2016 Purdue University Combined Research and Extension Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

DIVERSITY:
A diverse, inclusive community is an integral part of the Purdue experience. We strive to create and sustain a welcoming campus where all students can excel; increase and retain the number of historically underrepresented and diverse students, faculty and staff at Purdue; and prepare all students to thrive in our global environment. There are a wide range of faculty, staff and public initiatives across the Colleges of Agriculture, Health and Human Sciences (HHS) and Veterinary Medicine. For example, Navigating Our Differences, a 3 day, 5-module experiential cultural competence training intertwines research-based theories and frameworks with activities and discussion from participants own experiences. This Extension based program is available annually for tenure-track faculty, administration and non-academic staff. We also have programs in agriculture and HHS that range from nutrition out-reach to low income and underserved minorities to the Hometown Collaboration Initiative (HCI) with specific activities geared toward recruiting and engaging a diverse mix of local citizens in a collaborative conversation about the community.
Ag Research continues to invest in enhancing the diversity of our graduate program. We have built a strong relationship with the HBCUs by visits and exchange programs each year, As a result, our enrollment of diverse graduate students has gone from 7% to 14% in 5 years. While we still have a long way to go to reach our target of 20%, we have made progress and expect to make additional progress as a recipient of one of Purdue's inaugural Diversity Transformation Awards (DTA). The goal of the project is to enhance connection among faculty from the College of Agriculture and faculty from partner HBCUs (NC A&T, Alcorn State, Tuskegee) through a short-term faculty exchange and hosting program. Over the next 2 years, we will host 20 faculty per year from HBCU partner schools and enable 20 faculty per year from Purdue to reciprocate with travel to HBCU campuses for 1.5 to 2 days. To measure the impact of the exchanges on attitudes and behaviors, the Discovery Learning Research Center (DLRC) has developed a survey tool to assess the following areas: 1) demographics, 2) awareness of program, collaborations, and graduate students at HBCU and Purdue 3) impact on stereotypes about HBCU/Research Intensive Universities, and 4) likelihood of engagement, and enhanced cultural competency of faculty. This not only will expand research capacity at both institutions, but also will break down perceived barriers at each institution around cross-training, transferring, and recruiting the best and brightest graduate students
Extension is expanding the diversity of participants through a variety of programs and initiatives:
1) When it comes to achieving and sustaining diversity, the Indiana 4-H program is at the forefront of 2 extremely creative and unique initiatives. The initiatives are a series of Spanish promotional videos filmed by the Working for Our Dreams 4-H Club and an "En Español" tab on the Indiana 4-H website. These initiatives exemplify the mission of 4-H and make learning opportunities available to all Indiana youth, regardless of their race, primary language, or national origin. Indiana 4-H Volunteer applications have been available in the Spanish language for several years. The integration of the promotional videos on the website takes our commitment to the next level and demonstrates that Indiana 4-H is open to all youth, regardless of their race, primary language, or national origin.
2) 4-H Spark Clubs are groups designed to offer youth new learning experiences and opportunities related to a specific interest, and serve as an entry point to the full suite of opportunities Indiana 4-H can provide. New clubs are forming across Indiana including the Picapiedras (The Flintstones) at George Washington

High School that focuses on STEM education via a go-kart program associated with the Indianapolis 500. Another example is the elementary school Spark Club in Lafayette where 60% of students receive free or reduced lunch and 50% come from minority populations. These children are taking part year-round in: 1) A summer program at Purdue focusing on healthy lifestyle choices via sports, fitness, swimming, nutrition, computers, financial literacy, careers, gang avoidance, service learning, and select special events, and 2) The Tippecanoe County 4-H programming twice weekly after-school for positive experiences to keep youth engaged.
3) Indiana health coalitions facilitated by Purdue Extension, working to address priority community issues, are focusing on poverty and homelessness. Coalitions bring community partners together to enhance the quality of life for all citizens within a community. Programming in communities result from partnerships with local services and offer a variety of workshops to address parenting, stress management, communication, financial literacy, healthy lifestyle, and are available in Spanish.
4) The Hometown Collaboration Initiative is available to Indiana communities committed to building on their existing assets. It is available to cities, towns and counties in Indiana whose total population is 25,000 or less. The HCI is a long-term capacity-building program that is comprise of 3 phases that take communities about 2 years to complete. The focus of this program is to recruit HCI team members who represent the diversity of the community, including business/industry, local government, education, faith-based and nonprofit organizations, racial/ethnic minorities, elderly, and youth.
5) In 2002, Purdue Extension hosted the first Midwest Women in Agriculture conference. Due to its popularity over the next several years, the annual event led to the formation of the Purdue Women in Agriculture Team in 2006. The team's goal is to help address the educational needs of women employed in or involved with the agricultural industry. The team is composed of Purdue Extension Educators and Specialists, as well as representatives from industry. The Purdue Women in Agriculture Team is committed to providing educational opportunities, up-to-date resources and a network of support to position all women for success in the agriculture industry through skill development, confident decision making and personal wellbeing.
The College of Ag's Office of Multicultural Programs has been awarded 3 USDA Multicultural Scholars Programs awards over the last 5 years. The most recent program has focused on developing leaders in targeted majors. The program goes beyond getting the student in the door, it also reflects and addresses the complex web of needs and concerns of today's competitive marketplace. Four of the 7 scholars have graduated and are employed, 2 remain on the academic dean's list with another maintaining a solid GPA.
AGRABILITY
National AgrAbility Program (NAP) education outreach to 1890 and 1994 Land-Grant Institutions included workshops at Tuskegee University, Virginia State University, and the National Black Farmers Association conference. In addition, 1890 representatives were on the planning committees for the national AgrAbility training workshop and 13 1890 institutions were represented at the conference. A 1994 Land-Grant workshop is scheduled for 2017 at Chief Dull Knife College. Veteran-specific training sessions were included in the national training workshop and about 25 veterans and family members attended. A veterans resource web page was added to the website. A video, The Next Mission: Breaking down Barriers for Veterans in Agriculture, detailing how farming became their next mission after their service and how AgrAbility helped them in the process, was completed and distributed. NAP partnered with the Farmer Veteran Coalition in workshops and conference presentations, and a representative is on the NAP advisory team.
FOCUS ON INDIANA CROPS
Two crops are of significant importance to Indiana beyond corn and soybeans--mint and honeycrisp apples.
Honeycrisp apples: This project has focused on evaluating the influence of rootstocks on temperate fruit trees in various environments while also enhancing the sustainability of fruit farming using eXtension for delivering valuable information. Growers were made aware of several promising rootstocks.
Mint oil: The genetic base of commercial mint is narrow and genetic improvement is believed to be necessary for long-term sustainability of the crop and resulting oils. Purdue researchers have performed thousands of crosses to improve mint oil production. The best successes produced significant levels of

flowering and pollen production which increased pest pressure and resulted in additional chemical management. By moving to a biocontrol strategy, the team was able to reduce insect pressure while also improving worker safety.

PEST MANAGEMENT

As quality and field performance of commodity crops continue to improve, farmers find themselves facing more and more threats from pests. Some pests are familiar to farmers but are becoming more abundant and aggressive, while other pests are newly discovered.

Research

Honey Bees: Varroa mites and the viruses they transmit are one of the most important factors in the death of honey bee colonies, especially in northern states. Many beekeepers do not want to use pesticides in their hives to control Varroa mites so there is a great need for bees that are tolerant to mites. We discovered that bees can fight back by grooming mites from themselves and biting them to immobilize them. We have bred bees that are better at removing Varroa mites. We initiated a Midwest queen breeders cooperative that is sharing stock and producing about a thousand mite-resistant queens each year. This group also helped to evaluate different stocks of bees. In a blind study, beekeepers helped evaluate honeybee stocks in Indiana, Illinois, Michigan and Ohio. Hives with the Purdue stock had lower Varroa mite levels and higher honey production, and were preferred by beekeepers 10 to 1. In another study, researchers showed that in addition to exposure to pesticides from agricultural crops (neonicotinoids), honeybee hives were also contaminated with pyrethroid insecticides that come from use of repellants that target mosquitos and other nuisance pests. The study showed that bees pollinating non-cultivated plants rather than crops is the principle source of hive contamination.

Extension

We had more than 900 people attend Integrated Pest Management (IPM) workshops for large farm operations throughout the year around the state. More than 92% said they would use the new practices shared in the meetings. This included how to properly identify the pests and use the appropriate treatment. Nearly 40% of these participants influence pest management on 10,000 acres or more which should result in a significant positive impact on the bee population. Extension educators conducted a wide variety of workshops that included bee management in hives and on backyard vegetable gardens. While the focus of each of the workshops were different, survey results from 5 events indicated that close to 700 people would adopt a recommended bee management practice they had just learned and in 2 workshops, 250 people reported they adopted fertilizer and pesticide recommendations.

New Discovery

Nematodes! Another suite of important pests to manage are nematodes found in soybean, corn and mint fields. The team discovered a new plant parasitic nematode in Indiana on mint. Further research is necessary to determine how to reduce the impact or kill the parasite.

SOIL AND WATER

Billions of dollars are being spent for the design and implementation of agricultural conservation practices with the primary goal of reducing nonpoint source pollution agriculture. Purdue has numerous research and Extension projects happening across the campus. A few significant projects are highlighted here. During the initial year of the project, a team of 39 researchers and educators across 9 academic institutions and agencies in the Midwest came together with a goal to advance and coordinate research, Extension, and implementation of drainage water storage systems, specifically the practices of controlled drainage, saturated buffers, and drainage water recycling. The project team identified and described a network of 34 experimental drainage sites across 8 states representing 186 site-years of data encompassing a variety of agronomic, hydrologic, and climate data to allow for characterization of production and water quality impacts of drainage water storage. Sixteen of these experimental sites are currently collecting data to evaluate the drainage practices. A database framework was developed to manage experimental data from the project area to encourage collaboration and enhancements to the agro-ecosystem model DRAINMOD which will allow for improved modeling of drainage water storage. The team began outreach and education related to drainage water storage in the landscape piloting education modules on soil and water management concepts to grade 9-12 students and their teachers, reaching more than 700 drainage stakeholders during Extension events in Illinois, Indiana, Iowa, Minnesota,

Missouri, and Nebraska and presenting to more than 400 members of the research community at various conferences. This broad and growing network of research, Extension, and education provides a critical foundation for bringing about the long-term vision of transforming drainage to increase resiliency of drained agricultural landscape

We learned that with a little training and simple equipment, members of the public can generate data that provides valuable insights into the health of local streams. Twice a year, hundreds of volunteers participate in the Wabash Sampling Blitz (a river that runs through the state and near campus) at 206 sites. Volunteers proved consistently able to estimate nitrogen concentrations in the water with moderate to substantial agreement to lab values.

Long-term rainfall analyses, another multi-state project, revealed that dramatic changes can occur in seasonal rainfall even where there is no appreciable change on an annual basis. Understanding when and how much rain falls through the season shifts the management practices to better utilize water in the fields.

Purdue Extension Rainscaping Education Program provided training for communities to use sustainable landscape design and management practices by directing storm water to be absorbed by plants and soils. Communities are incorporating rain gardens, tours, education and exhibits to promote conservation of water.

In 2016, a total of 1,101 participants attended the Crop Diagnostic Training and Research Center Workshops. These participants have an impact over 17,000,000 acres of farmland in the Midwest. Examples of the information presented included the proper identification of agronomic pests and their damage to crops, managing resistant weeds, decision making tools for delayed planting and replanting, growth staging crops (primarily corn and soybeans), diagnosing nutrient deficiency symptoms in plants, current fertilizer recommendations, soil fertility issues, tillage issues, and forage identification and double-crop forage options. Participants highly rated the educational value of the workshops as indicated by our survey results: 99% of the participants indicated that the workshops clearly helped them improve their overall crop production knowledge; 98% of the participants (when considering their costs) indicated that attending these workshops was well worth their time and expense; 99% determined that the information gained will likely be shared with colleagues/customers; and finally, when the participants were asked to rate the overall value of the workshops, 92% were highly satisfied to satisfied with the program they attended. These values clearly indicate that the workshops conducted at the DTC are highly valuable to the participants and are very successful in training individuals in the area of production agriculture.

STRENGTHENING FAMILIES

Extension programs are supporting families via the Strengthening Families and the Co-Parenting programs. Families are learning how to help youth deal with peer pressure, improve communication skills, and solve problems, individually and as a family, and enjoy time together. For parents going through a divorce or separation, single parents who are co-parenting, or parents with a court order for parenting education, Extension programming helps to reduce conflict between co-parents to improve child well-being.

EMERGING TOPICS

Urban Agriculture and Farm-to-Fork

USDA describes urban agriculture as backyard, roof-top and balcony gardening, community gardening in vacant lots and parks, roadside urban fringe agriculture and livestock grazing in open space. At Purdue, urban agriculture has always been woven in the fabric of many undergraduate programs.. Purdue Extension wants to reduce urban land vacancy and increase food access and community resiliency in Marion County through a new urban-farmer training program and incubator farm. The program is adapting a beginning farmer program to an urban context. Many individuals, including underserved populations, have limited access to fresh produce in cities. Populations served with this initiative include African American/Black and other races and low income. Efforts seek to create a network of produce growers and learners to increase availability of urban produce productions. Activities center on training and networking in horticultural production. Program graduates will come away with business plans and strategies for overcoming the unique constraints of growing food on urban land. The program is being developed currently to utilize derelict land and convert it into 2 incubator farm sites offered via competitive application process to beginning farmers for less than market rate. Extension educators conducted 17 diversified

farming workshops which covered urban agriculture topics and trained nearly 275 farmers/food producers on these concepts.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	78.2	0.0	273.2	0.0
Actual	60.9	0.0	180.7	0.0

II. Merit Review Process

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

- Internal University Panel
- External Non-University Panel

2. Brief Explanation

Purdue receives federal formula funding for Hatch, Animal Health research and McIntire-Stennis for forestry research. Hatch, Animal Health, and McIntire-Stennis research projects offer a unique overview of individual, departmental, and team research at Purdue. The projects document the University's commitment to partnership with other land grant universities, the USDA, and the state of Indiana. Purdue faculty in the College of Agriculture, College of Veterinary Medicine, and selected Departments in the College of Health and Human Sciences who have a research appointment of 20% or more are required to submit a five-year plan of research. These five-year plans are peer reviewed under the direction of the office of Agricultural Research at Purdue (ARP) and submitted to USDA-NIFA for final review and approval. The review panel, consisting of three reviewers, faculty member department head, and Marshall Martin, Senior Associate Director of ARP, meets with the faculty member and provides feedback on the project. Once the faculty member submits any revisions to the project based on the feedback, ARP will then submit the project electronically through the REEport Project Initiation module. Faculty prepare online and submit Annual Progress Report plus a Final Report at the end of the 5-year period. The office of ARP is responsible for ensuring that Purdue faculty members comply with Hatch peer-review procedures and for the quality of reporting submitted to REEport.

III. Stakeholder Input

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

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

Brief explanation.

There are many ways we work with stakeholders to gather information. Every few years we conduct a general public survey at the Indiana State Fair which is one example of stakeholder surveys. In August 2016, Purdue Agricultural Research Program (ARP-- Ag Experiment Station) had a booth in the new Purdue Extension Ag/Hort Building at the Fairgrounds. We converted from paper surveys to electronic surveys on tablets and gave away stress relief toys in the shape of farm animals (cow, chicken, pig, etc.) to those that completed the form. Participants self-selected to approach the booth and all who approached the booth were provided a survey. 330 people participated.
Our Extension efforts to reach out to under-served and under-represented individuals, groups, and organizations across our communities and invite them to participate include marketing of our events and workshops, so that our stakeholders know they were eligible, how to register, where to attend, and so on. Some marketing is in Spanish. Examples of how we have marketed across the community include: 1) community-wide press releases and news articles via online, newspapers, radio and TV, 2) electronic and paper flyers, 3) websites, 4) newsletters, 5) social media, 6) emails, 7) and postcards. We collaborate with partner organizations and agencies in the community (providing them with information to share with their constituents) which extends the reach of our marketing. Some examples of partners in marketing across the community are: 1) Parks and recreation, 2) Schools, 3) Community centers, 4) Minority Health Coalition, 5) Hospitals and health services, and 6) civic groups/agencies. We also offer programs at specific community locations where individuals, groups or organizations can readily attend. Examples of programming locations to encourage participation are: 1) Child care facilities of low-income residents, 2) Community science centers, 3) Homeless shelters, 4) County correction facilities, 5) Farmers markets, 6) Early Head Start, 7) Public libraries, 8) YMCA/YWCA, 9) Senior services, and 10) Food pantries.

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.

As part of the College of Agriculture 5-year strategic planning process, to identify individuals and stakeholders to take part in these events, Extension produced letters and flyers for announcing community forums and inviting stakeholders to participate. Efforts to invite stakeholders to participate included reaching out to a variety of individuals, agencies and groups. Examples of some of the individuals, agencies and groups invited to participate were: WIC, Head Start, Senior Center, Extension Board, Extension Advisory Council, School corporation superintendents, principals, guidance counselors, and board members, minority coalitions, libraries, convention and visitors bureau, faith community and ministerial associations, Salvation Army, hospital, financial institutions, local charities, YMCA, boys and girls club, Veterans, community action programs, college success coalition members, social service agencies, elected and appointed officials, local division of Family and Children Services, county health department, county foundation, business leaders, Asian cultural center, Hispanic coordinator/programs, and Area Agency on Aging.

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.

We conducted a survey at the State Fair to determine research priorities that are important to the public. We utilized iPad tablets to collect data electronically via a Qualtrics survey. The survey had been IRB approved.
For the College of Agriculture 5-year strategic planning process 6 listening sessions were conducted by the Dean of the College in communities across Indiana to gather input from stakeholders on what we are doing well, and more importantly, where we can get better in research, teaching and extension. Extension facilitated community forums in 21 counties statewide. Four roundtable sessions were held at each forum to address building a vibrant Indiana, with a focus on: 1) Children, Youth, and Family, and 2) Community, Economy (Farms & Businesses), and Natural/Environmental Resources. Throughout the discussions and digging deeper into the top issues for each focus, priority issues were identified for the communities by the stakeholders. Using the Global Café technique, stakeholders met around tables to discuss issues and concerns, then share with the larger group, and finally to vote and map out priorities.

3. A statement of how the input will be considered

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

Brief explanation.

Research on campus is extremely complex and it is challenging to find questions to address the wide range of research done on campus from molecular and nano-particle research, to applied research on commodity animals. We provide a set of questions with broad categories to get a sense of priorities to stakeholders. We ask them to rate the importance of research on 8 topics such Food Safety, Crop Production and Bioenergy and Bioproducts to ensure our financial focus is on the topics they feel are important. We provide a written comment section for them to give us other ideas about what we should study and we discuss their interests at the fair booth when we ask them to take the survey. Fortunately, most of the topics identified in the survey comment section are sub-

categories within the broad categories posed in the survey-- we are already at work on them! Those topics where we aren't currently working are taken under consideration by the ARP office and they look for opportunities to promote research in those areas if appropriate.
Insight from stakeholders shared during the listening sessions, and themes, priorities, strategies, and activities generated from stakeholders in the community forums were incorporated into the College of Agriculture Strategic Plan that includes goals for research, Extension and teaching, as well as initiatives and actions to support those goals, and the metrics to help measure our progress. Research and Extension efforts reach beyond the College of Agriculture and include two other Colleges--Health and Human Sciences, and Veterinary Medicine. The College of Health and Human Sciences and Veterinary Medicine also completed strategic plans and received stakeholder input from around the state. We incorporated stakeholder input and blended it with our 3 college efforts to identify priorities and goals.

Brief Explanation of what you learned from your Stakeholders

We learned that the stakeholders feel that the research topics we're engaged in are Very to Extremely important. We are considering ways to expand the surveys to include a more diverse population to see if there are different opinions regarding our research focus.
As a result of the statewide community forum activities, each of the 21 locations generated priority issues, strategies or activities to address the issues: 1) Children, Youth, and Family, and 2) Community, Economy (Farms & Businesses), and Natural/Environmental Resources. Stakeholders gave suggestions for activities for Purdue Research and Extension to consider implementing. Based on the input, Extension mapped out initiatives and activities, and funded 12 team-led projects. Initiatives and projects are posted here: https://extension.purdue.edu/Pages/strategic/default.aspx. Also from the statewide community forums, feedback was given that Purdue must more powerfully and strategically share its story. As a result, we created Extension Does--a multimedia campaign of digital, print, and TV resources that launched its first phase in fall 2016. This distills efforts down into 4 key areas of agriculture, community, health, and youth, with a brief overview of efforts, impacts, and successes. In the 2-phase plan, messages broadcast for statewide and legislative audiences, then localized materials for use at the county level, will promote regional programs and achievements. Campaign elements can be viewed at http://www.extensiondoes.org.

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
9221219	0	6377345	0

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	9958077	0	6769662	0
Actual Matching	17379330	0	29636381	0
Actual All Other	3238065	0	7933384	0
Total Actual Expended	30575472	0	44339427	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	5293781	0	3310294	0

V. Planned Program Table of Content

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	4%		4%	
201	Plant Genome, Genetics, and Genetic Mechanisms	4%		4%	
205	Plant Management Systems	10%		10%	
206	Basic Plant Biology	4%		4%	
302	Nutrient Utilization in Animals	4%		4%	
304	Animal Genome	4%		4%	
305	Animal Physiological Processes	4%		4%	
307	Animal Management Systems	10%		10%	
315	Animal Welfare/Well-Being and Protection	4%		4%	
402	Engineering Systems and Equipment	10%		10%	
501	New and Improved Food Processing Technologies	2%		2%	
502	New and Improved Food Products	2%		2%	
512	Quality Maintenance in Storing and Marketing Non-Food Products	2%		2%	
601	Economics of Agricultural Production and Farm Management	10%		10%	
604	Marketing and Distribution Practices	3%		3%	
606	International Trade and Development	4%		4%	
608	Community Resource Planning and Development	10%		10%	
801	Individual and Family Resource Management	3%		3%	
802	Human Development and Family Well-Being	3%		3%	
805	Community Institutions, Health, and Social Services	3%		3%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	37.2	0.0	171.4	0.0
Actual Paid	39.4	0.0	111.4	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**
3203754	0	3669443	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
3870475	0	12413979	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
927362	0	1811185	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.
Develop websites, online decision-making tools, apps
Publish research and Extension publications
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 by Extension specialists in: Taskforces, Review Committees, Advisory Boards, Editorial Boards, Commodity committees/boards, Invited presentations, Honors and Awards, Common Interest Groups, Professional Societies
Increase use of social media

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.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	231302	3554889	96308	138374

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

Patent Applications Submitted

Year:	2016
Actual:	3

Patents listed
9,518,268
9,512,437
9,506,081

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	72	104	176

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of education workshops

Year	Actual
2016	1978

Output #2

Output Measure

- Number of Extension publications
  Not reporting on this Output for this Annual Report

Output #3

Output Measure

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

Output #4

Output Measure

- Number of volunteers

Year	Actual
2016	4007

Output #5

Output Measure

- Number of consultations

Year	Actual
2016	32283

Output #6

Output Measure

- Number of research projects

Year	Actual
2016	110

Output #7

Output Measure

- Number of volunteer hours

Year	Actual
2016	20163

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 diagnostic technologies (GFSH 2.6)
8	Discoveries, innovations, technologies and technologies transferred related to understanding demographics, decision-making processes, business relationships and economic situations of retail input suppliers.(FME 1.2)
9	Discoveries, innovations, technologies, and technology transfer related to performance management of suppliers (retail, commercial, other) (FME 2.2)
10	Improved plant genetics (GFSH 1.2b)
11	Discoveries, innovations, technologies and technologies transferred related to performance management of suppliers (FME 2.2)
12	Increased efficiencies or increases in yield/unit (GFSH 1.3)
13	Innovations in food enterprises including production, allied services, processing, and distribution (GFSH 2.3)
14	Policy decisions informed by university research and Extension
15	Discoveries, innovations, technologies and technologies transferred related to farmers (FME 1.1)
16	Projects related to impacts on/from domestic policy
17	Projects related to consumer preferences based on product quality.

18	Improved animal genetics (GFSH 1.1)
19	Technologies, innovations, discovery related to improving health for animals/humans.
20	Discoveries, innovations, technologies related to improving data, data reconciliation, improving insights, enhancing data collaboration (Data 2.1)
21	Number of participants informed about financial management of agricultural operations

Outcome #1

1. **Outcome Measures**

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

Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

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

Not Reporting on this Outcome Measure

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.

Not Reporting on this Outcome Measure

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.

Not Reporting on this Outcome Measure

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 diagnostic technologies (GFSH 2.6)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	7

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Plant pavement cells form the outermost epidermal layer of plants into a mosaic that drives the expansion of leaves. Leaves are the primary driver for converting sunlight to energy. Identifying shape changes has been a manual and subjective process which has impacted the ability of researchers engineer plant architecture.

What has been done
LobeFinder is an algorithm created at Purdue that is designed to remove the guesswork and standardize the data, analyzing cell shapes and providing graphs of cell growth and behavior in a matter of seconds per cell.

Results
LobeFinder offers a way to determine how changes in the cell boundary impact overall cell growth and patterning. This program creates a new way to graph the growth behavior of cells over time and therefore analyze mutants and genetic variants in a novel and quantitative manner. The program was designed to provide a semi-automated workflow to extract the coordinates of the cell outline from fluorescence micrographs. This will greatly increase the throughput of leaf phenotyping at the cellular level. This algorithm could measure changes in the boundaries of a number of irregularly shaped objects, such as immune cells, shifts in the size of the Arctic ice cap or plumes of oil in the ocean.

4. Associated Knowledge Areas

KA Code	Knowledge Area
206	Basic Plant Biology

Outcome #8

1. Outcome Measures

Discoveries, innovations, technologies and technologies transferred related to understanding demographics, decision-making processes, business relationships and economic situations of retail input suppliers.(FME 1.2)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	229

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
This project examines issues in international agricultural trade and trade policy through the use of economic models. Focus is on impacts of commodity booms and spikes in world agricultural commodity prices. Attention is given to why these spikes occurred, how exporters and developing country importers responded in the short and long run, and what role the dramatic changes in macroeconomic factors that occurred at about the same time played in both price run-ups and trade policy responses. Impacts on US agricultural trade, national welfare and farmer income will also be evaluated as well as U.S. agricultural and trade policy responses.

What has been done

Specific objectives are to understand the relative importance of various factors believed to lie behind world agricultural price spikes (in 2008 and 2011) and later declines; to examine stabilization policies, including both trade and stockpiling policies, utilized in developing countries as a short run response to world price spikes, as well as other policy tools to respond to domestic supply shocks; to consider long run responses that foster more rapid agricultural development and to achieve greater self-sufficiency; from a methodological perspective, to collect new data and test hypotheses on the conduct of agricultural trade in order to better understand market institutions and imperfections, to develop trade models that capture dynamic elements of economic development, and to incorporate relevant institutions and market imperfections into economic models of international agricultural trade.

Results

Those studies highlighted the importance of neighbor country prices over global market prices, and the weak links between rural and urban prices, even when regional wholesale markets are tightly linked. The Afghan government is considering whether to build food security stocks, based on these findings. The team examined remote sensing for agriculture and forestry, and on why and how to collect commodity stocks data. In the U.S., work on agricultural market information has recently emphasized estimation of the economic value of that information, in order to convince policy makers of the benefit to expending more resources on data collection

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices
606	International Trade and Development

Outcome #9

1. Outcome Measures

Discoveries, innovations, technologies, and technology transfer related to performance management of suppliers (retail, commercial, other) (FME 2.2)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	2881

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

A clear understanding of consumers food demand is essential if policy goals are to be achieved. Use of alternative data for obtaining that understanding will allow demands to be assessed at a much more detailed level than is possible with other data types. The project also sought to ascertain whether price-sensitive consumers obtain their food at significant savings over consumers who are price-insensitive.

What has been done

Three primary objectives were undertaken. 1) develop measures of household price sensitivity and price search and employed such measures in regressions explaining the prices actually paid for similar or identical items as a function of demographic factors. The purpose was to identify factors that contribute to paying low prices. A focus was to measure the extent of savings available through price search, and the means households use to attain savings, especially the role of buying on sale vs. shopping at stores using everyday low pricing. 2), the team investigated the savings available by substitution, both among similar foods and among different types of specific foods, especially among brands of essentially the same food. This was related to price search and the methods used to pay low prices. For example, a shopper wanting to pay a low price for a given brand must either find a low price seller or wait for a sale. A consumer willing to switch brands obviously has more options and is likely to achieve considerably larger savings. 3) the team investigated the validity of the belief that healthy food costs more.

Results

Objective 1 discovered that there are large differences across households in terms of what they pay for the same good. It was found that this arises mostly by buying on sale or by buying at low price stores. It also provided evidence that the motivation for savings is not just a financial but also satisfactions from pride in one's shopping ability. Computer simulation as part of Objective 2 demonstrated the savings available from multi-brand and multi-store price search.The pricing project was extended by examining the important factors affecting supermarket price setting. Preliminary results indicate that some dimensions are much more important than others: for example, stores in the same market do price similarly, but the extent of private label-brand competition is of no consequence. In Objective 3, the team related food nutrition to food price and essentially found no relation. This will be explored further using such methods as nonparametric regression, for it appears that foods of intermediate nutrition tend to cost more than foods of either low or high nutrition. Work on Objective 3 has also been concerned with food away from home. This only indirectly involves prices, because food away from home is a more expensive form of food. The team studied whether nutrition concerns fall when people dine away from home. Evidence was found that they do. This project has been going for some time and in this period new methods were applied that were borrowed from the literature of financial economics.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices

Outcome #10

1. Outcome Measures

Improved plant genetics (GFSH 1.2b)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	25

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
There is little genetic diversity in the soybean cultivars in use today. Soybeans are an important of today's diet and will be continue to be critical as the population grows. New soybean cultivars are required if soy is to continue to play an important role in the future food supply.

What has been done
The research program lays a foundation for more sustainable production by using the unique and largely untapped diversity of wild soybeans to improve cultivated varieties.

Results
Using a combination of techniques, many genes underpinning key agronomic traits in soybeans that could be used to improve yield, plant architecture, disease resistance, seed oil, calcium content and resilience to climate change have been discovered.

4. Associated Knowledge Areas

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

Outcome #11

1. Outcome Measures

Discoveries, innovations, technologies and technologies transferred related to performance management of suppliers (FME 2.2)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	419

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Many factors govern consumer acceptance of beef; meat quality attributes such as tenderness, juiciness (marbling), and healthfulness predominate. However, producer profitability is largely determined by carcass weight, efficiency of gain, and feed costs. In general, technologies that increase carcass weights and decrease feed costs have a negative impact on meat quality.Inadequate meat quality is estimated to cost the beef industry $860 million annually, and the average amount of excess fat from fed cattle was estimated to cost the industry approximately $2 billion dollars annually. Alternative feeds present numerous challenges in the diet of finishing cattle. The elevated protein and sulfuric acid content of distillers dried grains solubles (DDGS) disrupts metabolism causing reduced growth, depressed feed efficiency, poor carcass quality, and increased nutrient excretion when fed to finishing cattle at more than 30% of the diet. Furthermore, fiber-based by-products and forage decrease dietary energy content, increase the cost per unit of energy, and present storage and handling challenges. Strategies that integrate fiber-based corn alternatives and forage with DDGS in cattle diets to optimize growth, nutrient digestibility, and efficiency are unclear. To integrate fiber-based by-products and forage with DDGS in beef cattle diets, problems associated with alternative feeds - such as nutrient imbalances, need to be overcome.

What has been done

The overall objective is to understand the effects of feed ingredients and/or specific nutrients on digestion, growth and development, and meat quality of beef cattle. Objectives were to 1) determine the effect of amino acids, fatty acids, and minerals fed during gestation and/or lactation on cow performance and subsequent growth, development, and meat quality of the offspring. 2) Determine the effect of amino acids, fatty acids, and minerals fed during the finishing phase (last 150 to 200 days) on growth, performance and meat quality.

Results

Objective 1: It was earlier reported by Purdue that dietary Selenium (Se) source did not affect performance, milk production, or reproductive efficiency of beef cows and did not alter pre-weaning performance of progeny from Se-adequate cows. However, the team's subsequent research on the progeny has demonstrated that maternal supplementation with organic Se appears to have a long-term benefit on intake of steer progeny and may result in improvements in growth that could decrease days need to achieve an adequate slaughter weight. Ongoing studies to examine the nutrients in distillers grains (protein and fat) indicated that inclusion gf additional protein had positive effects on cow performance, milk production, and milk composition. While increasing dietary fat improved conception rates it had either neutral or negative effects on cow and calf performance. Objective 2: It was also observed that supplementation of feedlot cattle with an essential oil blend did not improve performance or decrease the incidence of liver abscesses. In addition, essential oils had no negative impact on carcass quality or beef tenderness.

4. Associated Knowledge Areas

KA Code	Knowledge Area
305	Animal Physiological Processes
307	Animal Management Systems
315	Animal Welfare/Well-Being and Protection
501	New and Improved Food Processing Technologies
512	Quality Maintenance in Storing and Marketing Non-Food Products
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices

Outcome #12

1. Outcome Measures

Increased efficiencies or increases in yield/unit (GFSH 1.3)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	13453

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Fetal loss has major economic impact in the beef and dairy industries. An estimated 1-2% and 6-10% of pregnancies in beef and dairy cows, respectively, terminate in abortion, stillbirth or perinatal death at a projected cost of $750 to $1,000 per case. Prompt, accurate diagnosis of the cause for bovine abortion, stillbirth or perinatal death is essential to herd management and reduction of fetal loss. The diagnostic success rate for bovine abortion has not increased in step with improvements in laboratory tests. Improved testing for bovine viral diarrhea virus infection is especially needed because non-molecular techniques are unlikely to detect this virus in an aborted bovine fetus.

What has been done

The goal of this project is to improve the success rate in determining the cause of bovine abortion or perinatal death. The specific objectives of this project are to: 1) Increase the number and quality of laboratory submissions in cases of bovine abortion, stillbirth, and perinatal death. 2) Increase the diagnostic success rate in cases of bovine abortion, stillbirth, and perinatal death. 3) Correlate pathologic findings with results of microbiologic, virologic, toxicologic/chemical (especially selenium), molecular, and genetic analyses.

Results

Forty-two bovine accessions were classified as spontaneous abortion, stillbirth, or perinatal death by veterinary pathologists or pathology residents at the Indiana Animal Disease Diagnostic Laboratory (ADDL) at Southern Indiana Purdue Agricultural Center (SIPAC) from October 1, 2015, through September 30, 2016. Eleven cases were from Holstein, 7 from Angus, 13 from crossbred cattle; the remainder were from other beef breeds or breed not specified. An infectious cause for abortion was suspected from histologic lesions or microbiology test results in 19 cases. Of these 19 cases, 11 were considered bacterial abortion. Identified bacteria included Salmonella (2 cases), Coxiella (3 cases), Listeria (2 cases) and Yersinia (1 case). Placentitis and inflammation in other fetal tissues were the common lesions of bacterial abortion. Mycotic abortion,with placentitis as the major lesion, and thus and postmortem decomposition of fetuses could have contributed to failure to determine the cause for abortion or stillbirth attributed to Aspergillus fumigatus in one case. Six cases of abortion were attributed to protozoa (Neospora caninum). Only 1 case was considered a viral abortion and was attributed to bovine herpesvirus-1 (infectious bovine rhinotracheitis virus). Abortions were attributed to noninfectious causes when no fetal inflammation was detected and tests for abortifacient bacteria, viruses, and protozoa were negative. The presumptive noninfectious cause for fetal loss was twinning in one case and dystocia in another. Meconium aspiration was a nonspecific sign of fetal distress in several cases. No lesions or cause for abortion, stillbirth or perinatal death was determined in 16 cases (38%). More rapid and sensitive detection of infectious, nutritional, toxic, or genetic causes of abortion, stillbirth, and perinatal death will lead to decreased bovine fetal loss and improved herd health and productivity.

4. Associated Knowledge Areas

KA Code	Knowledge Area
304	Animal Genome
305	Animal Physiological Processes
307	Animal Management Systems

Outcome #13

1. Outcome Measures

Innovations in food enterprises including production, allied services, processing, and distribution (GFSH 2.3)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	5499

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A need exists to design and develop machines and procedures that will reduce agricultural labor requirements, improve food security and livelihoods, increase agricultural efficiency and productivity, automate common tasks, minimize the impact of machines on the environment, and produce a globally qualified STEM workforce. The outcomes from this project directly impact the efficiency and productivity of the machine systems critical to agricultural mechanization, the sensors and platforms to collect data, the development of international agriculture production systems, and the preparation of a future workforce who will be engaged in the international intersection of energy, food, water, and environmental sustainability.

What has been done
The project included 3 primary objectives. 1) Develop plant-centric mechanization technologies for advanced agricultural production systems. 2) Develop systems level simulation and modeling tools integrating the electrical, mechanical, and fluid domains for use in the design and optimization of agricultural machinery, enable through new control strategies to make machine systems more energy efficient and environmentally friendly. 3) Develop new hydraulic systems with improved energy efficiency, flexibility, and reliability.

Results
Objective 1: An energy survey is being performed for plant-centric mechanization to determine the average power and energy requirements, the feasibility of electrical (renewable source based) systems, and platform options. Results will be published in the upcoming year. Objective 2: A new kinematic simulation sub-model has been developed for the design and simulation of more efficient hydraulic systems and components. Objective 3: A new model and prototype of a mechanically actuated hydraulic pump/motor has been completed and testing is underway. A patent application is in process. The new pump/motor technology could significantly improve the efficiency of hydraulic systems in agricultural machines.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment

Outcome #14

1. Outcome Measures

Policy decisions informed by university research and Extension

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	8

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In May of 2015, Purdue Extension was commissioned by the State of Indiana to study Indiana county zoning ordinances as they apply to confined feeding operations (CAFO).

What has been done
The team provided a comprehensive assessment and comparison of CAFO regulations and standards across all Indiana counties. Additionally, the team also developed individual factsheets for all Indiana counties detailing their CAFO ordinance (or lack thereof in some cases). These results were presented to the state legislature in January of 2016 and are distributed through several Purdue websites.

Results
The following documents were created to support the understanding and implementation of CAFO regulations: A 40-page review/comparison of CAFO standards across Indiana counties plus factsheets for each Indiana county describing CAFO regulations and ordinances specific for each county. Of the 81 Indiana counties operating with a zoning ordinance, 64 zoning ordinances currently (August 2015) contain language specific to CAFOs. The report and factsheets compare CAFO provisions and standards across Indiana counties. Together with a description of the ordinance, the factsheets themselves contain related county-specific demographic information such as population, farmland percentage, top employing industries, county type (e.g. rural, urban, mixed), housing densities, which may impact the development of a CAFO ordinance. These

factsheets summarize and categorize the zoning ordinances and provisions specific to CAFOs above the general zoning district standards unless otherwise specified. CAFOs still have to follow the district standards in the zoning district in which they locate. Plan directors or a plan department employee in 52 of 64 counties with zoning provisions for CAFOs reviewed their county's factsheet for accuracy. Ordinances may also be amended periodically.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems
402	Engineering Systems and Equipment
601	Economics of Agricultural Production and Farm Management

Outcome #15

1. Outcome Measures

Discoveries, innovations, technologies and technologies transferred related to farmers (FME 1.1)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1859

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

As public perception continues to shape the dairy industry, an understanding of consumer's views and purchasing behaviors is critically important. Today, meat and dairy product shoppers are increasingly sensitive to the processes employed in the production of livestock products. Cattle producers are faced with decisions surrounding how to rear cattle to satisfy changing consumer preferences, manage changes due to pressures from large retailer supermarkets and restaurants and changes in legislation. The objectives of this research are to: 1) summarize consumer perceptions or views of 12 common dairy cattle management practices (humane methods of slaughter, humane transportation, increased pen or stall size, access to pasture, feeding of a GMO-free diet, feeding of an organic diet, feeding of a diet the animal would naturally consume, ability to interact with other animals of the same species, access to fresh water at all times, tail docking, use of antibiotics for sick animals, and dehorning), and 2) analyze relationships between respondent's household demographic characteristics and perceptions of three specific contentious dairy practices, including antibiotic use, tail docking, and dehorning.

What has been done
Previously completed and published research conducted by the team explored consumer preferences for pig and dairy cattle handling and treatment practices. Building upon past findings, the project goal was to improve the understanding of the impacts of potential animal welfare enhancing changes in dairy and beef cattle rearing systems on the supply and demand of beef and dairy products.

Results
An online, national survey was used to collect data on household demographics, dairy consumption and purchasing behavior, and perceptions of dairy production practices from more than 1,000 U.S. residents. While the final data will be released in publication in late spring 2017, the survey data indicated that more than 75% of the participants consumed dairy products. Of these respondents, consumers had altered their consumption of dairy products over the past three years because of animal welfare concerns and many had done so due to food safety concerns. Respondents perceived tail docking and dehorning to have the least beneficial and most negative implications for dairy cattle welfare of the dairy production practices considered.

4. Associated Knowledge Areas

KA Code	Knowledge Area
315	Animal Welfare/Well-Being and Protection
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices

Outcome #16

1. Outcome Measures

Projects related to impacts on/from domestic policy

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A rigorous study of the modern food marketing channel requires that agricultural economists adopt and make methodological improvements to modern economic tools, such as contract

theory, which is the study of incentive and pricing design. Food retailers are using increasingly sophisticated marketing and strategic pricing schemes to market food to consumers. Making contract theory more application friendly can improve policy analysis and reduce unintended consequences. Good policy making ultimately benefit consumers, firms and society in general. The organizing framework for this project is a branch of economics known as Contract Theory which is the study of how incentives and strategic pricing mechanisms should be designed to induce people to enhance productivity, minimize costs, purchase products, and/or achieve social objectives in policy making.

What has been done

Specific objectives of this project are: 1) Make methodological improvements to theoretical contracting models to make them more robust for applied work - that is, focus on developing models that impose only minimal critical assumptions. Economizing on the number of assumptions increases the probability that the predictions of the models will be more robust for applied work related to the agro-food sector. 2) Test the models and their robustness using experimental economics. 3) Use the models that have been successfully stressed tested to investigate relevant contemporary agribusiness or food policy issues. Examples of contemporary policy issues that can be analyzed with contracting models include the proposed New York City ban on sodas in large containers, or the new USDA-GIPSA rules to regulate contracts between food processors and farmers (Federal Register 2011; Crespi, Saitone and Sexton 2012).

Results

We examined the impact of a soda tax on soda consumption, and who gains and loses (in an economic sense) from the tax. The key finding is that a soda tax is predicted to cause soft-drink sellers to reduce the size of sodas across all size categories. This should lead to a reduction in consumption, which is the policy objective. Not surprisingly, soft-drink sellers are likely to have their profits reduced. In terms of consumer welfare, if consumers are segmented into a heavy consumption segment (those who consume lots of soda and buy the largest sizes) and a low-consumption segment (occasional soda drinkers who buy the small sizes), we find that heavy consumers will have their economic welfare reduced by the tax because their preferred soft-drink size will shrink and their per-ounce costs will increase. Surprisingly, low-consumption consumers' economic benefits will remain unchanged because sellers will adjust prices to compensate them for a reduction in the serving size. Sellers do this in order to retain their business because low consumption types are more likely to seek alternatives if their economic benefits from consuming soft-drinks decreases. Then we examined the impact of a soda size restriction (think NYC ban) on soda consumption, and who gains and loses from the restriction. The key finding is that the size-restriction is predicted to cause a decrease in size of only the large sized soft-drink. Sellers will keep the size of smaller drinks unchanged. This should lead to a reduction in consumption only by heavy soda consumers, which appears politically desirable. Low consumption consumers will largely be unaffected. Another surprising finding is that the economic welfare of consumers will be unaffected across all consumer segments. The reason is, although the seller will reduce the size of the largest soda, the seller will also drop the price so that consumers are compensated for being served a smaller large soda. Under the soda tax, this was not possible since a tax puts upward pressure on price. Soft-drink sellers, however, will suffer unambiguous economic losses.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices

Outcome #17

1. Outcome Measures

Projects related to consumer preferences based on product quality.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	5

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Providing consistently high quality and wholesome meat products to local consumers is crucial to the continued success of the local, regional, and national meat sectors. Numerous studies have reported that consumers are willing to pay premiums for meat products with guaranteed eating quality. Consumers who shop in the local market generally have a high level of expectation of local meat products. In particular they expect production-type related attributes (i.e. certified organic, grass-fed, and/or natural) and/or superior eating quality differences. Failure to meet this expectation due to quality-related issues will erode consumer satisfaction, and subsequently reduce profits for small/local processors over time. Collectively, knowledge generated will have immediate implications that could be used not only to provide solutions to many small/local meat processors, but also to offer consumers more consistent premium meat products. Moreover, improvements in quality attributes of beef will result in an increase in future profitability and sustainability of the US meat industry.

What has been done
The research program measures and improves beef quality, safety and value by assessing impacts of animal health, animal care, and processing management/production strategies.

Results
We investigated the effect of stepwise dry/wet-aging and freezing method on quality attributes of beef loins. We found that stepwise dry/wet-aging resulted in similar meat quality attributes, such as purge/thaw loss, color stability, and sensory characteristics compared to the conventionally dry-aged loin. These findings suggest that the stepwise dry/wet-aging could potentially provide beneficial impacts to local/small meat processors, who have limited cooler capacity, as the carcass chilling time in the cooler can be substantially reduced by the stepwise dry/wet aging. Consequently, it would allow rapid turnaround of beef sub-primal processing, resulting in more saleable yield through shorter hanging time and lower energy/operating costs compared to the

conventional carcass dry-aging for an extended period of time. Moreover, rapid cryogenic freezing can substantially improve meat quality attributes of freezer beef by providing equivalent quality attributes and improved waterholding capacity of aged/frozen/thawed meat.

4. Associated Knowledge Areas

KA Code	Knowledge Area
305	Animal Physiological Processes
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
601	Economics of Agricultural Production and Farm Management

Outcome #18

1. Outcome Measures

Improved animal genetics (GFSH 1.1)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
This multi-state program explores fundamental biological mechanisms using the most advanced technologies available that contribute new knowledge to improve the genetics, breeding and production of the poultry industry. These tools and our continued emphasis on their development and application are essential for improving efficiency of the birds directly (genotype selection) or indirectly (the management system, e.g., nutrition). Most important is improvement in the sustainability of poultry production. We operate in a world wherein it is imperative that researchers and stakeholders together consider the role and impact of our industries on the animal systems and the environment thus there is an essential need for continued creation of novel opportunities made possible by new technologies and knowledge to assist the industry in its continued positive evolution.

What has been done
The primary focus this past year was on the elucidation of genetic mechanisms that underlie economic traits and develop new methods to apply that knowledge to poultry breeding practices.

Results
The ability to locate genes that directly influence disease resistance and outcome is extremely difficulty for some diseases. In particular are those diseases termed complex, which means that many hundreds of genes influence these diseases and they are further complicated by environmental factors such as exercise, location and diet, similar to the incidence of diabetes in humans. The team was able to overcome these issues by combining genomics (the genetic DNA makeup of all of organisms) with the transcriptome (the RNA output of all those genes), we were then able to identify the vast majority of genes that play a role in susceptibility and resistance to this viral disease. Similar approaches may yield breakthroughs in other disease, including those in humans.

4. Associated Knowledge Areas

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

Outcome #19

1. Outcome Measures

Technologies, innovations, discovery related to improving health for animals/humans.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	11

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Aluminum adjuvants are widely used in veterinary and human vaccines. An adjuvant is a substance used in a vaccine or the application of other medicines that helps the body uptake the medicine better, or in this case an antigen. Antigens are molecules that help induce immune responses in the body. This research is aimed at two approaches to increase the immune response to aluminum adjuvanted vaccines. The first is to modify the interaction between aluminum adjuvants and antigens by adding phosphate groups to the vaccine antigens. This would lead to prolonged retention of antigen at the injection site. The second approach is to change the type of inflammation at the injection site. The inflammation is an important

determinant of the immune response that develops. This research may result in new vaccines and in improvements of existing vaccines by dose sparing of vaccine antigens and a reduction in the number of doses needed to induce a protective immune response.

What has been done
The overall goal of this research is to develop more effective formulations of aluminum adjuvanted vaccines. The specific objectives of this research are 1) Optimize the interaction between antigens and aluminum adjuvant particles by modifying the antigens with a linker agent terminal phosphate groups. Terminal phosphate groups can exchange with hydroxyl groups at the surface of the aluminum adjuvants resulting in a stable bond. By varying the number of linkers and the length of the linkers, the interaction between antigen and adjuvant can be changed and optimized. 2) Determine the kinetics of cell infiltration and gene expression at the injection site following intramuscular injection of the aluminum-adjuvanted vaccines. 3) Determine the effect of manipulation of the inflammatory response at the injection site on the subsequent immune response. Selective depletion of types of inflammatory cells and blocking of specific cytokines may result in a qualitatively and quantitatively enhanced immune response. Information obtained through these studies will be published in peer-reviewed journals, presented at national and international meetings and may generate commercial products.

Results
The effect of combining aluminum adjuvants with toll-like receptor (TLR) agonists on the transport of antigens to the draining lymph nodes was investigated in a mouse model. We also continued the studies of alpha-D-glucan dendrimer-like nanoparticles. The distribution of the nanoparticles in vivo and the effect on the transport of antigen to the draining lymph nodes was determined by in vivo imaging. We also determined the effect of the nanoparticles on the immune response to intranasally administered antigens. The data indicate that intranasal immunization works. The team saw a significant reduction of viruses in the lungs following challenge.

4. Associated Knowledge Areas

KA Code	Knowledge Area
304	Animal Genome
305	Animal Physiological Processes
315	Animal Welfare/Well-Being and Protection

Outcome #20

1. Outcome Measures

Discoveries, innovations, technologies related to improving data, data reconciliation, improving insights, enhancing data collaboration (Data 2.1)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	8

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

This project will improve cropping systems through utilization of widely available mobile communication and computing technology called an autogenic platform. This autogenic platform will automatically generate data (which is instantly shared among devices) when triggered by context such as the presence of implements and operators using intelligent algorithms that launch data collection with minimal user input. The system architecture will provide unique interfaces and data synchronization which enable farmers to improve management decisions -- both short and long-term. The open platform and its data formats will facilitate larger agricultural data sets for researchers than have ever been created before. Field records for precision farming will be much more automated and accessible through the shared centralized network data repository which will allow users to mine the data in real time from different perspectives. Through different (individually relatively simple) apps such as chisel, planter, fields, and personnel, private and synchronized data collection and interpretation should be more intuitive for users. The hardware and software architecture from this project will lead to working applications and a host of open source content that has the potential to substantially improve agricultural efficiency, reduce environmental impacts, and lead to improved agricultural sustainability, especially within the United States. The project will also lead to the development of an "Agricultural App Portal" which, through the release of a public developer framework, will become the basis for the first open source precision agriculture community in the world.

What has been done

The focus of this work is on cropping systems, but the infrastructure and platforms created will have broader applications in livestock and forestry. The particular objectives of this project are to: 1) Create an extensive autogenic data collection and analysis system enabled through user-centered mobile applications that synchronize machinery, operator, crop, and field data to enable data mining for management decision making. 2) Establish an "Agricultural App Portal" which, through the release of a public developer framework, will become the basis for the first open source precision agriculture community in the world. 3) Improve educational and research opportunities at graduate and undergraduate institutions with regard to technology implementation and data mining in agriculture. Applications to be developed include: Tillage Fields Personnel Machinery Products (seed, herbicide, fertilizer etc.) Planter and drill (separate applications for the different implements) Sprayer, spreader Import/Export.

Results

The autogenic concept was demonstrated fully with the development of a manure app. This app uses the smart phone GPS capability to know whether the operator and his/her machinery is in a certain field. It uses Bluetooth connectivity to a tag which includes accelerometers to determine which spreader is being used and whether that spreader is on or off. With minimal set-up which includes field boundaries, listing operators and manure sources, and synchronization to a cloud

database, the phone app completely logs records without operator intervention. The operator can just "spread manure" as they usually would, but rest assured that each load is logged in a secure and private record and that the path of spreading is recorded for future reference. Code for the manure app is on GitHub and is released open source. This development approach has helped educate several undergraduate and graduate students.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment

Outcome #21

1. Outcome Measures

Number of participants informed about financial management of agricultural operations

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	4449

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Revenues declined sharply for most U.S. crop and livestock farmers leading to financial stress on many U.S. farms and ranches. Farmers need to improve their skill sets in the areas of financial management, risk management and production management to remain economically viable. An economically viable food production sector is important not only to U.S. farmers, but also to U.S. consumers to ensure a long-run stable food supply. The decline in grain prices coupled with record-high land lease contracts will quickly affect a farms liquidity. Lenders, producers and the community in which they reside, may be adversely affected if decisions are left unchecked. The downturn in commodity prices, coupled with locked-in costs such as fertilizer, seed, and cash rent left many producers re-evaluating economic options for the farm. Tighter crop margins have made lease arrangements a more critical risk management decision for tenants and landlords. Many local lease agreements have stayed the course for generations and without a written contract. Corn and soybean farmers have seen a sharp decline in gross revenue over the past couple years and the decline in revenues is not being matched by a decline in costs. Agricultural climate of operating margins are getting tighter requiring farmers to address the business side of their farming operation including risk management strategies, commodity marketing strategies,

conservation management plans, and succession plan.

What has been done

The Purdue Center for Commercial Agriculture provided a series of 14 webinar programs, gave presentations at 35 workshops and conferences, and created 15 print and web-based publications to assist farmers in improving their financial management and risk management skill sets. The land rent spreadsheet, a collaboration of the Center for Commercial Agriculture and the University of Illinois was one tool made available for insights into how much of a premium farmers pay for the right to rent or lease a piece of land. This is critical when deployed across the entire farm enterprise. With premiums assessed, farmers can evaluate how quickly they are spending down the liquid reserves accrued over the past several years. Across Indiana, Purdue Extension offered a variety of workshops and PARP, CCH and CCA credits for advisors, producers, and farmers to address farm margins. Topics included: 1) soil health, water conservation and irrigation management, 2) how to determine where cuts or reduced inputs in operations can be made, 3) where to find tools to help evaluate individual farm needs with ways to cut production costs without affecting yields, 4) making long-term cash rent decisions, and 5) legal issues.

Results

Viewership of web-based broadcasts (viewed live or on YouTube) totaled 5,794. Feedback from participants via email and subsequent in-person contacts indicated material enabled participants to strengthen their managerial skill sets and make improved decisions. In particular, participants benefitted from use of a farm-management decision tool that helped them understand how cash rental agreements affect their working capital. Workshop participants indicated these results. 1) They felt better equipped to address financial and agronomic challenges. 2) Planting rates, fertilizer use, and budgeting decisions were most impactful information. 3) They learned a new practice that would increase profit margins for their farming operation. 4) They learned a new leasing option that was feasible for them. 5) They plan to talk to their tenant/landlord more often, will adjust their rent amount to reflect the current markets, or will change the type of lease they currently have. 7) They know their rights as a tenant/landlord, what their land is worth, and plan to implement a written lease. These gains in knowledge will help farmers managed tight margins in the years to come.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management

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

Extension programs conduct evaluation surveys to measure change in knowledge and intentions of participants, and follow-up surveys to assess change in behavior or practice and results of actions. Field, lab, and survey research projects monitor progress, testing of efficiencies, growth and success rates, economic mechanisms and new technologies, completion of study objectives and tasks, and publications/presentations of findings, to determine effectiveness and accomplishment.
Evaluation results included:
Outcome # 7 - Algorithm developed to determine function of new proteins that exert strong effects on growth properties of leaf epidermal cells
Outcome # 9 - Analysis showed consumers pay different prices for some goods and purchasing is influenced by motivation for saving and satisfaction from pride in shopping ability
Outcome # 10 - Research discovered key agronomic traits - plant architecture, disease resistance, seed oil, calcium content, and resilience to climate change - for improved yield of soybeans
Outcome # 11 - Evaluation of growth of beef cattle fed different dietary additives showed maternal supplementation with organic selenium has long-term benefit on steer progeny including improved growth and decreased days to slaughter weight
Outcome # 12 - Classification process of diagnoses of lab submissions on causes of bovine accession helped to address improved detection of causes of abortion, stillbirth and perinatal death help to decrease bovine loss and improve herd health
Outcome # 13 - Evaluation of new pump/motor technology showed improved efficiency of hydraulic systems in agricultural machines
Outcome # 15 - National survey on consumer perceptions on welfare of beef cattle showed many changed their consumption of dairy products due to food safety concerns
Outcome # 17 - For processing beef loins, analysis showed stepwise dry/wet-aging method had similar meat quality attributes purge/thaw loss, color stability, and sensory characteristics, compared to conventional dry-aged and could potentially provide beneficial impacts to local/small meat processors who have limited cooler capacity as carcass chilling

time can be substantially reduced
Outcome # 18 - By combining genomics (the genetic DNA makeup of all organisms) with the transcriptome (the RNA output of all those genes) could help identify the vast majority of genes that play a role in susceptibility and resistance to viral diseases in poultry
Outcome # 19 - Lab studies of mice evaluated efficacy of vaccines showing that nanoparticle-administered antigens via intranasal immunization elicit an the immune response

Key Items of Evaluation

Outcome # 14 - Assessment of county CAFO zoning ordinances provided basis for factsheets by county for demographics, farmland, employing industries, county type, and housing densities
Outcome # 16 - Analysis of economic mechanisms related to incentives, risk and pricing for soft drinks showed taxes would impact economics of seller and for heavy-consumption soda consumers, whereas soft drink size restriction would not
Outcome # 20 - Development for data collection and analysis for cropping systems through mobile applications (i.e., Apps) can synchronize machinery, operator, crop, and field data for management decision making
Outcome # 21 - Farmers attending workshops were better equipped to address financial and agronomic challenges of current farm margins

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: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	5.9	0.0	12.3	0.0
Actual Paid	2.1	0.0	8.0	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
934630	0	396863	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2174442	0	1652163	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
364878	0	941060	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Conduct meetings, conferences, workshops
Publish research and extension publications
Establish web sites, online decision-making tools
Organize field days
Consultations
Work with mass media
Leverage social 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

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	755	415	89	0

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

Patent Applications Submitted

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	10	54	64

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of Extension publications
  Not reporting on this Output for this Annual Report

Output #2

Output Measure

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

Output #3

Output Measure

- Number of research projects

Year	Actual
2016	28

Output #4

Output Measure

- Number of consultations

Year	Actual
2016	140

Output #5

Output Measure

- Number of education workshops

Year	Actual
2016	15

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 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 stewardship.
8	Number of participants who increase their knowledge of opportunities and challenges for agriculture under carbon dioxide emissions policies to address climate change.
9	CC 1.1 Number of current year citations of climate related publications
10	CC 1.8 Number of new climate relevant databases, monitoring systems, and inventories managed or under development
11	CC 1.3 Number of current year climate relevant research programs
12	NRE 1.16 Number of projects that incorporate ecosystem services and/or biodiversity considerations
13	Data 1.1 Number of discoveries, innovations, technologies related to improving data, data reconciliation, improving insights, enhancing data collaboration.

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.

Not Reporting on this Outcome Measure

Outcome #7

1. **Outcome Measures**

Number of participants who adopt management practices that maximize environmental stewardship.

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**

CC 1.1 Number of current year citations of climate related publications

2. **Associated Institution Types**

- 1862 Research

3a. **Outcome Type:**

Change in Knowledge Outcome Measure

3b. **Quantitative Outcome**

Year	Actual
2016	290

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

Issue (Who cares and Why)

Water availability and access are key to the health of many ecosystems. Access is complicated by pressures and needs of communities and by environmental factors including rainfall, severe weather, and increasing climate variability that reduces our ability to accurately plan for future water needs. Understanding relationships between soils and water-holding capacity will be imperative in the context of a changing climate and for irrigation demand. Many areas of the Midwest depend on access to underground water reserves for agricultural production, but few proactive, reasonable and scientifically-based water management policies have been effectively enacted. This is a classic example of an interdisciplinary problem. Crop modelers determine future water needs for agriculture. While soil scientists evaluate differences in water-holding capacity. Aquifer studies characterize the extent and conductivity of groundwater formations conducted by hydrogeologists based on typical cross-sections of regional geology. While surface water managers use watershed scales defined by topographic boundaries, which may not match the boundaries of underlying aquifers, especially confined aquifers that serve as water supplies in much of the country. These approaches illustrate how integrated water management is also a scaling problem. Datasets needed to support integrated water management activities are not available in a form easily integrated into simulation models. Traditional soil surveys based on taxonomic and morphologic variability have similar water storage properties. Through the efforts of the U.S. Geological Survey (SSURGO) and others, huge quantities of data detail the subsurface characterization of hundreds of aquifers. However large portions of data are not in geodatabases readily adapted to regional scale analysis, or may be available as data-layers for individual states, truncated at political boundaries that do not represent aquifer boundaries.

What has been done

The long-term goal of this research is to quantify water storage capacity in the soils and aquifers of Indiana and to determine how future changes in quantity and timing of water supply and demand will affect agronomic production. Specific research projects focused on development of spatial and temporal databases, field studies, remote sensing observations, and hydrologic and crop simulation modeling at multiple scales to predict sustainability of agronomic production in Indiana. Objectives include: 1) Quantify the subsurface water storage capacity in Indiana both in soils and in groundwater aquifers. 2) Evaluate agricultural water use in Indiana in relationship to climatic extremes and projections of future climate change and water demand. 3) Integrate our findings into on-line spatial databases for use in research, extension and teaching.

Results

Seamless datasets are being developed to enhance the usability of new, existing and archival data. 1) For estimating surface storage, high-resolution Digital Elevation Maps (DEMs) were used to focus on the Red River watershed in the north-central U.S. 2) The Variable Infiltration Capacity (VIC) model, modified to handle additional surface water storage, was integrated into the NASA Land Information System (LIS), a land surface modeling and data assimilation system. 3) Evaluations by collaborators at NASA focused on the Kankakee River watershed, and tested the model to determine if LIS can recreate the simulation results from the original study. 4) Groundwater aquifer parameters are being identified for the lower 48 states with the VIC model modifications, to simulate groundwater storage including the addition of water withdrawal numbers mapped to the VIC model resolution. 5) The Integrating Spatial Educational Experiences (Isee) app, (available for Apple devices), was updated. The app allows users to view selected soil properties derived from the detailed SSURGO data for 7 states: Indiana, Illinois, Kentucky, Ohio, Texas, West Virginia and Wisconsin. Users can easily zoom and pan the maps, and see an overview for an entire state, and details for any part of the state down to a scale of 1:18,000. The recent release includes ability to query the map to obtain site-specific explanations appropriate for three different user groups: 1) the public, 2) students familiar with basic soil science terminology,

and 3) expert soil scientists. As a result of the data collection, model integration efforts, and a mobile app, new tools are available to gain a greater understanding of water management.

4. Associated Knowledge Areas

KA Code	Knowledge Area
132	Weather and Climate

Outcome #10

1. Outcome Measures

CC 1.8 Number of new climate relevant databases, monitoring systems, and inventories managed or under development

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	58

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Since the 2007/2008 commodity crisis, there has been a resurgence of interest in sustainability of the world's food system and its contribution to feeding the world's population and ensuring environmental sustainability of the planet. The number of people the world must feed is expected to increase by another 2 billion by 2050. Coupled with significant nutritional improvements for the 2.1 billion people currently living on less than $2/day, this translates into a very substantial rise in demand for agricultural production. The Food and Agriculture Organization (FAO) estimates the increased demand at 70% of current production, with a figure nearer 100% in developing countries. Agriculture and forestry are likely to be the economic sectors whose productivity is most sharply affected by climate change. This pattern shift may reduce productivity of farming in regions of the world where poverty and malnutrition are most prevalent, while increasing yield variability and the vulnerability of the world's poor.

What has been done
The broad objective of this research is to improve our understanding of the interplay between population and income growth, biofuels policy and production, international trade, climate impacts and climate policy in determining future food security, land use change and greenhouse gas (GHG) emissions at global and regional scales. Land-based GHG emissions account for about 1/3 of all GHG emissions and could offer up to 50% of efficient abatement potential at modest carbon prices. Yet current predictions of land use change and GHG emissions over the coming

century are highly uncertain and often ignore economic factors altogether. Improving such predictions and developing coherent policy recommendations to account for the dynamic interplay between these forces is a high priority. To improve on the current state of knowledge and policies, the project has the following specific objectives: 1) Understand and quantify the drivers of global changes in land use and GHG emissions, project such changes forward to 2050 or 2100, and formulate optimal policy responses to such changes. 2) Evaluate the impact of uncertainty in climate impacts, climate change mitigation policies and energy prices on optimal and observed land-use change at a global scale over the long run. 3) Assess the impacts of these global changes on world food prices, food security, livelihoods and poverty in developing countries.

Results

The research provided a comprehensive analysis of the long run growth prospects for agriculture, by region, and globally. There is a 66% probability that crop prices in 2050 will be lower than 2006. This is primarily due to the slowdown in global population growth and near elimination of growth in the richest economies, where per capita consumption is highest. Overall, crop production is likely to rise about 90% between 2006 and 2050, but net land conversion globally will be modest due to productivity gains. This will limit the emission of carbon into the atmosphere. In the presence of aggressive, terrestrial climate mitigation policies, crop production and land conversion would be even lower. Future uncertainty in economic growth and climate impacts and climate policy will affect investments in R&D, technological progress, and land use change. When factoring in these uncertainties, it is optimal to invest more in R&D today, as a form of insurance against the worst-case scenarios. It is projected that in 2050 most of the world's insecure population will reside in South Asia and Africa. Unless these regions can boost agricultural productivity, they are likely to need massive food imports in the future. Adverse climate accentuates impacts in these regions. Global market integration is key to buffering future commodity prices and food security from the negative effects of climate.

4. Associated Knowledge Areas

KA Code	Knowledge Area
132	Weather and Climate

Outcome #11

1. Outcome Measures

CC 1.3 Number of current year climate relevant research programs

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual

2016 5

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Global environmental changes such as climate change pose threats to natural ecosystems and to human welfare. Characterizing the potential impacts of these changes is important for informing decisions that have consequences for the rate of environmental changes and for preparing society for the future. Responses of natural ecosystems are consequential for a variety of reasons. For instance, if environmental changes cause shifts in the abundance of plant species, this will affect the many species, including humans, that depend on those plants for food or other uses. Bees provide a valuable service to U.S. agriculture through pollination, contributing more than $15 billion in added crop value each year. A number of new and mounting pressures are crippling colonies and endangering bee populations. These threats include 1) Emerging diseases and parasites such as deformed wing virus, Varroa mites and Nosema fungi, 2) Lack of diversity and availability of pollen and nectar sources, and 3) Exposure to a wide variety of pesticides. From 2006 to 2011, losses of managed honeybee colonies averaged about 33% per year.

What has been done

A 2-year controlled field experiment that exposed goldenrod to a gradient of carbon dioxide (CO2) levels from 280 to 500 ppm showed strikingly similar decreases in pollen protein. Researchers examined protein levels in historical and experimental samples of goldenrod pollen. Previous research showed increases in CO2 can lower nutritional value of plants such as wheat and rice, but this study is the first to examine effects of rising CO2 on the diet of bees. Elevated levels of atmospheric CO2 - a building block for plant sugars - have allowed many plants to grow faster and bigger. However, this growth spurt can dilute total protein in plants, rather than concentrating it in the grain, resulting in a less nutritious food source. Bee species and honeybees need flowering plants for energy and nutrition. While nectar is the primary energy source for bee colonies, pollen is the sole source of protein for bees. Pollen is essential for development of bee larvae and helps maintain bee immunity to pathogens and parasites.

Results

Rising levels of atmospheric CO2 have reduced protein in goldenrod pollen, a key late-season food source for North American bees. Pollen protein levels dropped about 1/3 in samples collected from 1842-2014, a period during which the amount of CO2 in the Earth's atmosphere rose from about 280 to 398 ppm. The greatest drop in protein occurred during 1960-2014, a time when atmospheric CO2 levels rose dramatically. Goldenrod blooms from late July through October and is the last available pollen before winter. Bees must store substantial amounts of pollen to rear their winter young. Declines in pollen protein threatens bee health and survival, and weaken their ability to overwinter.

4. Associated Knowledge Areas

KA Code	Knowledge Area
132	Weather and Climate

Outcome #12

1. Outcome Measures

NRE 1.16 Number of projects that incorporate ecosystem services and/or biodiversity considerations

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	55

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Agricultural soils require ongoing efforts to maintain and improve their productive capacity, increase their resilience to climate variations, and enhance environmental quality. Cover crops effectively reduce nitrate-nitrogen (N) losses from the root zone by scavenging residual N in fall, and reductions are greater with greater cover crop growth. There are still significant management challenges to establish cover crops in fall after corn and soybeans, and to manage and terminate them at appropriate times in spring. Cover crops that survive the winter, such as cereal rye, generally scavenge more N than those that winter kill such as oats, but also keep the N unavailable until later in the cropping season, which poses practical management challenges.

What has been done
This research evaluates different strategies to 1) Improve soil quality, 2) Reduce nitrate leaching into drainage waters, and 3) Enhance agricultural sustainability. The long-term goal is to identify agricultural management practices in Indiana and the Midwest that improve soil and water quality, and enhance agricultural sustainability by increasing the resilience of cropping systems to climate variation. Emphasis is on managing drained agricultural lands for water quality and crop productivity and on integrating cover crops into corn-soybean production systems. Specific objectives are to evaluate the: 1) Effect of subsurface drain spacing on drainflow volumes, nitrate leaching, soil quality, and crop yields on poorly-structured silt loam soil in southeastern Indiana. 2) Impacts of drainage water management (controlled drainage) practices on nitrate loads, soil quality, and crop productivity at a site in eastern Indiana. 3) Impacts of various cover crops on soil quality, nutrient cycling, and crop productivity at several sites in Indiana.

Results
A number of conservation practices were studied that can lead to improved soil and water quality within annual cropping systems. Cereal rye cover crops had improved soil aggregation,

decreased penetration resistance, and increased soil water content in some study locations, all of which would eventually lead to improved crop production long-term. Findings have not yet shown any significant changes in crop yields, in years 3 and 4. Cover crop studies were conducted at Purdue research centers and farmer cooperator fields. Many soil, cover crop, and cash crop samples were taken. During the fifth and final year of a 9-state regional project on resiliency of corn-based cropping systems, samples were analyzed for soil aggregation, bulk density, water holding capacity, organic carbon, and soil nitrogen after 4 years of a cereal rye cover crop. Soil aggregation was significantly greater in the 0-10 and 10-20 cm depths in cover crop plots compared to control (no cover crop) plots in both corn and soybean phases of the corn-soybean rotation. No significant differences were found in other measured soil parameters. Data analysis for a 3-year project on farmer cooperator sites is in process. These sites include samples sent to four commercial soil health labs for analysis. Preliminary analysis suggests few changes in soil health ratings after 2 years of cover crops, on sites that have been long-term no-till. Finally, the long-term tile drainage/water quality study continued at a reduced level at the Southeastern Purdue Agricultural Center. Measurements of tile drainflow and nitrate concentrations in drainflow were suspended after 30 years of study, in part due to aging equipment and blockages in the main tile drain. Crop growth and yield, as affected by 4 drain spacings (5, 10, 20, 40 m), are still being measured. Crop yields are now generally similar among the 5, 10, and 20 meter spacing plots, all of which are greater than the 40 meter undrained control plot. Results from 2000-2015 are being compared to the first 15 years of the project. Nitrate-N concentrations are still holding in the 7 to 10 mg/liter range, similar to concentrations near the end of the first 15-year period, as a result of cover crop and fertilizer N practices. However, Nitrate-N loads have increased compared to the 1997-1999 period, due to increased precipitation, and greatly increased drain flow compared to the first 15 years. Further data analysis is underway to determine if there are additional questions that that these data could shed light on, if there would be a reinvestment and upgrade of equipment. These research outcomes can contribute to increased knowledge about cover crops and drainage management strategies and greater adoption of these practices in Indiana and the Midwest.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
132	Weather and Climate

Outcome #13

1. Outcome Measures

Data 1.1 Number of discoveries, innovations, technologies related to improving data, data reconciliation, improving insights, enhancing data collaboration.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	8

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Genetically modified organisms (GMOs) have been a source of contention in the U.S. and abroad, as some believe genetically modified crops pose potential risks to human health and the environment. Three U.S. regulatory agencies, Department of Agriculture, Food and Drug Administration and Environmental Protection Agency, have approved many GMO foods as safe to eat, and the U.S. is the global leader in planting GMO crops and developing agricultural biotechnology. However, in many European and Asian countries, consumer and economic concerns have led to strict regulations on GMO crops, with partial or full bans on their cultivation.

What has been done
Computable General Equilibrium (CGE) modelling is a new way of analyzing economy-wide impacts that take into account the linkages in the global economy. The goal is to contribute to the literature on GMO technology by estimating the impacts on price, supply and welfare. Using the CGE, in the Purdue-developed Global Trade Analysis Project extended database for biofuel (GTAP-BIO) model, economic consequences of changes to agricultural, energy, trade and environmental policies were examined. This was done by modeling 2 scenarios and evaluating them apart and in combination. The first scenario shows a global GMO ban. The second scenario shows increased GMO penetration. The focus is on the price and welfare impacts, and land use change greenhouse gas (GHG) emissions associated with GMO technologies.

Results
GTAP-BIO predicted a modest and region-specific rise in overall food costs under a global GMO ban. Replacing GMO corn, soybeans and cotton with conventionally bred varieties worldwide would cause a 0.27% to 2.2% increase in food costs, depending on the region, with poorer countries hit hardest. People in poorer regions would be most burdened by the price increase, as they spend about 70% of their income on food, compared with about 10% in the U.S. Total welfare losses with removing GMO technology are $9.75 billion. Conversely, if countries already planting GMOs expanded to match the rate of GMO planting in the U.S., global GHG emissions would decrease by 0.2 billion tons of carbon dioxide and allow 0.8 million hectares of cropland to return to forests and pastures. A ban on GMOs would trigger negative environmental and economic consequences.

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

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

Extension programs conduct evaluation surveys to measure change in knowledge and intentions of participants, and follow-up surveys to assess change in behavior or practice and results of actions. Lab and field research projects monitor progress and completion of study objectives and tasks, testing of new tools, simulations and models, and publications of findings, to determine effectiveness and accomplishment.
Evaluation results included:
Outcome # 10 - Global scale models were created to include climate change to determine future needs for food production
Outcome # 12 - Soil aggregation was significantly greater in the 0-10 and 10-20 cm depths in cover crop plots compared to control (no cover crop) plots in both corn and soybean phases of the corn-soybean rotation
Outcome # 13 - A ban on GMOs would trigger negative environmental and economic consequences across the globe, but especially for poorer regions

Key Items of Evaluation

Outcome # 9 - New tools were developed to include climate change for better understanding of water management for agriculture
Outcome # 11 - Rising levels of atmospheric carbon dioxide have reduced protein in goldenrod pollen, the late-season pollen needed for bees to overwinter, threatens bee health and survival

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: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	11.1	0.0	35.2	0.0
Actual Paid	4.0	0.0	16.0	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
1238554	0	500872	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2193221	0	2558656	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
355988	0	949825	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
Social media, including Facebook, Twitter, etc.

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

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	2693	193	549	0

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

Patent Applications Submitted

Year:	2016
Actual:	9

Patents listed
2,496,546
20150126645
9,228,154
9,499,444
9,363,880
9,272,468
9,334,505
2,829,704
9,408,930

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	1	114	115

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of Extension publications
  Not reporting on this Output for this Annual Report

Output #2

Output Measure

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

Output #3

Output Measure

- Number of research projects

Year	Actual
2016	42

Output #4

Output Measure

- Number of consultations

Year	Actual

2016	82

Output #5

Output Measure

- Number of education workshops

Year	Actual
2016	35

Output #6

Output Measure

- Number of volunteers

Year	Actual
2016	15

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	SE 4.2 Number of new varieties or other new feedstock sources
6	GF 2.1 Number of new or improved innovations developed for food enterprises
7	SE 4.1 Number of new technologies developed
8	CC 1.6 Number of new assessment and management tools developed, including models and measurements of greenhouse gas emissions.
9	Number of stakeholders participating and representing a diverse group of economic, social and sector backgrounds

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**

   SE 4.2 Number of new varieties or other new feedstock sources

2. **Associated Institution Types**

   - 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	10

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Current grain-based cropping systems are designed to optimize grain production but not suited to production of cellulose-containing biomass. Potential herbaceous perennials being considered for biofuels include switchgrass and Miscanthus. Switchgrass is a warm-season perennial grass that is very productive during warmer, drier summer months and has demonstrated potential in the U.S. corn belt. Miscanthus is a warm-season grass, but has been hypothesized to be superior to switchgrass in both biomass productivity and nutrient use efficiency. Miscanthus production has been mostly in the European Union and only limited data exist on productivity and nutrient management in the U.S. Merits of these systems need to be documented and integrated into full environmental and economic accounting. Ecological data for more novel systems (switchgrass for biomass, Miscanthus, and sorghum and maize with residue removal) are entirely lacking. 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 are 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.

What has been done

The CenUSA Bioenergy objective focuses on conducting comparative analyses of productivity potential and environmental impacts of the most promising perennial grass bioenergy crops and management systems using a network of 14 fields strategically located across the Central U.S. The goal is to produce a quantitative assessment of the net energy balance of candidate systems and optimize perennial feedstock production and ecosystem services on marginally productive cropland while maintaining food production on prime land.

Results

Findings were: 1) On most sites studied in the upper Midwest, the switchgrass cultivar "Liberty" developed explicitly for biomass production out-yielded the best forage-type switchgrass cultivars available. 2) At locations with severe winters (Minnesota), some plots of Liberty switchgrass were injured and biomass production was reduced. 3) Miscanthus x giganteus has high biomass yield at most Midwest locations, often double the yield of the best switchgrasses. However, this species is clonally propagated making establishment costs high, and since all plants are genetically identical, predisposing it to widespread disease and insect attack. 4) Soils with nutrient levels (nitrogen, phosphorous, potassium) that would restrict growth and yield of maize, alfalfa, and most other agronomic crops support high yields of switchgrass and Miscanthus x giganteus for multiple years (>5) without supplemental phosphorus and potassium fertilization and only modest (50 kg/ha/yr) N inputs. 5) Annual biomass systems (sorghum, maize, small grains) are production

systems familiar to farmers, and this familiarity may accelerate biomass production integration into the Midwest landscape. 6) Sorghum can out-yield perennials like switchgrass and Miscanthus x giganteus and other annuals like maize in certain extremely marginal sites (drought, landfills) and requires fewer inputs (nitrogen, water, phosphorous, potassium) than maize. 7) As compared to established perennial systems, annual biomass production systems (maize, sorghum) are vulnerable to weather events that interfere with farming operations (planting, nitrogen fertilization, and herbicide applications) and have a different level of risk associated with production. 8) Species differences in biomass composition (cellulose, hemicellulose, and lignin) are large and impacted by management, especially harvesting where disproportionate leaf to stem losses occur. 9) GHG emissions, especially nitrous oxide, are generally lower for biomass production systems where modest rates of nitrogen fertilizer are applied as with switchgrass and Miscanthus. 10) Environmental modeling reveals loss of nitrogen to surface waters is reduced markedly when perennial grasses are grown in place of maize/soybean rotations. 11) Other models have used these data and previously published results from the literature to predict biomass yields in the Midwest and U.S. Current studies have improved the models (Agricultural Production Systems Simulator-APSIM, Soil and Water Assessment Tool-SWAT, and others) but also identified critical biophysical research needed for further improvement.

4. Associated Knowledge Areas

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

Outcome #6

1. Outcome Measures

GF 2.1 Number of new or improved innovations developed for food enterprises

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	10

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

There is a global grass-roots movement for local production of fresh, healthy produce. This

becomes difficult to accomplish year-round in seasonal climates where there is a definite off-season for crop production. During off-season, northern communities are dependent upon produce being shipped long distances from locations where the growth climate is mild and labor is cheap. This adds cost to the consumer, adds to the environmental footprint of transportation, and detracts from the quality of produce harvested elsewhere for long-distance transportation. Protected horticulture can advance and extend growing seasons, but without inputs of energy for heating, cooling, and lighting, local off-season production of quality produce is not possible for local year-round production in seasonal climates, and profitability may be at risk. In 2006, NASA put a very promising bio-regenerative life-support research program on hold for budget-driven reasons. The project demonstrates self-sustaining, off-Earth life support for astronauts for pick-and-eat with greens and tomatoes harvested from the veggie plant-growth unit deployed on the International Space Station (ISS).

What has been done

Several projects have been completed for controlled environment agriculture (CEA) sustainability. The overall goal is to develop methods to deliver adequate renewable energy for crop growth, development, and yield, effectively and economically, so that crop production can be profitable for local producers year round. Developing technologies and protocols with potential to save considerable amounts of energy for sole-source lighting of leafy- green crops growing in a warehouse environment (phasic control, close-canopy, targeted light-emitting diodes (LED) lighting) will cut back significantly on utility bills of local growers. For the NASA project, to optimize light, carbon dioxide, and fertility for leafy vegetables and dwarf tomatoes, to be grown on the ISS for consumption by astronauts, 3 growth phases of leafy crops (lag, log, and plateau) were identified, and energy inputs and red to blue ratios for lighting optimized. For NASAs "pick-and-eat" project, "Veggie" plant-growth hardware were developed to grow vegetables, including height-adjustable overhead arrays of LEDs with water and nutrients supplied through plastic "pillows" that contain water in the micro-gravity environment of the ISS. Environmental and cultural conditions used on ISS (except for microgravity) were mimicked on the ground in growth chambers to grow Chinese cabbage and dwarf tomato using ground-based mock-ups of the ISS Veggie units. Root-volume restriction built into the pillows used to grow the plants in space were evaluated by comparing growth with that of plants gown in the same media and fertilizer, but in containers of larger root volume. A number of stress factors were identified and efforts are underway to minimize or eliminate stressors and their potential interactions, and for red to blue ratios and total photon flux to be optimized for test-crop growth responses. These growth conditions can provide valuable insight for controlled environment agriculture with respect to maximizing production of crops per unit volume.

Results

Plants were grown mimicking ISS-like environmental conditions of temperature (24.5 C days / 21 C nights), humidity (45% days / 55% nights), and carbon dioxide concentration (2800 ppm average). Initial trials on ISS conducted by astronauts involving 1 cultivar of leaf lettuce resulted in plant growth looking normal and similar to ground-controls. Trials of a promising cultivar of Chinese cabbage conducted on the ground in growth chambers varied combinations of growth-substrate composition, incorporated timed-release fertilizer concentrations, LED spectral composition, and total light intensity using Biomass-Production-Systems-for-Education (BPSe). These systems offer unique opportunities for hands-on experiments for space for high school and university labs and classrooms. The BPSe growth units under ISS environmental conditions resulted in inferior plant growth compared to greenhouse controls. Similar poor growth was found for a promising dwarf tomato cultivar under ISS conditions. Although multiple cultural and/or environmental stressor combinations are suspected to be causal, attempts to eliminate them failed to improve growth of Chinese cabbage, until carbon dioxide was reduced from 2800 PPM to near Earth-normal ambient. These results are important as we look to the increasing carbon

dioxide concentrations on earth. Investigations are underway to alleviate other-carbon dioxide environmental/cultural stressors to determine if eliminating those interactions can significantly reduce plant response to supra-optimal carbon dioxide. Parallel efforts are investigating whether genetics, and/or genetics and environment interactions, are responsible for the negative response of the Chinese cabbage cultivar. A successful project will help develop higher-plant food sources starting with vegetables known to contain healthful phytonutrients.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
402	Engineering Systems and Equipment
511	New and Improved Non-Food Products and Processes

Outcome #7

1. Outcome Measures

SE 4.1 Number of new technologies developed

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The sun is the principle source of energy for our planet, and photosynthesis is the primary mechanism by which that energy is captured and stored in the form of reduced carbon. An outcome of these biochemical events is that plants represent a quantitatively important, sustainable, and carbon-neutral source of energy for humans. To maximize the utility of plants for this, it is important that control is secured for the processes associated with energy capture and storage, including molecular mechanisms that allocate fixed carbon to the myriad biochemical pathways in plants. One most significant of these is the phenylpropanoid biosynthetic pathway which leads to the deposition of lignin. Lignin is a cross-linked phenolic polymer that makes the cell walls of specialized plant cells more rigid. Its synthesis represents the single largest metabolic sink for phenylalanine in the biosphere and as such represents a huge metabolic commitment for plant metabolism. Lignin is also a significant barrier to the use of crops for livestock feed, pulp and paper production, and to the generation of cellulosic biofuels.

What has been done

The research objective is to advance understanding of lignin biosynthesis while simultaneously adding to abilities to engineer plant metabolism so that it can be modified for improvement of agriculture. Although the enzymes of lignin biosynthesis have now been identified, little is known about how the expression is regulated. Several relevant transcription factors have been isolated, but it is unclear how their expression and activity dictate, or contribute to, the allocation of photosynthate to lignin as opposed to other plant components such as cellulose, starch, or any other sinks for reduced carbon. This research explores how the amount of lignin in a plant is controlled based on discoveries of two novel, plant-specific proteins (REF4 and RFR1) that are components of Mediator (a large multi-protein complex that facilitates interactions between DNA-bound transcription factors and RNA polymerase II to activate or repress expression of downstream genes). Mutants of Arabidopsis that lack REF4 and RFR1 are viable and show little in developmental changes, making them a tractable system to examine the function of Mediator. Of particular relevance is that these mutants accumulate more phenylpropanoid end products including lignin. Plants carrying a mutant dominant form of REF4 show the opposite. Thus, REF4 and RFR1 appear to be components of a system that determines the amount of carbon allocated to the phenylpropanoid biosynthetic pathway. To explain how REF4 and RFR1 function as components of Mediator, a set of experimental approaches were used. 1)Immunoprecipitation methods to determine proteins with which REF4 and RFR1 interact in the Mediator complex. These experiments establish which proteins are relevant to regulation of phenylpropanoid accumulation in plants and may simultaneously identify additional proteins relevant to this process. 2) Chromatin immunoprecipitation used to identify targets of the REF4 and RFR1 proteins in the Arabidopsis genome to understand which genes must be altered in their expression to divert more or less carbon into the lignin biosynthetic pathway. 3) Determination made about whether there are functional differences between REF4 and RFR1 by altering their relative expression levels in different tissues.

Results

The Mediator complex is a large, multi-subunit, transcription co-regulator that is conserved across eukaryotes. Studies of the Arabidopsis Mediator complex and its subunits have shown that it functions in nearly every aspect of plant development and fitness. The majority of insights into plant Mediator function have come from Arabidopsis because it is the only plant from which Mediator has been purified and from which an array of Mediator mutants have been isolated by forward and reverse genetics. So far, these studies indicate the overall structure and function of Mediator is well conserved between Kingdoms. Several studies have also expanded our knowledge of Mediator to other plant species, opening avenues of investigation into the role of Mediator in plant adaptation and fitness. Learning how REF4 and RFR1 function to coordinate transcription of genes required for lignin deposition provides insights into how this pathway can be manipulated for human energy needs. Considering that over 100,000,000 gigatons of lignin are synthesized annually in the biosphere, these proteins are important players in the global carbon cycle and represent important opportunities for the manipulation of lignin synthesis in plants.

4. Associated Knowledge Areas

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

Outcome #8

1. Outcome Measures

CC 1.6 Number of new assessment and management tools developed, including models and measurements of greenhouse gas emissions.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Due to the policy mandate of the Energy Independence and Security Act of 2007, significant land use changes may occur to meet 36 billion gallons of biofuels produced by 2022. Land use changes at such a large scale can potentially change prevailing agricultural practices. Moreover, land use changes resulting from increased production of bioenergy crops may have both positive and negative environmental impacts that need to be carefully evaluated so that sustainable production practices can be developed. Environmental impacts will vary depending on selection of bioenergy crop sources, soil and climate conditions, crop production practices, and scale of evaluation. With increase in the use of bioenergy, there is considerable debate regarding environmental benefits of energy crop production compared to other energy options. Even though perennial bioenergy crops are expected to provide greater environmental benefits of reduced losses of nutrients and soil erosion, there is no scientific consensus on extent of potential impacts related to greenhouse gas emission, air quality, water quality, soil nutrient depletion, erosion, and ecosystem services. Significant uncertainty exists in our knowledge of the extent of positive or negative benefits that can be realized because of various bioenergy crop production scenarios. The Department of Energy and the National Academy of Science have recommended specific studies to fill our knowledge gap regarding environmental impacts of various bioenergy crop production.

What has been done

This project evaluated the impacts of land use changes associated with food, feed, and bioenergy production and their impacts on environmental sustainability. The goals are to: 1) Quantify impacts of land use changes associated with bioenergy crop production on hydrology, water quality, and environmental sustainability. 2) Develop methods to optimize bioenergy and food crop selection and placement under single and multiple objective functions. 3) Develop methods and tools to quantify ecosystem services from mixed land use watersheds. The SWAT (Soil and Water Assessment Tool) is a model to simulate the quality and quantity of surface and ground

water to predict environmental impact of land use, land management practices, and climate change for assessing soil erosion prevention and control and regional management in watersheds. It was used to evaluate positive and negative environmental impacts of increased use of lands for production of bioenergy crops. The tool assesses the change in land use from crop production to bioenergy crops, and especially marginal lands and lands that have not used bioenergy crops before, like flooded areas or land with low value for crop production.

Results
Accomplishments were: 1) The SWAT model was improved for use with bioenergy crops. The project developed new algorithms and modified the SWAT model to simulate impacts of bioenergy crops on hydrology and water quality. 2) In collaboration with the SWAT team, the new algorithms were incorporated into the model so that the improved codes are distributed to SWAT modelers globally. 3) The project then used the improved SWAT model to evaluate impacts of bioenergy crop production on eco-hydrology and ecosystem services. 4) Marginal land areas in the Mississippi River basin were mapped for bioenergy crop production. 5) Impacts were evaluated for bioenergy crop production on marginal lands on hydrology and water quality. These efforts contribute to understanding of the potential impacts related to greenhouse gas emission, air quality, water quality, soil nutrient depletion, erosion, and ecosystem services from bioenergy crops.

4. Associated Knowledge Areas

KA Code	Knowledge Area
131	Alternative Uses of Land
402	Engineering Systems and Equipment

Outcome #9

1. Outcome Measures

Number of stakeholders participating and representing a diverse group of economic, social and sector backgrounds

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	72

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Sustainable energy production continues to grow in the public consciousness. As energy costs go up and with concerns about possible impacts to the environment from traditional energy production practices in the Midwest, Indiana residents and businesses are seeking information about solar energy for helping offset long-range energy costs. Agriculture producers are concerned about working with the utility company, what the payback period is, and how solar compares to utility power costs.

What has been done
Purdue Extension educators and specialists collaborated on a Solar Applications for Agriculture workshop. Working with many local, Indiana and national partners, Purdue Extension provided a program to address concerns about solar energy, including these topics:
1) Indiana Solar Installations. 2) Solar Photovoltaics Project Development. 3) Advances in Storage - Improved Batteries, 4) REMC Net Metering Program. 5) Solar Thermal Hot Water Applications for Agriculture. 6) Economic and Policy Evaluation of Solar Energy for Indiana Businesses and Residential Applications. 8) USDA Rural Development REAP Grant and Loan Guarantee Program.

Results
In the post-pre reflective survey, attendees indicated the changes in their understanding or skill related to solar energy. All topic areas saw improvement in understanding with these topics showing the greatest volume of improvement: 1) Solar Photovoltaics. 2) Solar Energy Storage 3) Solar Thermal Applications. Attendees indicated the workshop provided excellent information, and they learned about new technologies.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment
605	Natural Resource and Environmental Economics

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

Extension programs conduct evaluation surveys to measure change in knowledge and intentions of participants, and follow-up surveys to assess change in behavior or practice and results of actions. Field and lab research projects monitor progress and completion of study objectives and tasks, testing of simulations, models and new technologies, and publications of findings, to determine effectiveness and accomplishment.
Evaluation results included:
Outcome # 6 - Initial trials on NASA's International Space Station conducted by astronauts involving a single cultivar of leaf lettuce resulted in plant growth looking normal and similar to ground-controls
Outcome # 7 - Research revealed two novel, plant-specific proteins (REF4 and RFR1) as key to lignin synthesis in plants
Outcome # 9 - Producers increased knowledge of solar energy technologies and costs for agriculture

Key Items of Evaluation

Outcome # 5 - Environmental modeling reveals loss of nitrogen to surface waters is reduced markedly when perennial grasses are grown in place of maize/soybean rotations
Outcome # 8 - Incorporating bioenergy crops into the SWAT model helps to simulate impacts of bioenergy crops on hydrology and water quality globally

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	Diseases and Nematodes Affecting Plants	5%		5%	
216	Integrated Pest Management Systems	5%		5%	
308	Improved Animal Products (Before Harvest)	5%		5%	
501	New and Improved Food Processing Technologies	15%		15%	
503	Quality Maintenance in Storing and Marketing Food Products	10%		10%	
504	Home and Commercial Food Service	5%		5%	
607	Consumer Economics	10%		10%	
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	15%		15%	
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: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	4.5	0.0	7.0	0.0
Actual Paid	2.0	0.0	12.7	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**
972951	0	536162	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2163604	0	2058348	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
369334	0	1006105	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 pathogen. 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:
1) partnering with important stakeholders, 2) development of workshop materials and curricula, 3) conducting workshops, 4) development of web-based and distance education materials, 6) 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

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	8846	1614506	5165	39440

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

Patent Applications Submitted

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	6	216	222

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of education workshops

Year	Actual
2016	366

Output #2

Output Measure

- Number of research projects

Year	Actual
2016	44

Output #3

Output Measure

- Number of research publications

  Not reporting on this Output for this Annual Report

Output #4

Output Measure

- Number of Extension publications
  Not reporting on this Output for this Annual Report

Output #5

Output Measure

- Number of volunteers

Year	Actual
2016	137

Output #6

Output Measure

- Number of consultations

Year	Actual
2016	2216

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	Protecting animals from food borne pathogens and diseases
10	Viable technologies developed or modified for detection and characterization of food supply contamination from foodborne threats (FS 1.1)
11	Reported changes in prevention, detection, control, and intervention strategies
12	Projects focused on animal welfare
13	ANR # of viable technologies developed or modified for the detection and characterization of food supply contamination from foodborne threats.
14	New or improved innovations developed for food enterprises (GFSH 2.1)
15	Growers, producers, and food workers completing programs to increase food safety (FS 3.1)
16	Projects focused on increased understanding of the ecology of fecal indicators and pathogens (FS 4.1)

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

Not Reporting on this Outcome Measure

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

Not Reporting on this Outcome Measure

Outcome #9

1. **Outcome Measures**

Protecting animals from food borne pathogens and diseases

2. **Associated Institution Types**

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	129

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Development of an effective vaccine or vaccination strategy is critical to provide poultry protection against infectious diseases. The long-term goal is to prevent and control infectious diseases of economic significance in the U.S. poultry industry. The immediate goal is to develop a reverse genetics-based infectious bursal disease virus (IBDV) that can serve as a vaccine vector for protection against avian influenza AI and other emerging poultry viral diseases. The IBDV genome is small and a viral vector with small genome will minimize the interference with expression of the recombinant gene by expression of extraneous viral genes. Deletion of certain fragment from the IBDV segment would render the IBDV replication incompetent. Replication-incompetent IBDV can be generated by reverse genetics and serve as a vaccine vector. The IBDV vector can be utilized for a broad avian host range, including chickens and turkeys, since IBDV causes infection to these avian species. In addition, the replication-defective IBDV vector can provide protection against IBD and other emerging and economically important avian viral diseases, particularly avian influenza, in chickens and turkeys.

What has been done
Studies were conducted to determine functional genomics of the chicken innate immune system with a focus on the area containing 3 NLRP3 inflammasome. RNA was extracted from chicken macrophage cell line HD11 cells or bursa of Fabricius, reversetranscribed to cDNA, and subjected to PCR amplification of chicken NLRP3. The PCR amplicons were cloned and sequenced. The expression level of NLRP3 in various chicken tissues was determined.

Results
The result indicated that chicken tissues possess NLRP3, encompassing 2778 base pairs of nucleotides and encoding for 925 amino acids. Chicken NLRP3 is phylogenetically different from mammalian NLRP3. Chicken NLRP3 is ubiquitously expressed in chicken tissues. In addition, chicken NLRP3 functions as a cytosolic sensor for LPS and ATP and production and activation of mature chicken IL-1 is chicken NLRP3 dependent. The highest mRNA levels of chicken NLRP3 were present in kidney, bursa and spleen at 9.4x1010, 9.33x1010 and 8.57x1010 copy number/l, respectively. This foundational information will be helpful to scientists looking to create vaccines against poultry diseases, but also of value when considering how these diseases interact in poultry tissue differently than in human tissue.

4. Associated Knowledge Areas

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

Outcome #10

1. Outcome Measures

Viable technologies developed or modified for detection and characterization of food supply contamination from foodborne threats (FS 1.1)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	126

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Given the advances in materials and instrumentation there has been a significant improvement in the development of detection technologies. Nevertheless, given the complexity of the samples and the Limit of Detection (LOD) expected and the need to perform this step at a rapid rate in the field, the area of sensors development is continually challenged. Sensors that can detect pathogens and toxins as low as a single cell in complex matrices within a few minutes is the ultimate goal for the scientists and engineers involved in this technology development space. The overall objective of this study is to utilize and integrate the concepts of biosensor and nanotechnology based methods to develop simple technologies that can be deployed onsite for rapid detection (< 30 minutes) of food pathogens at the lowest possible limit of detection (< 10 cfu/ml).

What has been done
The major goal of this project is to develop effective onsite sensor technologies for enhanced onsite detection of pathogenic agents and disease markers. We are focused on developing signal enhancement strategies utilizing multifunctional nanoparticles to significantly improve the LOD of lateral flow immunochromatography (LF-IC) assays. Various (E. coli, Salmonella sp., Shigella sp., Listeria, Staphylococcus, Yersinia) foodborne and disease causing pathogens will be examined to achieve a LOD of < 10 cfu/ml (conventional LOD in LF-IC systems is ~106 cfu/ml) for pathogen detection.

Results
An onsite sensor to detect at 100 CFU/ml was developed based on magnetic lateral flow technology. Extensive specificity experiments were conducted. Initial evaluation of the sensor in juices was demonstrated.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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 #11

1. Outcome Measures

Reported changes in prevention, detection, control, and intervention strategies

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	11032

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Spoilage of grain in on-farm storage areas continues to be a major problem on U.S. farms in the cornbelt. This hurts farmers not just because of the discounts or dockage received when they deliver grain to the elevator, but more so when lives are lost in the process of trying to unload a silo that has caked up grain resulting from spoilage. In an extensive database of 181 grain entrapment incidences reviewed in a study at Purdue by Kingman et al. (2001), victims entrapped in grain were involved in bin unloading activities in 76% of the cases, while in 53% of the cases, corn that had gone out of condition (spoilage) was the agent of injury. There has been a fatal incident every month, with over 50% of the incidences related to farm or elevator workers trying to unload caked up grain since 2005.

What has been done
The focus of this research is investigating new innovative technologies and management practices that will permit farmers, elevator managers and grain processors to safely and effectively manage stored grain in silos without entry (zero entry). Current strict regulations for confined space entry by the Occupational Safety and Health Administration (OSHA), necessitates a paradigm shift from current unsafe operational practices where workers enter grain bins to perform tasks such as sampling, dislodging grain, etc. to avoidance of bin entry. In order to develop a zero entry platform for stored grain systems, technologies and systems for the effective management of the stored grain that prevent spoilage, and thus avoid bin entry must be developed.

Results
The first efforts toward this project have resulted in a probe being designed. Work to test and refine the probe is ongoing. This work will contribute toward enabling technologies to monitor bulk solids in confined spaces such as silos and grain bins, and permit adequate monitoring by

workers without entry into the silo.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
503	Quality Maintenance in Storing and Marketing Food Products
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 #12

1. Outcome Measures

Projects focused on animal welfare

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	11

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The livestock industry is a vital contributor to the economy of the state of Indiana, generating revenue of more than $29.5 billion in 2007 according to the U.S. census of agriculture. An outbreak of foreign animal disease will result in a devastating impact on Indiana's economy, livestock industry, and community. Planning for foreign animal disease (FAD) outbreak management is essential to safeguarding the health and welfare of humans and animals. In the event of a FAD outbreak, animal welfare, while not being ignored, may be suboptimal if there is not thoughtful and advanced consideration for it. One of the main challenges of integrating animal welfare into risk assessment models is the lack of a scientific-based approach to quantify the well-being of animals.

What has been done
The goal of this project is to integrate animal welfare components into planning for foreign animal disease (FAD) outbreak management in Indiana. The expected outcome from this project is to assist state decision makers in improving current data collection process and in planning for FAD

management. To accomplish this goal, the primary investigator has established an initial connection with the Indiana State Board of Animal Health (BOAH). The research hypothesis is that inclusion of animal welfare components in quantitative risk assessment models for FAD management planning will affect the critical outcome measures used for evaluating FAD outbreak contingency plans.

Results
Our team developed a risk assessment model to estimate the time elapsed before overcrowding or feed interruption emerged on the swine premises under movement restrictions during a classical swine fever (CSF) outbreak in Indiana. The study findings suggest that overcrowding and feed interruption could emerge early during a CSF outbreak among swine premises under movement restrictions. The early onset of adverse animal welfare outcomes may compete for the resources for other disease control activities and hamper outbreak control progress. The outputs derived from the risk model could be used to estimate and evaluate associated mitigation strategies for alleviating adverse animal welfare conditions resulting from movement restrictions.

4. Associated Knowledge Areas

KA Code	Knowledge Area
308	Improved Animal Products (Before Harvest)

Outcome #13

1. Outcome Measures

ANR # of viable technologies developed or modified for the detection and characterization of food supply contamination from foodborne threats.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	318

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Fresh and fresh-cut produce have been a major cause of foodborne illnesses. Among all produce, cantaloupe is particularly susceptible to both Gram-positive (e.g. Listeria) and negative (Salmonella) pathogens. The goal of this project is to create a technology platform for designing antimicrobial formulations which need negligible capital investment and minimal material cost to protect fresh and fresh-cut produce.

What has been done
It is hypothesized that the interactions among antimicrobial compounds and the retention of their efficacies during the storage of produce are essential for achieving cost-effective inhibition of pathogens. The project selected natural, food-grade antimicrobial compounds and examined their efficacies in cantaloupe-related food systems. Cantaloupe will be used as the model due to the high susceptibility of whole cantaloupes to pathogen contamination and the juicy surface of fresh-cut cantaloupe renders it highly favorable for pathogen growth yet hostile to the presence of antimicrobial compound. In this project 1) examine the interactions of antimicrobial compounds and evaluate their efficacies against selected pathogens in model systems, 2) design antimicrobial coating for cantaloupe whole uncut fruit and fresh-cut, and 3) conduct extension workshops and field trials with cantaloupe growers to evaluate antimicrobial formulations. The technology derived from this project will substantially enhance the microbial safety of cantaloupe products and other fresh and fresh-cut produce.

Results
The team discovered that bacteria is encased in the biofilm that sits on the surface of the cantaloupe that renders it essentially inert. When something pierces the biofilm, such as a knife slicing through the melon to serve it, the bacteria is then released, activated and could be deposited onto the flesh. It has been further confirmed that E. coli O157:H7 biofilm at cantaloupe surface is resistant to sodium hypochlorite, a conventional sanitizer of fruits, and lauroyl arginate ethyl, an antimicrobial food ingredient. A manuscript will soon be submitted. A review article "Delivery Systems of Antimicrobial Compounds to Food" was published with Trends in Food Science and Technology. A research article "Impact of starch-based emulsions on the antibacterial efficacies of nisin and thymol in cantaloupe juice" was published with Food Chemistry.

4. Associated Knowledge Areas

KA Code	Knowledge Area
212	Diseases and Nematodes Affecting Plants
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 #14

1. Outcome Measures

New or improved innovations developed for food enterprises (GFSH 2.1)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	20

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Food dispersions, such as gels, foams and emulsions, are major components of the human and animal diet. Examples of common food dispersions are jam, beer, whipped cream, dressings, mayonnaise, whole milk, butter, and margarine. The team will work to optimize how the diverse components (cells, drops, fibers, bubbles, crystals, particles) are organized and arranged in internal microstructures with various types of assemblies (gels, foams, colloids, emulsions) to engineer food dispersions with desired behaviors. Moreover, the enhanced knowledge of food interfacial phenomena can have a direct impact in the area of nutrition and health because interfacial properties strongly influence the dynamics by which foods interact with the gastrointestinal tract. Ultimately, we expect that by expanding our fundamental knowledge of interfacial phenomena, and improving the realistic representation of important interfacial processes in computer models, this research will help design formulation and processing strategies for the production of food dispersions with higher nutritive value manufactured with greater efficiency benefiting human health and enhancing food security.

What has been done

Most foods are heterogeneous systems composed of dispersed elements with distinct physical structure such as cells, fibers, emulsion droplets, and powder particles. These structural elements are enclosed by, and interact through, interfaces. Therefore, knowledge of the physical and chemical phenomena occurring at these interfaces is essential to improving the quality and nutritional value of foods. Our overall goal for this project is to expand our fundamental knowledge on the dynamics of interfacial phenomena in foods as a prerequisite to the development of food formulation and processing strategies aimed to the production of foods with higher nutritive value manufactured with greater efficiency. In this context, specific objectives are the accurate modeling and simulation of interfacial phenomena in food dispersions to: 1) assess the influence of food formulation on the dynamics of food interfaces; 2) characterize the rheological response of food interfaces to external fields (e.g. thermal, mechanical and electric fields); 3) assess the extent to which interfacial processes may be modulated by food environment and processing.

Results

We have developed new theoretical concepts and experimental protocols to characterize the evolving bulk and interfacial properties of food proteins and carbohydrates during processing, and to enhance the stability of food dispersions. In 2016 we have also investigated the influence of composition on the quality of gluten-free products. This research will help improve formulation of gluten-free products by characterizing the impact of composition on both the rheological behavior of gluten-free dough and the quality (firmness, volume and microstructure) of the corresponding breads among many other products.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
702	Requirements and Function of Nutrients and Other Food Components

Outcome #15

1. Outcome Measures

Growers, producers, and food workers completing programs to increase food safety (FS 3.1)

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	9509

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
According to Centers for Disease Control estimates, approximately 46% of all foodborne illness outbreaks originate with fresh produce. Using good agricultural practices (GAPs) on farms where fruits and vegetables are produced can reduce illness caused by eating contaminated produce. Purdue has adapted and delivered an 8-hour training program to fruit and vegetable producers in the state. However, operators of many small operations that sell directly to the consumer or provide food to foodbanks have not attended the day-long training, and feedback from those who have attended indicate that it would be more helpful if it were tailored to the scale and type of operation they have. We identified a need for a GAPs education program tailored to produce direct marketers.

What has been done
A Purdue Extension team adapted the 8-hour Purdue GAPs A to Z curriculum for delivery as a 2-hour On-Farm Food Safety for Produce Direct Marketers and trained a team of Field Extension Educators to deliver the program. In addition to a PowerPoint slide set, a handout on water testing was developed. Participants were offered Farm Food Safety Decision Trees For Fruit and Vegetable Growers (Elizabeth A. Bihn, et. al., Cornell University) and a test kit for one free test of microbial water quality.

Results
The training was delivered to over 200 people in 22 counties at 26 events. Participants found the program useful and planned to improved food safety practices in their operations. Based on 120 surveys returned immediately after the event, 86% of participants found the program very useful

and the education they received prompted 85% to anticipate making a change in their practices. After the growing season, participants were invited to respond to a survey by US mail or online. Forty-one people responded, about 20% of attendees. Nearly three-quarters of these respondents sold more than half of their produce directly to the final consumer. All respondents reported the information presented was at least somewhat useful, and 63% found it very useful. A little over half (58%) changed food safety practices on their farm because of the workshop. Of those who made changes, three-quarters improved post-harvest handling and packaging, almost half improved management of manure or waste, 40% improved training and management of workers and 40% improved practices at the point of sale. Less than 20% improved water use or testing or wildlife management. Examples of changes include timing of manure application and improved management of wash water including temperature and use of sanitizers. Cost estimates of the changes ranged from $0 to $150. Around 10% reported increased sales or gaining access to new markets as a result of attending the program and making changes, with value of the increase estimated to be $250 or less. The program has increased awareness and knowledge about food safety among farmers who grow fruit and vegetables and sell directly to the public. Farmers are planning to make changes on their farms to improve food safety, and some have already done so. These actions should improve the safety of food in the local supply chain, reducing illness, and enhancing the public's ability to enjoy nourishing food produced on nearby farms.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
503	Quality Maintenance in Storing and Marketing Food Products
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 #16

1. Outcome Measures

Projects focused on increased understanding of the ecology of fecal indicators and pathogens (FS 4.1)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual

2016 3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The FDAs Food Safety Modernization Act (FSMA) is now law and producers are looking to Purdue to provide guidance regarding who is required to follow the new rules and how to implement. Faculty across the College of Agriculture have been conducting research and training farmers on best practices for food safety, especially with regard to fresh produce. Much of this research and extension work, has been USDA funded and translated into very successful training programs including GAPS A-Z and Direct Marketing workshops.

What has been done
Purdue scientists and extension staff are working with Indiana State Department of Health, Indiana State Department of Agriculture to train farmers/producers of all sizes on how to be in compliance. The Produce Safety Alliance has been authorized by FDA to create curriculum and materials for courses and to train people to lead the courses. Six people are certified as Lead Trainers under the Produce Safety. Efforts are underway to identify and train producers that may not be required to comply but are still held liable should there be an outbreak on their farm.

Results
Marketing materials have been created, including a website (www.safeproduceIN.com), rack cards and the first course was conducted in 2016. The team anticipates having the bulk of required growers participate during 2017.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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

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

Extension programs conduct evaluation surveys to measure change in knowledge and intentions of participants, and follow-up surveys to assess change in behavior or practice and results of actions. Lab and simulation research projects monitor progress and development/testing of technologies, completion of study objectives and tasks, and publications/presentations of findings, to determine effectiveness and accomplishment.
Evaluation results included:
Outcome #10 - Developed sensors to detect single molecules and single pathogens at 100 cfu/ml for food safety and human health
Outcome #11 - Developed probe to test grain in silos to avoid bin entry by farm workers
Outcome #13 - Identified effectiveness of antimicrobial compounds on cantaloupe for food safety of cantaloupe products and other fresh and fresh-cut produce
Outcome #14 - Identified properties of food protein and carbohydrates during processing of gluten-free dough and breads
Outcome #16 - Monitoring of required training for produce farmers

Key Items of Evaluation

Outcome #9 - Genetic research identified immune system inflammatory response to infection diseases in chickens
Outcome #12 - Created risk assessment model to evaluate mitigation strategies for animal welfare during disease outbreaks
Outcome #15 - As a result of attending food safety training, participants changed food safety practices on their farms relating to post-harvest handling/packaging, management of manure, training and management of workers, and point of sale

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: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	1.2	0.0	11.0	0.0
Actual Paid	0.6	0.0	4.9	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**
829661	0	247833	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2056965	0	1207466	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
347508	0	921638	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

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1667	1602929	20990	24620

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

Patent Applications Submitted

Year: 2016
Actual: 1

Patents listed
9,497,928

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	0	26	26

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of Extension publications
  Not reporting on this Output for this Annual Report

Output #2

Output Measure

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

Output #3

Output Measure

- Number of research projects

Year	Actual
2016	6

Output #4

Output Measure

- Number of consultations

Year	Actual
2016	1473

Output #5

Output Measure

- Number of education workshops

Year	Actual
2016	355

Output #6

Output Measure

- Number of volunteers

Year	Actual
2016	108

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	Number of early childhood educators reported a gain in knowledge and adoption of more physical engagement activities and better food choices into the daily lives of children to combat childhood obesity
13	GSFH 4.5, 4.7, 4.8; FCS 1.3 Number of discoveries, innovations, technologies that relate to human health (including cancer), nutrition and well-being (including bio-actives and botanicals), chronic Diseases, and impacts of environmental factors on health.
14	Number of increased efficiencies related to reducing obesity (i.e., reduced fat, improved digestibility, improved nutritional value, etc.)

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.

Not Reporting on this Outcome Measure

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

Number of early childhood educators reported a gain in knowledge and adoption of more physical engagement activities and better food choices into the daily lives of children to combat childhood obesity

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	4741

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Obese children are more likely to be obese as adults, and are more at risk for serious adult health problems such as heart disease, diabetes, stroke, cancer, and osteoarthritis. About 15% of Indiana adolescents are considered obese and 16% overweight. National prevalence of obesity among children ages 2-5 years is 8%. In Indiana it is slightly higher, especially among lower-income WIC children (14-16%). Healthy lifestyle habits, including physical activity, can lower the risk of becoming obesity.

What has been done
I am Moving, I am Learning (IMIL) is a program for childcare providers that promotes moderate to vigorous physical activity in young children to combat childhood obesity. IMIL training is presented by Purdue Extension in 12 lessons, taught individually, or in a series of 4 or more. IMIL training provided 553 childcare providers and other related individuals with lessons in 22 counties of Indiana, with information on: 1) Increasing the quantity of time spent in moderate to vigorous physical activity, 2) Improving the quality of structured movement experiences intentionally facilitated by adults, and 3) Promoting healthy nutrition choices every day.

Results

Some 91% of IMIL participants indicated they would be able to use the information learned. In post/pre reflective statements, participant responses to 10 of 11 statements about strategies and practices to help children be more active showed statistically significant increases in knowledge. The largest increases were for: 1) Strategies to support children, families, and staff in applying moderate to vigorous physical activities, 2) How moderate to vigorous physical activity supports preschool readiness, 3) How to use appropriate verbal cues to encourage various movement activities, 4) Health benefits associated with including moderate to vigorous physical activity, and 5) Developmentally appropriate strategies to promote physical activity in children. For implementing practices and strategies, all showed statistically significant changes. Top 3 statements with the largest increases were: 1) Build in movement activities with children that achieve 60 minutes of moderate to vigorous physical activity per day, 2) Discuss strategies with parents to support moderate to vigorous physical activity with children at home, and 3) Use movement vocabulary to support children's development. Participants indicated their next steps in applying what they learned, these themes emerged: 1) Incorporate more active movement for children, 2) Plan outside activities, including more music and movement, 3) Use the information and activities to make curriculum and environmental changes, and 4) Use the information learned for staff development. These results show the IMIL program is making a difference in the level of knowledge childcare providers have about the importance of physical activity for children and the long-term health benefits, and in childcare providers implementing practices to get children to be more activity to make a difference for children to help reduce childhood obesity.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior

Outcome #13

1. Outcome Measures

GSFH 4.5, 4.7, 4.8; FCS 1.3 Number of discoveries, innovations, technologies that relate to human health (including cancer), nutrition and well-being (including bio-actives and botanicals), chronic Diseases, and impacts of environmental factors on health.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	57

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Very little is known about the molecular process of dietary fat absorption in humans. Understanding molecular mechanisms involved in dietary fat absorption will help contribute to knowledge for developing prevention and treatment strategies for some of the most common health problems such as obesity, diabetes, cardiovascular disease and cancer.

What has been done
The long-term goal of the laboratory research is to identify novel factors that differentially regulate dietary fat absorption and may serve as targets or methods for preventive and therapeutic interventions for obesity, cardiovascular disease, liver disease and diabetes. There are 3 research objectives: 1) To determine the role of 2 enzymes (diacylglycerol acyltransferase or DGAT1 and DGAT2), in catalyzing the metabolism of lipids (triacylglycerol or TAG) in the intestine, 2) To determine the role of acyl-CoA synthetase 5 enzymes (ACSL5) in intestinal fatty acid and TAG metabolism; and 3) To identify and characterize lipid droplet-associated proteins (chylomicrons) in intestinal cells.

Results
Findings were that DGAT1 and DGAT2 work complementarily to make triacylglycerol during the process of dietary fat absorption. DGAT1 makes triacylglycerols that are important for packaging large amounts of dietary fat on chylomicrons, whereas, DGAT2 makes triacylglycerols that are important for initiating the synthesis and determining the numbers of chylomicrons made. In the phenotype of mice deficient in ACSL5, the research found ACSL5 is indeed important in determining the rate of dietary fat absorption and contributes to energy balance. For the protein structure of lipid droplets from intestinal cells of mice after a high fat diet challenge, the research compared how lean and obese mice respond differently to a high fat dietary challenge. The proteins associated with the lipid droplets include some proteins that are common for both groups, some that are unique to lean or obese, and some that are differentially present between the 2 groups. This information is helping to build a model to test hypotheses about how dietary fat is absorbed differently in obese compared to lean mice.

4. Associated Knowledge Areas

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

Outcome #14

1. Outcome Measures

Number of increased efficiencies related to reducing obesity (i.e., reduced fat, improved digestibility, improved nutritional value, etc.)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The 2015 Dietary Guidelines Advisory Committee report emphasizes several important points: 1) The majority of adults living in the U.S. are overweight or obese, they consume excess energy, foods and beverages that are nutritionally poor, and they have health profiles characterized by high risks of developing cardio-metabolic diseases and cancer. 2) Research supports the effectiveness of consuming healthy dietary patterns, including a Mediterranean-style diet or a Dietary Approaches to Stop Hypertension (DASH)-style diet, and improving body weight body composition through diet and exercise to counter obesity and disease. 3) There is ambiguity and inconsistency in scientific literature about the impact of red meats in diets designed to promote health. While the overall recommendation is to reduce consumption of red and processed meats, it is not well known whether this includes lean, minimally processed red meats. 4) National survey data show the majority of dietary protein is obtained by consuming animal-based foods, including meats, poultry, dairy, eggs, and fish. Recommendations to change how much of these protein-rich foods and beverages are consumed may affect not only consumer health, but agricultural infrastructure and practices.

What has been done
Collectively, 4 research studies focused on the Dietary Guidelines Advisory Report. The broad objective is to assess the impact of dietary protein intake and protein-rich animal-based agricultural food commodities on the effectiveness of healthy diet patterns. Specific objectives are to assess the: 1) Effects of within-day patterning of dietary protein intake (even vs. skewed) on energy-restriction and strength training-induced changes in body composition, skeletal muscle size, appetite, glucose response, and metabolic syndrome parameters, 2) Health effects associated with the inclusion of greater amounts of red meat (pork and beef) versus poultry and fish into a healthy Mediterranean-style dietary pattern, which recommends restricting red meat consumption, 3) Impact of protein source (pork vs. chicken/fish) as part of a DASH diet on blood pressure control in older adults, and 4) Associations between the quantity and sources of protein intake and body composition in a nationally representative sample of US adults aged 50 and older.

Results
1) The study to assess the impact of protein source (pork vs. chicken/fish) as part of a DASH diet on blood pressure control in older adults, found that adults with elevated blood pressure may effectively incorporate lean pork into a DASH-style diet for blood pressure reduction, and 2) Other research results describe the effects of dietary protein intake on sleep quality, neural responses to visual food stimuli, and body composition changes after weight loss. Individual findings were: 1) Eating whole eggs in a vegetable salad increases the absorption of vitamin E contained in the vegetables, 2) Subclinical hypothyroidism does not affect glucose tolerance and insulin sensitivity in overweight and obese adults who consume whey protein supplements and perform exercise

training, and 3) Consuming a dietary fiber composite with a meal blunts the post-meal serum glucose and insulin responses, which may be helpful to adults at risk for hyperglycemia. Scientists, health practitioners, and nutrition and health policy and program officials may use these findings to develop and implement dietary guidelines about consumption patterns of healthy foods and beverage to help people improve their health and reduce weight/obesity.

4. Associated Knowledge Areas

KA Code	Knowledge Area
701	Nutrient Composition of Food
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

Extension programs conduct evaluation surveys to measure change in knowledge and intentions of participants, and follow-up surveys to assess change in behavior or practice and results of actions. Lab research projects monitor progress and completion of study objectives and tasks, and publications of findings, to determine effectiveness and accomplishment.
Evaluation results included:
Outcome # 12 - Childcare providers learned how to include more physical activity for children and implemented practices in their program
Outcome # 14 - Research determined subclinical hypothyroidism does not affect glucose tolerance and insulin sensitivity in overweight and obese adults who consume whey protein supplements and perform exercise training

Key Items of Evaluation

Outcome # 13 - Research determined roles of key intestine enzymes in fat absorption, and compared and contrasted these roles between lean and obese

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%	
610	Domestic Policy Analysis	3%		3%	
611	Foreign Policy and Programs	3%		3%	
701	Nutrient Composition of Food	3%		3%	
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	3%		3%	
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	3%		3%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	16.9	0.0	29.6	0.0
Actual Paid	10.8	0.0	35.3	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**
1522808	0	478978	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2613073	0	5037040	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
426169	0	1017229	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 development and adult volunteer training
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 in 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, 4-H youth - adult 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

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	121565	4153133	264257	1168408

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

Patent Applications Submitted

Year: 2016

Actual: 8

Patents listed

9,253,973
9,315,778
CN 2,652,138
9,518,114
9,441,256
9,354,237
9,500,654
9,353,072

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	61	85	146

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of education workshops

Year	Actual
2016	8411

Output #2

Output Measure

- Number of research publications

Not reporting on this Output for this Annual Report

Output #3

Output Measure

- Number of Extension publications

Not reporting on this Output for this Annual Report

Output #4

Output Measure

- Number of community collaborations, coalitions, partnerships

Year	Actual
2016	4715

Output #5

Output Measure

- Number of volunteers

Year	Actual
2016	9227

Output #6

Output Measure

- Number of research projects

Year	Actual
2016	81

Output #7

Output Measure

- Number of consultations

Year	Actual
2016	69137

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	Number of farms informed about succession planning
7	Number of farmers, ranchers, and other agricultural workers with disabilities received services to enhance their quality of life.
8	Number of youth will demonstrate a capacity for science process skills
9	Number of high school youth demonstrate entrepreneurship skills.
10	Number of at risk children active in healthy living activities and community service year round.
11	Number of participants that increase deeper appreciation for the complexity of organizations/ communities, need to plan strategically and important skills.
12	Number of participants engaged in a planning process
13	Number of community members indicating knowledge of local government issues
14	Number of families and individuals strengthened by spending time together, setting goals, developing parenting skills, communicating, and dealing with stress.
15	Percent of participants can identify dietary recommendations for eating and preparing more heart-healthy meals
16	Number of parents (divorcing, single, co-parenting) improved their communication and skills in managing conflict amidst the changes occurring for their children.
17	Number of dollars received by those community coalitions across Indiana to address local health priorities including poverty and homelessness.

18	GFSH 4.6, 4.8, FCS 1.1, 1.2, 1.4 HHS 3.2 HHS 3.4 - Number of discoveries, innovations, technologies that relate to family well-being, interpersonal relationships, resource management, parenting and relationships, child development, early childhood education and care

Outcome #1

1. **Outcome Measures**

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

Not Reporting on this Outcome Measure

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.

Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

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

Not Reporting on this Outcome Measure

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.

Not Reporting on this Outcome Measure

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

Number of farms informed about succession planning

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	547

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Succession planning is important for the continuity of small farms. Recent research indicates development of the farm family business requires focus on both family continuity and business profitability. Purdue's Family Business Succession Survey (Marshall et al., 2012) showed more than 55% of family businesses plan to transfer the business to a family member. However, 44% had not started a management transfer plan and 54% had not started an ownership transfer plan. In addition, less than 20% had a written management or ownership transfer plan in place. Succession planning is mentioned in Extension advisory committee discussions, program evaluations, and informal conversations as an area in which information and resources are needed. Families struggle with getting the process started, including not knowing whom to contact, and have difficulty starting the conversation with family members. If there is an unexpected death, disability, divorce, or other unexpected leave, the farm can struggle and may have to be sold. Indiana farm women and women throughout the U.S. are continuing to take larger roles in managing and owning farming operations and diversified agriculture enterprises. To help these women be successful in decision-making, have sound financial management and maintain overall emotional well-being in their operations, educational opportunities directed to this specific audience are necessary.

What has been done
Purdue formed a Succession Planning Team, comprised of Extension educators and faculty/specialists, to address the needs of families planning the continuation of farm businesses. Research goals were to enhance: 1) farm family well-being, 2) economic viability of small and medium family farms, and 3) farm family cohesion and management succession. Findings were incorporated into: 1) Education for the younger generation of family business managers via farm management courses at the university, 2) Extension programs across the state for the older generation of family business managers, and 3) Family farm business structures via publications,

extension activities, and website (Purdue Initiative for Family Firms - https://ag.purdue.edu/agecon/piff/pages/piff.aspx).
To cultivate strong Indiana farm families through the succession planning process, 3 Extension programs are implemented: 1) Regional workshops, 2) Introduction to succession planning presentation, and 3) Farm family visits. Regional workshops are coordinated during the winter months across Indiana and address: 1) Beginning succession planning steps, 2) Financial skills, 3) Communication strategies, 4) Business structures, 5) Risk management tools, 6) Options for asset transfer to the next generation, and 7) Management transfer plans. Workshop presenters include experienced local professionals (i.e., attorneys and accountants), Faculty/Specialists and Educators. Introduction to Succession Planning is a presentation delivered at educational workshops, at conferences and many other venues. The presentation covers basic steps and considerations for succession planning including: 1) Estate/succession planning definitions, 2) Recent research studies, 3) Feasibility of adding a family member, 4) Elements of a family business, 5) Options for business structures, 6) Human resource risks, and 7) Management succession. Farm Family Visits are scheduled after the workshops or presentations for those seeking advice on preparing succession plans. Purdue team members provide assistance with succession planning and advise families on preparing for meetings with accountants and attorneys. Purdue has another team - Women in Agriculture - for providing offerings specific to women through an annual Midwest Conference. Educators and agri-business professionals collaborate to offer sessions designed to address the personal, family and farm issues affecting the lives, farm and family businesses of Midwest farm women. Succession planning is always a topic made available to women attending this conference.

Results
Program evaluations completed by participants indicate the workshops have been beneficial to families starting their succession plans. 100% of respondents indicated information presented was useful to them and they felt better prepared to start their farm succession plans as a result of attending. Most valuable topics were communication, the need for getting started with planning, 6 tips for a succession plan, success of family ownership, how to get started, a beginning point, feasibility, and adding family members. Asked to name something they planned to implement, responses included "take action to finish what we've started", "start meeting regularly", "visit the lawyer, CPA, and financial advisor", "start communicating with all family members" and "listen to ideas my son has." For the Women in Ag conference, women attending indicated that they gained ideas they could try immediately with the most important concepts learned as better communication techniques in discussing family farm management, estate planning, and succession planning and how to do it well. Succession planning continues to be important to the future of farming families in Indiana.

4. Associated Knowledge Areas

KA Code	Knowledge Area
801	Individual and Family Resource Management
802	Human Development and Family Well-Being
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #7

1. Outcome Measures

Number of farmers, ranchers, and other agricultural workers with disabilities received services to enhance their quality of life.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1289

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Agriculture is one of the most dangerous occupations. In addition to injuries sustained while performing agriculture-related tasks, agricultural workers incur disability injuries through many other means, such as falls and auto collisions. Disabling diseases like multiple sclerosis and cancer affect many additional agricultural workers. A study published in the Journal of Agromedicine projects that there are 0.49-1.05 million people with disabilities in the agricultural workforce and an additional, 0.55-1.18 million household members in agricultural households with disabilities. This yields a total disability prevalence range of 1.04-2.23 million in the agricultural population.

What has been done
The mission of AgrAbility is to enable a lifestyle of high quality for farmers, ranchers, and other agricultural workers with disabilities, so that they, their families, and their communities continue to succeed. AgrAbility consists of: 1) 21 State and Regional AgrAbility Projects providing direct services to customers, and 2) the National AgrAbility Project (NAP) provides support services, education and resources to the states Priority areas are: 1) Education of professionals and consumers on issues related to disability and agriculture, 2) Networking with organizations and individual to enhance services, resources, and support for customers, 3) Direct assistance to AgrAbility customers, and 4) Responsibility for marketing the program to key audiences to increase awareness of AgrAbility and its initiatives. The NAP develops service capacity through innovative educational programs designed to advance individual capabilities adapt new technologies, and deliver program content through educational venues. Main partners are Breaking New Ground Resource Center at Purdue, Goodwill of the Finger Lakes, the Arthritis Foundation Heartland Region and the University of Illinois Urbana-Champaign.

Results

Some 127 new assistive technology products were added to the mobile friendly formatted toolbox assistive technology on-line database. The 23-page Arthritis and Gardening booklet including arthritis basics, gardening pre-planning, tools and accessories, overall health, pain management, and small-scale fruit and vegetable production was completed and distributed. A demographic study from the AgrAbility states reported 2,613 farmers and ranchers have received services since 2014. Most clients were employed full-time as owner/operator of the farm or ranch and were male. Primary types of agriculture operations were dairy, livestock and field/grain operations. Leading disabilities were back injuries, joint injuries, arthritis, and orthopedic injuries. NAP education outreach to 1890 and 1994 Land-Grant Institutions included workshops at Tuskegee University, Virginia State University, and the National Black Farmers Association conference. Also, 1890 representatives were on the planning committees for the national AgrAbility training workshop and 13 1890 institutions were represented at the conference. A 1994 Land-Grant workshop is scheduled for 2017 at Chief Dull Knife College. Veteran-specific training sessions were included in the national training workshop and about 25 veterans and family members attended. A veterans resource web page was added to the website. A video, The Next Mission: Breaking down Barriers for Veterans in Agriculture, detailing how farming became their next mission after their service and how AgrAbility helped them in the process was completed and distributed. NAP collaborated with the Farmer Veteran Coalition in workshops and conference presentations, and a representative is on the NAP advisory team. AgrAbility 1991-2016: 25 Years, 25 Stories, a book highlighting success stories of AgrAbility clients and initiatives, plus sections on resource development, internet outreach and other program information, was published and distributed.

4. Associated Knowledge Areas

KA Code	Knowledge Area
723	Hazards to Human Health and Safety
801	Individual and Family Resource Management
802	Human Development and Family Well-Being
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #8

1. Outcome Measures

Number of youth will demonstrate a capacity for science process skills

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual

2016 1712

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Students in Indianapolis Public Schools have a low graduation rate compared to the rest of Indiana. Many minority students who live in poverty in Indianapolis have parents who are not able assist in their child's academics. Creating opportunities through STEM activities may enable them to develop skills to help them get past these complicated issues. It is important to reach underserved teen populations in Indianapolis with activities that expose them to opportunities related to potential careers and to apply what they learn in real-life situations. Motorsports is a $4 billion business in Indiana and may provide opportunities for young adults in STEM fields.

What has been done

A new afterschool 4-H Spark Club Picapiedras (The Flintstones) started at George Washington High School. SPARK Clubs are groups designed to offer youth new learning experiences and opportunities related to a specific interest, and serve as an entry point to the full suite of opportunities Indiana 4-H can provide. With guidance from the Purdue Office of Engagement's Motorsports STEM for Manufacturing and Medicine (M-STEM3) initiative, the students took part in the High School Go-Karting Series just before the Indianapolis 500. The goal was to build excitement for STEM education in a racing setting. Students designed a go-kart from the ground up using gel cell lead-acid batteries. Competition categories for the go-karts and teams addressed kart energy efficiency (finishing the race using the least amount of power), community outreach on electric vehicle perception, kart design review (unique characteristics of kart designs, including the battery system and drivetrain), and race placement (final placement numbers). The Picapiedras created a fundraising strategy, with a budget plan and resource allocation, and raised several hundred dollars in donations from local businesses. They developed marketing materials and a PowerPoint presentation to tell their story; completed their first public speaking engagement for the George Washington community partners meeting in Spanish and English to a group of 30 adults; and many community presentations about electric vehicles. In addition to STEM, this project helped all team members learn more about fundamental skills valuable in any career-teamwork, running meetings, communicating with group members and with those not in the group. The project unified lessons in responsibility, resourcefulness, communication, and STEM.

Results

On the day of the race, the driver had a minor accident, but it did not prevent them from finishing strong in the race. The students were all lower income Latino youth, some of whom have only been in the U.S. for a year or two. One student during the presentation to community partners made a statement that "this is the first time I have had a chance to be part of and feel confident communicating in a group of other students." Other students have made similar statements and as the 4-H Club has developed, there have been many firsts for them: 1) First time any of them have had leadership roles, 2) First time conducting Roberts Rules of order, 3) First time speaking in front of other students, and 4) First time sharing and planning something with other students. 4-H has provided these opportunities that are important for successful education for students with the guidance of a few adults. Overall, this project combines lessons of responsibility, resourcefulness, communications, and STEM, all of which help with job preparedness in any industry. Purdue Extension plans to bring the go-kart program to 4 additional schools including those in rural areas to improve workforce readiness and STEM skills.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #9

1. Outcome Measures

Number of high school youth demonstrate entrepreneurship skills.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	30

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A key component to the success of Indiana's communities is the strength of its small businesses. The Purdue Entrepreneurship Academy encourages youth in Indiana to return to their communities and create or start innovative businesses that will enhance local economies.

What has been done
Purdue Entrepreneurship academy, sponsored by Purdue Extension and Indiana 4-H Youth Development, is an annual weeklong event that gives high school students the opportunity to interact with business leaders and entrepreneurship experts from Purdue and throughout the state. In addition to classroom instruction, one-on-one mentorship and networking, students form teams to create competitive business plans that they present to a panel of judges at the conclusion of the event. Some 30 high school juniors and seniors from 13 Indiana counties spent 6 days at Purdue learning the basics of entrepreneurship from the Purdue Foundry, the entrepreneurship and commercialization hub in Purdue's Discovery Park. Groups of 5 teens were assigned a business case based on actual products commercialized through Purdue and then worked together to create a business model, plan a business pitch, and identify target customer bases. They also developed skills related to professional communication, building teams and confidently delivering presentations. A real-world entrepreneur affiliated with Purdue was a mentor for each team to provide guidance and support as the teens developed their pitch. After a week of work, the teams presented their ten-slide, 15-minute investor pitches to a panel of judges.

Results
The team pitches ranged from plate armor to a product that reduces wind resistance on wind

turbine blades to a biomedical product. After attending the Purdue Entrepreneurship Academy: 1) 100% of the teens believe they have the skills necessary to start their own business, 2) 92% believe they understand what it takes to start their own business, 3) 92% understand the barriers and risks involved in building a successful business, and 4) 80% would like to start their own business. The teens also gained a deeper understanding of being an entrepreneur. When asked to describe an entrepreneur, the pre-survey responses included basic descriptions such as "someone who starts a business." After the academy, responses included "someone who comes up with a productive business model to better their community," and "problem solver." Plans are in place to repeat this challenge annually, working to inspire teens to create their own businesses, take their plans back home and start a business in their community.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #10

1. Outcome Measures

Number of at risk children active in healthy living activities and community service year round.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	11

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A large population of youth in greater Lafayette, Indiana lack connection to their community and opportunities for positive engagement outside of the classroom. Over 60% of students in Lafayette receive free or reduced lunch and 50% come from minority populations. Using funds from the USDA-NIFA funded Children, Youth and Families at Risk (CYFAR) grant, Indiana 4-H partnered with a long-standing summer enrichment program focused on positive youth development.

What has been done
The Purdue Athletic Life Success (PALS) program and Tippecanoe County 4-H program partnered to establish 2 afterschool 4-H clubs targeting underserved audiences. County Extension staff and 4-H club adult volunteers worked with the Indiana 4-H Program and a

longstanding, campus-based free summer program in the Purdue Department of Health and Kinesiology. The Purdue Athletes Life Success (PALS) provides positive growth and character development experiences for children who qualify for the program based on family income. The curriculum focuses on healthy lifestyle choices and during the 4-week summer program, is centered on sports, fitness, swimming, nutrition, computers, financial literacy, careers, gang avoidance, service learning, and select special events. PALS empowers young people to stay in school, set life goals, and learn successful life skills, and is structured around 4 character pillars: kindness, fairness, courage, and compassion. For a year-round experience, youth who were PALS participants over the summer could take part in 2 new 4-H clubs that meet September to May, after school twice weekly for positive experiences to keep youth engaged. The subject matter for children in grades 3-4 and 5-6 during the school year included a variety of activities to enhance knowledge on healthy living, inspire creative thinking, make physical activity fun and exciting, and demonstrate effectiveness of positive relationships resulting in youth making healthy life choices.

Results

Leaders have incorporated community into their programs via service and field trips that demonstrate opportunities for healthy living. Animal shelters, parks, and a nursing home are just a few community segments benefiting from the 4-H clubs. Both clubs are hosted by public schools well equipped to use technology in learning. Aside from each school being a one-to-one school where each student has access to a tablet, the clubs purchased hardware and software to supplement educational activities such as creating music videos during a dancing unit, and to prepare newsletters and items for promoting the club, sharing the impact in the school and community. The schools and club leaders, aware of the limited nature of CYFAR funding, are working toward sustainability in 3 areas: financial, programming, and volunteers. Over 110 children (75% are in poverty) are active in the 2 clubs. Baseline assessments were completed and averages on a 4-point scale identified for self-esteem (3.38), hope (3.32), physical competence (2.98), social conscience (3.82), personal values (3.75) and caring (3.45) to give measures of psychological well-being and health risk behaviors among these youth. Assessments of physical activity showed participating youth did not meet public health recommendations (at least one hour of physical activity per day). In future, these assessments will be repeated for comparison over time as youth continue to participate. First the intermediate school club started, then the elementary school club. With over 110 children now active in these two new clubs, program and club development continues, with plans to expand to the high school as these children advance in their schooling and 4-H experiences.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #11

1. Outcome Measures

Number of participants that increase deeper appreciation for the complexity of organizations/ communities, need to plan strategically and important skills.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	2506

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Community members often desire to pursue a goal or vision, yet struggle to effectively work together to accomplish the outcome. Likewise, it is common for a few individuals to be the driving force behind changes within a community, thus hindering an opportunity for inclusive community-wide buy-in for a big idea.

What has been done
Hometown Collaboration Initiative (HCI) is an initiative of the Indiana Office of Community and Rural Affairs (OCRA) in partnership with Purdue Extension Community Development, the Purdue Center for Regional Development, and the Indiana Communities Institute of Ball State University. During phase 1, foundation, each HCI team takes steps to recruit and engage a diverse mix of local people who are willing to explore new ways to strengthen their community and take an active role in launching all phases of HCI. Initiative participants carefully study and analyze data, existing community plans and the viewpoints of local residents. Key activities include studying a Data SnapShot report on county data, conducting a community survey, assessing local assets, hosting a community forum and selecting a building block. In phase 2, building block, each HCI team, using information and deliberations undertaken during the first phase, chooses their focus of effort for their community: economy, leadership or placemaking. Economy projects work to build a supportive community environment for small businesses and entrepreneurs. Leadership activities develop a new generation of local leaders who will take an active part in addressing community priorities. For placemaking, the focus is on enhancing community design and public spaces by building on physical and natural resource assets of the community. During the final phase, HCI teams work with key partners to propose a Capstone Project, and if approved by the State HCI Coordinating Team, put into action a plan intended to place their community on the path to achieving its longer-term goals and aspirations. There have been 179 sessions delivered to HCI communities over the past two years.

Results
Each year, Indiana communities or counties with a current population of 25,000 or fewer submit applications to become an HCI community. At least 4 are selected annually and engaged in the HCI process: http://www.indianahci.org/communities/index.php. Communities progress at their own pace as they address their community plan. Each project is unique to the community assets, input, and goals. There are 14 communities involved in HCI in the past 2 years representing more than 300 actively engaged team members. More than 9,000 volunteer hours have been contributed by local residents to HCI which are valued at nearly $200,000 based on 2015 hourly rates for volunteer time for Indiana residents from the Independent Sector. Communities have

been able to leverage funds with nearly $1 million captured by 6 HCI communities to date, representing a $16 return for each $1 of seed funds awarded to these communities by the Office of Community and Rural Affairs. Enhancing the Value of Public Spaces (EVPS), a community development signature program, continues as one of the key programs for HCI communities focusing on placemaking. Perry County (pop. 19,558) successfully completed all HCI and EVPS sessions, completed an action plan and launched a new virtual public space, Pick Perry http://www.pickperry.com, over the course of a year and a half. This effort featured a new collaboration between the Convention and Visitors Bureau, the Tell City mayor's office and the Chamber of Commerce with input and guidance from multiple county-wide stakeholder groups. In Lebanon (pop. 15,781), participants have completed the HCI and EVPS sessions and are working toward public art installations throughout their downtown to enhance quality of life, and feature downtown businesses. In feedback surveys, participants indicated the workshops provided useful knowledge and tools to make decisions and take direct action for public spaces projects. All would recommend HCI to others and reported the intention to take action within 12 months. EVPS is providing residents with a forum for input and engagement in the future planning and management of community public spaces while uncovering new ways of thinking about local assets and public spaces.

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development

Outcome #12

1. Outcome Measures

Number of participants engaged in a planning process

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	6372

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Public spaces are essential to the social, economic, and environmental sustainability of communities. They are the shared resources such as parks and town centers that define a sense of place and where residents experience social interactions, explore nature, and purchase goods and services. Management decisions of these public spaces, made by public policy makers,

private business owners, and residents, affect the wellbeing and livelihood of the community. In many cases, Indiana communities underestimate and inefficiently leverage the value of public space to the detriment of their quality of place. Quality of place is a significant factor in community and economic development outcomes that are critical for community vitality and sustainability.

What has been done

Purdue Extension Community Development program is Enhancing the Value of Public Spaces (EVPS): www.cdext.purdue.edu/signature-programs/quality-places/enhancing-the-value-of-public-spaces. This Indiana-based curriculum is designed for use by decision makers and local leaders who oversee community public spaces (e.g., parks boards, plan commission members, executive leadership, non-profit organizations). The program combines data collection and analysis with inclusive public deliberation to guide the design of a high-quality action plan that can result in sustainable and impactful improvements for public spaces, private investment, and ultimately, an enhanced quality of life for residents. EVPS consists of 3 components: 1) The Indiana-based curriculum, 2) Community Workshop forum to bring together key stakeholders and decision makers to provide input into crafting the high quality action plan, and 3) Working group meetings facilitated by Purdue Extension to provide technical assistance needed to complete a high-quality action plan. The facilitation process can take approximately 15 to 20 hours over the course of 3-6 months. EVPS conducted 17 events with 335 participants in 7 communities: Bartholomew County, Decatur County, City of Kokomo, City of Washington, City of Lebanon, Tell City, and City of West Lafayette. EVPS is a team-oriented effort with a minimum of 3 Purdue facilitators and 2 or 3 local hosts collaborating with stakeholder groups to develop a public spaces action plan.

Results

Participating communities are successfully completing public spaces action plans for use with diverse efforts. The Parks and Recreation Department for West Lafayette (pop. 45,550) collaborated with the EVPS team to launch their yearlong parks and recreation master plan update. The team led 2 community-visioning sessions and crafted a user feedback survey to collect suggestions on facilities, services and future efforts. The feedback survey, available online and in paper at public offices, distributed through multiple online formats, and featured in local news articles, garnered over 1,000 responses. The EVPS team presented results to the city council members, parks board members and in 2 public feedback forums. A final public input report was prepared and submitted to the parks board for use with the consulting group to finalize the master plan update (www.westlafayette.in.gov/egov/documents/1470232950_39432.pdf). EVPS collaboration with the City of Kokomo (pop. 57,995) for the citywide comprehensive plan update with a one-day working group visioning and feedback session, which resulted in park and recreation strategies added to the comprehensive plan. Washington (pop. 11,887) convened a diverse working group to focus on complete streets, walkability and greenway trails through the city. The working group is completing their high quality action plan and finalizing the selection of an engineering team to implement the first stages of their plan in collaboration with an existing bridge renovation. The Bartholomew County Parks and Recreation Board, serving a population of 79,587, focused on a plan for a county park and Department of Natural Resources Nature Preserve, Anderson Falls. The board, residents, and stakeholders convened for the planning meetings desired to promote stewardship, conservation, security, and access to this unique property. The committee is in the final stages to complete their high-quality action plan. Decatur County (pop. 26,277), which recently acquired a former Department of Natural Resources reservoir property, is developing a management and site plan. The EVPS team coached their committee on site-appropriate management techniques and action plan development. The committee will complete their action plan and begin site improvements with the goal of opening the new county park for public access. With the help of EVPS, these communities are working collaboratively, taking action and moving toward improving their public spaces.

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development

Outcome #13

1. Outcome Measures

Number of community members indicating knowledge of local government issues

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1637

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Local governments have many tools and options to implement when looking at their local budget. Not only do they make decisions on expenditures but they also have the ability to make decisions on local income taxes, other local taxes such as the wheel tax, property tax relief, and on implementation of other tools such as tax increment financing or referenda. Legislative changes, the state budget, national economic trends, and other factors further complicate local governments complex fiscal system. Local government officials need a sound understanding of the budgeting and revenue option, accurate information and data, insightful education, and an opportunity to learn from each other to more effectively create budgets and make better-informed fiscal decisions which ensure the sustainability of government services and the efficient use of the taxpayer's dollar.

What has been done

Purdue Extension educators collaborated with a regional educator and an Extension specialist to develop and deliver the On Local Government program. Webinars, broadcast from Purdue and made available across the state, explained road funding in Indiana, reviewed pending legislation on special Local Option Income Tax distributions and farmland assessment, and provided an overview of research on the capacity and cost constraints of our local government revenue system. Educators organized host sites, invited local elected officials and others involved in local government to attend in their county, viewed the live webinars with their local audience, then facilitated a discussion and planning for the local group afterward.

Results

Over 400 elected officials, government employees, community leaders and citizens participated in the On Local Government program through 38 unique host sites. Of the participants surveyed: 1) 63% stated the program helped them better understand state and local government finance, and 2) 93% indicated they felt more confident in their role with local government after attending the program. One participant stated they felt the program encouraged them to look at longer term planning to leverage road funding with grants. One participant said the program would help them "insure as budgets are determined, state and local legislation as well as trends are accounted for in insuring fiscal responsibility in appropriating funds to benefit my local community." Overall, the program informed elected officials and civic leaders and encouraged them to think critically and access data and resources when making local government finance decisions.

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development
805	Community Institutions, Health, and Social Services

Outcome #14

1. Outcome Measures

Number of families and individuals strengthened by spending time together, setting goals, developing parenting skills, communicating, and dealing with stress.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	7761

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

In Indiana, there are 538,742 youth between 9 and 14 years-old. These youth are growing more independent and beginning to turn to one another instead of their families as they form stronger, more complex friendships and peer relationships. According to Kids Count Data book, in the past month, 17% of Indiana high school students used a drug other than alcohol or tobacco and 7% used a drug other than alcohol, tobacco or marijuana. In Indiana, 12% of parents report usually/always feeling stress from parenting, and parents living in poverty are more likely to report usually/always feeling stress than those living in higher-income families. Teens who experience high levels of conflict or low levels of support from their parents are more likely to engage in risky behaviors, such as early drug use or drinking and smoking, and are more likely to struggle with

depressive symptoms. When parents are actively engaged, children are likely to have better academic performance, attendance, graduation rates, attitudes, behaviors and overall well-being.

What has been done
Strengthening Families Program: For Parents and Youth 10 to 14 (SFP: 10-14) from Iowa State University Extension was adopted for implementation in Indiana. Programs were delivered in 4 counties for 17 adults and 34 youth. The program includes 7 2-hour sessions including separate sessions for youth and parents, then joint family sessions. In youth sessions, they learned about peer pressure resistance, reducing stress, finding family values, problem solving, goal setting, and resisting substance use. In parent sessions, they learned what it is like to be a youth today, how to love but set limits, to develop family rules and establish consequences, to encourage good behavior, to build bridges between youth and parents, and to protect youth against substance use. Joint sessions to strengthen communication and problem-solving skills helped families bond through learning game activities and projects, like making a family tree and identifying family member strengths. Families learned how to help youth deal with peer pressure, improve communication skills, and solve problems, individually and as a family, and enjoy time together. Together, families discovered how to understand each other better.

Results
Some 13 adult and 17 youth evaluations were completed. Results for parents showed significant changes to all 20 statements. For example, when asked how often they "take time to do something fun together as a family" the responses for most of the time went from zero to nine. The top 5 statements (showing the largest increase) were: 1) Talk with my child about his or her future goals without criticizing, 2) Find ways to keep my child involved in family work activities, like chores, 3) Spend special time one-on-one with my youth, 4) Wait to deal with problems with my child until I have cooled down, and 5) Try to see things from my youth's point of view. For most valuable thing learned, one parent stated "It's not a learned thing per se, but my son HATES going anywhere, unless it's to hang out with his friends, but whenever I told him it was a workshop day, he was completely agreeable. It was a fun course and we have benefited from it. Thank you!" One parent recognized the stress her son was going through because of the family divorce situation and she learned how to avoid engaging in arguments with her son and how he was beginning to listen to her. Another parent, going through drug rehab, was dedicated to use the family meetings, 5-minute chores, "I" statements, and listening to her daughter more to make sure her daughter did not end up abusing drugs like her. Parents discovered the dreams and goals of their youth through a poster activity. Now family members can better support the youth. Parents commented on how they are able to keep calm during situations and use more "I" statements. Youth were getting more involved in family chores and parents noted fewer misbehaviors by their youth at home. Youth responses increased most for these items: 1) I listen to my parent(s)/caregiver(s) point of view, 2) I do things to help me feel better when I am under stress, and 3) I know one-step to take to reach one of my goals. For the most valuable things, youth mentioned dealing with peer pressure, how to reduce, handle or deal with stress, and better relationships with their family, such as not to fight with family, being respectful, and how to treat others. The information learned and skills developed will help strengthen families and arm youth with valuable and much-needed skills.

4. Associated Knowledge Areas

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

Outcome #15

1. Outcome Measures

Percent of participants can identify dietary recommendations for eating and preparing more heart-healthy meals

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	97

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Heart disease is the number one cause of death among men and women in the U.S. Each year, 600,000 die from heart disease-about 1 in every 4 deaths. Heart disease costs the U.S. $108.9 billion each year in healthcare services, medication costs and lost productivity. Heart disease is also the number one cause of death for men and women in Indiana with 66% overweight or obese, 40% with high cholesterol, and 33% with high blood pressure. The good news is that there are several risk factors and lifestyle activities that can be modified to help reduce risk of developing heart disease. Prevention of heart disease is possible.

What has been done
Purdue Extension works statewide to educate adults on heart disease and teach them ways to reduce their risks for developing this chronic disease. Through the Be Heart Smart program, participants learn how to identify and monitor risk factors for heart disease and make simple changes to their daily routine that can improve heart health. Be Heart Smart is offered as a series of 4, 1-hour classes. Topics covered include risk factors for heart disease, cholesterol and blood pressure guidelines, a heart-healthy eating plan, stress reduction techniques, and tips for how to talk to your healthcare provider. Each lesson provides suggested action items for heart-healthy behaviors to start making a difference. Be Heart Smart was presented 51 times in 43 counties, reaching 530 individuals. Of those reporting, participants were mainly female (86%), aged 61 years or older (72%), and White (91%).

Results
When asked, 80% of participants were concerned that they are at-risk for heart problems. There were statistically significant improvements in knowledge for: 1) Identifying controllable versus uncontrollable risk factors, 2) Recommended blood pressure levels, 3) Recommended cholesterol levels, 4) Healthy body mass index, 5) How to decrease sodium in the diet, 6) Recommendations of the DASH Eating Plan, 7) Benefits of physical activity, and 8) 2ays to decrease stress.

Participants intend to make behavioral changes, including: 1) 96% would monitor controllable risk factors for heart disease such as blood pressure and cholesterol, and 2) 88% would increase daily physical activity. One noted that information provided was "real stuff for a real problem. It has changed how I see and do things in my daily life." Another noted applying the information learned "is possible to do and does not have to be complicated." The findings suggest that after the program, adults are more knowledgeable about risk factors for heart disease, strategies to prevent or reduce personal risk of heart disease, and intend to incorporate heart-healthy behaviors into their daily activities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
723	Hazards to Human Health and Safety
805	Community Institutions, Health, and Social Services

Outcome #16

1. Outcome Measures

Number of parents (divorcing, single, co-parenting) improved their communication and skills in managing conflict amidst the changes occurring for their children.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	17

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Nearly half of Indiana families have children younger than 18 years, 38% have at least one child younger than 5 years, 27% are single mother-headed families, and 9% are single father-headed families. About 1/4 of children in Indiana are living with a parent or guardian who became divorced or separated at some point after they were born. Family composition and the relationship between parents are strongly linked to child well-being. The more changes in family structure, the more difficult the instability becomes, increasing problem behaviors. Children in families with high levels of stress are twice as likely as peers to be disengaged in school and 4 times as likely to have behavioral or emotional problems. Kids Count reports that 50% of Indiana high school students live in families where arguments repeatedly occur, 38% live in a family that has serious arguments, and 38% reside in a family that insults each other. There are 17 states mandating all

divorcing parents to take a parenting class, but in Indiana, a co-parenting education requirement is at the discretion of the court.

What has been done
Co-Parenting for Successful Kids, adopted from the University of Nebraska Extension, was offered in 2 counties in Indiana to parents going through a divorce or separation or to single parents who are co-parenting. The program was held in person as a 4-hour class or online where parents completed at their own pace. Both formats offer information to parents to help make them more responsive, responsible, and respectful covering these topics: 1) How divorce affects children, 2) How to help children adjust, 3) using "I" messages in communication, 4) keeping children out of the middle of adult conflict, 5) developing a co-parenting plan, and 6) stress management.

Results
There were 35 children, ages 11 months to 21 years, impacted in a positive way by a parent taking the training. Some 11 parents had a divorce pending, 3 had a divorce but were making child custody modifications, 2 were required by the county to take the class, and 1 was never married. Parent knowledge increased in: 1) How to keep my children out of the middle in interactions with the other parent, 2) How children are affected by divorce or custody modification, and 3) Understanding how to develop a child focused parenting plan. For parent intentions after the program, the actions they plan to take were: 1) Use strategies I learned in class to keep my children out of the middle in interactions with the other parent, and 2) Help my children adjust to divorce or custody modification based on their ages and stages. Parents indicated information, ideas or approaches as most useful were: 1) How divorce or child custody affect children including grief, 2) Adjustment for the child including the parent using the "I" message. Parents plan to apply what they learned: 1) Being more positive, 2) Working on the co-parenting relationship (such as using "I" messages), and 3) To stress less. Based on evaluations, parents are gaining knowledge and planning to make behavioral changes to improve their communication and relationships skills, not only with their child but with the other parent. Use of the "I" message was a common theme in terms of what they learned and how they intend to make better use of such messages. Reducing conflict between co-parents will improve child well-being when both co-parents are responsive, responsible, and respectful to each other.

4. Associated Knowledge Areas

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

Outcome #17

1. Outcome Measures

Number of dollars received by those community coalitions across Indiana to address local health priorities including poverty and homelessness.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1600000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Poverty affects all, not just the poor. Studies show children in poverty are more likely to have language deficits and gaps in school achievement. Children growing up in poverty have higher rates of health problems, including obesity, diabetes, heart disease, substance abuse, and mental illness. Research shows that long-term poverty leads to toxic stress. The Kids Count study shows Indiana has a 21.2% poverty rate. Child poverty rates continue to climb. Children in single parent families have a higher rate of poverty. In Indiana, the single mother family has the highest poverty rate at 48.8%. The National Coalition for the Homeless reports individuals and demographic groups more likely to experience poverty are more likely to experience homelessness. Women are more likely to bear child-rearing responsibilities, making them more at risk for becoming homeless and/or living in poverty. In general, women, with or without children, are more likely to experience domestic violence, physical illness, stress, sexual assaults and overall higher rates of victimization than their male counterparts. In many cases, women in these difficult situations turn to substances in order to deal with their difficult circumstances, often leaving them hating themselves, feeling depressed about their situations, and finding it difficult to regain control of their lives. This negative self-image affects not only the women themselves but also their children and families. Homeless services and facilities across the state, provide overnight shelters, a safe place for women fleeing domestic violence or those in the midst of substance abuse.

What has been done
Bridges Out of Poverty: Strategies for Professionals and Communities builds a new consciousness of economic diversity and presents the interlocking nature of the challenges faced by people in poverty and communities as a whole. By using program material, participants have an opportunity to bring community partners together to enhance the quality of life for all citizens within a community, those from poverty, middle class, and wealth. To address systemic issues around the complexity of poverty, Purdue Extension conducted training workshops across Indiana, with 481 participants attending Bridges trainings. Indiana health coalitions facilitated by Purdue Extension, working to address priority community issues, are focusing on poverty and homelessness. Programming in communities result from partnerships with local services and offer a variety of workshops to address parenting, stress management, communication, financial literacy, and healthy lifestyle. Purdue Extension-Allen County, working with families of local homeless centers and with unemployed adults in local service programs, provided financial literacy workshops, "Making Your Money Work" to build employment skills, communication skills, wellness, post-secondary education options as well as self-confidence. Purdue Extension-Dearborn County, presented parenting programs to residents of the homeless shelter. "See the world through my eyes" provided 4 lessons to help children grow: 1) Live well, 2) Love them, 3)

Try to understand the world as I see it, and 4) Teach them. Parenting Piece by Piece provided 4 workshops on individual strengths, ages and stages of youth, stress balance, talking, listening, and communicating. Purdue Extension-Putnam County, conducted workshops geared toward individuals living in poverty, and held at local homeless shelter and faith-based organizations. Purdue Extension-St. Joseph County offered "A Healthier, Happier You!" to women living in shelters. This 2-hour lesson with 10 steps to increase overall health and well-being, included setting goals for: physical fitness, good nutrition, stress management, balanced positive thinking, personal care and safety, healthy relationships, work satisfaction, effective money management, enrichment/fun/laughter, and spiritual nourishment.

Results

After attending Bridges out of Poverty for professionals, 95% of participants reported improved knowledge, 99% said they better understand the difference between socioeconomic classes, 100% said they understand how the hidden rules of class affect decisions, values, and language, and 100% said they better understand the importance of building effective, positive relationships with their clientele. Some said they will judge less and try to understand their clients more, and to not judge others, but look beneath the surface. Homeless clients taking part in financial literacy workshops shared these results: 2 months after moving out of the shelter, a participant was able to use money management skills learned in the workshop to save money while grocery shopping. Clients were using more of the tools mentioned in the workshops to manage their money. They had accounts at financial institutions. They reported they collectively had $25.00 in savings and $85,132.00 in debt. Regarding positive perspectives, homeless clients stated, "I never knew anyone thought so highly of me," and "I never realized how little I thought of myself," "I am really going to work on having a more positive view of myself." Self-identified goals for the homeless clients addressed getting more physical activity into their daily lives and eating more fruits and vegetables. Individuals said they would make a conscious effort to have a more positive attitude about themselves, try to look at difficult situations as challenges as opposed to stressors, incorporate more fun activities into their lives and make strides to do daily verbal positive affirmations. From parenting workshops, homeless client gains were: 71% increased their knowledge of effective parenting or how to work with children. 82% plan to do one or more new thing to improve their parenting or interactions with children (e.g., to pay attention, listen more, be more patient, talk to them, reason with them, let them make more choices on their own, be more active, and spend more time). Because of the healthy living classes, homeless clients reported they will try to maintain a sleep schedule, plan to manage stress and communicate better and listen more, and plan to make sure they are clear in expressing their feelings and ideas. For managing stress, participants will stop and take a breath and meditate, and plan to walk to cool down. Through these programming efforts to focus on poverty and homelessness via health coalitions and community partnerships, through training for professionals working in this area, and by helping to build skills among homeless clients, Purdue Extension works to impact positive results throughout the community.

4. Associated Knowledge Areas

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

Outcome #18

1. Outcome Measures

GFSH 4.6, 4.8, FCS 1.1, 1.2, 1.4 HHS 3.2 HHS 3.4 - Number of discoveries, innovations, technologies that relate to family well-being, interpersonal relationships, resource management, parenting and relationships, child development, early childhood education and care

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	4

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Bowlby and Ainsworth's theory of attachment poses that caregiving behavior is a key factor in influencing and maintaining a child's organization of behavior, and ultimately, emotional security throughout childhood. Although frequently studied during infancy, the role of the primary caregiver as a secure base from which a child can organize her/his behavior, derive security, explore, and learn about the environment during the preschool years is scant at best. Little is known about the role of caregiving in the maintenance and elaboration of attachment relationships during the childhood years. This has prompted the critique that attachment is a theory of infant and adult relationships with a large gap in between left to the imagination (Waters et al., 1994).

What has been done
The main goal of the research was to study child-mother attachment relationship processes in 2 domains: behavioral and representational during childhood, and their relations to child social exchanges with peers and other adults in preschool and school contexts. The research activity proposed addresses questions concerned with: 1) Contributions of maternal quality of care (i.e., sensitivity) to children's attachment secure base behavior and attachment related representations in childhood, 2) Interaction processes implicated in the development of children's organization of attachment related information, and 3) Associations between children's attachment behavior, and representation and social competence during childhood.

Results
Results showed the contributions of the quality of maternal care to the organization of preschool children attachment behaviors and child attachment security. One study included a sample of mothers from military families, while another employed samples from 4 countries (Colombia, Mexico, Peru, U.S.). Findings demonstrate that the quality of care during early childhood plays a key role in child emotional security (an important predictor of social competence). This is the case

no matter the setting and was shown in all the samples and countries studied. Further research provided evidence of the organization of attachment mental representations and how those are co-constructed in dyadic interactions with caregivers.

4. Associated Knowledge Areas

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

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

Extension programs conduct evaluation surveys to measure change in knowledge and intentions of participants, and follow-up surveys to assess change in behavior or practice and results of actions. Survey research projects monitor progress and completion of study objectives and tasks, and publications/presentations of findings, to determine effectiveness and accomplishment.
Evaluation results included:
Outcome # 6 - Families and women in agriculture learned how to develop their farm succession plan
Outcome # 9 - High school youth developed business plans through their entrepreneurship training
Outcome # 12 - Indiana communities completed public spaces action plans
Outcome # 13 - Elected officials, government employees, community leaders and citizens attending "On Local Government" increased their understanding of state and local government finance
Outcome # 14 - Parents and middle-school youth learned communication skills to strengthen families
Outcome # 15 - Adults improved their knowledge of how to reduce risks for developing heart disease
Outcome # 16 - Parents (divorcing, single, co-parenting) improved their communication and skills in managing conflict amidst the changes occurring for their children
Outcome # 18 - Research identified maternal care contributions to the organization of

attachment behavior and security among preschool children

Key Items of Evaluation

Outcome # 7 - AgrAbility experimental group participants: 1) increased their quality of life levels by 28%, while the no-treatment control groups fell by 4%. Increases in independent living and working levels were 29% for the treatment group and 8% for the control group.
Outcome # 8 - Underserved high school youth gained STEM skills via motorsports in their Spark Club
Outcome # 10 - At risk children engaged in positive experiences year-round for healthy living and community service
Outcome # 11 - Fourteen Indiana communities completed 9,000 volunteer hours valued at $200,000 (Independent Sector) to strengthen their communities focusing on the economy, leadership or placemaking projects
Outcome # 17 - Community coalitions brought together efforts to address poverty and homelessness across Indiana via community partnerships, by helping to build skills among homeless clients, and in training for professionals working in this area

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: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	1.4	0.0	6.7	0.0
Actual Paid	6.4	0.0	34.1	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**
1255719	0	939511	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2307550	0	4708729	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
446826	0	1286342	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

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	85394	260867	48086	283384

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

Patent Applications Submitted

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	211	216	427

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of education workshops

Year	Actual
2016	1141

Output #2

Output Measure

- Number of research projects

Year	Actual
2016	189

Output #3

Output Measure

- Number of Extension publications

Not reporting on this Output for this Annual Report

Output #4

Output Measure

- Number of consultations

Year	Actual
2016	12907

Output #5

Output Measure

- Number of volunteers

Year	Actual
2016	1345

Output #6

Output Measure

- Number of research publications
  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 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	New diagnostic systems (NRE 1.5)
24	Discoveries, innovations, technologies and technology transferred related to understanding the key demographics, decision-making processes, business relationships and economic situations of farmers and landowners. (FME 1.1)
25	Viable prevention and control strategies (NRE 1.4)
26	New productions and logistic practices developed and tested (NRE 1.11).
27	Projects focused on understanding of the roles of humans, plants and animals (NRE 1.13)
28	Viable technologies developed or modified for detection and characterization (NRE 1.3)
29	Projects characterizing social, economic and/or cultural practices (NRE 1.15)
30	Projects that incorporate ecosystem services and/or biodiversity considerations (NRE 1.16)

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.

Not Reporting on this Outcome Measure

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.

Not Reporting on this Outcome Measure

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.

Not Reporting on this Outcome Measure

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.

Not Reporting on this Outcome Measure

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

New diagnostic systems (NRE 1.5)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	8

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
One-sixth of the Earth's land is highly vulnerable to invasive species, and most countries have a limited capacity to protect their natural resources from non-native animals, plants or microbes, a global analysis shows. Invasive species can spread quickly and dramatically alter landscapes, ecosystems and human health and livelihoods, often with harmful consequences. Notable examples of invasive species in the U.S. include Burmese pythons, West Nile virus, emerald ash borers and tumbleweed.

What has been done
Researchers from multiple institutions, including Purdue, teamed up to create the first worldwide analysis of invasive species threats, providing a global-scale outlook on how the introduction and spread of invasive species could shift in coming decades as a result of increasing globalization and climate change. They also assessed the ability of each nation to manage existing invasive species and respond to new ones, the first country-level evaluation of its kind.

Results
The analysis showed that invasive species will increasingly threaten developing countries and the

last remaining biodiversity hotspots due to increased air travel to these areas and expansion of agriculture, factors that can provide opportunity for non-native species to gain a foothold. This could endanger livelihoods and food security in already-fragile economies.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
123	Management and Sustainability of Forest Resources

Outcome #24

1. Outcome Measures

Discoveries, innovations, technologies and technology transferred related to understanding the key demographics, decision-making processes, business relationships and economic situations of farmers and landowners. (FME 1.1)

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	8

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Maintaining the many benefits that working forests provide all citizens of Indiana is dependent upon the land management decisions made by forest landowners. This program utilizes demonstration forests and online resources to train private woodland owners and natural resource professionals, focusing on the establishment of stewardship practices and plans that result in environmental and economic benefits.

What has been done
1) Three issues of the Woodland Steward were printed and mailed to over 31,000 woodland owners in Indiana during the reporting period. 2) Co-hosted a workshop for 67 professional foresters and wildlife biologists who either manage public forests or advise private woodland owners. The focus of the workshop was how to create forest management prescriptions for critical wildlife species groups (birds, bats, reptiles and amphibians, small mammals).

Results
1) Woodland Steward mailing: We learned that 54% of the Steward readership regularly utilize

information; 51%, who own an estimated 1.2 million ac, have implemented at least one practice they learned. 2) Workshop surveys: Most participants indicated the information learned would help them write management plans (92%) on 35,000 acres or advise about forest and wildlife management (86%) 1,121 private landowners who own over 120,000 acres. Our workshops had a Net Promoter Score of 67%, indicating that most who attended could be considered loyal enthusiasts that refer others to extension. A NPS of 50-80% is considered effective.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
131	Alternative Uses of Land
135	Aquatic and Terrestrial Wildlife

Outcome #25

1. Outcome Measures

Viable prevention and control strategies (NRE 1.4)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	4

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The health of urban and production hardwood forests in Indiana is increasingly threatened by both indigenous and invasive wood-boring insect pests. Invasive threats include thousand canker disease in black walnut trees and emerald ash borer on ash trees. Indigenous threats include the peach bark beetle that destroys black cherry trees. Thousand cankers disease is a fungus that is carried to black walnut trees via walnut twig beetles, but it is not understood why they beetles are attracted to some trees and not others. The peach bark beetle burrows into the black cherry trees and its larvae destroy the tree. No technology exists to identify those trees that may be most susceptible to attack. Understanding the influence of genetics and environment on the susceptibility of these important trees could provide clues that reduce colonization of these wood borers and the millions of dollars in damage they cause.

What has been done
This project characterizes and tests the bioactivity of volatiles (chemicals emitted by trees) released from different genotypes of black walnut and black cherry trees, and also determines the influence of site condition on kairomone production by a single genotype. Objective 1) Determine how genotype and environmental stress attracts the walnut twig beetle that carries the thousand canker disease and 2) Explore the influence of environmental stress on how peach bark beetles colonization black cherry.

Results
Objective 1) Through this work, it was determined in the lab that walnut twig beetles (WTB) are attracted to specific volatiles emitted from walnut trees. The team is currently investigating the extent to which these compounds attract beetles in the field. 2) Demonstrated that female peach bark beetles produce a volatile pheromone that attracts males. A powerful host-produced attractant (benzaldehyde) was identified as a chemical that attracts the females to the trees.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
123	Management and Sustainability of Forest Resources

Outcome #26

1. Outcome Measures

New productions and logistic practices developed and tested (NRE 1.11).

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	4

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Monitoring of best management practices (BMP) effectiveness at the subwatershed scale is needed to gain insights into nutrient and pollutant transformation rates as well as the impacts of export of pollutants to downstream receiving waters. To scale these findings and accurately simulate functions, sub and watershed scale water quality monitoring will be combined with distributed hydrological water quality modeling. Models developed through this work should be

spatially distributed to capture the impacts of individual BMPs and physically based to simulate pollutant fate and transport processes. Ideally, these distributed models should be validated, i.e., tested, against both distributed and watershed scale (stream) observations. Together, this approach will be used to predict the effectiveness of BMPs and BMP implementation at the farm, subwatershed and watershed scales, improve and assess the ability of watershed management models to address emerging environmental issues.

What has been done
1) Monitor water quality from a variety of watersheds with a range of conditions (e.g., differing landuse and associated implemented BMPs, varying geographic/geologic conditions), 2) Develop and evaluate models for predicting BMP performance and water quality at the field and watershed-scales when considering climate change.

Results
Results show that at the event scale, impervious area has the greatest control on hydrology. But at annual scales, the storm water mitigation and vegetated area, particularly trees, reduces runoff volumes. Differences were observed in water quality between storm water control measure outflow and stream water suggest the potential for water quality improvements. However, significant effects were only observed at 1 of 4 of the monitoring sites. These results are being extended to investigate the cumulative effect of storm water control at the small watershed scale by nesting monitoring locations and monitoring water quality and water quantity throughout multiple storm events and during base flow.

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

Outcome #27

1. Outcome Measures

Projects focused on understanding of the roles of humans, plants and animals (NRE 1.13)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual

2016 586

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Linking sub-cellular responses with population-level effects requires a broad understanding of how changes in gene expression or metabolites relate to the organism and important ecological responses that impact growth and reproduction. This information can be used to effectively manage ecological systems and allow proactive rather than reactive strategies for restoring ecosystem health. To date, only a few collaborative efforts have attempted to bridge research at the cellular to ecosystem level examining current and emerging agrochemical impacts. A wide array of targeted and global (omics) analytical tools to improve assessment of ecological impacts from run-off from concentrated animal feeding operations (CAFOs) and other environmental stressors that include heavy metals, nutrients, and oxygen depletion have been developed and harnessed.

What has been done
Determined impacts from agrochemical exposure to cells, organisms, and ecosystems.

Results
The mechanisms of toxicity and effects of different chemicals were assessed in fish. Nanosilver particles delay vascular development in zebrafish embryos in a reversible-way, depending on dose used. Atrazine-exposed embryos develop later-in-life adverse health outcomes, including effects to the reproductive and neuroendocrine systems. Developing fish can also be affected by changes in temperature since temperature is an important determinant of sex in many fish species.

4. Associated Knowledge Areas

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

Outcome #28

1. Outcome Measures

Viable technologies developed or modified for detection and characterization (NRE 1.3)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	10

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Its estimated that global production of oil-based lubricants and hydraulic fluids is in excess of 42 billion liters with a considerable portion going to agricultural machines. Studies have shown that about 50% of the oil-based fluids are lost due to the use of petroleum-based fluids with energy inefficient system configurations. This technology causes environmental and economic problems related to excessive fuel consumption and toxic leakages. This research proposes an alternative technology for the actuation of agricultural machines based on more energy efficient system architectures for the hydraulic system and on the use of water as a working fluid.

What has been done
In 2016, the team tackled the goals of formulating criteria for designing the most critical element of the hydraulic system - the hydraulic power supply unit - to operate with water at high pressure (up to 500 bar). Two different design concepts were investigated: axial piston units - to privilege overall system efficiency - and external gear units - for very cost effective systems.

Results
An advanced numerical model to comprehensively account for the effects of mixed lubrication regime in the lateral lubricating interfaces has been formulated and implemented. The developed lateral gap model can account for the influence of surface features which is a critical factor that needs to be considered for designing efficient water-based external gear machines (EGMs) along with the structural and thermal effects on the lubricant flow in the lateral interface. A test rig is being re-designed to directly measure piston leakage when water is used as a working fluid. The redesign will also allow for the verification of the piston-cylinder interface pressure field, temperature field, and leakage values predicted when using water as a working fluid by the piston module of the fluid structure interaction modeling (FSTI). Next steps include finalizing the sizing of the test rig components, creating the relevant manufacturing drawings, and setting up FSTI simulations in order to model how the piston-cylinder interface will behave in the re-designed test rig.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
133	Pollution Prevention and Mitigation

Outcome #29

1. Outcome Measures

Projects characterizing social, economic and/or cultural practices (NRE 1.15)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	39

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The next 5 years will be a period in which ecosystem services on public and private lands will experience increased pressure from changes in direct and derived demand for public lands uses, as well as possible ecosystem changes from increased variation in extreme weather events, invasive species, altered wildfire regimes and other natural hazards. Many policy issues revolve around the fact that so many of these values are public good in nature and are therefore subject to market failure in changing economic and natural environments. Public policy with regard to public land, water, air quality and other natural assets continues to evolve using more efficient economic incentive mechanisms; the success of these mechanisms lies in the ability to measure the value of natural assets and ecosystem services under changing economic and natural environments.

What has been done
This multi-state project focused on one objective in 2016 with several sub-tasks. Objective 3 Integrated Ecosystem Services Valuation and Management Task 3-1: Economic Analysis of Ecosystem Services Flows Task 3-2: Economic Analysis of Recreation Services Task 3-3: Economic Analysis of Water Quality, Quantity and Flow.

Results
Task 3-1: Estimated the willingness-to-accept payment of farmers to change their tillage practices to sequester atmospheric carbon in farm soils. Completed research estimating the economic value of pest control ecosystem services generated by grass riparian buffer strips that provide habitat for beneficial insects that prey upon the soybean aphid. Worked with graduate student at Purdue to construct a database of recreational fishing destinations and substitute sites for anglers intercepted at fishing sites along the coast of Lake Michigan in Illinois and Indiana during the 2015 fishing season. Conducted applied econometric research (ongoing) on the environmental

and cost effectiveness of USDA investments in agricultural conservation programs, such as EIP, that generate water quality regulation ecosystem services in the Corn Belt region. Published research on economic and water quality tradeoffs from cellulosic biofuels cropping systems in agricultural watersheds. Conducted research and developed a web-based decision support tool on the expected change in profitability from investing in center-pivot irrigation under climate change (2041-2070) in the Corn Belt region.

4. Associated Knowledge Areas

KA Code	Knowledge Area
104	Protect Soil from Harmful Effects of Natural Elements
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources

Outcome #30

1. Outcome Measures

Projects that incorporate ecosystem services and/or biodiversity considerations (NRE 1.16)

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	11629

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Rainscaping includes the use of sustainable landscape design and management practices at both the household and community scales to prevent pollution from reaching water bodies by directing storm water to be absorbed by plants and soils. The Purdue Rainscaping Education Program provides training and resources on practices that can be installed in a residential setting or small scale public spaces project. Its focus includes community awareness and education for bioretention/rain garden planning, installation, and maintenance that targets Purdue Master Gardeners, conservation agencies and organizations, storm water professionals, and landscape companies and consultants.

What has been done
The Rainscaping Education Program team conducted program edits and revisions based on pilot experiences, participant feedback surveys, advisory board recommendations and feedback from

three external expert reviewers. The resulting products are a curriculum guide, host tool kit, revised website and online rain garden mapping feature, and updated training videos. All program products are currently undergoing copyediting and design with Agricultural Communications staff. The final products will be available early in 2017. The Rainscaping Education Program team implemented a two-day, 15-hour training program in Lake County. The program was held in collaboration with the Lake County Extension Office, Lake County Soil and Water Conservation District and hosted at the Merrillville Stormwater Utility office. Program participants reflected the target audiences and represented organizations and agencies from across the state. The Merrillville Stormwater Utility office demonstration rain garden was designed by the program partners hosting the training. The team is currently planning to hold additional state-wide rain garden training programs and also offer a train the trainer program for Extension Educators during fall 2017. Additionally, the team is completing the final plant database edits for Indiana's inclusion in the national rain garden design app hosted by the University of Connecticut.

Results

The 150 square foot demonstration garden is visibly located next to the front door of the Stormwater building to highlight the mission of the office while also displaying how rain gardens can be both functional and attractive. The team and program participants completed a management plan for the garden, which will be maintained by the storm water utility staff. Feedback survey results from the 2016 program revealed all participants rated an increase in knowledge in all session topics after participating in the program. Furthermore, all participants intend to directly apply the program information to their community programs within the year and would recommend the program to others. The flipped classroom model was also well received with participants describing they preferred to read and view video content outside of class to allow for extensive experiential learning through activities, tours and the garden installation. Participant comments additionally reflected that many felt more confident in educating others about rain gardens and now knew how to comprehensively site, size, design, install and conduct long-term maintenance for rain gardens. Follow up communication post workshop indicated that participants are using program materials and resources to launch broader community education rain garden programs in Floyd, Marshall, Grant and Allen Counties. These activities have included rain garden installations with educational signs, tours, community education programs, and exhibitor booths.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water

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

Extension programs conduct evaluation surveys to measure change in knowledge and intentions of participants, and follow-up surveys to assess change in behavior or practice and results of actions. Field and lab research projects monitor progress and completion of study objectives and tasks, testing of new systems, best management practices, and impacts on wildlife, and publications of findings, to determine effectiveness and accomplishment.
Evaluation results included:
Outcome #24 - Woodland owners reading Woodland Steward newsletters implemented at least one practice of forest stewardship, invasive species, wildlife habitat management or economics potentially impacting 1.2 million acres of forestland
Outcome #25 - Isolated traits of pest attraction to walnut and cherry trees for improved detection of thousand cankers disease and pest infestation
Outcome #27 - Evaluation of impact of agrochemical pollutants on fish showed delayed vascular development and adverse health outcomes on the reproductive and neuroendocrine systems
Outcome #28 - Evaluation of water-based lubrication for hydraulic agriculture machinery showed pressure, temperature and leakage values compared to oil-based lubricants
Outcome #29 - Surveyed farmers on willingness to accept payment to change tillage practices to sequester atmospheric carbon in farm soils

Key Items of Evaluation

Outcome #23 - Worldwide analysis of invasive species showed increasing threat for developing countries
Outcome #26 - Synthesis of monitoring data from best management practices showed impervious areas had greatest control on hydrology and storm water mitigation and vegetated areas particularly trees, reduced runoff volume
Outcome #30 - Follow-up survey results showed participants in flipped classroom approach to rainscaping training used program materials and launched broader community education rain garden programs, including rain garden installation with educational signs,

tours, community education programs and exhibitor booths

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

Childhood Obesity (Outcome 1, Indicator 1.c)	
4970	Number of children and youth who reported eating more of healthy foods.
Climate Change (Outcome 1, Indicator 4)	
0	Number of new crop varieties, animal breeds, and genotypes whit climate adaptive traits.
Global Food Security and Hunger (Outcome 1, Indicator 4.a)	
14415	Number of participants adopting best practices and technologies resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources.
Global Food Security and Hunger (Outcome 2, Indicator 1)	
883	Number of new or improved innovations developed for food enterprises.
Food Safety (Outcome 1, Indicator 1)	
0	Number of viable technologies developed or modified for the detection and
Sustainable Energy (Outcome 3, Indicator 2)	
0	Number of farmers who adopted a dedicated bioenergy crop
Sustainable Energy (Outcome 3, Indicator 4)	
0	Tons of feedstocks delivered.