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

**Program # 11**

**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 | 10% | | 0% | |
| 402 | Engineering Systems and Equipment | 0% | | 10% | |
| 404 | Instrumentation and Control Systems | 0% | | 9% | |
| 501 | New and Improved Food Processing Technologies | 0% | | 20% | |
| 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 | 70% | | 14% | |
| 512 | Quality Maintenance in Storing and Marketing Non-Food Products | 0% | | 6% | |
| 712 | Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins | 10% | | 12% | |
| | **Total** | 100% | | 100% | |

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

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

| Year: 2012 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| Actual Paid Professional | 3.1 | 0.0 | 6.0 | 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** |
| 145178 | 0 | 634339 | 0 |
| **1862 Matching** | **1890 Matching** | **1862 Matching** | **1890 Matching** |
| 145178 | 0 | 579189 | 0 |
| **1862 All Other** | **1890 All Other** | **1862 All Other** | **1890 All Other** |
| 0 | 0 | 2578940 | 0 |

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

### 1. Brief description of the Activity

Research to: Connect Michigan industries with the 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 new biiobased economic sector; identify and isolate beneficial plant compounds that can be used to make new functional foods; develoop the processes and technologies to manufacture functional foods; pursue new artisan distilling process technology for raw material pretreatment, fermentation, distillation and aging; develop innovative processing that adds value to fresh or processed meat products; identify breeding and genetic improvements related to food quality, nutrition and processing; develop packaging systems to enhance food quality and shelf life; develop new biosensors and DNAchips that can rapidly and accurately detect a braod spectrum of harmful organisms in food and water, such as E. coli, Salmonella, Listeria, Campylobacter and Girardia; and train Native American adults on energy crops and renwable resources.

### 2. Brief description of the target audience

Agriculture and natural resources industry representatives, crop and animal producers, biotechnology company representatives, state agency representatives, private citizens, small and medium-sized entrepreneurs and Native American growers.

### 3. How was eXtension used?

eXtension was one of the major components in 2012 for multi-state and integrated activities. Members and contributors consisted of both AgBioResearch and Extension staff (119 people contributed in 2012). The public website had 68,139 site visits (a 28% increase) and 151,906 pageviews (a 15% increase) in 2012. The Ask an Expert component had 2,072 questions answered for Michigan residents with 252 questions answered by other state experts and Michigan answering 261 questions from other states.

Ask an Expert statistics were analyzed for our program areas and found for Food and Non-Food Quality, Nurtition, Engineering and Processing there were 5 staff paid by formula funds (1 fte). An examples is:

Question: what baseline tests do oil/gas well drilling companys have to test for in the groundwater before and after drilling.

Answer: The baseline water quality would be from the nearest water well. If there is not a nearby water well and a water well is required for fracking water, a water well is drilled on site. This is what

occurred when Encana drilled the Pioneer well in Missaukee County. The water well is drilled before the oil and gas well, so a test of the water prior to any drilling of the oil and gas well can document baseline water quality. I have seen oil and gas companies agree to the water testing in the lease. If it is not in the lease then you will need to discuss your concerns with them about monitoring water quality. They should not object to this. Tell them you want the water tested before, during and after drilling and fracking. It is recommended that a qualified, independent company conduct the water test so there is no question later about what materials and methods were used to collect the water sample.

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

**1. Standard output measures**

| 2012 | Direct Contacts Adults | Indirect Contacts Adults | Direct Contacts Youth | Indirect Contacts Youth |
|---|---|---|---|---|
| **Actual** | 1191 | 3200 | 0 | 0 |

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

**Patent Applications Submitted**

Year: 2012

Actual: 14

**Patents listed**

MICL02007 - Development of Nanostructured Biosensors for Rapid Detection of Disease-Causing Agents in Food and Water - 61/646,426, 5/14/2012; 61/528,892, 8/30/2011; 61,557,644, 11/9/2011; 13/477,199, 5/22/2012; 13/184,998, 7/18/2011; 13/477,205, 5/22/2012. MICL0211 -Characterizing Packaging Systems through Assessment of Mass Transfer and Degradability of Biopolymers - 61/509,034, 7/18/2011. MICL02185 - Nanostructured Interfaces for Biocalaysis - 61/558,091, 11/10/2011; 61/530,708, 9/2/2011; 61/531,304, 9/6/2011. MICL02189 - Bioderived Fuels and Chemicals - 61/568,726, 12/9/2011; 13/183,114, 7/14/2011; 13/145,731, 7/21/2011. MICL02217 - Evaluation, Development and Implementation of Sustainable Packaging Systems - 61/509,034, 7/18/2011.

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

**Number of Peer Reviewed Publications**

| 2012 | Extension | Research | Total |
|---|---|---|---|
| **Actual** | 0 | 25 | 25 |

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

**Output Target**

**<u>Output #1</u>**

**Output Measure**

- Number of research projects focusing on food quality, nutrition, engineering and processing.

| Year | Actual |
|---|---|
| 2012 | 22 |

**Output #2**

**Output Measure**

- Number of participants trained in bioenergy and bioproducts.

| Year | Actual |
|---|---|
| 2012 | 591 |

**Output #3**

**Output Measure**

- Number of participants trained on food safety within the community food systems.

| Year | Actual |
|---|---|
| 2012 | 600 |

## V(G). State Defined Outcomes

## V. State Defined Outcomes Table of Content

| O. No. | OUTCOME NAME |
|---|---|
| 1 | Number of research programs to connect Michigan industries with research, education and entrepreneurial activity needed in the basic sciences, engineering, plant science and agriculture to provide the state with a foundation for vigorous development of a strong biobased economic sector. |
| 2 | Number of research projects to develop the processes and technologies to manufacture functional foods. |
| 3 | 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. |
| 4 | Number of research programs to identify breeding and genetic improvement related to food quality, nutrition and processing. |
| 5 | Number of research programs to develop packaging systems to enhance food quality and shelf life. |

## Outcome #1

### 1. Outcome Measures

Number of research programs to connect Michigan industries with research, education and entrepreneurial activity needed in the basic sciences, engineering, 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 Extension
- 1862 Research

### 3a. Outcome Type:

Change in Knowledge Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2012 | 2 |

### 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**
Research to explore the development of the next generation of alternative fuels has resulted in the creation of a reactor system design, called Bioreactor for Incompatible Gases, which received a provisional patent from MSU Technologies. The novel reactor uses a fermentation process driven by microbes - whose food is hydrogen gas, oxygen gas and carbon dioxide gas - to create isobutanol. Isobutanol has a high energy content ? about 85 percent that of gasoline. One of the big advantages of isobutanol is that it is a direct substitute for gasoline. Ethanol, another alternative fuel, can only be added to gasoline in low concentrations. That?s one of the reasons for the emerging interest in isobutanol as an alternative fuel. The reactor system is being scaled up and tested by Michigan Biotechnology Institute.

**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 |

**Outcome #2**

**1. Outcome Measures**

Number of research projects to develop the 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 |
|---|---|
| 2012 | 7 |

**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**
Research focused on improving the safety of commercially produced food products has found that x-ray technology is effective in killing bacterial pathogens, such as E. coli and Salmonella, on baby spinach and lettuces without causing undesirable changes in product quality. Rayfresh Foods, Inc., in Ann Arbor, Mich., used MSU?s findings to build the first commercial-sized x-ray machine for food irradiation.

Research to investigate E. coli contamination on commercial-sized food processing lines has resulted in improved conveyer belt materials and designs for optimal cleaning and sanitizing.

**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 #3**

**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 |
|---|---|
| 2012 | 3 |

**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, traciig 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**
Research on the development of biosensors to detect target pathogens for public protection has resulted in the recent development of nanoparticle-based biosensors for the detection of pathogens such as E.coli and Salmonella enteritidis. Scientist Vangie Alocilja and her team have developed and applied for patents on more than 20 biosensors, including mechanisms to detect E. coli, Salmonella, Mycobacterium tuberculosis and Bacillus anthracis - the bacterium that causes anthrax - as well as sensors that can detect various viruses, including the influenza virus.

**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 #4**

**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 |
|---|---|
| 2012 | 8 |

**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**
Preliminary research conducted on the application of deoxynivalenol (DON) and its effects on serotonin levels showed that obese mice fed low levels of DON lose weight and body fat. Initially, the mice refuse all food, but their bodies adapt and they eat about 10 percent less than they had been and maintain that lower intake level and weight loss. As Americans continue to struggle with obesity, the market for safe, effective weight loss products continues to balloon with waistlines.

Research to improve poultry carcass chilling and enhance muscle protein functionality showed that the crust-freezing method (rapidly freezing the outer layer of a product to seal in moisture) improved air-chilling efficacy and meat tenderness when breast muscle was simultaneously stretched during chilling. In related research, hot-boned turkey breasts after crust-freezing were minced at sub-zero temperature for an extended time. The combination of crust freezing and cold-mincing technique significantly improved protein-gelation and meat turnover time.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 501 | New and Improved Food Processing Technologies |
| 502 | New and Improved Food Products |

**Outcome #5**

**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 |
|---|---|
| 2012 | 2 |

### 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**
Research exploring new approaches for decontaminating fresh and fresh-cut produce using chlorine dioxide found that the greatest effect on the reduction of Salmonella populations on tomatoes was found when tomatoes were chlorinate washed, followed by chlorine dioxide gas and refrigeration.

Research exploring new approaches for decontaminating fresh and fresh-cut produce using chlorine dioxide found that the greatest effect on the reduction of Salmonella populations on tomatoes was found when tomatoes were chlorinate washed, followed by chlorine dioxide gas and refrigeration.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 402 | Engineering Systems and Equipment |
| 503 | Quality Maintenance in Storing and Marketing 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

### Brief Explanation

The ongoing economic challenges being faced by Michigan -- including the recent federal funding sequestration process -- 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.Although overall research FTEs only decreased by one -- from 65 FTEs to 64 FTEs this past year, we are down from 77.1 FTEs just two years ago. Attrition and faculty departures also continue to have an impact on program outcomes.

The extreme weather conditions during last year's growing season also delayed or greatly diminished some of the research projects being conducted at our various research centers both on- and off-campus, particularly related to plant research around food and biofuel crops.

We also opted in this year's annual reporting to revert back to our original 6 planned program areas for ease of reporting and better integration of research and Extension efforts. This has, once again, resulted in some instances in skewed results for some planned programs and outcome measures.This should be rectified after this year's reporting cycle.

## 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 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.

That said, the most notable qualitative impacts realized in this program were:

- X-ray technology has been found to be effective in killing bacterial pathogens, such as E. coli and Salmonella, on baby spinach and lettuces without causing undesirable changes in product quality. Rayfresh Foods, Inc., in Ann Arbor, Mich., used MSU's findings to build the first commercial-sized x-ray machine for food irradiation.
- A decade of research and evaluation on the development of biosensors to detect target pathogens for public protection has resulted in the recent development of nanoparticle-based biosensors for the detection of pathogens such as E.coli and Salmonella enteritidis. To date, MSU AgBioResearch scientist Vangie Alocilja and her team have developed and applied for patents on more than 20 biosensors, including mechanisms to detect E. coli, Salmonella, Mycobacterium tuberculosis and Bacillus anthracis - the bacterium that causes anthrax - as well as sensors that can detect various viruses, including the influenza virus.
- An evaluation of the potential benefits of deoxynivalenol (DON) used as a potential weight loss product showed that obese mice fed low levels of DON lose weight and body fat. Initially, the mice refuse all food, but their bodies adapt and they eat about 10 percent less than they had been and maintain that lower intake level and weight loss.
- Advances made in evaluating sustainable packaging options have resulted in a new biobased blend of packaging made of thermoplastic cassava starch (TPCS) and polylactic acid (PLA) that solves many of the limitations of PLA or TPCS alone, such as fragility and hydrophilicity. The production of TPCS/PLA blends enables the use of cassava starch and creates a new platform for the production of functional membranes and establishes a unique market for farmers around the world while creating a new biobased blend with enhanced mechanical and barrier properties for short-term packaging applications.

Examples Of MSUE Evaluation Results Not Previously Reported For This Area:

**Cottage Food Safety**

**Issue (who cares and why)**

The Michigan Cottage Food Law enabling the product of certain foods in a home kitchen for direct sales is still new. Members of the MSU Extension and Product Center Counselors collaborated with an MSUE educator to provide food safety, cottage food, and business development content in a single session that could be easily presented around the state.

**What has been done**

Educators revised materials developed in 2011 designed to be presented in three seperate sesions into a single of the Food Safety Team to conduct four Cottage Food: How to Start a Successful Business sessions Michigan. Additional educators utilized the curriculum and pilot on-line registration system all over Michigan. During February and March, four programs were given in Berrien, Branch, Hillsdale, and Lenawee Counties involving 88 participants.

**Results/Impact**

Based on 74 evaluations surveys returned, 15 new cottage food businesses were established. On average, 93% of the participants reported understanding what is necessary

to run a successful food business, and 78% felt that the sessions met or more than met their needs in starting a cottage food business.

**Key Items of Evaluation**

Key research results are:

- X-ray technology has been found to be effective in killing bacterial pathogens, such as E. coli and Salmonella, on baby spinach and lettuces without causing undesirable changes in product quality. Rayfresh Foods, Inc., in Ann Arbor, Mich., used MSU's findings to build the first commercial-sized x-ray machine for food irradiation.
- The recent development of nanoparticle-based biosensors for the detection of pathogens such as E.coli and Salmonella enteritidis to help protect public health. MSU AgBioResearch scientists Vangie Alocilja and her team have developed and applied for patents on more than 20 biosensors, including mechanisms to detect E. coli, Salmonella, Mycobacterium tuberculosis and Bacillus anthracis - the bacterium that causes anthrax - as well as sensors that can detect various viruses, including the influenza virus.
- Advances in sustainable packaging have resulted in a new biobased blend of packaging made of thermoplastic cassava starch (TPCS) and polylactic acid (PLA) that solves many of the limitations of PLA or TPCS alone, such as fragility and hydrophilicity. The production of TPCS/PLA blends enables the use of cassava starch and creates a new platform for the production of functional membranes and establishes a unique market for farmers around the world while creating a new biobased blend with enhanced mechanical and barrier properties for short-term packaging applications.
- The application of deoxynivalenol (DON) and its effects on serotonin levels showed (in preliminary results) that obese mice fed low levels of DON lose weight and body fat. Initially, the mice refuse all food, but their bodies adapt and they eat about 10 percent less than they had been and maintain that lower intake level and weight loss. As Americans continue to struggle with obesity, the market for safe, effective weight loss continues to balloon with waistlines.

Results from MSUE Institute Workteams relevant to this area:

Agriculture and Agribusiness Institute-Bioenergy

- 192 tons of carbon sequestered by bioenergy crops
- 205 new acres of no-till or perennial crop production
- 40% - Amount of fossil energy displaced by bioenergy, % of fossil energy

Health and Nutrition Institute-Food Safety

- 671 producers become more knowledgeable about food safety issues by participating in GAP audits and other food safety programs

Greening Michigan Institute-Food Safety

- 119 participants increased understanding of food insecurity issues
- 162 food council members gained knowledge needed to effectively serve.
- 130 decision makers gained knowledge of the roles food councils can play in their community