

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	5%		17%	
202	Plant Genetic Resources	6%		9%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	7%		10%	
204	Plant Product Quality and Utility (Preharvest)	5%		5%	
205	Plant Management Systems	28%		16%	
206	Basic Plant Biology	3%		10%	
211	Insects, Mites, and Other Arthropods Affecting Plants	3%		8%	
212	Pathogens and Nematodes Affecting Plants	15%		11%	
215	Biological Control of Pests Affecting Plants	3%		5%	
216	Integrated Pest Management Systems	20%		9%	
806	Youth Development	5%		0%	
	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
Plan	16.3	0.0	16.0	0.0
Actual Paid Professional	30.1	0.0	19.0	0.0
Actual Volunteer	10.0	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
1464770	0	2114464	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
1464770	0	1930629	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	8596468	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 activities 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?

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 Plant Sciences there were 13 staff paid by formula funds (5 fte). A few examples were:

Question: Hello, We have beautiful old Arborvitae trees that range from heights of 10 - 20 feet. We have placed our soaker hoses in a straight line near the outer edges of the trees. Should we have more soaker hoses placed near these trees? Should they be placed with two hoses going straight on each side of the tree? Should they weave around the trees or have a circle or two around each tree? Regarding watering, should this be done only once per week if we've had a good rain or should they be watered more? Our beds sit above our lawn. How long should we keep the hose on? Thank You, Mary

Answer: When it comes to watering, there are no hard and fast answers. It depends on what type of soil you have, how hot it is and how much rain you are getting. It depends on how the trees look. The trees need to have water that goes all the way around each tree and you won't know unless your stick fingers in the soil and check. The moisture needs to be in the soil at least 12 inches deep. You are going to determine if the trees have enough water if it is not raining. You want damp, not wet or soggy soil. You want to see one inch of water a week in the rain gauge and then you don't have to water until the soil is dry in the top three inches or so. Trees should be mulched with 3 inches of woodchips. Keep the trunks dry and clean to the ground. But evergreens can have damage and not show it for as much as six months so that's why it is critical to keep up on moisture. If the tree is turning brown, the damage is done.

Question: what variety of blueberry is best to plant in houghton and do you need more than one variety for pollination?

Answer: I am not sure where you will buy them but here are the varieties we recommend in northern Michigan. Highbush Blueray, Bluetta and Patriot, and half-high Northblue and Chippewa. You do not need another variety to pollinate, but if you have more than one variety you will get more fruit and it will be larger.

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	4785	14355	5903	11806

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

Patent Applications Submitted

Year: 2012
 Actual: 28

Patents listed

MICL02179 - A Proteomics Study of Self-Incompatibility in Sweet Cherry - PCT/US2011/045044, 7/22/2011; 2011280960, 7/22/2011; 11746700.1, 7/22/2011; 61/576,515, 12/16/2011; PCT/US2011/044981, 7/22/2011; 201181001, 7/22/2011; 1174699.5, 7/22/2011. MICL01533 - Genetic Engineering of Oilseed Crops - 13/519,660, 6/28/2012. MICL01654 - Genetic Improvement of Bean - PCT/US2011/047050, 8/09/2011. MICL01810 - Genetic Improvement of Strawberries and Blueberries - 2011/3174, 12/27/2011; BLU030, 12/12/2011. MICL01814 - Applied Behavioral Ecology of Insects - PCT/US2011/043038, 7/6/2011; 31-2013, 7/6/2011. MICL01832 -Management of Turfgrass Diseases - 13/472,213, 5/15/2012. MICL01940 - Regulation of Metabolism in Developing Seeds of Arabidopsis - 13/350,287, 1/13/2012; PCT/US2011/054881, 10/5/2011. MICL01986 - Tree Fruit IPM - 13/526,214, 6/18/2012. MICL02133 - Molecular-Genetic Analysis of Disease Resistance Signaling - 61/608,747, 3/9/2012. MICL02141 - Molecular Insights into Geobacter Films - 61/558,091, 11/10/2011; 61,530,708, 9/2/2011; 13/221,495, 8/30/2011; 13/221,459, 8/30/2011. MICL02166 - Chemical Catalysis and Processing for Advanced Biofuels and Biochemicals - 61/607,057, 3/6/2012; 61/568,726, 12/9/2011; 13/183,114, 7/14/2011. MICL02172 - Genetic and Genomic Approaches for Studying Fruit Ripening in Solanaceae - 61/505,004, 7/6/2011; PCT/US2011/052607, 9/21/2011.

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2012	Extension	Research	Total
Actual	1	82	83

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of research projects on plant sciences.

Year: 2012
 Actual: 78

Output #2

Output Measure

- Number of adult participants trained in plant management systems.

Year	Actual
2012	3630

Output #3

Output Measure

- Number of youth participants trained in plant management systems.

Year	Actual
2012	5903

Output #4

Output Measure

- Number of adult participants trained in pathogens and nematodes affecting plants.

Year	Actual
2012	403

Output #5

Output Measure

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

Year	Actual
2012	752

V(G). State Defined Outcomes**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Number of youth participants with increased knowledge of plant management systems.
2	Number of adult participants with increased knowledge of pathogens and nematodes affecting plants.
3	Number of adult participants with increased knowledge of integrated pest management (IPM).
4	Number of research programs to develop insect and disease control and/or cultural and management strategies for organic crops.
5	Number of research programs to develop biological controls for pest insects and diseases to minimize any effects on the environment.
6	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.
7	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.
8	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.
9	Number of research programs to develop improved varieties of economically important crops for Michigan and the region.
10	Number of adult participants with increased knowledge of plant management systems.
11	Number of research programs to develop weed control methodologies, protocols and practices.
12	Number of research programs to develop controls for pathogens and nematodes affecting plants.
13	Number of research programs to develop production protocols and environmental and cultural strategies for the floriculture/nursery industry.
14	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 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
2012	5018

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Residents of areas in all 83 Michigan counties, both urban and rural, have limited access to full service grocery stores and healthy food. Racial and ethnic minorities are particularly vulnerable to diet-related disease, and low income minority communities have been excluded from meaningful entrepreneurial and job opportunities in the food system. Youth obesity is increasing, and the life expectancy of the next generation is predicted to drop rather than rise. Every day people go hungry, and numbers of people without enough to eat have increased with Michigan's economic downturn. Source: Michigan Good Food Charter 2010. The Healthy Food Financing Initiative (HFFI) Working Group considers a food desert as a low-income census tract where a substantial number or share of residents has low access to a supermarket or large grocery store. Furthermore, to qualify as a food desert tract, at least 33 percent of the tract's population or a minimum of 500 people in the tract must have low access to a supermarket or large grocery store. (USDA Economic Research Service Food Desert Locator Map definition of a "food desert" <http://www.ers.usda.gov/data-products/food-desert-locator/documentation.aspx>).

What has been done

Plant science and gardening programs were offered to over 1,000 youth across Wayne county including at Bulman Elementary School in Redford, 4-H Community Center in Detroit, A.L. Holmes Public School in Detroit, and in several Downriver communities. These programs are designed to encourage fitness, healthy eating habits and can serve as community service projects.

Results

Of the 400 participants who were invited to share their school progress records to see if learning life skills in gardening could transfer to skills in completing tasks like homework assignments and testing skills, about 74% presented documented improved grades at the end of the school year and 70% reported improved test scores in reading and comprehension.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
806	Youth Development

Outcome #2

1. Outcome Measures

Number of adult participants with increased knowledge of pathogens and nematodes affecting plants.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	367

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Unseasonable warm weather in late winter caused fruit trees in northwest Michigan to break dormancy and subsequently exposed to crop to a number of damaging frosts and freezes that devastated the 2012 tree fruit crop.

What has been done

One example is a set of twenty-two, on-farm integrated pest management sessions held in northwest Michigan during the spring of 2012 and focused on helping growers cope with crop losses.

Results

A total of 403 participants were recorded over the 8 week period (some were repeat participants as information changes each week). Season long attendance (including repeat attendees) totaled 54 in Antrim County, 57 in Benzie County, 214 in Leelanau County, and 78 in Grand Traverse County.

Participants were surveyed to determine the adoption of new practices or use of technologies based on the information presented at sessions or developed by Specialists on campus. Forty-three participants responded to the survey and represented 1,286 acres of apple and 5,355 acres of cherry production. Respondents reported land holdings in Grand Traverse (9), Leelanau (20),

Benzie (9), Manistee (3) and Antrim (4) counties. Forty-two respondents identified themselves as growers; one indicated that he was retired.

Ninety percent of respondents (representing 6,446 acres of tree fruit production and 37 farms) reported using scouting to detect pests and time treatments based on MSU recommendations. Seventy-eight percent of respondents (representing 6,143 acres of tree fruit production and 32 farms) use Enviroweather pest or disease modeling to accurately time treatment applications with 28% referring to the site daily, 47% weekly, and 25% intermittently. Twenty-nine percent of respondents with apples reported using reduced risk pesticides and 53% were able to delay pesticides based on early MSU recommendations, allowing for application saving. 68% of respondents with cherry (representing 3,336 acres of cherry land) reported utilizing a non-bearing chlorothalonil program to save on fungicide costs.

The Special Local Need (SLN) label for Bravo Weather Stik for use after schuckplit (secured by the MSU Tree Fruit Pathology Lab and Trevor Nichols Research and Extension Center in collaboration with the Michigan Cherry Committee) was utilized on the equivalent of 694 acres of tart cherry in northwest Michigan. The SLN label reduced growers' fungicide costs and delayed decision-making to allow growers to more accurately assess the crop size before moving to a non-bearing program in unharvestable blocks.

Based on MSU recommendations northwest Michigan growers will reduce their use of fertilizers by a total of 108,350 lbs and pesticide use by 13,350 lbs during 2012.

Based on reductions or modifications in pesticide and fertilizer applications, and a reduction in mowing based on MSU recommendations the total input saving reported totaled \$502,976.73 for northwest Michigan growers who responded to the survey.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
212	Pathogens and Nematodes Affecting Plants

Outcome #3

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
2012	698

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The Michigan agribusiness professionals are in need of 2013 MSU seed, weed, fertilizer and pesticide recommendations for year-end bulk pesticide and fertilizer purchasing and sales decisions. They also need this information for tax purposes.

With rising production costs, it is important that farmers and agribusiness professionals consider all production and risk management options and remain up to date on the latest MSU recommendations. With favorable grain prices, the industry is expanding and farmers are making new investments on land, equipment and new technology.

Another concern for the industry is the potential new threats, such as weeds and insects.

What has been done

One example, MSUE conducted an annual crop and pest Management update for Michigan agribusiness. It was held at the MSU Pavilion at the end of December. It was offered to agribusiness professionals, mostly pesticide sales and services, commercial seed companies, crop consultants, and retail sales. Participants needing pesticide recertification credits before the end of the year to earn MAEAP, CCA and MDA credits.

Results

Three hundred and twenty participants from 44 counties attended the 2012 Integrated Crop and Pest Management Update on December 14.

Eighty percent of participants indicated that their 2013 production practices would change as a result of educational information received at this event.

This change in production practices will impact 115,412 acres in 2013. The net economic gain in terms of increased revenue or added savings that would potentially result from changing to new practices would be \$1,477,273.

Attendees who attended the previous year were asked about the impact of that event.

They indicated that the 2012 recommendations were implemented on 105,750 acres of cropland that resulted in a financial gain of \$1,004,625.

4. Associated Knowledge Areas

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

Outcome #4

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
2012	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

Research using repetitive cultivation (vs. a herbicide strip) for managing weeds in conventional orchards has shown that, by treating weeds like a cover crop, nitrogen becomes more available to the trees than when using a herbicide strip. The weeds serve as a catch for carbon and other nutrients instead of having a dead zone created by herbicides. This finding has application for both conventional and organic orchard floor management.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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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 #5

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
2012	8

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; and to develop biological and cultural tactics based on vegetation management.

Results

Research on pest management in Michigan fruit crops resulted in the validation of two degree day models for key moth pests, one in blueberry and the other in grape. The models are being widely

used for timing, monitoring and control activities. In 2012, these models performed well in combination with reduced-risk IGR or diamide insecticides. Delivery of the models through the MSU enviroweather website and through training of Extension educators and growers has supported this.

Further research on the effect of verroa mites on honey bees foraging and survival found that bees with mixed infections foraged earlier than either control bees or those with pure infections and that bees with mixed infections had lower survival than bees in other treatment categories. These data indicate that the effects of nosema infection may be dependent on co-infection and other factors. These findings will help in the development of a novel method for verroa mite control.

Investigations of asparagus miner management in asparagus included the development of a degree-day model, baits to trap and manage adult miner populations and an insecticide trial to determine the efficacy of different compounds against larvae. Through this combination, a 50 percent reduction in asparagus miner infested stems was achieved.

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 #6

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
2012	6

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

Research results in the 2012 bean breeding program included a yield of 40 cwt/acres of cranberry beans and many lines with resistance to common bacterial blight in kidney bean and cranberry bean trials. Rust is becoming an increasing threat to navy, black and small red bean producers in Michigan. Scientists have identified resistance to the emerging race in 22:2 in new navy, black and small red bean lines.

Work on the volatiles released from filamentous fungi, such as *Aspergillus*, which grows on stored grain has been published and may be helpful in the development of detection technologies.

Research on potato common scab has resulted in the discovery of a group of innovative biological agents for disease control. One of the bacterial strains shows strong antimicrobial activity against several important soil-borne pathogens, such as *Streptomyces scabies*. Ninety percent of the time, the research team's isolate was stronger in disease control than the commercial one. Further, it not only suppressed the disease but also promoted plant growth.

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 #7

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
2012	22

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

In research to develop improved potato varieties under MSU's SolCAP project, exotic germplasm has been identified that will enhance varietal breeding efforts; a new set of genetic markers (8,300) called SNPs, has been developed; and genetic engineering allowing scientists to introduce new genes to improve varieties and advance germplasm for traits such as insect resistance, late blight and PVY resistance, lower reducing sugar, and nitrogen use efficiency.

Two new blueberry varieties ? Calypso and Osorno -- were released to help extend Michigan's blueberry season and enhance blueberry quality. Calypso ripens in mid-season and its overall fruit quality is far superior to current cultivars. Osorno is also a mid-season variety that has larger fruit and a better overall quality than earlier varieties, such as Aurora, Draper and Liberty.

Two new aphid-resistant soybean germplasms were released to the soybean industry in 2012. In addition, two food-grade soybean varieties were released, and one was licensed to a seed company.

Providing data and research tools to plant breeders and biologists that enable genomic-based plant breeding will be essential to improved agriculture in the 21st century. Using rice as the

foundation species, scientists have provided annotation for Poaceae species to permit cross-species analysis 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.

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 #8

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
2012	5

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

Research has recently shown that circadian rhythms prompt a plant's ability to defend against cold weather. This information will allow scientists to design improved crops for food and for the development of plants for the sustainable production of bioenergy.

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

Outcome #9

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
2012	17

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

Field studies testing the impact of alternative cultural practices on asparagus performance in a replant situation and examining the potential to integrate brassica cover crops into asparagus crops showed limited yield benefits with soil amendments, especially in fields that were fumigated prior to asparagus planting. However, sowing brassica cover crops in the second half of August into asparagus fields showed great potential for improving yield. The use of transplants as a substitute for one-year-old crowns showed the greatest benefit to asparagus yield.

Research to understand how plants receive and respond to stress has found compelling evidence that PM-CW adhesion is required for the activation of defense signaling in plants following infection by phytopathogenic bacteria and that the plant hormone abscisic acid (ABA) plays a role in mediating the drought response phenotype in *andr-1* mutant plants, which are highly susceptible to ABA-dependent drought stress.

An MSU scientist has identified a chromosome region in cherry that contains a gene(s) that controls cherry leaf spot (CLS) resistance, especially for tart cherries. This discovery will allow for the breeding of this resistance into commercial tart cherry cultivars. Further. The resistance is such that no sprays for CLS would be required as the leaves on the resistance selections do not yellow and do not fall off.

Research focused on developing reactions pathways for fuels and chemicals over the past year have identified biofuel compositions that reduce both particulate (soot) and nitrogen oxide (NOx) emissions from diesel engines. This is unusual, as NOx and soot emissions are usually a tradeoff, lowering one at the expense of the other. In addition, researchers have identified a universal chemical reaction rate constant for esterification reactions. This is an important generalization for what has been, until now a type of reaction that requires careful study.

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 #10

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
2012	5193

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

One example in this area, is the ability to select the right variety of sugarbeets for the right field that is imperative for success for the farmers. Different diseases and pest issues are different in every field. By selecting the right variety-yields and profit can be increased significantly.

What has been done

MSUE educators conducted a series of 5 Sugarbeet Variety selection meetings in 2012.

Results

Based on growers that attended these meetings they indicated by attending the meetings yields increased by 3 tons per acre and quality improved by 1/2%. When asked what they thought the projected impact per acre would be on average, they reported \$178 dollars per acre. These growers represented 33,453 acres that would be about 5.9 Million dollars increase in revenue. In conjunction with that 99% of the growers indicated that they are better able to select the right variety after attending this seminar.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems

Outcome #11

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
2012	5

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

Pre-emergence herbicides were applied in Nov. 2011 and April 2012 to 6-year-old dwarf apple trees. Glyphosate at 1.35 pounds per acre was added to all treatments to kill emerged weeds. No injury to apple trees was apparent from any treatment. Fall applied flumioxazin at .383 pounds per acre suppressed most weeds into July.

Manganese (Mn) containing water conditioners have been developed and marketed to help growers alleviate Mn deficiency symptoms in glyphosate-resistant soybean and to meet the water conditioning requirement for glyphosate without sacrificing weed control.

4. Associated Knowledge Areas

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

Outcome #12

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
2012	5

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

Research investigating how to best manage nematodes as part of a soil ecosystem demonstrated that microbial and organismal community structures vary by soil group, landscape and region, suggesting that one-size-fits-all approaches to managing soil-driven problems need to be reconsidered.

During the past year, more than 820 alerts related to IPM and ICM management and measurement systems, especially related to invasive species, were sent out via email, websites, commodity meeting oral reports, TV and radio interviews, etc., to cherry, apple, peach and some row crop growers in the upper Midwest to help them develop effective and adaptive IPM programs.

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 #13

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
2012	6

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

Research to develop more efficient greenhouse lighting strategies and technologies demonstrated that, with petunias, limited LD lighting to periods of photoperiod sensitivity can promote flowering while potentially reducing lighting costs and undesirable stem extension.

Research investigating the water and nutrient budgets for shade trees and conifers found that a soilless substrate consisting of 80 percent composted pine bark and 20 percent peat moss optimized water and nutrient inputs for these two nursery crops.

Research findings on production efficiency for American marigolds, geranium, gerbera, osteospermum and snapdragon in glass-glazed greenhouse compartments are being used to estimate the net profit per pot and per square meter week for each species.

4. Associated Knowledge Areas

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

Outcome #14

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 Extension
- 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)

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.

Results

A micro-irrigation overhead system to apply chemicals such as pesticides, growth regulators and chemical dyes was developed. Known as the Solid set Canopy Delivery System, the infrastructure was established in four Michigan orchard plots and was operated in October 2012 for growers, Extension educators and the public to demonstrate its effectiveness.

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

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:

- Investigations of asparagus miner management resulted in the development of a degree-day model, baits to trap and manage adult miner populations and an insecticide trial to determine the efficacy of different compounds against larvae. Evaluation of trials showed that, through this combination, a 50 percent reduction in asparagus miner infested stems was achieved.
- An evaluation of consumer preferences and the provision of an extended growing season for blueberries informed the development of two new blueberry varieties in 2012 - Calypso and Osorno. Calypso ripens in mid-season and its overall fruit quality is far superior to current cultivars. Osorno is also a mid-season variety that has larger fruit and a better overall quality than earlier varieties, such as Aurora, Draper and Liberty.
- Following substantial research and evaluation of numerous cherry rootstocks, an MSU scientist has identified a chromosome region in cherry that contains a gene(s) that controls cherry leaf spot (CLS) resistance, especially for tart cherries. This discovery will allow for the breeding of this resistance into commercial tart cherry cultivars. Further, the resistance is such that no sprays for CLS will be required as the leaves on the resistance selections do not yellow and do not fall off.

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

Master Gardener College

Summary of impact.

Issue (who cares and why)?

Michigan is the 2nd most diverse agricultural industry in the nation with a unique climate and resource base that provides for both food, feed and horticultural industries

from growing to processing. That same uniqueness also provides a tourism and manufacturing industry that must coexist with a socially aware population for environmental quality, safe and nutritious foods and economic prosperity.

Agriculture has become the fastest growing sector of the state's economy. MSU Extension needs to ensure a thriving knowledge base to be competitive in local, state, national and international markets that in turn, creates a thriving local economy for all residents.

Our resources are our greatest attribute. Air, water and soil quality must be sustained while fruit, vegetable, crop, livestock and ornamental industries remain efficient in yields, quality and input costs. Preservation, conservation and energy efficiencies must maintain social acceptability while the production and processing segments remain economically viable.

What has been done?

MSUE conducted Master Gardener College that included four, day-long educational tours that included stops to greenhouses, garden centers, and specialty nurseries and farms to address the needs described above.

Results/Impact?

Participants in the Master Gardener College program reported (119 respondents) that they would change their gardening practices that will enhance:

- 55% - **Water conservation** (reduce water usage, reduce lawn area, mow higher, mulch, use rain gage or moisture sensor before watering)
- 41% - **Water preservation** (water harvesting, rain barrels, rain gardens)
- 45% - **Proper fertilizer use** (best timing, reduced phosphorus use, slow-release sources)
- 42% - **Reduced pesticide use** (mulch leaves into turf, mulch garden to reduce weeds, select disease resistance plants)
- 58% - Proper plant selection (to reduce water use, right plant right place, to reduce pesticide and fertilizer need)
- 45% - Food gardening (growing fruits and vegetables)
- 39% - Reducing yard waste (recycling grass clippings, composting, mulching leaves into turf)

Evaluation specifically related to "Responsible Gardening to Protect the Environment" water quality session:

% of respondents who reported planned behavior changes:

- 60%- Test soil prior to fertilizing lawn/garden areas
- 53%- Address stormwater issues on my property by installing a rain garden, rain barrel, utilizing pervious pavement or pathways, etc.

- 53%- Apply no-P lawn fertilizer to my lawn, unless a soil test shows a need or I fall into one of the defined exemptions for use as specified by the MI Fertilizer Law.
- 73%- Avoid applying fertilizer on frozen or saturated soil.
- 53%- Practice proper setback distances from surface water as defined in the MI Fert. Law.
- 60%- Develop buffer strip utilizing native plants on my property adjacent to lakes, rivers or streams.
 - 73%- Look for fertilizer that contains water-soluble form of nitrogen to feed plants slowly over time instead of all at once, reducing the risk of excess fertilizers moving off site and ending up in nearby waterways.
 - 80%- Keep fertilizer and grass clippings off impervious surfaces to prevent them from washing into stormdrains and nearby waterways.
 - 67%- Maintain lawn at height of cut of at least 3 inches or taller.
 - 53%- Create a no-mow zone around surface water.
 - 53%- Address areas of lawn/garden with exposed soil by using vegetation to anchor soil in place in order to keep soil from washing off-site into nearby waterways, carrying with it unnecessary nutrients.
 - 27%- Use the Home-A-Syst to identify lawn/garden practices which may be negatively impacting my watershed.
 - 100% of respondents indicated that this session was very relevant or somewhat relevant for addressing their personal gardening needs.
 - 100% of respondents indicated the session was very relevant or somewhat relevant for addressing their volunteer outreach needs.

FRUIT CROP LOSS RESPONSE FOR 2012

Summary of impact.

Issue (who cares and why)?

The 2012 growing season started with record breaking warm temperatures in March, which forced fruit flower bud development along much earlier than normal. This was followed by a series of freeze events in April that resulted in a nearly complete crop loss in all of our tree fruit grown on the nearly 400 fruit farms in east Michigan. This was a series of events that took most of the fruit from the major fruit production areas east of the Mississippi River. This was the worst freeze event since 1945 for area growers.

What has been done?

MSUE responded by shifting the planned programming for fruit growers dramatically for the remainder of the season to help them adjust to such a significant disaster.

Results

Changes in programming included different pest management scouting and recommendations, fertility and weed management practices. I feel that I responded to this very different growing season quickly and concisely with appropriate and timely information, grower meetings, crop reports, MSUE News articles. This event also resulted in a flood of requests from elected officials, media, and agency representatives to MSUE.

Christmas Tree

Summary of impact.

Issue (who cares and why)?

Quality foliage determines the saleability of Christmas trees. Insects and diseases can cause significant damage to the foliage in any given year.

What has been done?

MSUE responded by helping growers on their management plans to control Douglas-fir Needle midge, hemlock scale, pine needle scale and pine tortoise scale. This included helping them scout their fields to determine when the insects were active, look at spray coverage and evaluate effectiveness of their spray programs.

Results

Evaluation surveys from these growers reported that because of these efforts they were able to harvest trees that would have been un-salable due to damage from these pest. They valued this at \$1,021,200 gain to their operations.

Key Items of Evaluation

Key research results for this area include:

- The development of an asparagus minor management strategy that includes a degree-day model, baits to trap and manage adult miner populations, and an insecticide trial to determine the efficacy of different compounds against larvae. Through this combination, a 50 percent reduction in asparagus miner infested stems was achieved.
- The release of two new blueberry varieties - Calypso and Osorno -- to help extend Michigan's blueberry season and enhance blueberry quality. Calypso ripens in mid-season and its overall fruit quality is far superior to current cultivars. Osorno is also a mid-season variety that has larger fruit and a better overall quality than earlier varieties, such as Aurora, Draper and Liberty.
- The identification of a chromosome region in cherry that contains a gene(s) that controls cherry leaf spot (CLS) resistance, especially for tart cherries. This discovery will allow for the breeding of this resistance into commercial tart cherry cultivars. Further, the resistance is such that no sprays for CLS will be required as the leaves on the resistance selections do not yellow and do not fall off.
- Manganese (Mn) containing water conditioners have been developed and marketed to help growers alleviate Mn deficiency symptoms in glyphosate-resistant soybean and to meet the water conditioning requirement for glyphosate without sacrificing weed control.
- The development of a micro-irrigation overhead system to apply chemicals such as pesticides, growth regulators and chemical dyes. Known as the Solid set Canopy Delivery System, the infrastructure was established in four Michigan orchard plots and was operated in October 2012 for growers, Extension educators and the public to demonstrate its effectiveness.

Results from MSUE Institute Workteams relevant to this area:

Agriculture and Agribusiness Institute

- 645 new farms adopting practices that manage risks
- 681,177 new acres adopting practices that manage risks
- 1,447 new farms adopting technology or tools to manage risks
- 62,961 new acres adopting technology or tools to manage risks
- 37 new retailers displaying information about their food supply
- 1,002 new farms adopting practices to increase yield, improve quality, or decrease inputs
- 249,823 new acres adopting practices to increase yield, improve quality, or decrease inputs
- 246 new farms adopting tools or technology to increase yield, improve quality, or decrease inputs
- inputs
 - 84,061 new acres adopting tools or technology to increase yield, improve quality, or decrease inputs
- inputs
 - 3,631,822 Dollars (\$) gained
 - 401,536,531 Dollars (\$) saved or protected
 - 1,666,138,132 Product protected (mass in pounds)
 - 4,006 Product protected (mass in acres)

Children and Youth Institute

- 23,611 youth educated on plant science
- 41,065 youth educated on environmental education/earth sciences
- 10,960 youth trained in biological sciences
- 14,225 youth trained in Ag in the Classroom