was detected between the angle of the front hoof and the carpal joint circumference (r = 0.77; P < 0.03). Positive correlations were detected between hide soiling vs. the front toe length (r = 0.71; P < 0.05) and angles between the front and rear hooves (r = 0.62; P <
0.10). In summary, provision of rubber covers for concrete slats had minor effects on overall cattle lameness.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 307 | Animal Management Systems |
| 315 | Animal Welfare/Well-Being and Protection |

**Outcome #10**

**1. Outcome Measures**

Number of research programs to test new cropping, grazing and feeding strategies for food animals.

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 8 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
As production costs rise, environmental concerns increase and consumer expectations become higher, those involved in the agrifood industry are looking for ways to maximize reproductive and performance efficiencies in a way that is economically and environmentally sustainable, and that protects human and animal health.

**What has been done**

Research to: develop a local/regional pasture-based beef production system encompassing the entire beef production chain; investigate strategies to maximize milk production output and ecosystem functions in grazing dairy systems; mitigate the environmental footprint of animal systems; develop a local/regional pasture-based beef production system encompassing the entire beef production chain; investigate strategies to maximize production output (milk)and ecosystem functions (processes and services) in grazing systems managed under various scenarios for the optimization of automatic milking and pasture systems; better understand the mineral needs of the pig; and to evaluate the effectiveness of mannaniligosaccharides on egg production, egg weight and bird livability of laying hens.

**Results**

We have published our research showing that the metabolic and physiologic effects of organic and inorganic Zn are different. This is an important finding in swine nutrition, and has stimulated additional work by many researchers around the world. Use of pharmacological doses of phytase (superdosing) with differing genetics and management, but only one form of phytase, does not appear to be useful to producers. However, this work needs to be duplicated with other commercially available phytase including its effect on zinc. To meet the needs of swine producers because of the devastating effects of PEDv, we investigated the purported effect of vitamin E on farrowing time. This work resulted in two winning awards for undergraduate researchers. Currently, the findings of this research is the basis of a large scale investigation in a commercial herd in North Carolina.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 302 | Nutrient Utilization in Animals |
| 307 | Animal Management Systems |
| 308 | Improved Animal Products (Before Harvest) |

**V(H). Planned Program (External Factors)**

**External factors which affected outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

**Brief Explanation**

During the 2014-2015 fiscal year, ABR and MSUE was able to continue rebuilding some of its resources after several years of either flat or funding cuts at both the state and federal levels. ABR was able to **fill voids in its research and support teams by hiring quality, skilled people for a variety of positions ranging from farm managers and grant coordinators to faculty and research technicians**. **Much needed equipment and**

**infrastructure updates were also conducted at many on-campus and outlying research facilities**, helping to keep operations to full capacity. In 2014, ABR and Project GREEEN funds helped bridge operating budget gaps at five of the 13 outlying research centers, enabling the repairs of equipment and several buildings. Together, the organizations look to re-invigorate the MSUE presence at the 13 outlying research centers throughout the state.

The **ongoing economic challenges** faced by Michigan continue to affect this planned program area. Consequences have included fewer new hires, delaying the award of new financial obligations, reducing levels of continued funding, and renegotiating or reducing the current scope of assistance through formula funds or block grants. Specifically, a 15 percent decreases in state funding FY2011-2012 coupled with a flat federal funding line for the following two years resulted in the elimination of 72 Extension educator positions across 83 counties, 22 academic and faculty positions on campus and 15 support staff. Administrative positions were reduced from 45 to 19 FTEs. Impacts on ABR came largely in the form of reductions in research infrastructure support. Investments in facility maintenance and equipment were postponed in an effort to avoid eliminating more than 45 research positions (faculty, support staff and graduate assistants) and one research facility had to be closed in light of the reductions. There were also fewer funds to seed research on emerging issues.

E**xtreme weather events** have also caused extensive hardship to the agriculture industry. The period between November 2013 and February 2014 was the coldest in Michigan since 1911 and among the five coldest periods on record in the state. And the winter of 2013-14 brought a series of bitterly cold air masses rolled down from the Arctic, through Canada and into Michigan. The spring 2012 ranks among the most destructive weather periods in Michigan fruit production history, with crop losses valued at more than $500 million. Peach production suffered a 95 percent loss; tart cherry, a 90 percent crop loss; apple production, an 88 percent loss; and grapes, an 85 percent loss. The summer 2012 brought the worst drought in Michigan since 1988 with many crops suffering substantial losses.

Together, MSUE and ABR continue to serve as the primary research and development arm for the agriculture and food industries in Michigan, valued at more than $100 billion annually

## V(I). Planned Program (Evaluation Studies)

### Evaluation Results

As Hatch dollars are base funding for faculty salaries, there is a built-in evaluation mechanism through annual reviews of overall performance, research productivity and the leveraging of additional research dollars. In addition, many of the research projects have an evaluative element that is required by state and federal-level funding sources that provides documentation related to project assumptions, goals and outcomes. This information is used to determine the overall success of the research initiatives; their contribution to providing practical, real-world solutions and resources to address challenges and problems; and whether continuation funding and/or new dollars are appropriate and necessary as funds are available.
MSU Extension example for youth and Animal Production and Protection
**Ensuring the safety of Michigan's poultry industry**
Issue
2015 marked the worst animal disease outbreak in history. By September, avian influenza

had claimed the lives of more than 48 million birds, destroying the livelihood of numerous farmers throughout the Midwest. In a precautionary effort to protect Michigan's poultry industry from this same devastation, the Michigan Department of Agricultur and Rural Development (MDARD) took strong measures by cancelling all poultry shows and exhibitions in the state. The cancellation occurred just one week before the first of 83 local fairs began, impacting thousands of 4-H youth who traditionally show and sell poultry projects at these events.
Response
Acting quickly, MSU Extension turned this negative situation into a positive learning opportunity by developing ways for 4-H'ers to demonstrate their knowledge and talent without live birds on site. Doing so ensured that the disease did not reach Michigan's domestic flocks and spread during fair season. Activities ranging from educational contests to showmanship with a life-like bird model provided options for county 4-H programs to showcase youths' work in the poultry area. In addition, MSU Extension worked alongside MDARD to create guidelines that allowed market bird projects to still be sold at local fairs.
Results
With the assistance of these alternative activities, Michigan 4-H families quickly turned the unfortunate circumstances into useful learning experiences about animal health, biosecurity and risk management. As a result: Youth in nearly 95% of county 4-H programs were able to exhibit their poultry expertise at fair while minimizing the potential spread of avian influenza. More than 4,100 youth enrolled in the 4-H Bird Science area played a key role in ensuring the health and safety of Michigan's poultry industry.

Another MSU Extension example
**Reducing the risk of zoonotic disease transmission**
Issue
Infectious disease outbreaks are a concern for many Michiganders, as well as people across the globe. Dependent on if the outbreak is in wildlife, animal industry or human populations, it can have devastating consequences for the biosystem, food supply or human health. When the disease is zoonotic - transmissible between humans and animals - the outcomes can be catastrophic in more than one sphere.
Response
To help youth understand the risk of zoonotic disease transmission and learn what precautions can be taken to minimize the danger, MSU Extension Michigan 4-H partnered with the Michigan Department of Agriculture and Rural Development and the Michigan Department of Health and Human Services. This partnership resulted in the development of resources that have been used across the state to improve youth awareness and understanding of zoonotic diseases.
Results
More than 61,000 copies of the Michigan 4-H zoonotic disease curriculum were distributed to 4-H members across the state. 2,000 zoonotic disease education toolkits and lessons were disseminated to Michigan 4-H clubs with 92 percent of surveyed youth indicating they would adapt behaviors to prevent zoonotic disease transmission. More than 400 signs promoting animal and human health were distributed to Michigan fairs and festivals to build awareness.

**4-H Programs focused on Animal Management Systems**
Issue
Sustaining the dairy industry in the future can be greatly effected by getting youth involved early to encourage them to pursue careers in this area.
Response

MSUE developed and implemented 4-H programs that included Michigan 4-H Youth Dairy Days, Michigan 4-H Dairy Conference, Michigan Veterinary Science Teen and Adult Leaders, and Michigan 4-H BEEF, SHEEP, SWINE TEEN AND ADULT LEADER WORKSHOP.
Results
Evaluation results found:

- 93% of youth (n=57) and 90% of adults (n=21) felt more knowledgeable about entrepreneurship and career opportunities for youth to pursue in science related fields after attending Michigan 4-H Youth Dairy Days.
- From the Michigan 4-H Dairy Conference, 98% of youth (n=42) and 91% of adults (n=11) felt more knowledgeable about entrepreneurship and career opportunities for youth to pursue in science related fields.
- 92% (n=99 youth and 69 adults) of participants felt more knowledgeable about entrepreneurship and career opportunities for youth to pursue in science related fields after attending the Michigan 4-H Veterinary Science Teen and Adult Leaders Workshop.
- 96% (n=81 youth and 64 adults) felt more knowledgeable about entrepreneurship and career opportunities for youth to pursue in science related fields after attending the Michigan 4-H Beef, Sheep and Swine Teen and Adult Leaders Workshop.

Some youth quotes:

- "This workshop was very helpful! It opened my mind to all new ideas and possibilities of a career." (Iosco County Youth)
- I enjoyed learning about new marketing strategies for my livestock projects." (Ogemaw County Youth)
- This really made me excited to learn more and maybe choose a career in animal science." (Barry County youth)

**Key Items of Evaluation**

- Enhance Michigan's First Green Industry: Agriculture and Agribusiness
  - 2,861 adults trained in animal management systems
    - (50%) - Helped in developing a new manure management plan for the farm.
    - (50%) - Helped in adjusting or changing current manure management plan.
    - (23%) - Helped in developing a new mortality management plan for the farm.
    - (18%) - Helped in adjusting or changing my current mortality management for the farm.
    - (9%) - Helped in reducing or eliminating runoff to surface waters or leaching to groundwater.

**For MSU AgBioResearch in FY15:**
Collaborative programs are very important to MSU AgBioResearch, even in a year that our stories focused more in the plant/soil areas, here is an example of cross-cutting research making impacts in other areas.

Putting marginal land to use
One of the greatest concerns about the decline of soil health in places such as Malawi is the subsequent increase in marginal agricultural landscapes, areas where the soil is too poor or the terrain too hostile for healthy crop growth. These lands are far from unique to southeast Africa. Anywhere the land is steep or marshy or the soil is rocky or has poor drainage can beconsidered marginal, as well as sites with poor soil nutrient availability. Helping farmers make use of these less fertile lands has been a major focus of MSU

AgBioResearch forage specialist Kim Cassida.
As part of a team alongside fellow MSU AgBioResearch scientists Jason Rowntree and Lisa Tiemann, Cassida has found that marginal landscapes are particularly useful for grazed livestock forage crops, which remove fewer nutrients from the soil than traditional cash crops.
"We look at a particular plot of land and determine the plants that are best suited for it," Cassida explained. "At the same time, the plants have to have the right nutrient profile for the animals because we're trying to produce the highest quality beef for the market."
The challenge with forage crops stems from the fact that their quality is neither uniform nor static. As a particular shoot ages, its nutrient levels decline, making a compromise between crop yield and nutritional value inevitable. One of the ways to o&daggerffset this issue is by growing mixtures of pasture species that complement one another in timing of nutritional value and yield. In addition to improving nutritional value, nitrogen-fixing legumes also improve soil fertility.
Working with alfalfa, the most common legume forage crop in Michigan, and other nitrogen-fixing legumes, grasses and annual forages, Cassida's team is pioneering forage mixes that not only provide excellent nutrition for livestock but also provide nitrogen and other nutrients for the entire soil ecosystem.

## V(A). Planned Program (Summary)

**Program # 6**

**1. Name of the Planned Program**

Food and Non-Food Quality, Nutrition, Engineering and Processing

☑ Reporting on this Program

**V(B). Program Knowledge Area(s)**

1. Program Knowledge Areas and Percentage

| KA Code | Knowledge Area | %1862 Extension | %1890 Extension | %1862 Research | %1890 Research |
|---|---|---|---|---|---|
| 205 | Plant Management Systems | 100% | | 19% | |
| 402 | Engineering Systems and Equipment | 0% | | 10% | |
| 404 | Instrumentation and Control Systems | 0% | | 10% | |
| 501 | New and Improved Food Processing Technologies | 0% | | 10% | |
| 502 | New and Improved Food Products | 0% | | 5% | |
| 503 | Quality Maintenance in Storing and Marketing Food Products | 0% | | 14% | |
| 511 | New and Improved Non-Food Products and Processes | 0% | | 16% | |
| 712 | Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins | 0% | | 16% | |
| | **Total** | 100% | | 100% | |

## V(C). Planned Program (Inputs)

**1. Actual amount of FTE/SYs expended this Program**

| Year: 2015 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| **Plan** | 2.9 | 0.0 | 6.0 | 0.0 |
| **Actual Paid** | 4.9 | 0.0 | 5.0 | 0.0 |
| **Actual Volunteer** | 0.0 | 0.0 | 0.0 | 0.0 |

**2. Actual dollars expended in this Program (includes Carryover Funds from previous years)**

| Extension | | Research | |
|---|---|---|---|
| **Smith-Lever 3b & 3c** | **1890 Extension** | **Hatch** | **Evans-Allen** |
| 195006 | 0 | 513000 | 0 |
| **1862 Matching** | **1890 Matching** | **1862 Matching** | **1890 Matching** |
| 195006 | 0 | 526768 | 0 |
| **1862 All Other** | **1890 All Other** | **1862 All Other** | **1890 All Other** |
| 0 | 0 | 1851304 | 0 |

## V(D). Planned Program (Activity)

### 1. Brief description of the Activity

Activities will be undertaken to:

- Connect Michigan industries with the research, education and entreprenuerial activity needed in the basic sciences, engineering, plant science and agriculture to provide the state with a foundation for the vigorous development of a strong biobased economic sector.
- Identify and isolate beneficial plant compounds and develop technologies and processes to make new functional foods.
- Develop new biosensors and DNA chips that can rapidly and accurately detect a broad spectrum of harmful organisms in food and water.
- Identify breeding and genetic improvements related to food quality, nutrition and processing.
- Develop packaging systems to enhance food quality and shelf life.

### 2. Brief description of the target audience

Agriculture and natural resources industry representatives, biotechnology company representatives, food industry representatives,state agency representatives, private citizens, entreprenuers, native American growers.

### 3. How was eXtension used?

All field educators are encouraged to be involved in eXtension through both Ask and Expert and Communities of Practice (CoP). A total of 4.99 fte's were involved in this area of plant soil with1.9 fte's funded through 3bc. An example from Ask and Expert:
Question: How do I find my results for the servsfae test i took 11.19.15 at kvcc?
Answer: Go to ServSafe.com and select Check Your Exam Score on the students tab. Select Create New Profile (unless you have already done this). You will then enter exam session # 1722483.

## V(E). Planned Program (Outputs)

### 1. Standard output measures

| 2015 | Direct Contacts Adults | Indirect Contacts Adults | Direct Contacts Youth | Indirect Contacts Youth |
|---|---|---|---|---|
| **Actual** | 6112 | 17562 | 0 | 0 |

**2. Number of Patent Applications Submitted (Standard Research Output)**

**Patent Applications Submitted**

Year: 2015

Actual: 1

**Patents listed**

MICL02007, Field-Operable Nano-Biosensors for Global Health, Biodefense, Food Safety, and Water Quality, Serial number 14/400,996 (Note, we have someone new providing this information to us and it seems lower compared to previous years).

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

| 2015 | Extension | Research | Total |
|---|---|---|---|
| **Actual** | 0 | 25 | 0 |

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Number of research projects focusing on food quality, nutrition, engineering and processing.

| Year | Actual |
|---|---|
| 2015 | 21 |

**Output #2**

**Output Measure**

- Number of adults trained on new and improved non-food and bioeconomy related products and processes.

| Year | Actual |
|---|---|
| 2015 | 265 |

**Output #3**

**Output Measure**

- Number of food handlers that increase their knowledge about food safety.

| Year | Actual |
|---|---|
| 2015 | 5854 |

**V(G). State Defined Outcomes**

## V. State Defined Outcomes Table of Content

| O. No. | OUTCOME NAME |
|---|---|
| 1 | Number of research programs to identify and isolate plant compounds and/or develop processes and technologies to manufacture functional foods. |
| 2 | Number of research programs to develop new biosensors and DNA chips that can rapidly and accurately detect a broad spectrum of harmful organisms in food and water. |
| 3 | Number of research programs to identify breeding and genetic improvement related to food quality, nutrition and processing. |
| 4 | Number of research programs to develop packaging systems to enhance food quality and shelf life. |
| 5 | Number of research programs to connect Michigan industries with research, education and entrepreneurial activity needed in the basic sciences, engineering and plant science and agriculture to provide the state with a foundation for vigorous development of a strong biobased economic sector. |
| 6 | Number of food handlers that increase their knowledge about food safety. |

**Outcome #1**

**1. Outcome Measures**

Number of research programs to identify and isolate plant compounds and/or develop processes and technologies to manufacture functional foods.

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 4 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Dwindling farm acreage, more expensive production and processing costs, and increased consumer expectations have prompted research into creating new - and enhancing existing - processes and technologies that manufacture healthy, functional foods. More significant, perhaps, is the potential of functional foods to mitigate disease, promote health and reduce health care costs.

**What has been done**
Research to: identify, develop and/or apply technology to ensure that the Michigan fruit, vegetable, chestnut and canola oil industries remain economically and environmentally sustainable; develop and process dairy foods that are consistent with the benefits of ingesting probiotics; develop improved methods for the design and operation of thermal processing systems for protein foods; develop technologies to support management systems for quality grains and oil seeds; evaluate the efficacy of processes and ingredients that impact known safety hazards in muscle foods; and to pursue new process technology for raw material pretreatment, fermentation, distillation and aging related to artisan distilling.

**Results**
The results from this past year have continued to support the premise that low-moisture pasteurization processes need to be validated for different types of products, given that efficacy can be affected by product structure, water activity, etc. Therefore, it is extremely important to use product-specific inactivation parameters when validating pasteurization processes.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 501 | New and Improved Food Processing Technologies |
| 502 | New and Improved Food Products |
| 503 | Quality Maintenance in Storing and Marketing Food Products |

**Outcome #2**

**1. Outcome Measures**

Number of research programs to develop new biosensors and DNA chips that can rapidly and accurately detect a broad spectrum of harmful organisms in food and water.

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 2 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
The rapid detection of harmful organisms and disease-causing agents in food and water, and the ability to track and trace sources is critical to human health. In the food safety arena, it is estimated that 48 million food-borne illnesses occur each year in the U.S., accounting for 128,000 hospitalizations and more than 3,000 deaths. Biosensors can play a key role in food safety by quickly identifying contaminants in water supplies, food processing and assembly lines, raw food materials and food products before they cause problems further up the food chain.

**What has been done**
Research to: Synthesize, characterize and evaluate nanostructured interfaces that enable molecular level investigations of systems of medical, scientific and technological interests; and to combine the novelty of nanoscale transducing material and biosensing techniques to address the detection and diagnostic challenges in food and water safety

**Results**
Our nano-biosensor technologies were featured at four international meetings in the Philippines, India, Sri Lanka, and Mexico. We have validated the biosensors in various food matrices and water samples. Our technology on anti-counterfeiting devices is continually featured in the Science of Innovation educational program by the National Science Foundation, US Patent and Trademark Office, and NBC Learn as a national resource to encourage and recruit K-12 students to the science fields.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 402 | Engineering Systems and Equipment |
| 404 | Instrumentation and Control Systems |
| 503 | Quality Maintenance in Storing and Marketing Food Products |

**Outcome #3**

**1. Outcome Measures**

Number of research programs to identify breeding and genetic improvement related to food quality, nutrition and processing.

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 5 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Genetic diversity is required to meet certain production needs in plant and animal agriculture to allow for sustained genetic improvement and to facilitate rapid adaptation to changing breeding objectives. Recent efforts in gene discovery and functional genomics are providing the necessary understanding to develop and evaluate different approaches to manipulate phytochemical composition

**What has been done**
Research to: determine the impact of heat stress on meat quality; help address the detection and diagnostic challenges in global health, biodefense and food/water safety; assess the risk of humans to mycotoxins via food-borne and air-borne exposure and develop appropriate mitigation strategies; understand the process of E. coli chromosomal DNA replication and its regulation at the biochemical level; identify protein markers that are indicators for soft wheat processing quality; limit human exposure to aflatoxin in food to help prevent liver cancer; characterize the role of hypoxia in metal-induced toxicity; and to develop innovative processing that adds value to fresh or processed meat products.

**Results**
The importance of muscle as a food is exemplified by the turkey meat processing industry. In the USA, there has been a continual increase in consumption of turkey meat from 4.9 pounds of

boneless equivalent in 1960 to 14.4 pounds in 2002. Breast meat yield is the primary profit center for the commercial poultry industry. A predominant factor leading to this increase in consumer consumption is that poultry breast meat is regarded as the ideal lean meat for a healthy diet. This is coupled to its affordability and ease of preparation. A 1% increase in breast yield will amount to at least $75 million increase in revenues
to the poultry industry. Commercial geneticists have placed a tremendous amount of selection pressure on breast yield and conformation, but not the mechanisms regulating the growth of muscle. The ability to regulate the growth and development of muscle depends on understanding the cellular regulatory mechanisms and cellular interactions that occur. Changes in muscle fiber size, extracellular areas available between the individual fibers and fiber bundles, and increased fat deposition will alter meat quality as have been illustrated by problems like pale, soft, and exudative turkey and pork. The results from this study will provide information on the role of specific genes whose function is currently poorly understood, on the growth and development of muscle. Results from these experiments will also enable breeders to develop strategies for genetic improvement of animals which will yield higher quality meat at low cost.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 501 | New and Improved Food Processing Technologies |
| 502 | New and Improved Food Products |

**Outcome #4**

**1. Outcome Measures**

Number of research programs to develop packaging systems to enhance food quality and shelf life.

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2015 | 5 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
In packaging systems, chlorine dioxide gas is used for vapor-phase decontamination in treating produce before packaging and sanitizing products inside their packages. Yet very little is known about its effects on packaging material properties and performances. In terms of the containers themselves, use of a reusable, plastic-based packaging system would greatly reduce the costs associated with packaging and address environmental issues.

**What has been done**
Research to: Promote functional and sustainable packaging systems that optimize the utilization of raw materials; and to develop and use new types of packaging systems for fruits and vegetables.

**Results**
Ongoing research assessing the transfer of E. coli O157:H7 and Salmonella during pilot-scale processing of fresh-cut Romaine lettuce, baby spinach and cilantro at different inoculation levels and inoculated:uninoculated product ratios with this work part of an FDA contact. These findings will be critical to refining the current FDA risk assessment for fresh-cut leafy greens. Other research completed a short study on Listeria growth in caramel apples. The end result of this work will be a same day test for E. coli O157:H7 and Listeria in produce wash water that can be used by industry to better ensure end product safety.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 402 | Engineering Systems and Equipment |
| 503 | Quality Maintenance in Storing and Marketing Food Products |

## Outcome #5

### 1. Outcome Measures

Number of research programs to connect Michigan industries with research, education and entrepreneurial activity needed in the basic sciences, engineering and plant science and agriculture to provide the state with a foundation for vigorous development of a strong biobased economic sector.

### 2. Associated Institution Types

- 1862 Research

### 3a. Outcome Type:

Change in Condition Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2015 | 5 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Michigan, along with many other states, continues to work on revitalizing its economy. A critical component of the state's and the nation's revitalization effort is to decrease dependence on foreign oil, while creating jobs and encouraging further alternative energy investments. These

efforts will have a significant impact on agriculture and manufacturing throughout the Great Lakes region and beyond, as sustainable alternatives to petroleum-based products are developed to strengthen the state's economy.

**What has been done**
Research to: develop innovative bioelectrocatalytic converters that achieve mediated electron transfer to dehydrogenases and optimize the reactor's performance for coupled bioconversions having commercialization potential; and to facilitate the development of bio-derived fuels and chemicals through property characterization

**Results**
One of the projects impacts the greater chemical engineering design community directly by providing improved models for process design. Current process design models yeild very poor results for multiphase equilibria, such as when two liquid phases and a vapor phase coexist. Without reliable process models, companies must rely on fits of data over limited ranges of temperature and composition which requires significant experimental data, which slows the rate of process design. The goal of this project is to develop improved models that represent hydrogen bonding that incorporate parameters inferred from spectroscopy and molecular simulations. During this reporting period, we have developed an initial model for binary behavior with one component that hydrogen bonds and a second component that does not participate in hydrogen bonding. We have a draft publiciation demonstrating that the popular Wertheim method is the same as the chemical theory method for
systems that form hydrogen bond chains. The publication shows that equivalence of the two methods. We have obtained preliminary NMR results.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 402 | Engineering Systems and Equipment |
| 501 | New and Improved Food Processing Technologies |
| 503 | Quality Maintenance in Storing and Marketing Food Products |
| 511 | New and Improved Non-Food Products and Processes |

**Outcome #6**

**1. Outcome Measures**

Number of food handlers that increase their knowledge about food safety.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2015 | 5114 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Creating safe food establishments. The U.S. Food and Drug Administration has called for increased efforts to improve food safety practices in retail food establishments, specifically a needed presence of certified food safety managers to oversee safety practices. Michigan state law mandates that every food service establishment employ a minimum of one certified manager. Studies have found that the presence of a certified food safety manager results in higher compliance levels with food safety practices and behaviors than in facilities lacking a certified manager. One study result showed that compliance was 79 percent with a certified manager versus 64 percent without.

**What has been done**
MSU Extension offers ServSafe, a national certification program for food service leaders. Restaurant customers can have increased confidence when they see a ServSafe‒certified manager on duty.

**Results**
ServSafe participants show an increase in implementing food safety practices in food preparation, employee hygiene and health, food storage and food transportation. MSU Extension 2014 ServSafe participants test scores include: Participants passing the national exam with an average score of 85%, surpassing the mandatory national score of 75%. 88% understanding how to implement food safety. 85% understanding how to receive, store and transport food.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 712 | Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins |

## V(H). Planned Program (External Factors)

**External factors which affected outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

**Brief Explanation**

During the 2014-2015 fiscal year, ABR and MSUE was able to continue rebuilding some of its resources after several years of either flat or funding cuts at both the state and federal levels. ABR was able to **fill voids in its research and support teams by hiring quality, skilled people for a variety of positions ranging from farm managers and grant coordinators to faculty and research technicians**. **Much needed equipment and infrastructure updates were also conducted at many on-campus and outlying research facilities**, helping to keep operations to full capacity. In 2014, ABR and Project GREEEN funds helped bridge operating budget gaps at five of the 13 outlying research centers, enabling the repairs of equipment and several buildings. Together, the organizations look to re-invigorate the MSUE presence at the 13 outlying research centers throughout the state.

The **ongoing economic challenges** faced by Michigan continue to affect this planned program area. Consequences have included fewer new hires, delaying the award of new financial obligations, reducing levels of continued funding, and renegotiating or reducing the current scope of assistance through formula funds or block grants. Specifically, a 15 percent decreases in state funding FY2011-2012 coupled with a flat federal funding line for the following two years resulted in the elimination of 72 Extension educator positions across 83 counties, 22 academic and faculty positions on campus and 15 support staff. Administrative positions were reduced from 45 to 19 FTEs. Impacts on ABR came largely in the form of reductions in research infrastructure support. Investments in facility maintenance and equipment were postponed in an effort to avoid eliminating more than 45 research positions (faculty, support staff and graduate assistants) and one research facility had to be closed in light of the reductions. There were also fewer funds to seed research on emerging issues.

E**xtreme weather events** have also caused extensive hardship to the agriculture industry. The period between November 2013 and February 2014 was the coldest in Michigan since 1911 and among the five coldest periods on record in the state. And the winter of 2013-14 brought a series of bitterly cold air masses rolled down from the Arctic, through Canada and into Michigan. The spring 2012 ranks among the most destructive weather periods in Michigan fruit production history, with crop losses valued at more than $500 million. Peach production suffered a 95 percent loss; tart cherry, a 90 percent crop loss; apple production, an 88 percent loss; and grapes, an 85 percent loss. The summer 2012 brought the worst drought in Michigan since 1988 with many crops suffering substantial losses.

Together, MSUE and ABR continue to serve as the primary research and development arm for the agriculture and food industries in Michigan, valued at more than $100 billion annually.

## V(I). Planned Program (Evaluation Studies)

### Evaluation Results

As Hatch dollars are base funding for faculty salaries, there is a built-in evaluation mechanism through annual reviews of overall performance, research productivity and the leveraging of additional research dollars. In addition, many of the research projects have an evaluative element that is required by state and federal-level funding sources that provides documentation related to project assumptions, goals and outcomes. This information is used to determine the overall success of the research initiatives; their contribution to providing practical, real-world solutions and resources to address challenges and problems; and whether continuation funding and/or new dollars are appropriate and

necessary as funds are available.
Example of integration that includes partnerships between AgBioResearch, the Great Lakes Bioenergy Research Center (GLBRC), and MSU Extension.

**Reducing MSU's campus carbon footprint**

Issue

MSU takes seriously its role in reducing its carbon footprint and increasing sustainability, an issue of importance to many Michiganders. The T. B. Simon Power Plant at MSU burns coal, natural gas and biomass, which is then used to provide steam heat and electricity for the lecture halls, dorms and research labs. A partnership between the Great Lakes Bioenergy Research Center (GLBRC) and the power plant reduced the carbon footprint of the university by co-firing switchgrass, a renewable fuel, with coal.

Response

MSU Extension bioenergy educators worked with the GLBRC and MSU in addition to harvesting and delivering the switchgrass to campus. In 2014, 416 tons of switchgrass were harvested from GLBRC fields and delivered to the power plant where it was burned to offset coal use and reduce the power plant's carbon footprint.

Results

This collaborative effort demonstrates the benefits of biomass combustion in helping to meet sustainable energy goals described in MSU's Energy Transition Plan. Switchgrass has 100 times less sulfur than coal resulting in lower sulfur oxide emissions. Switchgrass has five times less nitrogen than coal resulting in lower nitrogen oxide emissions. In the soil, switchgrass will sequester 179.9 grams of carbon dioxide per kilogram.

Another MSU Extension example of Food and Non-Food Quality, Nutrition, Engineering and Processing

**Increasing food safety of chipping potatoes**

Issue

Michigan leads the nation in chipping potato production. In recent years, concern for food safety has become more acute on the part of all sectors of the food system. Chipping potatoes are no exception. This concern has led buyers to demand new audit requirements of their suppliers.

Response

After a prominent international chipping potato manufacturer required all growers to be audited as a prerequisite of sale, a group of growers turned to MSU Extension for help. A worker training program was developed that included a robust food safety manual and a digital recordkeeping system that ensured compliance and simplified recordkeeping.

Results

75% of all potatoes grown in Michigan are destined for potato chips. The impact of the new audit requirements affected over 10,000 acres and annual sales in excess of $40 million. (This was calculated assuming a price of $11.60 per hundredweight and an average yield of 345 hundredweight per acre.) One in every five potato chips produced by this international manufacturer will be grown under these food safety practices.

Another example of MSU Extension

**Teaching skills for home food entrepreneurship**

Issue

Many Michiganders want to start food businesses and rely on their home kitchens when getting started. The Michigan Cottage Food Law allows aspiring food entrepreneurs to sell home-processed foods to the public. In 2012, updates to the Michigan Food Code and Cottage Food Law created the need for food safety education among this group of small business owners. Confidence among consumers increases when seeing cottage food

products sold by vendors with a food safety certificate. Certification reflects quality cleaning and sanitizing practices, proper ingredient handling and product labeling.
Response
Michigan Cottage Food Law workshops through MSU Extension enable residents to become certified to prepare and store particular foods in a home kitchen to establish their home businesses.
Results
MSU Extension participants rated a two-hour Cottage Food Law program with an overall satisfaction rate of 92 percent. Additional Cottage Food Law program surveys reflected: 99% of participants have a better understanding of what is necessary to run a successful Cottage Food Law business. More than 50% of participants indicated they gained new knowledge about proper cleaning and sanitizing. A six-month follow-up showed that 25% of participants planned to start cottage food businesses in 2015.

**Key Items of Evaluation**

- Improve Health and Nutrition for Michigan Residents
  - 5.854 adults were trained on consumer food safety
    - Participants who took the national exam passed with an average score of 85%,
    - 88% understanding how to implement food safety.
    - 85% understanding how to receive, store and transport food.

**For Research in FY 15**
A Fresher Vegetable: Re-evaluating how food is stored
Every day, millions of people buy packaged fresh-cut produce from their local grocery stores, secure in the knowledge that what they bring home will, indeed, be fresh when they eat it. But that freshness does not last forever. All packaged food -- fresh-cut vegetables in particular -- has a limited shelf life. A team of Michigan State University (MSU) researchers is working to extend that shelf life while improving food safety.
MSU AgBioResearch food scientists Elliot Ryser, Eva Almenar, Janice Harte and Randy Beaudry, together with colleagues from Rutgers University and Ohio State University, are studying the impact and increasing the efficacy of sanitizers and gases used in packaging fresh-cut produce through a $2 million grant from the U.S. Department of Agriculture (USDA) National Institute of Food and Agriculture.
Chemical compounds are used to treat produce before packaging to neutralize any harmful pathogens that may be present, such as Salmonella or E. coli. The use of these sanitizers is required by federal regulation before the produce can be sold. Most produce packages are also filled with gases, such as carbon dioxide, to inhibit the growth of microbes. The MSU team was tasked with finding the right balance between the compounds and gases to ensure maximum food safety without sacrificing freshness.
A series of pathogen outbreaks and product recalls -- most notably a 2006 E. coli outbreak in fresh spinach that resulted in over 270 hospitalizations and three deaths -- were the impetus for this project.
"This is part of a much larger USDA project to look at safety in fresh fruits and vegetables," said Ryser, professor in the MSU Department of Food Science and Human Nutrition. "After being treated with sanitizers, many products are packaged under various atmospheres and exposed to fluctuating temperature conditions, which can increase the chances that they become contaminated or lose their freshness. Our findings will be built into USDA's risk assessment program to improve food safety."
Combating pathogens begins as soon as the produce is harvested. The produce is washed before packaging with water that has been mixed with sanitizing agents such as chlorine

and peracetic acid to remove pathogens. These compounds remove 90 percent to 99 percent of the pathogens from the produce itself. Though that eliminates the vast majority of pathogens, a colony of 1,000 Salmonella cells on a single tomato is capable of contaminating an entire batch. Ryser's lab studied this spread of pathogen from inoculated to non-inoculated produce in tomatoes, onions, celery and cantaloupe.
Ryser and his team found that controlling the temperature at which produce is stored is critical to controlling pathogen spread. The produce can undergo significant temperature fluctuations during transportation from the field to the store. Often vegetables are briefly kept in warmer areas such as loading docks or unrefrigerated rooms for cleaning, during which time pathogens -- which may have been present in non-harmful quantities -- can rapidly proliferate.

For more on this story, please visit:
http://agbioresearch.msu.edu/news/a_fresher_vegetable_re_evaluating_how_food_is_stored

# VI. National Outcomes and Indicators

## 1. NIFA Selected Outcomes and Indicators

| | |
|---|---|
| **Childhood Obesity (Outcome 1, Indicator 1.c)** | |
| 0 | Number of children and youth who reported eating more of healthy foods. |
| **Climate Change (Outcome 1, Indicator 4)** | |
| 0 | Number of new crop varieties, animal breeds, and genotypes whit climate adaptive traits. |
| **Global Food Security and Hunger (Outcome 1, Indicator 4.a)** | |
| 0 | Number of participants adopting best practices and technologies resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources. |
| **Global Food Security and Hunger (Outcome 2, Indicator 1)** | |
| 0 | Number of new or improved innovations developed for food enterprises. |
| **Food Safety (Outcome 1, Indicator 1)** | |
| 0 | Number of viable technologies developed or modified for the detection and |
| **Sustainable Energy (Outcome 3, Indicator 2)** | |
| 0 | Number of farmers who adopted a dedicated bioenergy crop |
| **Sustainable Energy (Outcome 3, Indicator 4)** | |
| 0 | Tons of feedstocks delivered. |