

**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	0%		14%	
402	Engineering Systems and Equipment	0%		10%	
501	New and Improved Food Processing Technologies	0%		15%	
502	New and Improved Food Products	0%		15%	
503	Quality Maintenance in Storing and Marketing Food Products	0%		14%	
504	Home and Commercial Food Service	10%		0%	
511	New and Improved Non-Food Products and Processes	30%		16%	
512	Quality Maintenance in Storing and Marketing Non-Food Products	10%		0%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	50%		16%	
	<b>Total</b>	100%		100%	

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

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

Year: 2014	Extension		Research	
	1862	1890	1862	1890
<b>Plan</b>	3.1	0.0	6.0	0.0
<b>Actual Paid</b>	6.0	0.0	6.3	0.0
<b>Actual Volunteer</b>	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
239227	0	568380	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
239227	0	575177	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	2065480	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 entrepreneurial 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, entrepreneurs, native American growers.

#### 3. How was eXtension used?

All MSUE field educators and specialists are encourage to be involved in eXtension through both the Ask an Expert and Communities of Practice (CoP). A total 5.51 fte's were involved in this area of food and non-food quality with 1.73 fte's funded through 3bc funds. Examples from Ask an Expert Questions are below:

**Title of Question:** biogas energy

**Question:**

- 1]What is the difference between composite gas cylinders, high pressure steel cylinders and LPG cylinders?
- 2] Which of the above storage facilities is recommended for packaging methane gas from biogas operations?

**Response:**

I called the Compressed Gas Association and also talked with several propane gas distributors in my locale. This is what I learned. The difference between composite gas cylinders, high pressure steel cylinders and LPG cylinders is in weight and use. Composite cylinders weigh less and can be used for the

basic same purposes as other cylinders. One caveat to that statement is no one I spoke with had high pressure composite cylinders. However, composite cylinders (tanks) have been used to hold rocket fuel for years. As far as use goes, LPG cylinders and composite gas cylinders are typically used in outdoor gas grills. They typically operate at a pressure of 175 psi but can go as high as 275 psi for certain uses. High pressure steel cylinders hold gases used for welding and other industrial uses. The standard high pressure cylinder is at 2,300 psi while the high volume cylinder can be as high as 6,000 psi. I do not know which of the three is best for methane utilization, however, one welding supply shop I spoke with said they sell three grades of methane - a commercial grade (93% methane), a technical grade (97% methane), and a pipeline quality grade (99% methane). They come in cylinders with a pressure ranging between 1,800-2,400 psi. Obviously you will want to remove moisture, carbon dioxide and hydrogen sulfide before charging your cylinders. You don't want to bottle biogas, you want to bottle methane.

**Title of Response: COTTAGE LAW FOODS**

**Question:** Hello, I would like to know if canned applesauce and pie filling is allowed to be sold under the cottage food law. Thank you.

**Response:**

Hello,

No applesauce and apple pie filling are not allowe to be sold under the cottage food law. Here is the website that will be of help to you in regards to the MI Cottage Food Law and what can be sold and what cannot. [www.michigan.gov/cottagefood](http://www.michigan.gov/cottagefood) There is lots of useful information at this site that you will be interested in.

Another example:

**Title of Question:** servsafe info

**Question:** Hello from Washtenaw County. What us the difference between the 8 hour Servsafe class and the 16 hour one? K

**Response:**

Hi K -

The 16-hour ServSafe is more intensive. We go over each chapter at a slower pace, ending the second day with the exam. The 8-hour course is more of a review course, with only six hours of "class" and two hours for the exam. If one already is experienced in food service or has been certified before, the 8-hour is usually a good review.

If you have further questions, you can call your local MSU Extension office and ask for the food safety educator. They will be able to give you her/his number.

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

**1. Standard output measures**

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
<b>Actual</b>	7523	22569	0	0

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

**Patent Applications Submitted**

Year: 2014

Actual: 23

**Patents listed**

MICL02290: Property Modeling and Prediction for the Bioeconomy #61/961,526 (10/17/13); #8613780 (12/24/13); #2507200 (2/12/14); #8,735,633 (5/27/14); #258051 (11/28/13);

MICL02291: Bioreactor Engineering for Gas-Intensive Fermentations to Produce Biobased Fuels and Chemicals: #14/199,714 (3/6/14); #14/193,943 (2/28/14) ; #8623196 (1/7/14)

MICL02289 : Thermochemical Conversion of Plant Biomass to Liquid and Solid Fuels #14/061,460 (10/23/13); #PCT/US2014/031115 (3/18/14);

MICL02217:Evaluation, Development and Implementation of Sustainable Packaging Systems #14/069,556 (11/1/13)

;MICL02111: New Approach for Decontaminating and Improving the Quality of Fresh and Fresh-Cut Produce Utilizing Packaging Design and Chlorine Dioxide #14/233,314 (4/29/14); #14/069,556 (11/1/13);

MICL02007: Field-Operable Nano-Biosensors for Global Health, Biodefense, Food Safety, and Water Quality: #14/356,406 (5/3/14); #14/174,074 (2/6/14);

MICL02308: Improving biofuel crops by targeting biosynthesis and storage of mixed-linkage glucan in stem parenchyma tissue of model grasses. #14/365,744 (6/16/14); ; #14/349,137 (4/2/14); #61/842,077 (7/2/13); #PCT/US2014/044662 (6/27/14);

MICL01967:Engineering Methods to Improve the Safety of Commercially Produced Food Products #61/844,285 (7/9/13); MICL02240: Molecular Mechanisms Associated with Turkey Skeletal Muscle Growth and Meat Quality: #61/844,285 (7/9/13); MICL01981:Enhancing Economic and Nutritional Value of Food Products Through Food Processing Technology #61/844,324 (7/9/13); #14/054,388 (10/15/13)

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

**Number of Peer Reviewed Publications**

2014	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
2014	22

**Output #2**

**Output Measure**

- Number of adults trained on new and improved non-food and bioeconomy related products and processes.

Year	Actual
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2014 194

**Output #3**

**Output Measure**

- Number of adults trained in home and commercial food safety.

<b>Year</b>	<b>Actual</b>
2014	7329

**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.

## **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**

<b>Year</b>	<b>Actual</b>
2014	5

### **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**

A major emphasis under this project in this reporting year was on the study of Computed Tomography (CT) imaging, hyperspectral imaging, and spectroscopy, for automated detection of undesirable fiber in processing carrots. The research involved the collection of hundreds of field samples followed by CT scanning and a laboratory processing method to extract and measure fiber content in individual samples for direct reference to electronic measurements. Results to date are demonstrating the ability to directly and also possibly indirectly (through evaluation of

certain physiological zones of the carrot such as the phloem and xylem that experience related changes in fibrous carrots) detect undesirable fibrous tissue with CT, at least in cases of significant fiber presence. Analysis is continuing on the hyperspectral and spectral data, which was collected on the cut top end of the carrots. Similar research has been conducted under this project on CT for internal quality evaluation of chestnuts and other commodities with good success. The carrot fiber detection study has also included extensive structural/component analysis for cellulosic and lignin content in an effort to better understand and quantify the material which is the focus of detection. Publications and professional presentations in addition to industry interaction have been outcomes of this project. This specific project is directed at development of a technique and technology for detecting an undesirable characteristic (heavy fiber), which can present a choking hazard to humans, especially infants, in addition to being an undesirable texture characteristic in carrot-containing foods in general.

#### 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 Action Outcome Measure

##### 3b. Quantitative Outcome

Year	Actual
2014	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; investigate using radio frequency identification (RFID) in tracking, tracing and security issues related to the movement of goods through the supply chain; 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**

The focus of this umbrella project is on the development of novel field-operable biosensors for rapid detection of bacterial pathogens of concern to global health, biodefense, food safety, and water quality. The following specific targets are of interest to this umbrella project: Mycobacterium tuberculosis, pathogenic Escherichia coli, and Salmonella species. Expected deliverables include bio-nano-conjugates and biosensor devices that have the following features: field-portable, handheld, lightweight, highly sensitive, specific, reliable, simple to use, inexpensive, and provide results in less than an hour. Applications to global diseases is highly innovative and could potentially transform diagnostic practices at local clinics and home-health. The biosensor devices can also be transformative when applied to field screening for biodefense, food safety, and water monitoring. Because these devices are inexpensive, they could be critical tools in reducing healthcare costs.

Our technologies were featured during the National Summer Teacher Institute held on August 10-14, 2014 in Santa Clara, CA. The Institute was sponsored by the US Patent and Trademark Office. The Institute was attended by about 40 high school science teachers from about 20 states. The impact of our technologies is potentially far reaching as these teachers would be developing academic curricula about technology innovation which would then educate thousands of young people who will be our next-generation scientists and innovators.

Our technology on anti-counterfeiting devices is continually featured in the Science of Innovation educational program by the National Science Foundation and the US Patent Office through the NBC Learn as a national resource to encourage and recruit K-12 students to the science fields. The video is entitled "Science of Innovation: Anti-Counterfeiting Devices" and can be viewed at [www.nbclearn.com/innovation/cuecard/62970](http://www.nbclearn.com/innovation/cuecard/62970). This material will impact thousands of K-12 students and teachers not only in the US but also around the world. My TEDMED talk continues to gain audiences from many sectors. The TED talk is featured in the following website: <http://www.youtube.com/watch?v=QGauio0Eev0>

#### **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
402	Engineering Systems and Equipment
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**

<b>Year</b>	<b>Actual</b>
2014	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**

During wheat milling, bran is separated from the endosperm, although a clean separation is not possible and there is always some starch adherent to the bran. Understanding the physicochemical properties of bran starch and its relationship with bran tissue is required to maximize bran utilization. In this study, bran starch had a higher percent of small starch granules, a higher amylose content, higher crystallinity, broader gelatinization temperature range, higher enthalpy of gelatinization, lower retrogradation rate, and lower pasting peak and setback viscosities than those of the counterpart endosperm starch. A-type X-ray diffraction patterns were

found for both bran starch and endosperm starch. Bran starch content was found to be negatively correlated with percent large bran particles (greater than 2 mm). The neutral saccharide profile of the wheat bran was dominated by arabinose, xylose, and glucose, whereas mannose and galactose were present in small amounts. Environment (i.e., crop year) affected the contents of arabinose and xylose in the bran of the studied varieties. Bran thickness was found to be positively correlated with bran starch content. Bound ferulic acid (BFA) and BFA to xylose ratio showed positive correlations with percent large bran particles and negative correlations with bran starch content. SEM images revealed that the outer layers of wheat bran were deformed after milling and the aleurone layer was no longer visible. Milled bran tissue was about twice as thick as intact outer layers of the wheat kernel. Observed relationships between bran characteristics and bran starch content explained why there was a correlation between percent large bran particles and bran starch quantity.

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**

<b>KA Code</b>	<b>Knowledge Area</b>
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
2014	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

To expand the use of ClO<sub>2</sub> as a sanitizing agent for fresh produce, a thorough analysis of the by-products that result upon the interaction between gaseous ClO<sub>2</sub> and the organic matter as well as its implications in human health are needed. ClO<sub>2</sub> primary by-products include chlorite, chlorate, chloride. The current methodologies for assessing the byproducts were not accurate or precise, with the new methodology it is possible to accurately track the interaction of ClO<sub>2</sub> gas with the fresh produce. The new system allow us to identify what is the more effective treatment for specific fresh produce. For example is the specific treatment for a specific fresh produce high concentration short time (treatment applied during the packaging process) or it is low concentration long exposure time (sustain release treatment and applied within the package system). In order to model and evaluate the packaging design and assess the distribution of the gas in the package it is critical to identify the mass transfer profile of ClO<sub>2</sub> gas in air at different temperatures and in presence and absence of light. Most of the mass transfer data reported had been determined theoretically. Therefore our work in the mass transfer and determination of the diffusion coefficient is very important.

Our work on Tallman lettering, a technique where the dissimilar portions of look-alike, sound alike drug names is capitalized, provides objective evidence supporting the Tallman strategy as helpful in differentiating drug doppelgangers. This is significant as the Institute for Safe Medication Practices (ISMP) estimates that about 25% of medication errors result from look-alike, sound-alike drug names which are easily confused (Joint Commission and the WHO, 2007). In fact, both members of the research

community (Lambert, 1999) and official agencies (Joint Commission and the WHO, 2007) have concluded confusable drug names to be one of the most common causes of medication error, and an issue of significant global concern. This publication is currently under revision for possible inclusion in the Journal of Applied Ergonomics.

#### 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 Knowledge Outcome Measure

##### 3b. Quantitative Outcome

Year	Actual
2014	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

The lab's solid fuel research centers on developing a water resistant briquette or pellet. Hydrophobicity, energy density and grindability of the torrefied material are key properties that must meet benchmarks before adoption of this renewable option will become widespread. In addition to solid fuels, liquid fuel from biomass, using pyrolysis and electrocatalysis, is being investigated that could supply renewable feedstock to America's petroleum refineries. Electrocatalysis is used to saturate carbon-carbon and carbon-oxygen double bonds using electricity from wind and solar energy sources.

During the past year we have identified four genes from the model grass *Brachypodium distachyon* that show strong and exclusive expression in stem parenchyma cells. We have cloned the promoters from this genes and have generated binary vectors which can be used to express genes with these promoters in monocot plants. We have used these constructs to transform *Brachypodium* plants with a gene that synthesizes mixed-linkage glucan. We are currently growing these plants and will shortly begin to analyze them for the expression of the gene and for the presence of mixed-linkage glucan.

### 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
512	Quality Maintenance in Storing and Marketing Non-Food Products

### 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 2013-2014 fiscal year, ABR and MSUE was able to start 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 GREEN 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 decrease 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.

Recent **extreme weather events** also caused extensive hardship to the agriculture industry. 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.

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 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.

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**

#### **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.

### **Extension**

Example of evaluation results for home and commercial food safety include:

### **Situation & Need for Educational Programming:**

Food Safety is a global issue from farm to table. Its impact on human health is significant across the life span with emphasis on certain vulnerable populations. Food-borne illness outbreaks occur on an ongoing basis crossing all socioeconomic lines from production, consumption and preservation of foods. Overall health is impacted by the safety of the food supply and foodborne illness. According to public health and food safety experts, each year millions of illnesses in this country can be traced to food-borne bacteria. While the likelihood of serious complications is unknown, the Food and Drug Administration estimates that two to three percent of all food-borne illnesses lead to secondary long-term illnesses. For example, certain strains of E.coli can cause kidney failure in young children and infants; Salmonella can lead to reactive arthritis and serious infections; Listeria can cause meningitis and stillbirths; and Campylobacter may be the most common precipitating factor for Guillain-Barre syndrome. Food-borne illness costs the U.S. economy billions of dollars each year in lost productivity, hospitalization, long-term disability, and even death as these statistics reveal.

### **What has been done:**

MSUE implemented a food safety program that delivered classes and presentations on Good Agricultural Practices (GAP) that prepare farmers to sell their produce in retail markets and ensure the safety of their produce for sale. In these programs, participants learned about topics in produce safety, responsibility in food safety, good agricultural practices and how to implement changes in their operation that can further enhance quality and safety of their food. Presentations were available online or through designated partner locations.

### **Results:**

During 2014, Chipping potato farmers have implemented new practices on over 10,000 acres that further enhanced the safety of our food supply as a direct result of the services that MSU Extension provided.

- 442 Farmers (food producers) became more aware of food safety issues by participating in Good Agricultural Practices (GAP) audits and other food safety programs.
- At least \$40,020,000 dollars of Michigan produce was improved in safety this year as a direct result of MSUE programming and consultation on good agricultural practices.\*

\*Three chipping potato growers producing a total of between 10,000 and 13,000 acres of chipping potatoes annually. Each acre produces an average of 345 cwt/acre and average gross revenue of \$11.60/cwt

## **Key Items of Evaluation**

### **Research**

Millions of Americans with diabetes use a variety of meters to check their blood glucose levels and manage the disease. This concept is spurring Michigan State University (MSU) AgBioResearch scientist R. Mark Worden to commercialize a biosensor system that would have widespread applications in other venues, such as food processing facilities or clinical laboratories that assess high volume samples from many sources. Worden, a professor in the MSU

Department of Chemical Engineering and Materials Science (CHEMS), began working in oxidation-reduction reactions, also known as redox, in the late 1990s. These chemical reactions are important in a number of areas, including biofuel production. As the research progressed, Worden developed expertise in nanotechnology and biocatalysts, which are often used to perform chemical transformations on organic compounds.

Over the years, various stages of this project received funding from the National Science Foundation (NSF) and other organizations. In looking at various aspects of these reactions and trying to exploit their economic benefits, Worden developed a biosensor system that was recently patented by MSU.

#### **Extension**

MSUE utilizes the Institute Work Teams for planning, evaluating and reporting. The Health and Nutrition Institute Food Safety Work Team found as a result of attending the food preservation workshop:

- 816/850 (96%) will follow research based/tested recipes for home food preservation
- 826/850 (97%) will use correct processing methods to safely preserve low and high acid foods
- 821/839 (98%) will use correct processing times to safely preserve low and high acid foods

Other evaluations found:

- 1131 participants gained knowledge in preserving foods including canning methods for low and high acid foods and methods for freezing and dehydrating foods
- 342 participants implemented 2 or more actions related to a safe food environment
- 621 participants correctly answered 75% at the end of session questions on knowledge/competency tests
- 746 gained knowledge on the proper process for hand washing
- 742 participants gained knowledge on cross-contamination
- 589 participants gained knowledge on safe temperatures for cold and hot foods/cooling hot foods and storing temperatures
- 6 producers become more aware of food safety issues by participating in GAP audits and other food safety programs.