2013 Purdue University Combined Research and Extension Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

Purdue University is Indiana's land grant institution, with over 3,000 faculty and 62,000 students on five campuses. We are extremely proud of the research and teaching being done in the college and across the campus that allows us to be ranked 24th in 2013 by U.S. News & World's Report "Top 50 Public Universities" survey among public universities. The Wall Street Journal reported a survey of corporate recruiters that ranked Purdue University 4th in the nation in preparing its students for the work force which demonstrates our commitment and success in the area of STEM education. The College of Agriculture includes eleven academic departments with over 300 faculty and 300 county Extension educators. The department of Forestry and Natural Resources continues to be a leader, being ranked in the top 10 worldwide. Our Ag and Biological Engineering programs (undergrad and graduate) have been ranked number 1 in the country for several years. Purdue College of Agriculture was ranked #6 in the QS Word rankings in 2013.

In 2012, we condensed our Plan of Work to be more consistent with USDA's priorities of global food security and hunger, food safety, childhood obesity, climate change, and sustainable energy as these are Indiana's top issues as well. In addition, we have 2 separate areas, one for natural resources and the environment, and one for human, family, and community health and well-being.

The work conducted under the funding received from USDA is consistent with the Vision and Mission of the College. VISION: Purdue Agriculture will make the world better through students who are prepared to make a difference, research with purpose leading to discovery with impact and engagement that transforms lives and livelihoods. MISSION: Through leadership and innovation in learning, discover, and engagement, Purdue Agriculture strives to be at the forefront of sustainable and dynamic agricultural, food, and natural resource systems, helping make a better Indiana, nation, and world.

Global Food Security and Hunger

There are many ways a college of our size and scope approaches the issues of Food Security and Hunger. Below you'll find some unique stories that demonstrate the diversity of our work in this important area.

Research conducted in the lab of Natalia Dudareva, distinguished professor of biochemistry and horticulture, by her postdoctoral research associate, Michael Gutensohn, discovered the enzymatic process used by plants to increase flavor in tomatoes. Tomatoes available in the Northern states typically are grown in warmer climates, such as in Florida, California and Mexico, and harvested immature and still green so that they can ripen during or after shipment. Picking them before they are ripe affects their flavor, which has led to complaints from consumers--and potential reduction in consumption when flavor is not there. The research has the potential to enhance production of flavorful tomatoes and it is possible that the pathway is utilized by other crops and can be used to produce certain flavors, fragrances and pharmaceuticals.

Having more than two sets of chromosomes can increase a plant's ability to take up nutrients and survive in saline soils. Brian Dilkes, assistant professor in horticulture and landscape architecture found that polyploidy, the condition of having more than two genome copies, causes the flowering plant Arabidopsis thaliana to accumulate a greater amount of potassium in its leaves and demonstrate a higher tolerance to saline environments. Most flowering plants are diploid, having two copies of a genome. He believes that polyploidy can play a role in plant adaptation and may explain why genomes in plants evolve the way they do.

Sylvie Brouder, professor of agronomy, and five other Purdue agricultural and library science professors are leading an effort to develop new tools to store and make available to the public the abundance of research data that could help the agricultural industry and policymakers not only now but also many years in the future. They organized the Smarter Agriculture workshop in Potomac, MD, Oct. 10-11 to identify the critical issues that must be addressed to enhance the accessibility of data. With the Obama administration mandate that the direct results of federally funded scientific research be made available to the public digitally, this team is looking for ways that would promote greater and easier access to data as well as education about data literacy. This could be used to help drive innovative breakthroughs in agriculture and will create the next generation workforce who are prepared to handle and utilize data in the future.

Childhood Obesity

Impacting childhood obesity requires a full arsenal of research, education and tactical approaches. Fast food restaurants continue to be a significant source of food for families to feed kids on the run. Dr. Kevin Keener, professor of food science, has been creating new technologies that could be used by fast food and traditional restaurants that reduce the harmful effects associated with frying food that doesn't impact quality. He found that panelists' preferences in a taste test were nearly equally divided between chicken patties fried in a radiant fryer and those fried in a conventional oil immersion fryer. While panelists preferred the flavor and less oily texture of the radiant-fried patties, they preferred the crispiness and appearance of immersion-fried chicken patties. Panelists were split on their overall preference: 34 favored the radiant-fried patty, and 33 selected the immersion-fried patty. One panelist did not indicate a preference. The radiant fryer uses infrared energy to produce the appealing crispy exterior unique to fried food.

Food Safety

During the 2012 growing season, an outbreak of Salmonella was traced to cantaloupes grown on a farm in Indiana. This followed a larger outbreak of foodborne illness linked to cantaloupe in Colorado during the 2011 season. As a result of these outbreaks, Indiana cantaloupe and watermelon growers faced considerable production and marketing challenges in the 2013 season. It was generally understood that the 2013 season would be critical in re-establishing the reputation of Indiana-grown produce. Compounding these challenges was an announcement by the Food and Drug Administration (February 2013) that, as an information gathering exercise, they would be inspecting cantaloupe packinghouses on a nationwide basis during the 2013 production season. Regulatory powers granted in the Food Safety and Modernization Act of 2011 meant that FDA could engage in enforcement activity (including recall) if adverse findings were encountered. We developed a series of tools and protocols that were shown to improve cleanliness and reduce contamination issues associated with cantaloupe harvesting, storage and transportation. Our "farm" and Extension staff made themselves available to farmers to support them during FDA inspections and performed parallel environmental sampling alongside the FDA. Approximately 75% of the total cantaloupe production farms in Indiana participated in cantaloupe specific workshops. The 2013 cantaloupe and watermelon season came to a close with Purdue playing a significant role in helping to prevent another outbreak of foodborne illness.

Climate Change

Teaching the concepts of climate and climate change is challenging. To learn about climate change and its impact on crops and water usage, the students and faculty need to be able to interpret, analyze, explain and evaluate historical data and model-based data projections. A Dynamics of Climate Toolkit was developed with grants and support from the Departments of Curriculum and Instruction, Earth, Atmospheric, and Planetary Sciences, and Agronomy, Purdue University. The toolkit was designed, in part, to provide a suite of tools for teachers of all educational levels, to both understand the science of climate and climate change and the pedagogy for effectively teaching about climate and climate change. Its rich data sets and visualization activities provide a model framework for the proposed Education program that is: 1) grounded in the research on student and faculty conceptions of climate and climate

change, 2) based on instructional activities and experiences that engage participants in analyzing and interpreting climatic data sets and visualizations andthat require the application of scientific concepts, and 3) designed in accordance with the research on effective teacher professional development. Pedagogically, the toolkit promotes active learning and collaboration. The toolkit was developed and field tested by a team composed of teachers, scientists, and professional educators with expertise in pedagogy and climate science. Included in the toolkit are: PowerPoint slides, participant activities, supporting materials that visualize scientific concepts, presenter guide, and background and educational resource links that was developed and tested by a team of teachers, scientists and educators with experts in pedagogy and climate science.

Sustainable Energy

It's natural to focus attention on sustainable energy through plant development and production processes, but just as important is the work being done to reduce energy through the machines used on the farm and in other equipment--including heavy equipment. Researchers at the MaHa Fluid Power Research Center, a unit of the college's Agriculture and Biological Engineering department, have shown how to reduce fuel consumption while improving the efficiency of hydraulic steering systems in heavy construction equipment. The new approach incorporates several innovations. It eliminates valves now needed to direct the flow of hydraulic fluid in steering systems and uses advanced algorithms and models to precisely control hydraulic pumps. New designs might also incorporate textured "microstructured" surfaces inside pumps to improve performance. This new architecture lends itself to high-energy efficiency, resulting in lower fuel consumption and reduced emissions, higher machine productivity and reduced operator fatigue.

Natural Resources and the Environment

The business of raising fish, while still relatively small in Indiana, is a growing part of the state's agricultural economy. A 2013 study estimated sales from Indiana fish farms amounted to more than $15 million in 2012, an increase from $3.5 million in 2006, according to the publication Economic Importance of the Aquaculture Industry in Indiana. There are about 50 fish producers in Indiana, compared with 18 just seven years ago. Kwamena Quagrainie, aquaculture marketing specialist in the Department of Agricultural Economics, conducted the study with graduate student, Megan Broughton.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	77.5	0.0	263.1	0.0
Actual	77.7	0.0	222.3	0.0

II. Merit Review Process

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

- Internal University Panel
- External Non-University Panel
- Combined External and Internal University External Non-University Panel

2. Brief Explanation

III. Stakeholder Input

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

- Use of media to announce public meetings and listening sessions
- Targeted invitation to traditional stakeholder groups
- Targeted invitation to non-traditional stakeholder groups
- Targeted invitation to traditional stakeholder individuals
- Targeted invitation to non-traditional stakeholder individuals
- Targeted invitation to selected individuals from general public

Brief explanation.

{NO DATA ENTERED}

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

1. Method to identify individuals and groups

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

Brief explanation.

{NO DATA ENTERED}

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

1. Methods for collecting Stakeholder Input

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

Brief explanation.

{NO DATA ENTERED}

3. A statement of how the input will be considered

- To Identify Emerging Issues
- Redirect Extension Programs
- In the Action Plans
- To Set Priorities

Brief explanation.

{NO DATA ENTERED}

Brief Explanation of what you learned from your Stakeholders

We have learned that Purdue is a trusted resource for research, education and extension in the Planned Programs that we report on. Formal and informal surveys show that stakeholders agree that our research, education and extension programs are heading in a direction consistent with stakeholder needs across the diverse population of Indiana.

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
8159326	0	5764209	0

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	8420975	0	5812267	0
Actual Matching	13708243	0	26118330	0
Actual All Other	2305961	0	7596092	0
Total Actual Expended	24435179	0	39526689	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	522586	0	2246114	0

V. Planned Program Table of Content

S. No.	PROGRAM NAME
1	Global Food Security and Hunger
2	Climate Change
3	Sustainable Energy
4	Food Safety
5	Childhood Obesity
6	Human, Family, and Community, Health and Well-being
7	Natural Resources and Environment

V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Global Food Security and Hunger

☑ 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
102	Soil, Plant, Water, Nutrient Relationships	10%		10%	
201	Plant Genome, Genetics, and Genetic Mechanisms	10%		10%	
205	Plant Management Systems	20%		20%	
212	Pathogens and Nematodes Affecting Plants	10%		10%	
213	Weeds Affecting Plants	5%		5%	
301	Reproductive Performance of Animals	5%		5%	
302	Nutrient Utilization in Animals	5%		5%	
311	Animal Diseases	5%		5%	
315	Animal Welfare/Well-Being and Protection	5%		5%	
403	Waste Disposal, Recycling, and Reuse	5%		5%	
503	Quality Maintenance in Storing and Marketing Food Products	5%		5%	
601	Economics of Agricultural Production and Farm Management	10%		10%	
604	Marketing and Distribution Practices	5%		5%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	29.9	0.0	89.4	0.0
Actual Paid Professional	37.8	0.0	116.2	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**
2823195	0	3179861	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
3089543	0	10710462	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
632639	0	1681024	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

- Develop publications, workshops, consultations, seminars, certification programs, distance education modules, field days, and other opportunities.
- Conduct research
- Collaborate with other agencies
- Coordinate meetings with important stakeholders (researchers, industry, organizations, farmers, regulatory, etc.)
- Increase number of participants in life-long learning programs.
- Foster leadership and economic development and facilitate strong partnerships and participation in state, regional, national, and international agencies, organizations, and groups.
- Encourage participation in: Taskforces, Review Committees, Advisory Boards, Editorial Boards, Commodity committees/boards, Invited presentations, Honors and Awards, Common Interest Groups, Professional Societies

2. Brief description of the target audience

National and International: livestock and crop producers, livestock and crop industry (entire value chain), elected officials and decision makers, agencies, extension specialists, potential 3rd party partners (NGO's, educational institutions, etc.), consumers, industry

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	121645	1680726	25569	25712

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

Patent Applications Submitted

Year: 2013

Actual: 8

Patents listed

8,277,352 US
5286408 Japan
10-1276965 South Korea
8,474,254 US
8,453,441 US
8,454,469 US
844605/Trademark New Zealand
844605/Trademark New Zealand

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	361	362	723

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of workshops conducted

Year	Actual
2013	2392

Output #2

Output Measure

- Number of Extension products (publications, web resources, apps, etc)

Year	Actual
2013	361

Output #3

Output Measure

- Number of research publications

Year	Actual
2013	183

Output #4

Output Measure

- Number of volunteers

Year	Actual
2013	3622

Output #5

Output Measure

- Number of workshop participants

Year	Actual
2013	63806

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	An impact on livestock resulting from new knowledge related to the environment, productivity, and/or health & welfare.
2	An impact on crops resulting from new knowledge related to the environment, productivity, and/or biotic/abiotic stress.
3	An economic and/or community impact resulting from new knowledge about food production systems, marketing & retail management, logistics & systems, and/or business development.
4	An impact on hunger and/or malnutrition resulting from new knowledge about food products, food quality, and/or food quantity.
5	An impact on non-food products resulting from new knowledge related to non-food products, and/or non-food systems.
6	An impact on disaster preparation, education, and/or recovery.
7	New research studies on plant mechanisms that can impact food security

Outcome #1

1. Outcome Measures

An impact on livestock resulting from new knowledge related to the environment, productivity, and/or health & welfare.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Turkey coronavirus (TCoV) infection causes acute atrophic enteritis in turkeys, leading to decreased weight gain and uneven flock growth which has contributed to significant economic loss in the U.S. turkey industry since 1990's. There are no effective vaccines or treatment to prevent and control the disease.

What has been done
Studies were carried out and revealed that: (1) The complete nucleotide sequence of polyprotein gene 1 and the assembled full-length genome sequence of turkey coronavirus (TCoV) consists of a total of 13 open reading frames (ORFs); (2) The real-time reverse transcription polymerase chain reaction (RRT-PCR) assay developed using a dual-labeled fluorescent probe targeting the 3' end of TCoV spike gene is rapid, sensitive, and specific for detection, differentiation, and quantitation of TCoV in turkey tissues; (3) TCoV nucleocapsid (N) protein elicits non-neutralizing humoral immunity as well as N-protein specific cellular immunity; (4) DNA carrying TCoV N gene and that for S1 gene induce specific cellular and humoral immune responses to TCoV and reduce TCoV infectivity; and (5) DNA vaccination with TCoV N gene coupled with turkey calreticulin (CRT) gene induce a protective immune response against TCoV infection.

Results
We studied the scientific evidence for which TCoV gene can be a useful vaccine candidate and developed a workable and practical vaccine (DNA or vectored vaccine) against TCoV infection based on the scientific evidence. We have concluded that S gene is a good candidate. Additional work is needed to reach this goal.

4. Associated Knowledge Areas

KA Code	Knowledge Area
302	Nutrient Utilization in Animals
315	Animal Welfare/Well-Being and Protection

Outcome #2

1. Outcome Measures

An impact on crops resulting from new knowledge related to the environment, productivity, and/or biotic/abiotic stress.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Changes in Hessian fly (Hf) population structure and virulence causes resistant wheat cultivars to lose their effectiveness. This puts the wheat crop in danger and has led to widespread outbreaks and crop failure. New resistance genes are needed for deployment as well as more basic knowledge about mechanisms of resistance and susceptibility.

What has been done
A gene, H33, conferring resistance to Hessian fly populations from Maryland, Delaware, South Carolina, and Georgia, was mapped to the distal end of wheat chromosome 3AS and flanking molecular markers were developed for use in breeding. Genes responsive to Hf attack and unique to cells right at the feeding site of larva were identified and expression levels quantified. The promoter of the Dirigent gene was cloned along with promoters from 4 additional Hessian fly-responsive genes whose expression occurred right at the larval feeding sites. These promoters have potential for driving synthetic transgenes providing new forms of resistance. Two of these promoters were ligated to the GUS reporter gene and transformed into wheat for positional expression analysis. Two wheat transformation vectors were constructed containing insecticidal genes for use in Hessian fly feeding assays and possibly as transgenes. Bt CRY11 protein was used in Hf feeding assay to evaluate its possible use as transgenes.

Results
New wheat germplasm conferring resistance to Hessian fly is now available for use in a region of the US where very few wheat lines are resistant. The linked molecular markers will simplify and

accelerate introgression of this new resistance into cultivars. Use of this material could have a large economic impact. Promoters and insecticidal genes are now available that can be combined to provide new forms of resistance to Hessian fly. These synthetic transgenes can be pyramided with native resistance genes in order to protect them and increase the duration of their effectiveness.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
201	Plant Genome, Genetics, and Genetic Mechanisms
205	Plant Management Systems

Outcome #3

1. Outcome Measures

An economic and/or community impact resulting from new knowledge about food production systems, marketing & retail management, logistics & systems, and/or business development.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	450

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Crop producers need fact-based information in order to remain productive and competitive in agriculture. Researchers and Extension specialists need a forum at which to share their practical research with farmers who can then benefit from adoption of these practices. A field day at each Purdue Ag Center (PACs) provides an opportunity to meet both needs. By hosting a field day that encourages research and extension specialists to share their latest research on various crop production activities or pest management practices with local farmers and others through field tours with deomonstration plots. This provides an efficient means of getting results to producers, industry representatives and the public.

What has been done
The Pinney Purdue Field Day begins with four concurrent presentations, and an Ag Outlook session which provides an economic forecast for the future. The new Purdue Extension Director was introduced and he made additional comments about farm income, farmland values and cash

rents. Those who attend also receive credits for their private (PARP) and commercial (CCH) pesticide applicator licenses. In addition, Certified Crop Advisers can get continuing education units (CEUs). There is also a twilight program which offers PARP, CCH credits and CCA CEUs. For 2013 there were presentations on corn, soybean and nutrient management, weeds, diseases and the impact of tire types used in production agriculture.

Results
365 attended the field day; 80 for twilight program. Attendees were from 16 different counties. From the 128 survey responses, it was determioned that the attendees cover over 120,000 acres of crops in northern Indiana. Over 80% of respondents plan to apply information gleaned from the field day to increase profits and yields on their farms. The biggest immediate impact in their operations, was stated to be corn seeding rate, nitrogen fertilizer rates, control of new weeds (Palmer amaranth), corn and soybean diseases, marketing and tires. One farmer, after hearing Dr. Kiersten Wise's talk on corn diseases, went home and scouted his corn field, sent a sample to plant and pest diagnostic lab and confirmed that he had Goss' wilt on his farm. Another farmer, upon hearing the impact Palmer amaranth may have on future weed control issues, said "the pigweed talk scared the h*** out of me" to which one of the presenters commented "mission accomplished!"

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
205	Plant Management Systems
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
302	Nutrient Utilization in Animals
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices

Outcome #4

1. Outcome Measures

An impact on hunger and/or malnutrition resulting from new knowledge about food products, food quality, and/or food quantity.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Silver carp (Hypophthalmicthys molitrix) is regarded as an invasive, underutilized freshwater fish causing environmental and economic complications along the U.S. Mississippi River System. In the US, this fish lacks commercial value as a food commodity. In recent years, fish protein hydrolysates (FPH) have caught attention as possible food ingredients due to their high nutritive value and improved functionalities arising from the production of short peptides and free amino acids during hydrolysis. Several novel applications have been identified such as a cryoprotectant to prevent protein denaturation during frozen storage.

What has been done
Silver carp protein hydrolysates (FPH) were enzymatically prepared using Protamex®. We characterized the FPH and evaluated their cryoprotectant potential in frozen, freeze-thawed mince as an alternative to commercial sucrose-sorbitol blends currently used by the frozen seafood industry. The effectiveness of FPH to slow down conformational changes of the mince myofibrillar proteins was confirmed in several experiments, including retention of salt-extractable proteins, increased antifreeze activity, and low expressible moisture.

Results
Results from this study provide preliminary evidence for the development of effective cryoprotectants using an underutilized, invasive fish species that can be exploited for environmental and economic gain in the form of value-added ingredients, and further provide opportunities to understand the fundamental physicochemical properties governing cryoprotection provided by FPH in a frozen muscle (mince) food system.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
205	Plant Management Systems
302	Nutrient Utilization in Animals
604	Marketing and Distribution Practices

Outcome #5

1. Outcome Measures

An impact on non-food products resulting from new knowledge related to non-food products, and/or non-food systems.

Not Reporting on this Outcome Measure

Outcome #6

1. **Outcome Measures**

An impact on disaster preparation, education, and/or recovery.

Not Reporting on this Outcome Measure

Outcome #7

1. **Outcome Measures**

New research studies on plant mechanisms that can impact food security

2. **Associated Institution Types**

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Plants produce the amino acid phenylalanine (Phe) not only as a building block for proteins, but also as a precursor for more than 8000 compounds. These Phe-derived compounds constitute approximately 30-45% of plant matter and have a profound impact on plant growth, development, reproduction and defense. Animals are incapable of synthesizing Phe and must primarily obtain it directly or indirectly from plants. Despite the major role of Phe in plant metabolism, our knowledge about its biosynthesis and regulation in plants remains fragmented.

What has been done
We have demonstrated for the first time that plants possess multiple Phe biosynthetic pathways, both of which start from prephenate. We revealed that the arogenate pathway is the predominant route plants use to synthesize Phe, then provided genetic evidence that plants also contain an operational alternative route, also starting from prephenate, similar to the phenylpyruvate pathway found in most microbes. Characterization of this second pathway uncovered that Phe biosynthesis occurs in multiple subcellular compartments and that there is an interconnection between aromatic amino acid catabolism and biosynthesis in plants. We also showed that attenuation of the allosteric regulation by Phe on arogenate dehydratase, which catalyzes the last step in the arogenate pathway, leads to the higher Phe production and can be used as one of the approaches to increase yield of Phe-derived compounds.

Results

The research resulted in fundamental discovery of genes and enzymes involved in Phe biosynthesis, provided evidence for the existence of an alternative Phe biosynthetic pathway in plants, and filled important gaps in our knowledge of Phe metabolism. The finding that the microbial-like phenylpyruvate pathway does in fact operate in plants raises many questions about the control of carbon flux towards Phe and its downstream metabolites. The discovered genes and knowledge about structural and regulatory properties of the Phe biosynthetic network could be used for future rational metabolic engineering of plants to improve flavor and aroma quality, boost plant defenses, increase pollinator attraction and heighten amounts of biologically active compounds.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms

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

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Outcome 1 - lab study - Vaccination developed for turkey coronovirus
Outcome 2 - lab study - wheat genetic resistance to Hessian fly
Outcome 3 - post-survey of knowledge gained and intentions to apply information
Outcome 4 - lab study - silver carp protein use in frozen seafood
Outcome 7 - lab study - amino acid phenylalamine (Phe) biosynthesis and regulation in plants

Key Items of Evaluation

Outcome 1 - Initial results of genetic coupling identified as practical vaccine
Outcome 2 - developed new wheat germplasm conferring resistance to Hessian fly
Outcome 3 - over 80% of producers indicated they would apply what they learned to their operations to increase profit and yield

Outcome 4 - preliminary evidence for effective cryoprotectants from silver carp hydrolysate

Outcome 7 - fundamental discovery of genes and enzymes involved in Phe biosynthesis for future rational metabolic engineering of plants to improve flavor and aroma quality, boost plant defenses, increase pollinator attraction and heighten amounts of biologically active compounds

V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Climate Change

☑ 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
102	Soil, Plant, Water, Nutrient Relationships	10%		10%	
112	Watershed Protection and Management	5%		5%	
123	Management and Sustainability of Forest Resources	10%		10%	
132	Weather and Climate	10%		10%	
135	Aquatic and Terrestrial Wildlife	10%		10%	
201	Plant Genome, Genetics, and Genetic Mechanisms	10%		10%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	10%		10%	
212	Pathogens and Nematodes Affecting Plants	5%		5%	
213	Weeds Affecting Plants	5%		5%	
306	Environmental Stress in Animals	5%		5%	
605	Natural Resource and Environmental Economics	15%		15%	
610	Domestic Policy Analysis	5%		5%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	5.9	0.0	12.3	0.0
Actual Paid Professional	1.4	0.0	6.6	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**
680288	0	261808	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1514476	0	1781441	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
239207	0	896594	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

- Conduct meetings, conferences, workshops
- Publish research and extension publications
- Establish web sites
- Organize field days
- Consultations
- Work with mass media

2. Brief description of the target audience

- Producers
- Consumers
- Youth
- Elected officials and policy makers
- Professionals involved in weather and climate

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	3566	30	528	0

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

Patent Applications Submitted

Year: 2013
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	6	33	39

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of Extension publications, written, new or revised

Year	Actual
2013	6

Output #2

Output Measure

- Number of research publications

Year	Actual
2013	27

Output #3

Output Measure

- Number of research projects

Year	Actual
2013	19

Output #4

Output Measure

- Number of consultations

Year	Actual
2013	45

Output #5

Output Measure

- Number of educational workshops or seminars conducted

Year	Actual
2013	31

Output #6

Output Measure

- Number of volunteers

Year	Actual
2013	43

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of observers monitoring weather and climate
2	Number of research-based studies, publications, and reports for policy organization members and legislators on climate change
3	Number of participants who increase their knowledge about climate change
4	Number of participants who reduce pesticide, nutrient and water inputs while maintaining high quality turf
5	Number of participants who increase knowledge of pesticides, nutrients and water inputs for maintaining high quality turf
6	Number of participants who increase knowledge of management practices that maximize environmental stewardship
7	Number of participants who adopt management practices that maximize environmental stewardhip
8	Number of participants who increase their knowledge of opportunities and challenges for agriculture under carbon dioxide emissions policies to address climate change
9	New research studies on reducing farm carbon footprint
10	New crop varieties, animal breed, and genotypes with climate adaptive traits

Outcome #1

1. **Outcome Measures**

Number of observers monitoring weather and climate

Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

Number of research-based studies, publications, and reports for policy organization members and legislators on climate change

Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

Number of participants who increase their knowledge about climate change

Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

Number of participants who reduce pesticide, nutrient and water inputs while maintaining high quality turf

Not Reporting on this Outcome Measure

Outcome #5

1. **Outcome Measures**

Number of participants who increase knowledge of pesticides, nutrients and water inputs for maintaining high quality turf

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Number of participants who increase knowledge of management practices that maximize environmental stewardship

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Weather and climate patterns are a driving force behind success or failure of cropping systems. With U.S. corn and soybean production accounting for nearly one-third of global supplies and contributing over $50 billion annually to the national economy, ability to successfully produce crops under more variable climate conditions is critical for food security and rural livelihoods. Farmers can benefit from incorporating climate information into their farm management planning, but use of such information remains limited.

What has been done
The Useful to Usable (U2U) project strives to enhance usability and up-take of climate information for farmers and their advisors, and bolster Extension's capacity to address agro-climate issues across the Corn Belt. Long-term, these efforts will lead to more profitable agricultural systems across the Corn Belt and greater resilience to a changing climate. U2U tools are based on existing data and agro-climate model research looking at impact of climate on crop yields, nitrogen management, and cost-effectiveness of irrigation and tiling. Combining physical and social science disciplines, we strive to transform existing climate information into actionable knowledge.

Results
Social science members of team engaged stakeholders through surveys and focus groups to understand concerns about climate impacts and information needs. An online usability survey with agricultural advisors showed most were likely to use a decision tool (75%), recommend it to other advisors (83%), and they identified over a dozen decisions/problems that could be addressed with the tool. Follow up data will be collected after farmers/advisors have spent time using the decision management tools.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
123	Management and Sustainability of Forest Resources
605	Natural Resource and Environmental Economics

Outcome #7

1. Outcome Measures

Number of participants who adopt management practices that maximize environmental stewardhip

Not Reporting on this Outcome Measure

Outcome #8

1. Outcome Measures

Number of participants who increase their knowledge of opportunities and challenges for agriculture under carbon dioxide emissions policies to address climate change

Not Reporting on this Outcome Measure

Outcome #9

1. Outcome Measures

New research studies on reducing farm carbon footprint

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Greenhouse gas (GHG) emissions from livestock can have an impact on the overall global GHG atmosphere emissions, contributing to climate change. GHG impact related to swine production has had variable numbers reported by different agencies and experts. Real data with a wide range of diets and production practices is needed to clarify swine's impact on global warming.

What has been done
In a multi-state effort, an AFRI-USDA grant has been awarded to look at several contributing factors in swine production to GHG emissions. We created an integrated resource management tool to mitigate the carbon footprint of swine. In the past year we have improved a swine carbon footprint modeling program to include more feedstuffs and have been able to estimate the GHG emissions and carbon footprint from a multi-phase swine production site.

Results
Increased use of by-product feed stuffs may improve carbon footprint of swine operations from feed, but will likely increase GHG emissions from the facility due to low nutrient digestibility of these feed stuffs, generating more methane emissions (methane has 298 times the CO_2 equivalence).

4. Associated Knowledge Areas

KA Code	Knowledge Area
132	Weather and Climate
306	Environmental Stress in Animals

Outcome #10

1. Outcome Measures

New crop varieties, animal breed, and genotypes with climate adaptive traits

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Although farmers have faced challenges of droughts and heat waves for thousands of years, there is mounting concern that changes in our climate may hamper agricultural productivity in the US and around the world. Abiotic stresses are the most important factors limiting crop productivity

in contemporary environments. Climate modeling studies suggest that drought and high day- and night-time temperatures will become more common in the future and will represent a tremendous environmental hurdle to global food production. Efforts to develop agronomic crops with enhanced stress tolerance are of vital concern.

What has been done
Germplasm and trait development efforts in maize and sorghum are focused on use of natural and induced genetic variation for abiotic stress to improve stress tolerance using forward and reverse genetics strategies. This is an international and trans-disciplinary collaboration that couples efforts to genetically dissect and deploy genes for high-temperature and drought stress tolerance with development of crop modeling and climate assessment tools to study impacts of scaling-up new, stress-tolerant cultivars.

Results
Development of "climate resilient" cultivars of maize and sorghum will contribute to adaptation of agriculture to warmer and drier environments. Impacts of this project include: (1) basic physiology and biochemistry research which identifies biomarkers for key adaptation traits, and (2) genetic studies of abiotic stress tolerance in temperate and tropical maize and sorghum that impact crop improvement for adaptation to climate change and global food security.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
132	Weather and Climate
201	Plant Genome, Genetics, and Genetic Mechanisms
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants

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

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Outcome 6 - Stakeholder surveys and focus groups to understand concerns about climate impacts and information needs. Evaluation of impact and uptake of decision support tools, baseline measured to date; Follow-up planned to assess use of tools.

Outcome 9 - swine carbon footprint modeling program

Outcome 10 - Genetically dissect and deploy genes for high-temperature and drought stress tolerance with development of maize and sorghum crop modeling and climate assessment tools

Key Items of Evaluation

Outcome 6 -Stakeholders were likely to use tool (75%), recommend it to other advisors (83%), and they identified over a dozen decisions/problems that could be addressed with the tool.

Outcome 9 - Multi-phase swine production site carbon footprin

Outcome 10 - Impacts of scaling-up new, stress-tolerant cultivars; Identified biomarkers for key adaptation traits in maize and sorghum

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Sustainable Energy

☑ 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
102	Soil, Plant, Water, Nutrient Relationships	10%		10%	
131	Alternative Uses of Land	5%		5%	
201	Plant Genome, Genetics, and Genetic Mechanisms	10%		10%	
204	Plant Product Quality and Utility (Preharvest)	15%		15%	
213	Weeds Affecting Plants	5%		5%	
216	Integrated Pest Management Systems	5%		5%	
402	Engineering Systems and Equipment	10%		10%	
511	New and Improved Non-Food Products and Processes	10%		10%	
605	Natural Resource and Environmental Economics	20%		20%	
610	Domestic Policy Analysis	10%		10%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	11.1	0.0	35.2	0.0
Actual Paid Professional	5.6	0.0	20.3	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**
995415	0	417385	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1710053	0	2889728	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
300667	0	997776	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

- Conduct meetings, conferences, workshops, seminars
- Conduct research projects
- Publish research and extension publications
- Publish newsletters
- Establish web sites
- Organize field days and demonstrations
- Consultations
- Work with mass media

2. Brief description of the target audience

- Producers
- Consumers
- Youth
- Professionals related to energy
- Agribusiness
- Elected officials and public policy decision makers

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	2726	100	475	0

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

Patent Applications Submitted

Year: 2013
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	7	93	100

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of Extension publications written, new or revised

Year	Actual
2013	7

Output #2

Output Measure

- Number of research publications

Year	Actual
2013	51

Output #3

Output Measure

- Number of research projects

Year	Actual
2013	40

Output #4

Output Measure

- Number of consultations

Year	Actual
2013	471

Output #5

Output Measure

- Number of educational workshops or seminars conducted

Year	Actual
2013	69

Output #6

Output Measure

- Number of volunteers
  Not reporting on this Output for this Annual Report

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of energy producers, farmers, and consumers who increase their knowledge of the technical and economic implications of various Indiana crops being used for biofuels
2	Number of technologies developed and disseminated that will increase the efficiency of bio-fuel production
3	Number of participants who increased their knowledge of policy issues related to sustainable energy
4	Number of research-based studies, publications, and reports for policy organization members and legislators on sustainable energy
5	New research studies on biomass and/or biofuels (engineering)
6	New energy saving technologies for farmers
7	New research studies on biomass and/or biofuels (plant/genomics)
8	New research studies on biomass and/or biofuels (process)
9	new research studies on biomass and/or biofuels (economics and policy)
10	new research studies on biomass and/or biofuels (production)

Outcome #1

1. **Outcome Measures**

   Number of energy producers, farmers, and consumers who increase their knowledge of the technical and economic implications of various Indiana crops being used for biofuels

   Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

   Number of technologies developed and disseminated that will increase the efficiency of bio-fuel production

   Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

   Number of participants who increased their knowledge of policy issues related to sustainable energy

   Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

   Number of research-based studies, publications, and reports for policy organization members and legislators on sustainable energy

   Not Reporting on this Outcome Measure

Outcome #5

1. **Outcome Measures**

   New research studies on biomass and/or biofuels (engineering)

2. **Associated Institution Types**

   - 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Producing fuels and chemicals from plant biomass requires technologies that break down large polymers in raw material and then de-oxygenate the resulting intermediate polymers. Deoxygenation is required to increase energy content of chemicals so that a product with characteristics more similar to conventional, petroleum-derived fuels such as gasoline, diesel fuel, and jet fuel is formed. New catalysts that can effectively and efficiently deoxygenate plant biomass compounds are needed.

What has been done
Aluminum chloride is effective in converting glucose to 5-hydroxymethyl furfural (HMF), a potentially valuable intermediate in biofuel production, but at low yields due to undesired conversion of the sugar to humins. We demonstrated that the addition of maleic acid as a co-catalyst significantly shifted the product distribution from undesired humins to HMF. We further demonstrated that other Bronsted acids, such as sulfuric acid, have the same ability to alter the product distribution.

Results
This is a significant finding that may allow for the development of better catalysts for converting plant biomass to biofuels. It also illuminates new avenues for research to develop more selective catalysts for dehydrating plant-derived sugars to valuable fuels and chemicals.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
402	Engineering Systems and Equipment
511	New and Improved Non-Food Products and Processes

<u>Outcome #6</u>

1. Outcome Measures

New energy saving technologies for farmers

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Grain drying has been one of the largest consumers of energy in Midwest grain operations. Farmers in the Midwest have taken advantage of the USDA Rural Development - Rural Energy for America Program (REAP) grant and loan guarantee program to replace their old grain dryers with newer more efficient models.

What has been done
Through our energy audit program in that last four years, we have helped nearly 500 farm operations across six states make decisions about energy use in their grain drying operations throughout the Midwestern Corn Belt. Using validated tools we created which can simulate energy costs of high capacity or continuous flow dryers and in-bin drying systems, we offer energy assessments of drying systems so that less efficient grain dryers can be replaced by more efficient systems.

Results
The program continues to attract more farmers resulting in significant reduction in energy use and improved grain quality. About 75% of our client farmers this year received USDA REAP funds, which would mean approximately $768,750 federal dollars were awarded (about $25,000 per farmer on average). Dryer replacements estimates yield annual energy savings of about $1.5 million.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment
511	New and Improved Non-Food Products and Processes
605	Natural Resource and Environmental Economics

Outcome #7

1. Outcome Measures

New research studies on biomass and/or biofuels (plant/genomics)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Phenylpropanoid metabolism produces many compounds of interest including lignin. Extraction of lignin during pulping process is costly and damaging to the environment. Production of plants with more readily extractable lignin would be beneficial for both economic gain and for long-term environmental sustainability. Quantity and quality of lignin in forage species has been found to impact negatively their digestibility in ruminant animals. Lignin significantly interferes with saccharification of biomass used for biofuel production. Ability to engineer lignin biosynthesis is critical to all these efforts.

What has been done
We previously identified several semi-dominant mutants of Arabidopsis that contain lower levels of soluble phenylpropanoids and lignin much like other plants in which phenylpropanoid pathway genes are mutated or down-regulated. We have now shown genes affected in this mutant, reduced epidermal fluorescence 4 (ref4) and its paralog, REF4-related 1 (RFR1), play a role in suppression of phenylpropanoid biosynthesis in wild-type plants. We found disruption of both REF4 and RFR1 results in enhanced expression of multiple phenylpropanoid biosynthetic genes, and increased accumulation of downstream products. We showed that wild-type RFR1 substantially mitigates phenotype of dominant ref4-3 mutant, suggesting REF4 and RFR1 may compete with one another for common binding partners.

Results
Understanding molecular mechanisms by which carbon flux is partitioned in plants, and how flux through phenylpropanoid pathway in particular is regulated and allocated to different branches of pathway is essential for eventual rational manipulation of phenylpropanoid flux for bioenergy applications. We identified REF4 and RFR1, and by extension the Mediator complex, as critical factors influencing level of phenylpropanoid products synthesized in wild-type plants. These experiments and their extensions will inform future bioengineering efforts aimed at regulating

lignin biosynthesis, a pathway of plant metabolism that is important on a global scale.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms

Outcome #8

1. Outcome Measures

New research studies on biomass and/or biofuels (process)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The combined approaches for this research addresses the need for reducing cost of production of biofuels while also creating value-added bioproducts from agriculturally-derived renewable resources. This approach requires integration of both engineering fundamentals and economic analysis for development of efficient cellulose to biofuel processes.

What has been done
Our research has addressed barriers to reducing cost of catalytic conversion of cellulosic materials, particularly wood and corn stover, to sugars and biofuel products. This was achieved through fundamental studies on interactions of proteins at solid (biomass) interfaces, and the impact of pretreatment chemistry on accessibility and susceptibility of cellulose conversion to fermentable sugars, and to biofuel products. Combining studies on pretreatment severity and understanding of enzyme characteristics has led to approaches that significantly reduce amount of enzyme required for hydrolysis of cellulosic fractions in pretreated hardwoods.

Results
This research achieved better understanding of interactions of cellulose and lignin in cell wall structure with respect to enzymes that hydrolyze the cellulosic fraction to glucose. Results so far, have identified the fundamental mechanisms that cause significant and non-productive use of

added cellulase enzymes, and conditions that enable amount of enzyme to be added for a given level of hydrolysis to be significantly decreased. Major effect is reduction of enzyme required to hydrolyze pretreated lignocellulosic biomass.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
402	Engineering Systems and Equipment
511	New and Improved Non-Food Products and Processes

Outcome #9

1. Outcome Measures

new research studies on biomass and/or biofuels (economics and policy)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The US government has implemented policies encouraging development of biomass-based sources of energy in hope that they would increase farm revenue, reduce greenhouse gas emissions, and increase energy security. So far, these policies have not been successful in achieving their goals and economic barriers are a cause of this failure. A thorough economic analysis is needed to understand these limitations.

What has been done
An economic analysis to determine marginal cost of supplying biomass to processing facilities has been conducted. This work analyzes the forces shaping biomass supply including, but not limited to, market structure, spatial competition for feedstock, soil dynamics and irrigation, soil erosion and use of cover crops in different regions of the corn belt.

Results
Our research has provided insights into the importance of spatial competition on the economic viability of biomass-based energy in the corn belt and the viability of objectives put forth by the

Renewable Fuel Standard. It has also found that dynamic effects on soils are likely to be important especially in the Western Corn Belt where reductions in soil's water holding capacity may result in increased pressure on aquifers for irrigation. These analyses have found an essential contradiction between biofuels and water policies.

4. Associated Knowledge Areas

KA Code	Knowledge Area
605	Natural Resource and Environmental Economics
610	Domestic Policy Analysis

Outcome #10

1. Outcome Measures

new research studies on biomass and/or biofuels (production)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In the pursuit of energy security, policy makers and the US agricultural industry alike have focused on transitioning from agronomic crops (e.g. maize grain) to theoretically more sustainable 2nd generation, dedicated energy crops. Perennial grasses such as switchgrass and Miscanthus have been targeted for use on more marginal land areas lying within the highly-productive Midwestern landscapes so as not to displace food/feed crops. Yet, despite anticipated high productivity with environmental co-benefits for such grasses, significant concerns have been raised by stakeholders from farmers who dislike the lack of year-to-year flexibility associated with perennial crops and fear low profits during stand establishment to conservationists who suggest non-native species (e.g., Miscanthus) may become invasive. Increasingly, the agricultural community has become interested in novel annuals as promising, generation 1.5, dedicated energy crops. A comparative analysis of biomass productivity and environmental impact of biomass cropping systems is underway at 4 locations in Indiana. For some biomass systems we are varying nitrogen fertilizer input.

What has been done

We are collecting data on yield, composition, and input use efficiency (nitrogen, water, radiation). Compared to maize, sorghum N use efficiency is high. Yields under extreme drought were less than 500 kg/ha for maize whereas sorghum yields often exceed 10,000 kg/ha under identical conditions. Like sorghum, switchgrass and Miscanthus require less N than maize for high yield, but are difficult to establish in some marginal soils. Composition in not altered markedly by N input, location and year if harvested at similar maturities.

Results
Perennial grasses are excellent choices for biomass production, but establishment can be difficult on some marginal lands. Maize producers should find the transition to sorghum biomass production relatively straightforward since production practices of these species are similar. The high input use efficiency of sorghum, along with its reliable production across an array of marginal soils makes it an attractive "Generation 1.5" biomass feedstock.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
131	Alternative Uses of Land

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

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Outcome 5 - lab study - analysis of catalysts of glucose conversion in biofuel production
Outcome 6 - energy audits for grain drying operations
Outcome 7 - lab study - genetic modification of biomass feedstocks to more easily convert to biofuels
Outcome 8 - lab study - catalytic conversion of cellulosic materials, particularly wood and corn stover, to sugars and biofuel products
Outcome 9 - economic analysis - biofuel and environmental policies in the corn belt
Outcome 10 - field study - comparison of biomass grasses

Key Items of Evaluation

Outcome 5 - Maleic acid and Bronsted acids shown as effective co-catalysts in biofuel production

Outcome 6 - 75% of clients received USDA REAP funds and replaced dryers resulting in estimated annual energy savings of $1.5 million

Outcome 7 - manipulating genes REF4, RFR1 and Mediator complex to alter phenylpropanoid pathway makes lignan easier to convert to biofuels

Outcome 8 - effect is reduction of enzyme required to hydrolyze pretreated lignocellulosic biomass

Outcome 9 - important factors were spatial competition on biomass-based energy in the corn belt, objectives of the Renewable Fuel Standard, and dynamic effects on soils (especially in the Western Corn Belt) which result in finding a contradiction between biofuels and water policies

Outcome 10 - Perennial grasses excellent for biomass production, but establishment of some difficult on marginal lands. Maize producers transition to sorghum biomass production relatively straightforward since practices similar.

V(A). Planned Program (Summary)

Program # 4

1. Name of the Planned Program

Food Safety

☑ 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%		5%	
204	Plant Product Quality and Utility (Preharvest)	5%		5%	
212	Pathogens and Nematodes Affecting Plants	5%		5%	
216	Integrated Pest Management Systems	5%		5%	
308	Improved Animal Products (Before Harvest)	10%		10%	
501	New and Improved Food Processing Technologies	20%		20%	
503	Quality Maintenance in Storing and Marketing Food Products	10%		10%	
504	Home and Commercial Food Service	10%		10%	
607	Consumer Economics	5%		5%	
702	Requirements and Function of Nutrients and Other Food Components	5%		5%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources	5%		5%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	15%		15%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	4.5	0.0	7.1	0.0

Actual Paid Professional	3.2	0.0	15.3	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**
867745	0	476550	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1620470	0	2335078	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
251452	0	917921	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research-based programs will focus on conducting research experiments and programs emphasizing our key interest areas including detection and control of foodborne pathogens.

A wide variety of programs will be delivered to our targeted audiences. Some programs will include a complete development of curriculum, while others will involve the use of readily available programs used in other states and/or available for purchase through different organizations. Our output effort will include:

• partnering with important stakeholders,•development of workshop materials and curricula •conducting workshops •development of web-based and distance education materials •working with the media

We expect to increase our offerings through distance education and/or web-based materials. Most programs involve some type of collaboration or partnerships with our stakeholders, with industry, with consumers, or with regulatory agencies. Evaluation tools vary greatly depending on the intended audience and program type ranging from surveys, to pre-and post test, to national certification exams, and intensive follow up surveys to better assess knowledge gain.

2. Brief description of the target audience

- Animal production personnel
- Plant production personnel
- Food manufacturing and processing plant personnel
- Food service and food retail workers
- Consumers
- Youth
- State and county health departments
- Federal regulatory officials
- State industry associations
- First Responders

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	55620	1653474	1458	6600

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

Patent Applications Submitted

Year: 2013

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	27	32	59

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of food safety programs offered to consumers

Year	Actual
2013	354

Output #2

Output Measure

- Number of programs offered to the food industry

Year	Actual
2013	207

Output #3

Output Measure

- Number of research projects on food safety

Year	Actual
2013	27

Output #4

Output Measure

- Number of research publications related to control of foodborne hazards

Year	Actual
2013	10

Output #5

Output Measure

- Number of research publications related to detection of foodborne pathogens

Year	Actual
2013	14

Output #6

Output Measure

- Number of research publications related to food defense and protection

Year	Actual
2013	4

Output #7

Output Measure

- Number of Extension publications related to food safety

Year	Actual
2013	27

Output #8

Output Measure

- Number of volunteers

Year	Actual
2013	69

Output #9

Output Measure

- Number of consultations

Year	Actual
2013	457

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of incidents (reduction is goal) of foodborne illness associated with unsafe food handling practices
2	Number of persons who increased their knowledge of cooking foods adequately
3	Number of persons who increased their knowledge of avoiding cross-contamination
4	Number of persons who increased their knowledge of keeping food at a safe temperature
5	Number of persons who increased their knowledge of storing foods properly
6	Number of persons who increased their knowledge of proper hand washing
7	Number of participants passing food handler certificate
8	Number of participants adopting best management practices related to food safety
9	New research studies improve food safety (packaging, ingredients, shelf-life studies, etc.)
10	New research studies leading to a reduction in foodborne pathogen transmission.

Outcome #1

1. **Outcome Measures**

Number of incidents (reduction is goal) of foodborne illness associated with unsafe food handling practices

Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

Number of persons who increased their knowledge of cooking foods adequately

Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

Number of persons who increased their knowledge of avoiding cross-contamination

Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

Number of persons who increased their knowledge of keeping food at a safe temperature

2. **Associated Institution Types**

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	657

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The Center of Disease Control and Prevention estimates that each year roughly 1 in 6 Americans (or 48 million people) gets sick, 128,000 are hospitalized, and 3,000 die of foodborne diseases. With over 600 food service establishments in Johnson County, food sanitation education is an on-going priority. State law requires at least one person per foodservice establishment to be certified in food sanitation.

What has been done
Purdue Extension Johnson County has organized and taught the SERVSAFE Retail Food Safety Certification and Recertification monthly in Johnson County. These programs are marketed through the Johnson County Health Department and the Indiana Restaurant Association website

Results
Purdue provided an additional 8-hours of educational trainings in Food Sanitation with 620 participants out of 657 receiving their National Food Protection Manager's Certification. This brings the food service operator into compliance with the Indiana State Department of Health's Certification for Food Handler's requirements. Three-month follow up surveys indicated:
-97% washed hands during food preparation and service compared to 31% prior to training
-91% checked the temperature of food to make sure that it was cooked to a safe temperature compared to 35% prior to training
-83% took temperatures of food to make sure that the food was cooled quickly to safe temperatures compared to 23% prior to training
-93% kept raw and ready-to-eat foods separated to prevent cross contamination compared to 38% prior to training.
-95% made sure that all work surfaces, equipment and utensils were cleaned and sanitized before preparing and serving foods compared to 41% prior to training.

4. Associated Knowledge Areas

KA Code	Knowledge Area
504	Home and Commercial Food Service
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #5

1. Outcome Measures

Number of persons who increased their knowledge of storing foods properly

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Number of persons who increased their knowledge of proper hand washing

Not Reporting on this Outcome Measure

Outcome #7

1. **Outcome Measures**

Number of participants passing food handler certificate

Not Reporting on this Outcome Measure

Outcome #8

1. **Outcome Measures**

Number of participants adopting best management practices related to food safety

2. **Associated Institution Types**

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
There exists a large need to provide educational programming on food safety technologies for poultry and egg processing. It is estimated that over four million foodborne illnesses are caused by pathogens associated with poultry and eggs.

What has been done
To address the above need, seven technical presentations on novel food technologies including cryogenic egg cooling, atmospheric plasma, UV, high pressure processing, ozonation and others have been provided. These programs were delivered to over 500 persons in both the United States and Mexico.

Results
Over 500 industry personnel have been educated on novel food technologies for controlling pathogens in egg and poultry processing. Participants from companies saw value in the new technologies and made plans to implement some of these food safety improvements to their existing processing lines, cleaning and sanitation activities, and food safety validation programs.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
504	Home and Commercial Food Service
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #9

1. Outcome Measures

New research studies improve food safety (packaging, ingredients, shelf-life studies, etc.)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Drop coalescence is a familiar event in nature (e.g. the process that produces raindrops), and central to many important technological processes in food and agriculture ranging from crop spraying to the stability of food emulsions. It is well known that surfactants play an important role in preventing drop coalescence by slowing the drainage of the fluid film separating the drops just before coalescence starts. But it is still unclear how surfactants affect the rate of coalescence after the drops make contact.

What has been done
A new study from our laboratory in food emulsion models reveals that the rate of drop coalescence will slow much more than was thought in response to increasing levels of surfactants. When drops coalesce, their surface area decreases unevenly and the surface contraction is most severe on the meniscus bridge formed between the drops. Surfactants accumulate on the meniscus, further weakening the pull of surface tension. We developed high-fidelity simulation models which enabled detailed examination of the process at the tiny lengthscale of the joining meniscus, and so the effects of the surfactants on coalescence and, ultimately, in emulsion stability, were accurately quantified.

Results
New insights into the physical mechanisms of coalescence are important, both for scientific understanding as well as for its broad impact on commercial food production. New findings from this study provide additional opportunities to control the coarsening rate of the dispersed phase in food emulsions. By fine -tuning surfactant strength and concentration, novel processing techniques may be developed to slow the rate of drop coalescence and consequently enhance emulsion stability both during manufacturing and during the shelf -life of the food product. Besides commercial food production, we expect that this study will enhance our understanding of other two-phase systems involving small drops, including crop spraying, microfluidics, atomization in combustion engines, and high-throughput screening for rapid assaying of therapeutic drug candidates.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #10

1. Outcome Measures

New research studies leading to a reduction in foodborne pathogen transmission.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The Centers for Disease Control and Prevention estimate that there are approximately 55 million cases of foodborne illness in the United States each year resulting in 127,000 hospitalizations and over 3000 deaths. Annual economic losses due to hospital care, lost wages, legal awards and settlements are estimated to range from 7 to 10 billion dollars. Many of these illnesses are associated with the consumption of contaminated meat, poultry or dairy products. High profile

meat recalls due to contamination reduce both consumer confidence and product value and threaten the sustainability of the various associated industries.

What has been done
We have previously demonstrated that phage-based technologies can significantly reduce foodborne pathogen transmission in live animals. We are currently focused on more closely examining the biology of effective phages. This includes examining kinetics, killing efficiencies and genomic sequencing. This has led to the more rational design of phage-based antibacterials. In the past year we have developed phage cocktails that not only limit foodborne pathogen transmission in live animals, but reduce contamination in various food matrices (e.g., ground beef, spinach). We have begun to answer basic questions regarding the development of phage resistance in treated bacteria as well possible adverse immune reactions in treated animals.

Results
We have developed methods to reduce transmission of bacteria at different parts of the food production chain that rely on the natural ability of bacteriophages to identify and destroy specific bacteria. In live animals, direct feeding of bacteriophages to pigs reduced Salmonella concentrations by 90 to 99.9%. Importantly, we have shown that phage treatment does not impact the animal itself. More recently, we demonstrated that application of bacteriophages to spinach reduced E. coli O157:H7 contamination up 99.9%. Taken together, these results indicate that bacteriophages can be an effective and practical tool for food producers in ensuring the safety of their products.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Outcome 4 - pre-survey and 3-month follow-up survey on food safety

Outcome 5 - lab study - simulation models for examination of surfactants on coalescence and emulsion stability

Outcome 8 - post survey of participants in training for new technologies for safe egg/poultry processing

Outcome 9 - lab study - food emulsion models on rate of drop coalescence in response to surfactants

Outcome 10 - lab study - biology and physiology of effective phages in reducing foodborne pathogen transmission in live animals

Key Items of Evaluation

Outcome 4 - 91% checked the temperature of food to make sure that it was cooked to a safe temperature compared to 35% prior to training. 83% took temperatures of food to make sure that the food was cooled quickly to safe temps compared to 23% prior to training. 93% kept raw and ready-to-each foods separated to prevent cross contamination compared to 38% prior to training.

Outcome 5 - Developed approaches to control dispersion by fine-tuning surfactant strength and concentration which can impact food shelf life, crop spraying, microfluidics, atomization in combustion engines, and high-throughput screening for rapid assaying of potential therapeutic drug candidates.

Outcome 8 - Participants saw value in the new technologies, and made plans to implement some of these food safety improvements to their existing processing lines, cleaning and sanitation activities, and food safety validation programs.

Outcome 9 - Showed control on coarsening rate of dispersed phase in food emulsion.

Outcome 10 - Direct feeding of bacteriophages to pigs reduced Salmonella concentrations by 90 to 99.9%. And, phage treatment does not impact the animal itself.

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Childhood Obesity

☑ 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	10%		10%	
502	New and Improved Food Products	10%		10%	
607	Consumer Economics	10%		10%	
610	Domestic Policy Analysis	5%		5%	
701	Nutrient Composition of Food	5%		5%	
702	Requirements and Function of Nutrients and Other Food Components	10%		10%	
703	Nutrition Education and Behavior	20%		20%	
806	Youth Development	30%		30%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	1.2	0.0	11.0	0.0
Actual Paid Professional	0.9	0.0	8.2	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**
621957	0	259199	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1465068	0	1705470	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
245036	0	892796	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

- Conduct research
- Conduct educational workshops, seminars, short courses, conferences
- Partner with other agencies interested in childhood obesity
- Work with the media
- Develop curricula, publications, web sites, distance education materials

- Publish research and Extension articles

2. Brief description of the target audience

- Parents
- Youth
- Children
- Consumers
- Day Care Providers
- Healthcare Providers
- State and county health departments
- Professional organizations

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	594	2368	4418	5283

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

Patent Applications Submitted

Year:	2013
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	0	16	16

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of Extension publications written, new or revised

Year	Actual
2013	0

Output #2

Output Measure

- Number of research publications

Year	Actual
2013	16

Output #3

Output Measure

- Number of research projects

Year	Actual
2013	0

Output #4

Output Measure

- Number of consultations

Year	Actual
2013	26

Output #5

Output Measure

- Number of educational workshops or seminars conducted

Year	Actual
2013	119

Output #6

Output Measure

- Number of volunteers

Year	Actual
2013	23

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of persons who adopt one or more practices to improve food choices
2	Number of participants who have increased their knowledge of how to raise healthy eaters
3	Number of persons who increased their knowledge of selection and preparation of foods with reduced fat and/or calories
4	Number of persons who increased knowledge of USDA serving sizes
5	Number of participants consuming appropriate serving sizes
6	Number of participants demonstrating ability to choose or prepare foods with reduced fat and/or calories
7	Number of youth who increased knowledge of the importance of physical activity
8	Number of participants who adopt increased physical activity levels
9	Number of participants who increased their knowledge of the connection between food choices and risk of chronic disease
10	Number of participants who increased their knowledge of the relationship between nutrition and health
11	Number of participants who adopt one or more practices to improve food choices and activity levels
12	New research studies on fat development in the body
13	New research studies on how the body deals with fat (absorption, elimination, processes, regulation, etc.)
14	New diagnostic technologies related to human health
15	New research studies on molecular function of the body related to fat

Outcome #1

1. **Outcome Measures**

Number of persons who adopt one or more practices to improve food choices

Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

Number of participants who have increased their knowledge of how to raise healthy eaters

2. **Associated Institution Types**

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In Indiana over 20,000 children are served meals and snacks each day through USDA'S Child and Adult Care Food Program (CACFP). CACFP sponsors report a need for increased variety of fruits and vegetables, leaner and more varied entrée choices, more appealing food presentation, more varied snacks, and less reliance on ready-to-serve foods high in fat, sugar, and sodium. Many childcare foodservice staff have minimal training in nutrition or food preparation.

What has been done
Extension educators worked with childcare providers to offer RECIPE for Growing Healthy Children to inspire staff to create a total environment promoting quality meals and snacks, nutrition education, and positive role modeling, resulting in lifelong healthy beliefs and behaviors. Childcare providers are introduced to six practices that redefine nutrition programs from feeding children to growing healthy children. Each section is devoted to one practice: 1) role model what we want children to be, say, and do; 2) set up a mealtime environment that encourages healthy behaviors and promotes wellbeing; 3) create nutritious meals and snacks; 4) involve children in food and fun; 5) partner with parents; and 6) enjoy eating together.

Results
After program, participants reported an intention to role model healthy choices and positive behaviors during meals and snacks. Almost 80% were likely to use one of the recommended tools to assess current mealtime environment in their facility. Over 75% were likely to make changes to improve mealtime environment. Over 65% were likely to share information they learned with parents and caregivers. Almost 60% were likely to use ideas shared to promote family meals to families they serve. Recipes they plan to incorporate in their facility menus include baked sweet potato fries, pizza pasta bake, cucumber dip, and baked French toast.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
806	Youth Development

Outcome #3

1. Outcome Measures

Number of persons who increased their knowledge of selection and preparation of foods with reduced fat and/or calories

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Number of persons who increased knowledge of USDA serving sizes

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Number of participants consuming appropriate serving sizes

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Number of participants demonstrating ability to choose or prepare foods with reduced fat and/or calories

Not Reporting on this Outcome Measure

Outcome #7

1. **Outcome Measures**

Number of youth who increased knowledge of the importance of physical activity

Not Reporting on this Outcome Measure

Outcome #8

1. **Outcome Measures**

Number of participants who adopt increased physical activity levels

Not Reporting on this Outcome Measure

Outcome #9

1. **Outcome Measures**

Number of participants who increased their knowledge of the connection between food choices and risk of chronic disease

Not Reporting on this Outcome Measure

Outcome #10

1. **Outcome Measures**

Number of participants who increased their knowledge of the relationship between nutrition and health

Not Reporting on this Outcome Measure

Outcome #11

1. **Outcome Measures**

Number of participants who adopt one or more practices to improve food choices and activity levels

Not Reporting on this Outcome Measure

Outcome #12

1. Outcome Measures

New research studies on fat development in the body

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Obesity is a chronic and low-grade state of inflammation largely due to inflammatory activation of adipocytes (fat cells) and macrophages infiltrated into adipose (fat)tissue. Development of new fat cells (adipogenesis) and activation of oxidative stress in adipose tissue are known to be major causes of obesity and its related inflammatory diseases. Recent studies on non-fat cells suggested that curcumin has anti-inflammatory, anti-oxidative, and anti-cancer properties. Curcumin is the yellow, dietary component of curry spice turmeric.

What has been done
Our research goal was to develop a safe, dietary strategy to prevent generation of new fat cells and their pathogenic function in inflammation. We determined how curcumin regulates oxidative stress-induced inflammatory interaction between adipocytes and macrophages both in vitro and in vivo. We created a new, non-invasive and non-staining molecular imaging system which allowed us to monitor the uptake of curcumin, the generation of intracellular lipid droplets and inflammatory makers in adipocytes.

Results
Preliminary findings: 1) curcumin exerts a dose-dependent inhibition specific to the early stages of adipogenesis in vitro; 2) curcumin inhibits adipogenesis-associated oxidative stress in vitro; and 3) curcumin suppresses the expression of pro-oxidant and inflammation markers in adipocytes. Our studies provide evidence of an inhibitory role of curcumin in adipogenesis, adipogenesis-associated oxidative stress, and inflammation.

4. Associated Knowledge Areas

KA Code	Knowledge Area
702	Requirements and Function of Nutrients and Other Food Components

Outcome #13

1. Outcome Measures

New research studies on how the body deals with fat (absorption, elimination, processes, regulation, etc.)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Dietary fat is the most energy dense nutrient we consume and therefore plays an important role in the energy balance equation and contributes to the problems of overweight and obesity. Dietary fat also plays a role in regulating blood lipid concentrations. Blood lipid concentrations are a determinant of risk of cardiovascular disease. Therefore, understanding the molecular mechanisms involved in dietary fat absorption is very important and may lead to preventive and therapeutic interventions for the problems of overweight, obesity, cardiovascular disease and diabetes.

What has been done
We used genetic and dietary mouse models which are resistant or susceptible to obesity and cardiovascular disease to investigate dietary fat absorption in the intestine. We used a novel imaging technique, Coherent anti-Stokes Raman Scattering microscopy.

Results
We discovered an important role of two specific genes involved in the synthesis of triglycerides, the storage of triglycerides and the catabolism of fatty acids in regulating dietary fat absorption.

4. Associated Knowledge Areas

KA Code	Knowledge Area
702	Requirements and Function of Nutrients and Other Food Components

Outcome #14

1. Outcome Measures

New diagnostic technologies related to human health

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
About 25-30% of US adults are obese. Different dietary factors have been proposed to play a role in obesity development. To understand which dietary factors are the biggest contributors, it is important to have accurate measures of what and how much people are eating. However, usual methods of measuring dietary intake depend on self-reporting, so determination of dietary intake depends on how accurately people remember what and how much they consumed.

What has been done
One way to address the accuracy of consumption is to measure outputs of certain molecules in the urine that are metabolites of what was eaten. We conducted a study comparing different methods to track percentage of metabolites in urine collected compared to actual urine output in a 24 hour period. We gave 20 participants two different forms of para-aminobenzoic acid (PABA or POTABA) to take, 3 times a day. This compound is excreted entirely in the urine, therefore if all urine in a 24 hour period is collected, the full amount given of PABA or POTABA will be recovered. In the US, only pharmaceutical-grade POTABA is available for human ingestion, and pharmaceutical-grade PABA is not (it must be obtained from the UK). We found no statistically significant differences in the amount of PABA or POTABA recovered, therefore either one is recommended for use to verify all urine was collected.

Results
Use of PABA or POTABA to measure what, when and how much people are eating by measuring compounds from the diet excreted in urine is a step forward in helping to more accurately measure what people eat, thus helping to better determine the most salient dietary contributors to the development of obesity.

4. Associated Knowledge Areas

KA Code	Knowledge Area
702	Requirements and Function of Nutrients and Other Food Components

Outcome #15

1. Outcome Measures

New research studies on molecular function of the body related to fat

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Molecular mechanism linking consumption to obesity is elusive. During thermal food processing, carbonyl groups of reducing sugars and amino residues on proteins can generate advanced glycation end products (AGEs) via a non-enzymatic glycation browning reaction. A prolonged non-enzymatic glycation reaction between glucose and amino residues under a hyperglycemic condition can also form glycated proteins in mammalian cells. It has been documented that AGEs are involved in the development of diabetes and vascular diseases.

What has been done
At molecular level, AGEs interact with and activate its receptors (RAGE), resulting in oxidative stress of cells. We are focusing on role of Polo-like kinase 1 (Plk1) in RAGE signaling and its effect on childhood obesity by investigating how Plk1 regulates adipogenesis, a cellular event that has to be accurately controlled to prevent obesity.

Results
We show that oxidative stress-induced activation of PI3K pathway is Plk1 dependent and Plk1 is essential for lipid biosynthesis. Our working model is: accumulation of AGEs due to uptake of excess unhealthy food results in oxidative stress, which leads to elevation of Plk1. Increased Plk1 activates PI3K pathway, subsequently contributing to increased lipid biosynthesis via SREBP pathway and childhood obesity.

4. Associated Knowledge Areas

KA Code	Knowledge Area

702 Requirements and Function of Nutrients and Other Food Components

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

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Outcome 2 - Post program evaluation on intentions to act and incoporate practices in childcare work and in family

Outcome 12 - lab study - analyzed how curcumin regulates oxidative stress-induced inflammation

Outcome 13 - lab study - used imaging technique, Coherent anti-Stokes Raman Scattering microscopy, to investigate dietary fat absrption in intestine

Outcome 14 - lab study - comparison of measures for tracking dietary intake

Outcome 15 - lab study - analyzed molecular activity of oxidative stress of cells and obesity

Key Items of Evaluation

Outcome 2 - 60% and more reported intention to role model a variety of healthy choices and positive behaviors during meals and snacks

Outcome 12 - evidence that curcumin has inhibitory role in adipogeneisis and inflammation

Outcome 13 - discovered two specific genes involved in synthesis and storage of triglycerides and catabolism of fatty acids in regulating dietary fat absorption

Outcome 14 - compounds from diet excreted in urine accurately indicate what people eat

Outcome 15 - polo-like kinase 1 (Plk1) found to regulate adiopgenesis, not simply cell-division cycle

V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Human, Family, and Community, Health and Well-being

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
608	Community Resource Planning and Development	12%		12%	
701	Nutrient Composition of Food	5%		5%	
702	Requirements and Function of Nutrients and Other Food Components	10%		10%	
703	Nutrition Education and Behavior	10%		10%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources	5%		5%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	10%		10%	
721	Insects and Other Pests Affecting Humans	3%		3%	
723	Hazards to Human Health and Safety	3%		3%	
801	Individual and Family Resource Management	12%		12%	
802	Human Development and Family Well-Being	12%		12%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	10%		10%	
805	Community Institutions, Health, and Social Services	3%		3%	
806	Youth Development	5%		5%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	53.3	0.0	190.8	0.0

Actual Paid Professional	23.9	0.0	33.4	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**
1598741	0	690707	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2621892	0	3766507	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
354685	0	1179785	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

- Develop, workshops, consultations, seminars, certification programs, distance education modules, field days, and other opportunities
- Develop and implement curriculum
- Conduct evaluation/research
- Provide youth and volunteer training and development
- Develop web sites
- Provide staff development
- Collaborate with other agencies/stakeholders
- Publish research and extension articles
- Increase number of participants in life-long learning programs.
- Foster leadership and economic development and facilitate strong partnerships n state, regional, national, and international agencies, organizations, and groups.
- Encourage participation by extension specialists in: Taskforces, Review Committees, Advisory Boards, Editorial Boards, Commodity committees/boards, Invited presentations, Honors and Awards, Common Interest Groups, Professional Societies

2. Brief description of the target audience

Families, parents, youth, 4H youth/volunteers/administration/parents, children, appointed and elected public officials, Commodity boards and committees,

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

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

Patent Applications Submitted

Year:	2013
Actual:	1

Patents listed
8,501,486 US

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	7857	67	7924

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of programs offered to parents, childcare providers, youth, adults, low-wealth households and consumers

Year	Actual
2013	5679

Output #2

Output Measure

- Number of research publications

Year	Actual
2013	51

Output #3

Output Measure

- Number of Extension publications written, new or revised

Year	Actual
2013	7857

Output #4

Output Measure

- Number of new partnerships, coalitions, advisory boards created

Year	Actual
2013	571

Output #5

Output Measure

- Number of new/revised curriculum topics (youth)

Year	Actual
2013	457

Output #6

Output Measure

- Number involved in community collaborations (youth)

Year	Actual
2013	501

Output #7

Output Measure

- Number of volunteer development opportunities

Year	Actual
2013	3482

Output #8

Output Measure

- Number of quality, educational workshops for youth

Year	Actual
2013	6070

Output #9

Output Measure

- Number of youth participating in Career Events

Year	Actual
2013	25347

Output #10

Output Measure

- Number of youth participating in educational workshops

Year	Actual
2013	136682

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	An impact on human health resulting from new knowledge about nutrition & wellness, chronic diseases, and/or environmental factors
2	An impact on family well-being resulting from new knowledge about family resources management, parenting & relationships, and/or child development.
3	An impact on youth development resulting from new knowledge about youth leadership, life skills, volunteers, and/or career development.
4	An impact on economic and/or community development resulting from new knowledge about leadership, economic development, government operations and/or community development
5	An impact on policy and/or regulation related to human, family and community, health and well-being.
6	An impact on individuals and families regarding financial literacy
7	An impact on child development
8	New research studies on treatments for chronic conditions

Outcome #1

1. Outcome Measures

An impact on human health resulting from new knowledge about nutrition & wellness, chronic diseases, and/or environmental factors

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Breast cancer is the primary cancer for women, with devastating consequences physically, emotionally and financially. Vitamin D holds great promise as a potential preventive agent for breast cancer as supported by epidemiological, intervention, animal and cell-based studies. There is a critical shift in energy metabolism during cancer progression towards increased glucose metabolism, reduced pyruvate oxidative phosphorylation, increased glycolysis and increased lactate production, and increased glutamine metabolism through the Krebs cycle. This shift is essential in cells to produce sufficient energy and other necessary components for proliferation. In addition, there is a dramatic increase in obesity and diabetes, and vitamin D is associated with improved insulin sensitivity in epidemiological studies.

What has been done
In our laboratory, we focused on dietary vitamin D and the development of tumors in rodent models.

Results
Our results show that the active metabolite of vitamin D, 1,25-dihydroxyvitamin D (1,25(OH)2D), alters energy metabolism during cancer progression. Our results in a cell model of early breast cancer progression show that 1,25(OH)2D reduced the dependence on glucose in the cells in early stage progression, and reduced glucose uptake, glycolysis, and glucose utilization in the TCA cycle. Further, our results in a muscle cell model demonstrates that vitamin D improves insulin sensitivity. These results will contribute to guiding the development of evidence-based recommendations for dietary vitamin D to prevent the development of breast cancer as well as prevention of insulin resistance.

4. Associated Knowledge Areas

KA Code	Knowledge Area
723	Hazards to Human Health and Safety
802	Human Development and Family Well-Being

Outcome #2

1. Outcome Measures

An impact on family well-being resulting from new knowledge about family resources management, parenting & relationships, and/or child development.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In the U.S., nearly one million teen girls get pregnant each year. Nearly 4 out of 10 young women get pregnant at least once before they turn 20. Each year federal government alone spends $40 billion to help families that began with a teenage birth. In 2011, 329,797 babies were born to women aged 15-19 years, for a live birth rate of 31.3/1,000 women in this age group. In 2005 in Indiana, age-specific pregnancy rate for 15-17 year olds was 20.5/1,000 and was 78.8/1,000 for 18-19 year olds.

What has been done
Pregnancy and Parenting Education of Adolescents through Extension (PPEATE) was a two-part program to assist teens and their families learn how to share experiences and support one another to gain self-confidence needed to be best mother they can be: 1) Have a Healthy Baby educates prenatal teens about importance of following healthy lifestyle during/after pregnancy, 2) Moms Together group meets monthly for parenting education, connections to local agencies, mentor mother support. Program was provided 160 times in 8 counties for 52 pregnant teens, 102 parenting teens (mothers and fathers), 33 mentor moms and 19 childcare workers.

Results
Teens reported improved birth outcomes from pre- to post-assessments, including contact with local health education providers, enrollment in prenatal care, and/or enrollment in smoking/substance abuse programs. During Moms Together, seven of 12 instructional Parenting Counts modules yielded significant differences in pre-post knowledge of teens. In Have a Healthy

Baby program, significant differences for pre-post-attitudes of pregnant teens for daily physical activity, nutrition habits, food safety practices, and toward breastfeeding their baby for the first 12 months of life.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
801	Individual and Family Resource Management
802	Human Development and Family Well-Being
805	Community Institutions, Health, and Social Services

Outcome #3

1. Outcome Measures

An impact on youth development resulting from new knowledge about youth leadership, life skills, volunteers, and/or career development.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Youth who develop decision making skills and positive personal character are more likely to cooperate and work well with others. Learning through team building skills allows youth to begin to recognize and identify needs, concerns and interests of others resulting in success when dealing with others.

What has been done
To address issues of hunger and food insecurity, Indiana 4-H members were challenged to Take a Bite Out of Hunger by planning activities to focus on supporting local food pantries, food banks, soup kitchens, etc. in their communities.

Results
38 events were reported across Indiana with 13,790 items collected and delivered to food pantries or food banks with an additional $133,282.79 contributed to support those efforts. All projects were youth created and implemented ranging from trick or treating for canned goods to

establishing and hosting canned food drives in collaboration with local 4-H Fair organizations.

4. Associated Knowledge Areas

KA Code	Knowledge Area
801	Individual and Family Resource Management
802	Human Development and Family Well-Being
805	Community Institutions, Health, and Social Services
806	Youth Development

Outcome #4

1. Outcome Measures

An impact on economic and/or community development resulting from new knowledge about leadership, economic development, government operations and/or community development

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Purdue Women in Agriculture team has provided education on succession and estate planning since 2002. Over the years, participants at a variety of these educational programs indicated their top human risk concerns as understanding relationships within a family farm, stress, wellbeing, estate, transition, and succession planning, and communication.

What has been done
Purdue Extension Women in Agriculture and Farm Succession Planning Teams developed a two-part workshop, Cultivating Strong Indiana Farm Family Relationships for Today and Tomorrow, which was designed to provide farm families with risk management tools to develop strong communication skills and an outline for succession planning. Workshop topics covered by the program were new farmer financial skills, working together through transition, communicating for success, business structure and taxes, pre and post nuptial agreements, and strategies for managing conflict.

Results

Over 80 farm family members and industry professionals attended workshops at five regional locations across Indiana. After attending:
93% felt workshop provided resources to support them in future succession planning decisions.
93% had increased their understanding of importance of building and maintaining effective relationships.
74% increased confidence in having effective conversations with family members about succession planning.
88% gained at least one new skill they could use in managing conflict with family members.
60% were planning to change how they communicated with family members when addressing future issues.
88% increased their knowledge of different business structures available for succession planning.
Ideas/Tools they would use immediately in their farm family operation were: operating with a team approach, having meetings that are planned or structured, evaluating estate plan with attorney, accountant, banker and insurance agent, using conflict management with family, and gathering team to establish under which entity we should be operating.

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development
801	Individual and Family Resource Management

Outcome #5

1. Outcome Measures

An impact on policy and/or regulation related to human, family and community, health and well-being.

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

An impact on individuals and families regarding financial literacy

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Parents of teenagers worry that their children will make major financial mistakes. Only 14% of 25,000 Americans correctly answered all five questions on a 2013 financial literacy quiz administered by the FINRA Investor Education Foundation. Forty-nine percent of mothers think their children are not going to be able to find a job, while 44% believe their children will not be able to finance a student loan.

What has been done
Presented in 4 instructional modules, Captain Cash was experienced by 2,659 Indiana third graders who were from farms, rural and small towns, and suburban or urban locations.

Results
Significant improvements in financial literacy were realized. Children are saving money, know how someone their age can earn money, plan to continue schooling after high school, understand value of education, save money for future, spend money on things they need before buying things they want, and know that borrowed money must be paid back.

4. Associated Knowledge Areas

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

Outcome #7

1. Outcome Measures

An impact on child development

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Play with blocks provides young children and their parents or childcare providers with unique

opportunities for building positive relationships, early learning, and school readiness. Constructive, open-ended play with blocks, with a supportive adult playmate, leads to improved cognitive, language, social-emotional, and physical skills for young children. Block play has been associated with academic success in mathematics, spatial abilities and literacy skills.

What has been done
Extension educators hosted 37 Block Parties in seven counties to introduce block play research to over 600 parents and childcare providers/preschool teachers. Educators offered suggestions and provided support materials to aid local communities in securing funding to purchase blocks and to put on their own local block parties.

Results
Parents reported they learned a great deal about block play. 88% said they "knew nothing" or "knew something" about benefits of block play before attending, and only 12% said they "knew a lot." After Block Party, 57% said they "knew a lot." Teachers and childcare providers reported gains in knowledge about block play, its benefits and how to facilitate children's play with blocks. They reported somewhat higher levels of knowledge than parents before attending, and a vast majority reported they "knew a lot" after attending. 73% of parents and 93% of professionals reported their "interest in encouraging block play" had increased.

4. Associated Knowledge Areas

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

Outcome #8

1. Outcome Measures

New research studies on treatments for chronic conditions

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Successful islet transplantation could dramatically impact lives of individuals living with type 1 diabetes by eliminating need for life-long insulin administration, improving quality of life, decreasing risk of hyper/hypoglycemic events, and reducing risk of long-term chronic complications. A major challenge that currently limits efficacy of islet transplantation as a therapy to replace insulin injections is loss of transplanted islets from attack by immune system.

What has been done
We developed a unique method whereby islets can grow their own protective, biocompatible shell to protect themselves from attack of immune system molecules and cells while allowing for proper detection of glucose and production of insulin. We used a new type of biomaterial that mimics hard tissues found in nature to overcome failures of previous soft polymer materials. We tested biosilica-coated islets for survival after transplantation and reverse hyperglycemia in diabetic mice, and in vitro with cytokines (small proteins produced by immune system) known to participate in death of islets in human type 1 diabetes.

Results
Biosilica coating provided partial protection to islets from cytokine challenge. We demonstrated biosilica coating increased survival of human islets in culture. Methods could improve efficacy of islet transplantation as a treatment for individuals with type 1 diabetes to achieve insulin independence, eliminating or reducing the need for insulin injections, without suppressing the immune system.

4. Associated Knowledge Areas

KA Code	Knowledge Area
723	Hazards to Human Health and Safety

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

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Outcome 1 - lab study - Vitamin D impact on cancer cell development
Outcome 2 - pretest and posttest on knowledge, self-efficacy and behavior related to nutrition and parenting.

Outcome 3 - community events to collect donations of food and money
Outcome 4 - post-survey on knowledge, confidence, skill and intention to take action
Outcome 6 - pretest posttest; follow-up surveys on financial literacy
Outcome 7 - post-pretest survey on knowledge about and interest in block play
Outcome 8 - lab study - biosilica coating on transplanted islet for diabetes treatment

Key Items of Evaluation

Outcome 1 - Discovery contributes to guidelines for dietary vitamin D toward preventing development of breast cancer and preventing insulin resistance

Outcome 2 - Improved prenatal care; significant improvement in knowledge about parenting and attitudes toward physical activity, nutrition, food safety and breastfeeding.

Outcome 3 - 13,790 food items collected and delivered to food pantries/banks; $133,282.79 contributed to support those efforts

Outcome 4 - Farm families increased knowledge of and confidence in their ability to develop a family succession plan, and intended to take actions for their farm operations

Outcome 6 - Using paired T-tests, statistically significant difference in knowledge about saving money from pre- to posttest

Outcome 7 - Knowledge about and interest in using block play with children increased

Outcome 8 - increased acceptance of biosilica coated islet transplant helped achieve insulin independence, eliminating/reducing need for insulin injections, without suppressing immune system

V(A). Planned Program (Summary)

Program # 7

1. Name of the Planned Program

Natural Resources and Environment

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
101	Appraisal of Soil Resources	1%		1%	
102	Soil, Plant, Water, Nutrient Relationships	18%		18%	
104	Protect Soil from Harmful Effects of Natural Elements	5%		5%	
111	Conservation and Efficient Use of Water	2%		2%	
112	Watershed Protection and Management	6%		6%	
121	Management of Range Resources	1%		1%	
123	Management and Sustainability of Forest Resources	18%		18%	
125	Agroforestry	1%		1%	
131	Alternative Uses of Land	10%		10%	
132	Weather and Climate	4%		4%	
133	Pollution Prevention and Mitigation	24%		24%	
135	Aquatic and Terrestrial Wildlife	10%		10%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	1.4	0.0	6.7	0.0
Actual Paid Professional	4.8	0.0	22.3	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**
833634	0	526757	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1686741	0	2929644	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
282275	0	1030196	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

• Workshops •Extension publications •Public service announcements •Research projects •Web site development •Home and farm visits •Displays •IP video programs •Demonstrations and field days •One-on-one consultations •Collaboration with other agencies

2. Brief description of the target audience

• Agricultural producers •Rural and urban residents •Elected officials and other decision-makers •Owners of private and public forestlands and wildlands •Natural resource professionals •Technical service providers •Tree care providers •Right of way managers •Urban planners •Youth

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	121645	1680726	25569	25712

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

Patent Applications Submitted

Year: 2013

Actual: 8

Patents listed
8,277,352 US
5286408 Japan
10-1276965 South Korea
8,474,254 US
8,453,441 US
8,454,469 US
844605/Trademark New Zealand
844605/Trademark New Zealand

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	231	46	277

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of programs offered to producers, land owners, and land managers.

Year	Actual
2013	471

Output #2

Output Measure

- Number of research projects
  Not reporting on this Output for this Annual Report

Output #3

Output Measure

- Number of demonstrations and field days

Year	Actual
2013	553

Output #4

Output Measure

- Number of Extension publications written, new & revised

Year	Actual
2013	231

Output #5

Output Measure

- Number of K-12 Classroom visits

Year	Actual
2013	381

Output #6

Output Measure

- Number of one-on-one consultations

Year	Actual
2013	1431

Output #7

Output Measure

- Number of newsletter or magazine articles written

Year	Actual
2013	45

Output #8

Output Measure

- Number of volunteers trained
  Not reporting on this Output for this Annual Report

Output #9

Output Measure

- Number of Extension publications distributed

Year	Actual
2013	6694

Output #10

Output Measure

- Number of research publications

Year	Actual
2013	168

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of participants who increase knowledge of practices to protect water resources
2	Number of participants who improve decision making for use of water resources
3	Number of participants who increase knowledge of proper application of fertilizer, manure and waste products to soil and potential for environmental consequences of misapplication
4	Number of participants who increased adoption of proper application of fertilizer, manure and waste products to soil
5	Number of participants who increase knowledge of best management practices for optimal manure nutrient utilization with on- and off-site agricultural lands
6	Number of participants who adopt best management practices for optimal manure nutrient utilization with on- and off-site agricultural lands
7	Number of participants who increase knowledge of the value of ponds in landscapes and methods for installing and managing ponds
8	Number of participants who increase value of landscapes through better installation and management of ponds
9	Number of participants who increase knowledge of on-site wastewater treatment siting and maintenance needs
10	Number of participants who make more informed decisions for on-site wastewater treatment siting and maintenance
11	Number of water quality violations related to animal production and land application in the state of Indiana
12	Number of tree care providers in Indiana who become certified arborists.
13	Number of professional natural resource advisors who have the skills necessary to assess the health of the wildlands
14	Number of wildlands owners who have a relationship with knowledgeable professional natural resource advisors and have developed and implemented a management plan
15	Number of natural resource professionals and wildland owners who have worked with landowners to develop and implement management plans
16	Number of owners of wildlands who will have assessed the health of their lands and developed and implemented management plans
17	Number of landowners with knowledge of proper tree planting and management techniques

18	Number of participants who increased their knowledge of natural resource management
19	Number of participants who increased their knowledge of proper application of pesticides
20	Number of participants who increased their knowledge of topsoil importance
21	Number of participants who increased their knowledge of Indiana's diverse wildlife
22	Number of woodlot owners who improved their management skills
23	Increased utilization of technology and data to improve land management (forestry, farm, crop, water, other.)
24	Research, Education, Extension initiatives regarding forest and tree health
25	Prediction and detection of pests and pathogens

Outcome #1

1. **Outcome Measures**

Number of participants who increase knowledge of practices to protect water resources

Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

Number of participants who improve decision making for use of water resources

2. **Associated Institution Types**

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual

2013 0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Opportunities abound to advance the science and sustainable practice of agriculture through better use of the wealth of data collected by researchers, state and federal agency monitoring programs, public-private partnerships and farmer collaboratives. To date, however, the potential of these opportunities is largely unrealized reflecting a host of barriers that restrict data reuse for purposes beyond the intent for which it was originally collected.

What has been done
We conducted a workshop to coalesce the grass-roots efforts on data access and reuse currently on-going across a broad array of projects and entities. Our objectives were to foster the dialogue on critical steps in the pathway of short data lifecycles with limited return on investment to a data model featuring longer lifecycles and added value through data repurposing and aggregation. We identified and invited broad representation of data stakeholders with the intent of accelerating existing efforts through collaboration. The workshop format was designed to brainstorm, identify and foster beneficial linkages toward the broad goal of developing a functional data infrastructure for agriculture.

Results
Workshop participants learned about resources and opportunities to increase their ability to manage their own data and make it interoperable with other data streams. Critical next steps were identified in research, education, and outreach and extension. Private partners identified barriers to their ability to participate in the data value chain. Prioritized next steps include the development of (i) data standards for agriculture, (ii) educational programs for data literacy, and (iii) formal infrastructure for systematic reviews of agricultural research to facilitate better use of research results in agriculture management and policy. The Cochrane Collaborative model in medicine which supports evidence-based medical interventions through the collection of disparate data points was identified as a potential key model to explore for next steps.

4. Associated Knowledge Areas

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

Outcome #3

1. Outcome Measures

Number of participants who increase knowledge of proper application of fertilizer, manure and waste products to soil and potential for environmental consequences of misapplication

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Number of participants who increased adoption of proper application of fertilizer, manure and waste products to soil

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Indiana animal agriculture produces about 9.5 million tons of manure every year, equivalent to 1.4 tons per resident per year. Animal manure can cause water, air, and soil pollution and greenhouse gas from animal manure could have a long term impact on climate. Animal manure is also a valuable soil amendment and renewable energy source. With the increasing size of concentrated animal feeding operations, new knowledge and technology are needed for waste management and application, and for pollution assessment and mitigation.

What has been done
We completed a survey on Indiana poultry manure resource and finished a multi-state study on volatile fatty acids in, and odor and gases from stored dairy manure to gain fundamental knowledge about the relationship between dairy manure and its environmental impact. We developed two websites to distribute scientific and technical information to stakeholders. And established a task force on anaerobic digestion in Indiana to develop educational materials and promote the use of the technology. We participated in the multistate project of National Extension Programming in Climate Change Mitigation and Adaptation for Animal Agriculture. And engaged in international activities on biogas production from animal wastes.

Results
This was the first comprehensive poultry manure survey in Indiana. Stakeholders have a better understanding of the production, application, and current issues related to poultry manure. Its potential impact is to increase the use of poultry manure as organic fertilizer, reduce the costs for crop production, and better protect environment. Twenty-four members from representatives of 20 state agency, commodity group, industry, producer, biogas digester owner, and extension educator, staff, and faculty have joined the Task Force of anaerobic digestion. An increasing number of producers are interested in this technology. Three new large-scale anaerobic digester

systems are currently being constructed in Indiana. Engagement efforts reached about 150 individuals, including researchers, producers, and undergraduate students.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation

Outcome #5

1. Outcome Measures

Number of participants who increase knowledge of best management practices for optimal manure nutrient utilization with on- and off-site agricultural lands

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Number of participants who adopt best management practices for optimal manure nutrient utilization with on- and off-site agricultural lands

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Number of participants who increase knowledge of the value of ponds in landscapes and methods for installing and managing ponds

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Well over 150,000 private individuals own 74 percent of the state's forest land. Suburban sprawl, new roads and utilities, and the parcelling of larger forested tracts into house lots are all eroding recent gains in forest land. In addition to loss of larger forest tracts, a growing population of these landowners do not have experience in natural resource or woodland management.

What has been done
In connection with the Forestry and Natural Resources Issue Based Action Team (FNR IBAT), Purdue Extension Forestry and Wildlife specialists in cooperation from county based Purdue Extension Educators developed an 8 week curriculum to instruct and educate families about techniques, practices and assistance for developing and enhancing forests, landscapes, ponds and other natural resources on their land. Warrick Co was one of two test sites for this program. Besides classroom instruction, a field day was also developed to maximize understanding and learning.

Results
Participants completed a survey at the end of the program. They indicated the following results: 85 percent indicated the information presented will help them meet the natural resource goals for their property, 71 percent indicated the information presented will assist in their efforts to increase revenue potential for their properties, and 100 percent indicated they expect to change their land use practices with the knowledge they gained from the course. Each session was also evaluated to determine improvements in the course curriculum for the 2013-2014 programming year.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
135	Aquatic and Terrestrial Wildlife

Outcome #8

1. Outcome Measures

Number of participants who increase value of landscapes through better installation and management of ponds

Not Reporting on this Outcome Measure

Outcome #9

1. **Outcome Measures**

   Number of participants who increase knowledge of on-site wastewater treatment siting and maintenance needs

   Not Reporting on this Outcome Measure

Outcome #10

1. **Outcome Measures**

   Number of participants who make more informed decisions for on-site wastewater treatment siting and maintenance

   Not Reporting on this Outcome Measure

Outcome #11

1. **Outcome Measures**

   Number of water quality violations related to animal production and land application in the state of Indiana

   Not Reporting on this Outcome Measure

Outcome #12

1. **Outcome Measures**

   Number of tree care providers in Indiana who become certified arborists.

   Not Reporting on this Outcome Measure

Outcome #13

1. **Outcome Measures**

   Number of professional natural resource advisors who have the skills necessary to assess the health of the wildlands

   Not Reporting on this Outcome Measure

Outcome #14

1. **Outcome Measures**

   Number of wildlands owners who have a relationship with knowledgeable professional natural resource advisors and have developed and implemented a management plan

   Not Reporting on this Outcome Measure

Outcome #15

1. **Outcome Measures**

   Number of natural resource professionals and wildland owners who have worked with landowners to develop and implement management plans

   Not Reporting on this Outcome Measure

Outcome #16

1. **Outcome Measures**

   Number of owners of wildlands who will have assessed the health of their lands and developed and implemented management plans

   Not Reporting on this Outcome Measure

Outcome #17

1. **Outcome Measures**

   Number of landowners with knowledge of proper tree planting and management techniques

   Not Reporting on this Outcome Measure

Outcome #18

1. **Outcome Measures**

   Number of participants who increased their knowledge of natural resource management

2. **Associated Institution Types**

   - 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Human activities ranging from forest harvest through recreation in parks all impact wildlife. In response, humans can take a range of actions from modifying their own activities through reintroducing species that have gone extinct locally. To make the best possible decision about these actions we need a better understanding of the implications of these activities upon wildlife populations and the demographic and behavioral characteristics of those populations that underlie observed responses.

What has been done
A number of papers were published and a model developed that reflect the relationship between wildlife and human populations. The paper published in the Journal of Herpetology uses empirical data from telemetry studies to estimate the annual survival rates of an important endangered species in Indiana. This is vital background data to understand how we can manage hellbender populations. The paper published on Indiana bat response to highway projects uses a modeling tool developed in this lab to explore how road systems impact foraging by federally endangered bats. The paper published on the Karner blue butterfly uses a modeling tool developed in this lab to understand how recreation in Indiana Dunes National Lake Shore impacts this federally endangered butterfly. The paper published on the simulation SEARCH describes an important new modeling tool developed in my lab that will be used in the future to address many issues of land management.

Results
The paper published on the Karner blue butterfly has important implications for the management of recreation and habitat in numerous areas throughout the eastern U.S. where this federally endangered butterfly is a species of great concern. This research is of further of global importance as the first example of modeling the impacts of recreation upon an invertebrate. Our simulation SEARCH tool will be applied to help manage forest habitat for state endangered marten in WI and to help understand how raccoon dispersal in Indiana might impact the risk of disease spread.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
121	Management of Range Resources
123	Management and Sustainability of Forest Resources
135	Aquatic and Terrestrial Wildlife

Outcome #19

1. **Outcome Measures**

   Number of participants who increased their knowledge of proper application of pesticides

   Not Reporting on this Outcome Measure

Outcome #20

1. **Outcome Measures**

   Number of participants who increased their knowledge of topsoil importance

   Not Reporting on this Outcome Measure

Outcome #21

1. **Outcome Measures**

   Number of participants who increased their knowledge of Indiana's diverse wildlife

   Not Reporting on this Outcome Measure

Outcome #22

1. **Outcome Measures**

   Number of woodlot owners who improved their management skills

   Not Reporting on this Outcome Measure

Outcome #23

1. **Outcome Measures**

   Increased utilization of technology and data to improve land management (forestry, farm, crop, water, other.)

2. **Associated Institution Types**

   - 1862 Extension
   - 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Maps allow us to make sense of a space that is too large and too complex to comprehend in any other way. Soil maps make sense of the complicated patterns of soils across the landscape, yet the spatial aspects of soil science are taught poorly, if at all. Food and water security, biodiversity, climate change, etc. all have important spatial aspects in which soils play a crucial role. As soil science educators, we can and must do better as many of the major issues facing humanity have a soil component and spatial aspects that cannot be ignored.

What has been done
In 2005, Agronomy scientists began experimenting with teaching soil science using digital maps, which led to the development of Integrating Spatial Educational Experiences (Isee) web site (http://isee.purdue.edu/). A recently awarded multi-state USDA Higher Education Challenge Grant Project will expand the teaching-with-maps concept to 6 additional states and will create apps for mobile devices so that students can access the maps in the field.

Results
The teaching-with-maps approach has been fully incorporated into six courses in the Agronomy Department and in one course in the Earth, Atmospheric, and Planetary Sciences Department. Isee has impacted 1,254 students since the fall semester of 2010. Its website receives at least 200 visits each month, with usage increasing dramatically during the spring and fall when classes are in session. The statistics suggest that Isee is being used at other Indiana colleges and universities, as well as by students in middle and high school that participate in Indiana's Soil Judging Program each fall. From feedback received via the website and personal communications, Isee is being used by landowners and other members of the general public.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
121	Management of Range Resources
123	Management and Sustainability of Forest Resources
131	Alternative Uses of Land

Outcome #24

1. Outcome Measures

Research, Education, Extension initiatives regarding forest and tree health

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Thousand cankers disease has caused widespread death of black walnut trees throughout the West and was recently detected in Tennessee, Virginia, Pennsylvania and Ohio. This disease complex is caused by a Geosmithia fungus vectored by the walnut twig beetle (WTB). Male WTB locate suitable black walnut hosts by orienting to host odors and, once on an appropriate tree, release volatile aggregation pheromones that coordinate mass attack and mating. Current monitoring and detection efforts for WTB rely on a pheromone lure that is effective from a distance of only ~20 m. The goal of this project is to develop a kairomone-based lure for WTB and evaluate the capacity of other beetles attacking black walnut to vector Geosmithia morbida.

What has been done
We found that walnut twig beetles (WTB) are more attracted to volatiles of girdled branches and tested the efficacy of these volatile compounds to attract WTB in the field. Geosmithia morbida was not among the fungi isolated from 257 beetles reared from girdled branches of black walnut; however, a close relative, G. pallid, was recovered from two types of ambrosia beetles.

Results
Determining the capacity of other insects to vector G. morbida is essential for managing the disease complex and determining its potential environmental and economic impact. This work will also provide an advanced management tactic (i.e., kairomone lure) to aid in the early detection of WTB in urban trees, forests and parks, home landscapes, roadsides and public spaces. Identifying those bark and ambrosia beetles that attack black walnut in the native range will aid surveyors in differentiating between walnut twig beetle and other species. Also, knowing which fungi are carried by beetles will determine if we need to monitor for other beetle species that might carry G. morbida or other tree pathogens.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources

Outcome #25

1. Outcome Measures

Prediction and detection of pests and pathogens

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A nationwide network with a cohesive, distributed system to quickly detect high consequence pests and pathogens that have been introduced into agricultural and natural ecosystems, identify them, and immediately report them to appropriate responders and decision makers is needed to allow rapid decision making in critical growing time periods.

What has been done
CERIS (Center for Environmental and Regulatory Information Systems) located and staffed by Purdue using USDA cooperative funding, provides the NPDN (National Plant Diagnostic Network) with specific tools to query, and create reports and maps for over 200 NPDN members. A new NPDN web-based reporting tool, the Pest Threshold report, allows the user to view a table with a list of diagnostic results by state for a user defined date range and lists the number of occurrences of each diagnosis.

Results
First submitter reports, dynamically generated on a daily basis, are sent via email to the NPDN executive and associate directors, key USDA personnel from NIFA and APHIS, diagnosticians and appropriate state regulatory staff indicating the first time a pathogen is entered into the repository for a state. Email notifications indicating the first in state occurrences from the National Repository help to more quickly assess anomalies and potential outbreaks of pests and pathogens as well as detecting a false confirmation. The Pest Threshold Report is useful in looking for sudden spike in counts and which states are affected.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
104	Protect Soil from Harmful Effects of Natural Elements

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

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Outcome 2 - compilation and development of functional data infrastructure for agriculture
Outcome 4 - survey of stakeholders in poultry
Outcome 7 - post-survey; landowner knowledge of and intended change in practices for conservation; impact on revenue
Outcome 18 - lab studies for modeling habitat management for endangered species
Outcome 23 - applying mapping to soil studies
Outcome 24 - lab and field studies; analyzing beetle and fungi variables impacting disease
Outcome 25 - created network of data and tools for monitoring high consequence pests and pathogens

Key Items of Evaluation

Outcome 2 - Established use of models for Agriculture data review and use
Outcome 4 - identified production and application issues related to poultry manure
Outcome 7 - 71% indicated information will assist their efforts to increase revenue potential for their properties, 100% indicated they expect to change their land use practices with knowledge gained
Outcome 18 - Models developed for habitat management for hellbenders, bats, butterlies

Outcome 23 - Soil maps posted on web are being accessed by students at Purdue, other colleges, high schools and by land owners

Outcome 24 - Provided advanced management tactic for early detection; identified and monitored traits of beetles and fungi for disease impact and spread

Outcome 25 - Provide detection of outbreaks and sudden spikes in data more quickly for rapid responses and decision-making