2017 Purdue University Combined Research and Extension Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

For the past several years, Purdue's College of Agriculture (CoA) has been reporting impact of formula funds using 7 Planned Programs: Global Food Security and Hunger, Climate Change, Sustainable Energy, Childhood Obesity, Natural Resources and the Environment, Food Safety, and Human, Family and Community, Health and Well-being. For 2017, we have reorganized the summary to reflect the Research, Education and Economic goals of USDA: 1) Sustainable intensification of agricultural production, 2) Responding to climate and energy needs, 3) Sustainable use of natural resources, 4) Nutrition and childhood obesity, 5) Food safety, 6) Education and science literacy, 7) Rural prosperity/rural-urban interdependence.
Our Executive Summary has been an opportunity to showcase unique combinations of impact statements that don't fit neatly into a single impact statement or outcome. We have been and will continue to include stories related to Diversity and to Emerging Issues/Trends that we are seeing across the college. Many of these examples demonstrate how CoA works across college boundaries to leverage formula funding to make bigger impacts across Indiana, the nation and internationally.

1. SUSTAINABLE INTENSIFICATION OF AGRICULTURAL PRODUCTION
1.1 The Marriage Of Genotype And Phenotype
Phenotyping, the process of measuring and analyzing observable plant characteristics, is a technique that is now automated for field research at Purdue. The Indiana Corn and Soybean Innovation Center, a 25,500-square-foot facility at the Purdue Agronomy Center for Research and Education (ACRE), opened in summer 2016 and is the first field phenotyping facility in North America. Although scientists have made significant advances in sequencing the genetic material of key crops, the technology to help identify how those genes are expressed in observable traits in plants (the phenotype) lags behind. Making the connection between genotype and phenotype can help scientists modify desirable plant traits, improving climate adaptation, enhancing crop yield and nutritional characteristics, and optimizing management technologies for weed and pest control. Phenotyping is not a new technique, but measuring characteristics such as plant height, nitrogen content, and photosynthetic activity by hand is time-consuming and laborious. Automated field phenotyping using sensors, configurable harvesting equipment, and drones produces far more data in a shorter timeframe, allowing researchers to more quickly close the gap between genotype and phenotype.

1.2 Post Harvest - Not the End of the Story
Spoiled or moldy grain has a triple-bottom line impact when it shows up in the grain bin. First, it hits the bottom line profitability by having payments docked or shipments rejected. Spoiled grain can cake-up in the silo, causing injuries, and on occasion, fatalities, when the problem is severe. Should that spoiled grain get to the market, it also has the potential to make those that eat the grain extremely sick, or worse. Purdue has been working to improve the bin caking situation by developing innovative technologies and management practices that will permit farmers, elevator managers and grain processors to safely and effectively manage stored grain in bins without entry by a worker. The Purdue Post-Harvest Education and Research Center with 16 bins holding 500 bushels pilot facility for grain storage and handling was renovated and upgraded with new state-of-the-art sensors and monitoring software. Training

programs are being piloted with bin managers in the second year of the project. This impact is also import for rural prosperity and the health of farmers and workers. Farm safety is of the utmost concern of farmers and Purdue takes great pride in finding unique, cost effective ways to reduce accidents--especially the type of accidents that occur in bins that tend to be severe.

1.3 Profitably Transitioning To Organic Agriculture

Organic food sales in the U.S. have increased to a record $43 billion a year and currently account for 5% of the U.S. food market, according to the Organic Trade Association. U.S. growers sold $7.6 billion worth of certified organic commodities in 2016, an increase of 23% from the previous year. Hoosier farmers operating on thin margins see opportunity in the fast-growing organic grain market, but there have been few resources in the state to help with the complex transition. A team in the College of Agriculture is collaborating with Indiana University colleagues to change that. Thanks to a $200,000 grant from the USDA North Central Region Sustainable Agriculture Research and Education Program, they will compile information from farmers who have already made the transition, as well as industry experts like grain buyers and storage facility managers, to develop educational publications, workshops, field days, and regional meetings for farmers. The project has the potential to greatly raise awareness of opportunities in the growing organic marketplace with Indiana farmers. Agricultural diversification can help Indiana farmers spread production and financial risk. Demand for organic grains continues to grow, with over half of the domestic demand for organic corn and soybean being satisfied with imports. This presents a major opportunity for farmers willing to navigate the three-year transition process from conventional to organic management.

1.4 Urban Ag Certificate Cultivates Local Foods For Communities

In Indiana and across the country, urban agriculture is expanding. In Indianapolis alone, there are at least 150 urban and community gardens and more than 20 urban farms. Urban food production is helping meet growing demand for local food. Urban agriculture generates many other benefits for the community around it. The Urban Agriculture Certificate program cultivates community leadership and organic vegetable production knowledge to deliver benefits associated with urban agriculture community building and entrepreneurship. This Certificate program is a year-long experience with a three-month stretch of classroom-based learning during colder months and monthly field trips during the growing season. Participants receive in-depth instruction for small scale, organic crop production such as farm design through harvest techniques, clarify their project vision and strengthen their community impact, and most importantly, learn to think like an enterprise to achieve economic sustainability. This new curriculum is tailored to urban agriculture which occurs at a very small scale (usually an acre or less), at close proximity to non-agriculture land uses, and often in partnership with other individuals or organizations. Course delivery is a "flipped classroom", where students use Blackboard, instructional videos and homework assignments to learn foundational concepts at home prior to class, then discuss and apply concepts to their own urban farm or garden through in-class discussion and hands-on activities. Twenty-five people were in the pilot held in Indianapolis. Overall, course participants reported high levels of satisfaction, learning, and evidence of applying their new knowledge. Perhaps the most important outcome from this program is expansion and diversification of participant networks and relationships with others which help them to act strategically and to access resources.

1.5 Master Gardeners Cultivate Gardening Enthusiasts

Purdue Master Gardener volunteers learned more about gardening and gained skills for their own personal development, but also put this new knowledge to work in Indiana communities. Purdue Extension held Master Gardener (MG) basic training for gardening enthusiasts desiring to volunteer in consumer horticulture education projects. In 2017, 567 MG Interns were trained to begin volunteering in their communities. In 2017, more than 2,600 MGs logged 170,566 volunteer activity hours valued at over $3.9 million. MGs logged 38,920 educational training hours and made 1,346,403 contacts with clientele. MG associations throughout Indiana awarded $33,250 in scholarships and donated 56,366 pounds of produce grown in educational demonstration gardens to local food banks. They assisted 1,934 people at the

Indiana Flower and Patio Show and 2,297 people at the Indiana State Fair by providing home horticulture information through the Purdue Plant Info to Go Booth. MGs reported changes in their gardening practices as a result of their involvement in the program including increased use of pollinator plants or use of practices to protect pollinators (16%), choosing the right plant for the right place (15%), removing/replacing invasive plant species (13%), using environmentally sound pesticide practices (13%), and using environmentally sound fertilizer practices (12%). They also reported building leadership skills such as the ability to work effectively with others (24%), confidence to commit to a leadership position within the local association or program (18%), communication skills (16%), understanding their own personality type and those of others (16%), and ability to run effective meetings (7%). Others reported increased efficiency of gardening practices (36%), that they can save money by choosing the right plant for the right place (24%), and through more effective use and/or purchase of pesticides and fertilizers (19%).

1.6 Agriculture Impacts Across The Value Chain

Seventeen research and Extension personnel were engaged in Beginning Farmer activities in 2017. There are numerous positive results from the Beginning Farmer activities, but the main one has been the momentous change of support being offered to beginning and military veteran farmers across Indiana. New farmers now see Purdue Extension as a valid partner in helping them find resources and information, and are more likely to seek out that support to be more successful. Some of the activities, such as field trips and farm tours, resulted in two new farmer organizations being created, the Hoosier Young Farmer Coalition, and the Hoosier Military Veteran Coalition. Purdue Extension has created successful partnering with multiple local, state, and national organizations. The Purdue Beginning Farmer Program has been successful in bringing together many people concerned about maintaining farmers in farming and helping new farmers get started.

2. RESPONDING TO CLIMATE AND ENERGY NEEDS

2.1 Farmers Keep Their Cool With Climate Data

Useful to Usable (U2U), a Purdue University initiative to make climate data more accessible to farmers, has been named winner of Indiana's annual Governor's Award for Environmental Excellence. "These awards recognize Hoosier organizations that employ innovation, energy efficiency, pollution prevention and environmental stewardship," said Bruno Pigott, commissioner of Indiana Department of Environmental Management (IDEM). "We are excited to share these best practices with other organizations across the Hoosier state." U2U was designed to create interactive online resources farmers could use to measure and manage the effects of an increasingly variable climate. Researchers surveyed and interviewed crop producers and their advisors to determine what type of climate data they employ when making growing decisions. The team then used those insights to develop five decision-support tools to help farmers determine what and when to plant, as well as how to maximize yields while limiting negative effects on the environment. The U2U project lead director said the Award is "a really great validation of all the work we put in over six years, and an indication that the work we did really had an impact on the environment both here in Indiana and regionally." U2U research led to 162 scientific conference presentations, 53 Extension publications, book chapters, and magazine articles, and 55 peer-reviewed publications, including a special issue of the journal Climate Risk Management dedicated to the project.

2.2 Forests On The Move From Changes In Climate

Climate change can have profound impacts on biodiversity and the sustainability of many ecosystems. Various studies have investigated the impacts of climate change, but large-scale, trait-specific impacts are less understood. One lab analyzed abundance data over time for 86 tree species/groups across the eastern U.S. spanning the last three decades. The analysis showed that more tree species have experienced a westward shift (73%) than a poleward shift (62%) in their abundance, a trend that is stronger for saplings than adult trees. The observed shifts are primarily due to the changes of subpopulation abundances in the leading edges and are significantly associated with changes in moisture availability and successional processes. These spatial shifts are associated with species that have similar

traits (drought tolerance, wood density, and seed weight) and evolutionary histories (most angiosperms shifted westward and most gymnosperms shifted poleward). Results indicate that changes in moisture availability have stronger near-term impacts on vegetation dynamics than changes in temperature. The divergent responses to climate change by trait- and phylogenetic-specific groups could lead to changes in composition of forest ecosystems, putting the resilience and sustainability of various forest ecosystems in question.

3. SUSTAINABLE USE OF NATURAL RESOURCES

3.1 A Vital Resource

Water is a vital resource for the planet, humans and agriculture. Purdue and the Agriculture and Biological Engineering (ABE) department has several projects that will impact water management over the next few years. Hatch/Multistate project W3190 is focused on a suite of research questions and methods that will test the feasibility and economic efficiency of innovative water management practices, policies, and institutions. Insights gained will also improve the design of existing tools and the tools will empower stakeholders to objectively dissect complex water issues and correctly weigh benefits and costs of alternative options. If implemented, policy recommendations will help alleviate water conflicts. In its first year, the team conducted non-parametric evaluations of seasonal and regional monotonic trends for long-term and short-term precipitation, stream flow, and water quality to discern patterns and driving factors as indicated by variations and stationarity in the data.

3.2 To Drain or Not to Drain?

Another water-related study is finishing its eleventh year of monitoring drain flow, soil moisture at five depths, water table depth, and tile flow nitrate concentration at the Davis Purdue Agricultural Center. The analysis of results from the two free-draining and two controlled-drainage quadrants of the field shows that controlled drainage reduced drain flow by 14% to 49%, with similar reductions in nitrate load. The team examined whether the outlet should be lowered prior to or directly after a rainfall event to reduce the amount of time that the water table is at a level that would be detrimental to either trafficability or crop yield. It measured water table recession rates from two pairs of controlled- and free-draining fields located at the Davis Purdue Agricultural Center in Indiana over a period of 9 years from 2006 to 2014. For each pair, comparison of mean recession rate from the two fields indicated that controlled drainage reduced recession rate. Raising the outlet of the subsurface drainage system decreased the mean rate of water table recession by 29% to 62%, increasing the time needed for the water table level to fall from the surface to 60 cm depth by approximately 24 to 53 hours. Based on these results, lowering the outlet before storm events would reduce the amount of time that the water table is at a detrimental level for either crop growth or trafficability. However, the trade-off between costs and benefits of active management depends on the sensitivity of the crop and probability of a severe storm.

The Transforming Drainage regional project brought together agronomic, soil, hydrologic, water quality, and weather data at 16 experimental sites in 8 states, to quantify the impacts of the three drainage storage practices addressed in the project (controlled drainage, saturated buffers, and drainage water recycling). The database framework that was developed for managing experimental data supports coordinated synthesis and modeling of drainage storage approaches. It includes 34 experimental drainage sites across 8 states representing 186 site-years of data and containing 85 field measurement, 91 field management, and 25 weather data types to allow for characterization of production and water quality impacts across drainage water storage practices. The website, http://transformingdrainage.org, serves as the portal for drainage stakeholders and the general public to access project updates and information and interact with products and materials. The website, http://transformingdrainage.org, was developed as part of the research and serves as portal for drainage stakeholders and the general public to access project updates and information and interact with products and materials.

4.NUTRITION AND CHILDHOOD OBESITY

4.1 Multi-State: Growing Together
Growing Together is a multi-state (Indiana, Iowa, Nebraska, and Wisconsin) project to increase access to fruits and vegetables in food insecure areas. The goal is to foster communication and collaboration across colleges and disciplines to increase availability of the crops most needed by the food agencies. In Indiana, Extension's Agriculture and Natural Resources Educators and the Master Gardener Volunteers partner with the Community Wellness Coordinators from the Nutrition Education Program associated with the College of Health and Human Sciences(hhs) to connect with local food pantries. In 2017, the Purdue program provided grant funding (from the USDA Supplemental Nutrition Assistance Program) to 4 pilot counties to support Extension's Master Gardeners to build and maintain donation gardens in their communities. Among the 4 Indiana projects, more than 2,200 volunteer hours were committed to planting, maintaining, harvesting, and supporting the nearly 30 organizations that collaborated with the interdisciplinary project partners to serve as distribution and education sites. During the course of a year, the projects grew, donated, and distributed 6,042 pounds of produce across the 4 project communities via 14 agencies. Based on agency service numbers, the produce was available to more than 4,500 clients. In addition, Nutrition Education Program staff were able to acquire nearly $25,000 of in-kind donations of labor and resources to support the projects. This interdisciplinary collaborative activity enhanced the breadth and depth of local programing, coordination of services, and food access in Indiana communities. In 2018, the program will expand to offer up to $2,000 each to 10 Indiana County programs.

5. FOOD SAFETY

5.1 Safe Food Every day, Everywhere
Knowledge about the transmission and ecology of Listeria monocytogenes in retail establishments has remained limited, despite growing concerns about cross-contamination of ready-to-eat foods. A cross-sectional study was conducted to characterize the prevalence, distribution, and subtype diversity of L. monocytogenes in 120 retail deli establishments that were hypothesized to present an increased risk for environmental L. monocytogenes contamination (i.e., small establishments and establishments with a history of failed New York State Agriculture and Markets inspections). Analysis of these data along with previously reported data for 121 predominantly larger retail establishments in the same state identified establishment size, geographic location, and inspection history as significant predictors of L. monocytogenes presence and prevalence. The odds of an establishment being L. monocytogenes positive were approximately twice as high for large establishments, or establishments with poor inspection history (as compared with establishments without these attributes), even though correlation between location and inspection history complicated interpretation of results. Within an establishment, L. monocytogenes was significantly more prevalent on nonfood contact surfaces than on food contact surfaces; prevalence was particularly high for floors and in floor drains, sinks, the dairy case, and milk crates. The diversity of L. monocytogenes subtypes differed between sites, with "Lineage I" isolates significantly associated with nonfood contact surfaces and "Lineage II" isolates significantly associated with food contact surfaces. Isolates belonging to the same ribotype were often found dispersed across multiple sites within an operation. These initial observations suggest that the inclusion of lineage or subtype data into risk assessment models may allow for improved insights into L. monocytogenes transmission and control at retail as "Lineage II" strains tend to be less harmful for causing human illness. More work is required to understand the transmission and ecology of the listeria in retail environments to ensure society remains confident in the food supply.

6. EDUCATION AND SCIENCE LITERACY

6.1 Sparking Interest in 4-H
U.S. employers often suggest there is a gap in technical skills of future employees but also cite important skills such as communication, critical thinking, creativity and collaboration as areas with the largest gaps followed by leadership and computer skills. The Indiana 4-H Youth Development Program uses a strategic

initiative focused on building the skills and abilities of young people while expanding programming to serve new, diverse, and underserved audiences, allowing for the team to meet the needs and social conditions of 4-H members while striving for ongoing excellence in 4-H programming. 4-H SPARK experiences, introduced in the last two years, are educational experiences designed and marketed specifically to "spark" an interest in the 4-H Program and serve as a gateway experience for new 4-H volunteers and youth (grades 3-12). These are short-term experiences (6+ hours of educational instruction minimum) with a focus on a single topic anchored in one of three primary mission areas: Science, Healthy Living and Leadership. These experiences are intentionally designed to engage youth in grades 3-12 in collaborative learning environments while they learn by doing in out of school time. Guided by adult volunteers, youth focus on a topic of interest allowing them to explore as they learn, thus empowering them with new skills. Social media was an effective tool for marketing these experiences as in many cases, staff worked with new volunteers or community partners who also assisted in advertising via their networks. In 2016-2017, 1,858 youth were engaged in SPARK experiences with 46% of them engaging in a first-time experience with the Indiana 4-H Program. This represents an 85% increase over the first year of implementation. Also, there was a 27% retention rate of individual 4-H members from the prior year of SPARK participation. 69% were engaged in STEM education focused on a wide range of subjects from robotics to beekeeping to veterinary science. 22% participated in Healthy Living topics ranging from first aid and running/exercise programs, to crafting and sewing, to theatre. Leadership topics focused on journalism to leadership, cultural study and bicentennial history. These SPARK activities for positive youth development have expanded the involvement of youth participants across Indiana.

6.2 Enhancing the Value of Public Spaces
An integrated team consisting of Extension professionals from HHS (including the Nutrition Education Program), CD, and ANR identified a sustainable way to enhance the quality of life in Indiana using a science-driven, participatory approach. Enhancing the Value of Public Spaces: Creating Healthy Communities engages participants in analyzing current community assets and identifying an action plan to strategically guide policy, systems and environmental changes relevant to promoting healthy communities through public spaces. The integrated team developed an inter-disciplinary approach to program measurement and evaluation starting with a holistic logic model, a selective list of indicators that span across Extension programs, a timeline for when metrics need to be tracked and evaluation methods like surveys and focus groups need to be conducted, and lastly for reporting expectations. Decision makers and local leaders who oversee community public spaces participate in this program which combines data collection and analysis with inclusive public deliberation to guide the design of a high-quality action plan resulting in sustainable and impactful improvements for communities. As Extension in communities keeps evolving and expanding, there will be a need to develop, deliver and evaluate more inter-disciplinary programs. Working across programmatic boundaries resulted in an inter-disciplinary program to expand education and implementation efforts linking public spaces with environmental, physical and mental health benefits.

7. RURAL PROSPERITY/RURAL-URBAN INTERFACE

7.1 Agribusiness Know-How
Purdue provides an extraordinary number of resources to support farmers in decision making year-round. As farmers adopt more precision ag practices, tools and technologies, decision making becomes more complex. Purdue has partnered with the CME Group to produce the Ag Economy Barometer-a nationwide measure of the health of the U.S. agricultural economy. CME Group is one of the world's leading and most diverse derivatives marketplaces. On the first Tuesday of each month, the Ag Economy Barometer provides a sense of the agricultural economy's health with an index value. The index is based on a survey of 400 agricultural producers on economic sentiment each month. Quarterly, the index is accompanied by an in-depth survey of 100 agriculture and agribusiness thought leaders. As CME Group's roots are in agriculture, and Purdue University's Center for Commercial Agriculture has a long history of producing cutting-edge agricultural research, this partnership is designed to create a new and important tool for

producers, economists, traders, finance industry professionals and journalists who are interested in understanding the agriculture industry and the broader global economy.

7.2 Coffee and Cacao Is Safe When Using PICS Bags

Purdue's award winning triple-layered PICS bags, originally designed to protect cowpea from insects over winter storage has now demonstrated that it also works wheat, coffee and cacao. PICS bags allow farmers to store their grain without the use of insecticides, and provides them the flexibility to sell when prices are high, while having chemical-free high quality food for their families throughout the year. The PICS program originally involved 10 countries in West and Central Africa, but has expanded to Eastern and Southern Africa and to South Asia. The success of the technology has been shown by it transfer to farmers in >40,000 villages in Sub-Saharan Africa, the training of >2 million farmers on use of the bags, and by the private industry developing to manufacture and sell PICS bags in >23 countries in Africa and Asia.

7.3 Farmers Markets Get SNAP Boost

Sources of healthy, local produce are important to many community members, especially for those in urban areas and food deserts. Area farmers also need options to market and sell their produce, meats, or other goods. Farmers markets bring together vendors and consumers. Yet, markets need to be properly managed to comply with food safety guidelines, sustain business, and successfully serve the community. Purdue's Local Foods and Diversified Farming and Food Systems teams work with farmers and the community to ensure that farmer markets understand the laws and consumer expectations. Purdue Extension provides professional development training for market managers to offer valuable skill-building education and information to increase market efficacy. Outcomes of these meetings usually include guidance on how to improve markets through community partnerships, and about food safety concerns. One example is a regional, day-long training with information from the USDA and Indiana State Health Department. These meetings provide critical information such as how to accept SNAP/WIC at markets, specifics on what products can be bought using SNAP/WIC benefits, and details on how a market can sign up to accept these programs. An open discussion with a panel of county health department officials provided deeper insight around laws, audits and safety. Another program example is Market Basket 360, a Purdue Extension Issue-Based Action Team (IBAT) project, with two-day workshops, followed by six, two-hour follow-up webinars to cover more topics and to host speakers from around the U.S. The final session allowed market managers to present their annual project plans developed through the program which consisted of 36 learning hours and the additional out-of-classroom project. Attendees in the Regional training indicated they gained knowledge on upcoming opportunities, local food bank partnerships, and SNAP/WIC acceptance. Eleven markets indicated interest in applying for SNAP/WIC acceptance. Participants saw value in networking with other area markets and communicating with local health departments. The program had a positive impact on Health Department representatives as well who indicated that this program reduced perceived barriers to communicating with Health Departments with questions regarding compliance. As a result, fewer violations have been occurring in area markets. The training also included collecting information for a farmers market guide of all markets and stands in a nine-county area. This brochure is updated annually and now includes an interactive map at www.tinyurl.com/2017fmg. Market Basket 360 attendees (87%) reported leaving the program with greater confidence about managing their market, and that their participation in the program will make them a more effective market manager. Six months later, a follow up evaluation showed that market managers had made changes during the 2017 season including adding an event to the season, expanded volunteer engagement, worked on new market partnerships, invited elected officials to tour the market, and sought data about the market including attendance, market prices, consumer surveys.

8. EMERGING TRENDS/ISSUES

8.1 Digital Agriculture: Leveraging The Terabyte

The College of Agriculture (CoA) has established a Dean's Fellow to focus on Digital Agriculture. The Fellow is accountable for conducting an assessment/inventory and an analysis of digital agriculture at

Purdue, leading to a vision and strategy for next steps in research, teaching and Extension and the cross-cutting international mission that will enable Purdue to become world class in this important area. Faculty and staff across the College and University are being engaged for their input and perspective. Today, scientists in the CoA are using tools such as drones, rovers, and other innovative technologies to reap a new kind of harvest--the rich, massive data that will help farmers make better decisions in the future. The field is called digital agriculture, and these tools unlock a new era of plant sciences and data-driven farming that will transform both research and industry. With unparalleled facilities, strong interdisciplinary collaborations, corporate partnerships, and a core of experienced faculty, Purdue's COA stands poised as a leader of this new frontier. The college is focused on leveraging data more effectively, making more quantitative, informed, and better decisions using data. These efforts are at the intersection of many disciplines: plant science, engineering, computer science, data analytics, statistics, even aviation technology. Working together to create or develop new platforms to collect more data and take advantage of big data in agriculture is a significant focus.

8.2 Healthy Communities Impacted By Multi-Disciplinary Efforts For Opioids
Efforts to build activities and programs related to the opioid epidemic have involved all of Purdue Extension's program areas: 1) Agriculture and Natural Resources (ANR) educators in all 92 Indiana counties have established relationships with agricultural and rural communities, 2) Community Development (CD) personnel help local leaders and decision-makers build capacity for multifaceted, community conversations - and policy actions - related to opioids, 3) Health and Human Sciences (HHS) programs in parenting and family, health education, and coordinated webinars to help policymakers are among the ways in which HHS addresses the opioid crisis, and 4) Indiana 4-H Youth Development provides afterschool activities as a productive outlet for youth interest and offers a framework to build positive role models.

9. DIVERSITY

9.1 Ag Discovery Camp
In its first year, the 2017 Ag Discovery Camp at Purdue University is a partnership between the Office of Multicultural Programs (OMP) signature program Purdue Agribusiness Science Academy (PASA) summer institute, the Purdue College of Veterinary Medicine (PVM), and the United States Department of Agriculture (USDA) Agriculture Research Services (ARS). This two-week program allowed participating students to experience the many career paths available in the plant and soil sciences/environment field and the veterinary/wildlife field through hands-on activities relevant to each of the various disciplines within these agriculture sciences. The students learned about the interconnection between the disciplines of animal sciences, plant sciences and environmental sciences, and the importance of these careers to the agriculture industry and food security of the U.S. Ag Discovery students with strong academic records and top performance, who expressed interests in pursuing agriculture science at Purdue University, were invited to participate in the 2018 summer programs for PVM Boiler Vet Camp, and the Purdue Agribusiness Science Academy. Students accepted into either program can receive a partial scholarship to further explore a particular discipline in veterinary medicine and or agriculture. Seniors from the Ag Discovery program accepted into Purdue University for fall 2018 will be invited to participate in the Academic Boot Camp (ABC), a 5-week summer bridge program to transition underrepresented ethnic minority students into the campus culture and to ensure academic success. Half the students participating self-identified as Black or Latino.

9.2 Urban Youth Learn about African Americans and Women in Agriculture Urban
Elementary-age youth rarely receive information about agriculture, specifically about African Americans and women in agriculture. Content in Black History Month programming generally includes inventors such as George Washington Carver, athletes like Jackie Robinson, or activists like Martin Luther King Jr., but rarely looks beyond that. As far as women's role in agricultural advancement, no student in the group had seen the movie about Temple Grandin, a globally recognized advocate for animal welfare and autism

awareness. The Director of Boys and Girls Club in Terre Haute observed that African Americans- men and women--could be good stories for Club members and during 2016/2017, the Director worked with the Extension Board and Educators to identify and create "profiles" for the students to explore. The extraordinary scientific and engineering accomplishments of the individuals covered highlights advanced education to students, as well as demonstrating the value of STEM advancement. Seven different "profiles" were written in first person, three women and four African American men, encouraging participants to step into the life of these leaders. Twenty-six girls and boys were able to practice national geography, reading and comprehension, and touching different seed varieties (ex: soybeans, corn, peanuts). This multi-sensory format engaged children, encouraging them to participate and retain information. The students sat and listened attentively, attempting difficult pronunciation when reading aloud, and asking questions about each profile. The Program Director said that "members had a wonderful time with the presentation; they were eager to learn more and asked many questions. Very informative and kept the members attention."

9.3 Diversity facts about the CoA: in 2016/2017 there were 193 underrepresented minority (URM) undergraduates and 48 URM graduate students; 32% increase in URM since 2012; 7% of the college undergrads are URM, 58% of are women; 3 people are certified Intercultural Development Inventory administrators and there are 9 Diversity Catalyst faculty in the college. Cohort 1 of Purdue's USDA Multicultural Scholars program has had 6 scholars graduate between 2015-2017. Five have jobs and one is in graduate school. Cohort 2 has two scholars remaining with plans to graduate in 2017/2018; 2 have accepted job offers and one is serving overseas in AgriCorps. Similar to AmeriCorps and Peace Corps, AgriCorps connects American professionals with agriculture experience to the demands in developing countries for experiential, school-based, agricultural education.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	78.2	0.0	273.2	0.0
Actual	63.6	0.0	220.1	0.0

II. Merit Review Process

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

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

2. Brief Explanation

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 and Graduate Education at Purdue (ARGE) and submitted to USDA-NIFA for final review and approval. The review panel, consisting of three reviewers, faculty member department head, and Marshall Martin, Interim Director of the Indiana Agricultural Experiment Station and Senior Associate Director of ARGE, 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, ARGE 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 ARGE is responsible for ensuring that Purdue faculty members comply with Hatch peer-review procedures and for the quality of reporting submitted to REEport. Again, for 2017, there was 100% reporting compliance.

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.

The College of Agriculture, the Office of Agriculture Research and Graduate Education, plus Extension work closely with the following groups to understand the current and long-term direction desired by these stakeholders for the research and Extension programs: Indiana Soybean Alliance, Indiana Corn Marketing Council, Indiana Pork Board, Indiana Crop improvement Association, Indiana Farm Bureau (e.g, Supper Series and annual meeting), Dean's Advisory Council, Indiana Wine Grape Council, Production Agriculture Roundtable, Corn and Soybean Showcase, and Purdue Council for Agricultural Research, Extension and Teaching (PCARET). In addition, we glean extremely valuable information from the farmers and business people that attend our Purdue Agriculture Center (PAC) Field Days and activities. From October 2016- September 2017, the PAC's held more than 200 activities and hosted 11,500 visitors.
We continue to conduct surveys of Ag Research stakeholders at the Indiana State Fair. Over the past 2 years, more than 600 people have self-selected to participate in the online surveys. Overall, they are satisfied with the direction of CoA research programs.
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. The strategic plan is now in place and reflects the content brought to us by these stakeholders. As a college, we continue to work with these stakeholders to share our progress and to refine our activities based on stakeholder needs.

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.

Community Forums --During 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 Cafe technique, stakeholders met around tables to discuss issues and concerns, then share with the larger group, and finally to vote and map out priorities.
Additional efforts in 2017:
Opioid Epidemic - Purdue Extension sought input from The Indiana Governor's office, the Indiana State Department of Health, Indiana Family and Social Service administration, the Indiana Chamber of Commerce, AgriInstitute, North Central Region Center for Rural Development, and Indiana Clinical and Translational Sciences Institute regarding the community-based prevention education needs related to the opioid epidemic through face-to-face meetings in 2017.
Workforce Training -- The need for Purdue Extension to be engaged in workforce training was identified during the 2015 listening sessions held around Indiana as part of the Purdue College of Agriculture strategic planning process. With the advent of precision farming and manufacturing technologies, increased skills are needed by farmers and other workers in agricultural farms and firms. Precision farming, digital agriculture, and big data concepts are becoming common on farms, but mid-level employees, agribusiness professionals, and even farmers themselves, need further skills to utilize these rapidly emerging technologies fully. Demand for skilled, entry-level workers across many sectors of Indiana's economy has become a critical issue. Often, agriculture and natural resources have been omitted from the conversation. However recent changes in immigration policy and growing need for more technical skills within these fields have results in shortages of agricultural workers. For example, worker shortages are evident in season harvesting of produce, and rapid shift toward automation of milking in the dairy industry. As an ongoing effort to gather input on workforce training, Purdue Extension invited individuals from across Indiana representing industry, farmers, Indiana Corn Market Council, Indiana Soybean Alliance, Agriculture companies, Farm Bureau, Ivy Tech, and others to seek input on training for agriculture-related positions. Discussions were held around these and other questions: 1) What skills are needed? 2) What formats (classroom, distance learning, etc.) would be accessible to the intended audience? 3) Who should be included as partners? 4) Would you have need for this training for yourself or current or future employees? 5) Would you hire students who complete this training?

3. A statement of how the input will be considered

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

Brief explanation.

Community Forums -- Purdue Extension is currently funding programming efforts to address Children, Youth and Family that include strengthening families and parenting, expanding youth participation via 4-H Sparks Clubs, and increasing physical activity with walking programs. For Community, Economy and Natural Resources, programs are digital ready communities, confined

feeding operations (CAFOs), urban agriculture certificate program, conservation through community leadership, creating healthy communities, farm finances and managing tight margins, workplace skill development, farmers markets development and delivery, and training teachers to implement programs linking health and nature for youth.
Opioid Epidemic -- As a result of these conversations, to address the impact of the opioid crisis in Indiana's rural and farming communities, a consortium of eight Indiana agricultural and public health organization, including Purdue Extension, hosted a statewide symposium to build awareness and forge effective partnerships uniting to be proactive, preventive, and a positive force in addressing Indiana's opioid crisis. Purdue Extension highlighted numerous ways in which all four program areas are working to address the opioid crisis to the 400 symposium attendees. During the symposium, a panel of public policy leaders and experts from the health, economic development, and law enforcement sectors discussed the social and financial consequences of opioid abuse, as well as prevention and treatment initiatives.
Workforce Training -- Models of training for individuals who do not purse college degrees were explored, including: 1) winter short course, 2) a boot camp approach, and 3) mini-internships. Partnerships with Ivy Tech and Vincennes University were considered to expand facilities and delivery of some components. Agency involvement with Work One was proposed as a partner to direct prospective agricultural employees into training and financially support trainings for specific jobs. Initial training focus would be on the following job areas: 1) Field - agronomy, livestock, controlled environment, agriculture, wood products; 2) Production - crop farm labor, livestock workers, farm labor, forest/tree management; and 3) Agricultural Business - field crop services, post-harvest manufacturing, nursery labor, and wood manufacturing.

Brief Explanation of what you learned from your Stakeholders

Opioid Epidemic -- As a result of information and discussions at the symposium, Jim McClellan, Executive Director for Drug Prevention, Treatment, and Enforcement for the State of Indiana requested a proposal from Purdue Extension for resources needed to implement strengthening families to support efforts to reach a greater number of people and underserved populations across Indiana. Purdue Extension has submitted the proposal and is currently creating communication pieces relating to preventing drug abuse and resources and support for mental health in communities to address the opioid crisis in Indiana.
Workforce Training -- As a result of these discussions, next steps are: 1) Continue to pursue funding in support of employee training, 2) Develop two-tiered training for beginning or entry level employees and for retraining of farmers and key employees in precision technologies, 3) Work with expressed support to replace old winter short course with new model and begin planning program delivery, and 4) Monitor and track worker shortages in all of agriculture - livestock, crops, forestry, and nurseries / lawn care for ongoing planning.

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
{No Data Entered}	{No Data Entered}	{No Data Entered}	{No Data Entered}

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	10619610	0	6446341	0
Actual Matching	18249496	0	32501322	0
Actual All Other	3588813	0	7526762	0
Total Actual Expended	32457919	0	46474425	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	0	0	0	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: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	37.2	0.0	171.4	0.0
Actual Paid	38.2	0.0	115.0	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**
3166405	0	3164023	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
5088112	0	15243934	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
1056116	0	1980887	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

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	216155	1089918	75217	232760

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

Patent Applications Submitted

Year: 2017
Actual: 12

Patents listed
9,194,107
9,200,648
9,206,225
2496546
9,441,256
9,499,444
9,500,654
9,506,081
9,512,437
9,518,268
9,534,235
9,683,663

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	54	411	465

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of education workshops

Year	Actual
2017	1789

Output #2

Output Measure

- Number of volunteers

Year	Actual
2017	3006

Output #3

Output Measure

- Number of consultations

Year	Actual
2017	36253

Output #4

Output Measure

- Number of research projects

Year	Actual
2017	320

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	GF 1.2 - # Of improved animal genetics
2	GF 1.3 - # Of increased efficiencies (i.e.. (% pregnant), or increases in yield/unit (bushels/acre; lbs. product (meat, protein, milk) per animal ; lbs. feed per gain).
3	ANR-S - ANR Div Ag # of farmers/food producers who learn about available assistance
4	GF 2.1 - # New or improved innovations developed for food enterprises
5	GF 2.4 - # Producers (and other members of the food supply chain) that have increased revenue
6	GF 2.6 - # New diagnostic technologies
7	GF 2.11 - # Acres that incorporate ecosystem services and/or biodiversity considerations
8	ANR-S - Farm & Ag Mgmt - # of farms informed about succession planning
9	ANR-S - Field Crops - # of participants informed about agronomic issues
10	ANR-S - Livestock - # of participants informed about livestock management practices
11	ANR-M - Field Crops - # of participants who self-report that they adopted a recommended practice for their operation
12	ANR-S - Field Crops - # of participants informed about crop production issues
13	GF 2.3 - # Innovations adopted in food enterprises including production, allied services, processing, and distribution
14	ANR-S - Div Ag - # of people who learned about role of diversified agriculture in a local food system
15	ANR Diversified Food and Farming Systems - # of producers indicating adoption of recommended practices
16	FME 2.1 - # of discoveries, innovations, technologies and technology transfer related to performance management of farms
17	GSFH 4.5, 4.7, 4.8; FCS 1.3 - # of discoveries, innovations, technologies that relate to human health (including cancer), nutrition and well-being (including bioactivies and botanicals), chronic Diseases, and impacts of environmental factors on health

18	HHS 5.1 # of projects related to understanding the impact of new technology, discoveries and innovation on pricing, economics and/or markets
19	# of coalitions formed by farmers/producers/participants for diversified farming and food systems networking

Outcome #1

1. Outcome Measures

GF 1.2 - # Of improved animal genetics

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

GF 1.3 - # Of increased efficiencies (i.e.. (% pregnant), or increases in yield/unit (bushels/acre; lbs. product (meat, protein, milk) per animal ; lbs. feed per gain).

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	278

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Most phloem-related research in crop plants has focused on its function for carbon or nitrogen allocation with less effort on manipulating this tissue for crop improvement. Understanding how this tissue is involved in the communications between different organs of a plant during stress conditions is still at early stage. Plant stress physiologists have mainly focused on the responses of individual organ or tissue under stress conditions. For instance, root is the most studied tissue under drought, low P soil, or a plant with root diseases. The shoot is the most studied tissue under heat stress. Although to some extent informative, many of these prior studies ignored the importance of treating the plant as one unit. Recent evidence indicated that when a plant is grown under low P soil, or under attack by root pathogens, e.g., during suppressive soil situation, signals synthesized from shoot are transported to root via phloem to induce the adaptive alterations to cope with the adverse environment. Not only will the identification and functional characterization

of these signals elucidate the fundamental mechanisms at the whole plant level during these processes, these signals can also be used to "make" crops with better agronomic traits.

What has been done
The lab has been focused on identification and characterization of systemic signals in plants grown under either normal or low P condition. The second effort focused on simultaneous sink/source manipulation to improve the growth rate and yield of potato and rice.

Results
1)Using plantago major, a broadleaf plantain medicinal plant and common weed, the team identified 196 mRNAs residing in the vasculature that are responsible to phosphate deficiency. Sugar metabolism and cross talk among different hormones are two of the major pathways involved in phosphate deficiency response in the vasculature of plantago major. 2) Using Arabidopsis as a model, over 100 mRNAs were identified that reside in the phloem companion cells responsible to phosphate deficiency. A number of transcription factors related to hormonal synthesis and transport were discovered to be involved in early response to phosphate deficiency. 3)The lab produced transgenic potato plants in which the movement of sucrose was increased; the team is in the process of assessing the potato yield improvement.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
201	Plant Genome, Genetics, and Genetic Mechanisms
205	Plant Management Systems
206	Basic Plant Biology
302	Nutrient Utilization in Animals
304	Animal Genome
305	Animal Physiological Processes
307	Animal Management Systems
315	Animal Welfare/Well-Being and Protection
402	Engineering Systems and Equipment
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
512	Quality Maintenance in Storing and Marketing Non-Food Products
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices
606	International Trade and Development
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 #3

1. **Outcome Measures**

ANR-S - ANR Div Ag # of farmers/food producers who learn about available assistance

Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

GF 2.1 - # New or improved innovations developed for food enterprises

Not Reporting on this Outcome Measure

Outcome #5

1. **Outcome Measures**

GF 2.4 - # Producers (and other members of the food supply chain) that have increased revenue

Not Reporting on this Outcome Measure

Outcome #6

1. **Outcome Measures**

GF 2.6 - # New diagnostic technologies

Not Reporting on this Outcome Measure

Outcome #7

1. **Outcome Measures**

GF 2.11 - # Acres that incorporate ecosystem services and/or biodiversity considerations

Not Reporting on this Outcome Measure

Outcome #8

1. **Outcome Measures**

ANR-S - Farm & Ag Mgmt - # of farms informed about succession planning

Not Reporting on this Outcome Measure

Outcome #9

1. **Outcome Measures**

ANR-S - Field Crops - # of participants informed about agronomic issues

Not Reporting on this Outcome Measure

Outcome #10

1. **Outcome Measures**

ANR-S - Livestock - # of participants informed about livestock management practices

Not Reporting on this Outcome Measure

Outcome #11

1. **Outcome Measures**

ANR-M - Field Crops - # of participants who self-report that they adopted a recommended practice for their operation

Not Reporting on this Outcome Measure

Outcome #12

1. **Outcome Measures**

ANR-S - Field Crops - # of participants informed about crop production issues

Not Reporting on this Outcome Measure

Outcome #13

1. **Outcome Measures**

GF 2.3 - # Innovations adopted in food enterprises including production, allied services, processing, and distribution

Not Reporting on this Outcome Measure

Outcome #14

1. **Outcome Measures**

ANR-S - Div Ag - # of people who learned about role of diversified agriculture in a local food system

Not Reporting on this Outcome Measure

Outcome #15

1. **Outcome Measures**

ANR Diversified Food and Farming Systems - # of producers indicating adoption of recommended practices

2. **Associated Institution Types**

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	4240

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

In Indiana and across the country, urban agriculture is expanding. In Indianapolis alone, there are at least 150 urban and community gardens and more than 20 urban farms. This source of food production right in the urban setting is helping to meet growing demand for local food. In addition to producing food, urban agriculture generates many other benefits for the community around it.

What has been done

Purdue Extension Urban Agriculture Certificate is a yearlong experience with a three-month stretch of classroom-based learning during colder months and monthly field trips during the growing season. Participants: 1) Receive in-depth instruction for small scale, organic crop production from farm design through harvest techniques, 2) Clarify their project vision and strengthen their community impact, and 3) Learn to think like an enterprise to achieve economic sustainability. This new curriculum is tailored to urban agriculture which occurs at a very small scale (usually an acre or less), at close proximity to non-agriculture land uses, and often in partnership with other individuals or organizations. There are 25 learning modules, 50 instructional videos, a written guide for instructors, in-class activities, and student worksheets. The course is managed through Blackboard, an online learning platform. Course delivery is a flipped classroom where students use Blackboard, instructional videos and homework assignments to learn foundational concepts at home. Then students discuss and apply concepts to their own urban farm or garden through in-class discussion and hands-on activities. To receive the certificate, students meet four criteria: 1) Attend classes, missing no more than three, 2) Prepare for class by doing homework and participate fully while in class, 3) Complete their Master Plan assignment, including Roadmap for Strong Roots, Site Assessment for Fertile Ground, Growing Guide for Healthy Crops, and Enterprise Budget for Sustained Harvest, and 4) Complete the final course evaluation. The pilot program classroom portion was delivered November 2016 to March 2017, with summer field trips through the growing season. Twenty-five people were in the pilot held in Indianapolis.

Results

Overall, course participants reported high levels of satisfaction, learning, and evidence of applying their new knowledge. Highlights included: 1) A high level of satisfaction with every component of the course structure, especially: in-class presentations and presentations, the Master Plan assignment, homework and Community Voices videos. 2) An increase in confidence to begin or further develop an urban agriculture project. On a scale from 0-10, student average feeling of confidence increased 4 to 8.4. 3) An increase in clarity about the purpose of their urban agriculture project and the vision for their garden or farm. Student clarity of purpose increased 4.3 to 9.1. 4) An increased understanding to research an urban site environmental history, test its soil and determine red flags that should prevent using a property to grow food. Student confidence to do this type of assessment and make safety judgments increased 3.6 to 9.2. Perhaps the most important outcome from this program is expansion and diversification of participant networks and relationships with others which help them to act strategically and to access resources. A majority of participants reported they met many new people and their urban agriculture connections expanded significantly. Summarizing the direct impact on their urban farm or garden, participants wrote: 1) This course was incredibly helpful in the planning and development phase of the garden. It helped me to refine a big idea into easily manageable steps. As I move into building raised beds, managing soil health, irrigation, and pests, the knowledge I gained from the course will be invaluable. 2) This class directly motivated me to seek out a community organization interested in developing an agriculture project. It gave me the guidance and framework that I needed to feel comfortable leading such an endeavor, and it has already saved our garden from several planning errors. Without the deadlines and progress of the class, our garden planning would not have gotten underway to the extent necessary to have a spring garden season!

The urban agriculture certificate program cultivates community leadership and organic vegetable production knowledge to deliver benefits associated with urban agriculture community building and entrepreneurship.

4. Associated Knowledge Areas

KA Code	Knowledge Area

601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices
608	Community Resource Planning and Development

Outcome #16

1. Outcome Measures

FME 2.1 - # of discoveries, innovations, technologies and technology transfer related to performance management of farms

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	21

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Aquaponics is an intensive fish-vegetable production system that combines aquaculture with the production of plants in a hydroponic system. There are different ways aquaponics can be set up, but the basic principle is that fish are raised in tanks, and part or all the wastewater containing excreted nutrients is then circulated to the hydroponic plant production system. The plants take up the water and nutrients, thereby cleaning the water, which is circulated back into the fish tanks. Hydroponics production is more prevalent in the U.S. than aquaponics. This study sought to examine the different systems and scales of production to help answer questions relating to the financial viability under the different production systems and risks associated with the business. The U.S. Midwest has experienced frequent investments into the aquaponics business, but very few have remained viable. There are no established aquaponics business models in the region that potential investors can examine to help them make informed decisions concerning entry into the aquaponics business. An analysis of the financial risks associated with the different practices, i.e., aquaponics and hydroponics, provides useful financial guidelines. This study sought to examine the different systems and scales of production to help answer questions relating to the financial viability under the different production systems and risks associated with the business. Although there are some results for temperate regions, existing literature on the economics of aquaponics largely covers tropical locations and fish and vegetables species that are mostly applicable to such climates. Therefore, further research is needed especially in colder climates.

What has been done

The economics of two systems, aquaponics and hydroponics, were analyzed. The two systems involved the production of basil, lettuce, and cherry tomato in a hydroponics system, and for the

aquaponics system, tilapia was added. The experiments were conducted in a greenhouse with six tanks (fish tanks for aquaponics and water reservoir for hydroponics) of 380L during a 90-day period. Economic analysis was conducted on these systems, and then the operating costs and production of the 90-day experiments for a 10-year project period were extrapolated. Financial indices like Internal Rate of Return (IRR), Net Present Value (NVP), Payback, and Benefit/Cost (BC) were calculated considering a 6% annual discount rate. These indices allowed us to analyze the feasibility of each system. First, a comparison was made on the economic viability using the same vegetable price. Then, different vegetable prices were used for aquaponics production because some farms report premiums for their aquaponics vegetables. Hydroponics uses nutrients made of a mixture of commercial fertilizers. In aquaponic systems, plant nutrients are derived from fish waste. Particularly, ammonia is converted to nitrate by the nitrification process mediated by microbes. Some aquaponics facilities are certified for organic vegetable production, which attracts higher prices that can compensate for the higher cost of aquaponics production. The percentage of increase in vegetable prices was calculated that makes the two systems equally profitable.

Results

1) The initial investment in aquaponics was 8% higher than for hydroponics due to the use of aquatic heaters, biomedia and media bag, and dissolved oxygen probe. The cost of aquaponics is 11.6% higher mainly because of consumables for water testing, fish feed, and fingerlings. 2) In both systems, labor is the more expensive item, representing more than 49% of operating costs. 3) Regarding revenues, production of tilapia is ready to be sold every year, while lettuce, basil, and cherry tomato are harvested at different times throughout the year. The lettuce and basil production of the hydroponics system is higher than the aquaponics production. The reason could be as a result of using fertilizers instead of solid fish waste. The yield of vegetables in hydroponics is about 11% higher than aquaponics. 4) Hydroponics and aquaponics showed feasibility in a 10-year production project even using nonorganic prices. For hydroponics, all results show very good financial return on investment. A payback of 3.13 shows that the investment can be recovered in a rapid way. Besides, a positive NPV of almost $74,000 and a Benefit/Cost ratio greater than 1 show that hydroponics is a feasible business. For aquaponics,results from nonorganic prices are worse than hydroponics, although the NPV greater than $20,000 shows that this system would be also economically feasible. This is because the yield of vegetables is lower, the revenue from fish is lower, but costs and investments are high. However, if an increase in prices was considered due to organic production, aquaponics generates better revenues than hydroponics. An increase of 19.7% in vegetable prices makes NPV of both systems equal.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
205	Plant Management Systems
402	Engineering Systems and Equipment
601	Economics of Agricultural Production and Farm Management

Outcome #17

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	68

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Carotenoids are antioxidants, which are considered beneficial nutritionally. The carotenoids lutein and zeaxanthin are found in high concentrations in the macula of the retina of the eye. Recent increases in levels of age-related macular degeneration in the U.S. population may be related to deficiencies of lutein and zeaxanthin in the U.S. diet. Therefore, increasing levels of lutein and zeaxanthin in our diets may be beneficial for eye health. The carotenoid compounds beta-carotene and beta-cryptoxanthin have provitamin A structures that are processed into essential vitamin A in the human body. However, the U.S. population generally has enough vitamin A in their diets, as it can be provided in eggs, meats and dairy products. Nevertheless, some impoverished individuals in the U.S. population may not consume enough vitamin A, with some cases of vitamin A deficiency reported recently, and thus having more provitamin A in the food supply may be helpful to them. The project is focused on increasing the levels of carotenoids in corn grain used as a food source. There are organic farmers that grow non-GMO corn, yet and it can be contaminated by foreign pollen from GMO plants in nearby fields. Thus, there is a need to develop orange corn varieties and hybrids that prevent foreign pollen causing GMO contamination. Efforts will be made to move the same gene that keeps foreign pollen from pollinating popcorn hybrids into the orange corn hybrids.

What has been done
A quantitative trait locus (QTL) mapping study was used to see if there was a correlation in between the amount of orange that showed up in the corn and the amount of vitamin A in the kernel.

Results

The results of the QTL studies suggest that selection for orange color will successfully increase total carotenoid levels in the corn.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
206	Basic Plant Biology
502	New and Improved Food Products

Outcome #18

1. Outcome Measures

HHS 5.1 # of projects related to understanding the impact of new technology, discoveries and innovation on pricing, economics and/or markets

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	8

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Stakeholders have an essential need to better understand how agricultural research systems encourage the development and diffusion of new technologies to help farmers adapt in response to many changes in their decision-making environments. Understanding adaptation is a cross-cutting issue because of the diversity of changes farmers face. Various initiatives at the state, regional, and national level have emphasized the importance of research, Extension, and technology transfer in helping farmers adapt to substantive and diverse changes. Various stakeholder groups have called for research to address several changes that agricultural industries are facing. Issues include: drought, climate variability, and climate change; threats from evolving insect pests, weeds, and pathogens; and demands for new technologies and production practices that are productive while conserving natural resources and protecting environmental amenities, to name a few. Stakeholders recognize that simply developing new technologies is not enough. One must also consider how economic incentives and public policies facilitate or hinder technology adoption. NC-1034 research explicitly examines how public and private research systems identify needs and make innovations available. It also addresses stakeholder-driven needs to measurement of agricultural productivity growth and the contribution of agricultural

research investment to that growth.

What has been done
1) Measured trends, patterns, and sources of agricultural productivity growth. 2) Estimated the net benefits of public and private investments in agricultural research and characterize the nature of those benefits to consumers, producers, and the environment. 3) Examined possible future demands for technology as influenced by changes in population, climate and other environmental factors in addition to estimating the potential benefits of prospective technological developments

Results
Preliminary results from our analysis suggests that development and adoption of drought-tolerant corn, soybean, and wheat varieties can not only help conserve water, but also enhance water quality by alleviating pressure on the extensive margin (reducing the total area planted under a set of market conditions). These spillover effects of drought tolerant varieties have been neglected in past studies and increase the social value of investment in drought-tolerant related R&D. Quantifying the returns of R&D on drought-tolerant varieties is challenging. One particularly difficult challenge consists of factoring in the future impact of drought-resistant varieties in the face of climate change. We simulate future climatic conditions and re-calculate the societal benefits of R&D in drought-tolerant varieties. Our results suggest that returns to R&D in this technology may be drastically higher than those calculated without considering the future impact of climate change.

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
608	Community Resource Planning and Development
801	Individual and Family Resource Management

Outcome #19

1. Outcome Measures

# of coalitions formed by farmers/producers/participants for diversified farming and food systems networking

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The U.S. Agricultural Census has shown an increase in the age of farmers across the country as well as reduced numbers entering into the profession. Indiana is not an exception. In order to stem this trend, it is important that programs be designed to augment networking capabilities for farmers, improve the infrastructure available to support beginning farmers, and increase access to information that is necessary for the success of farmers starting out. The USDA has initiated several programs, including the Beginning Farmers and Ranchers Development, to address this issue. Because beginning farmers and ranchers are younger, more ethnically diverse, and more likely to be female and increasingly come from non-farm backgrounds, it has often been challenging for Extension Educators in Indiana to have the myriad of tools necessary to support them.

What has been done

The Purdue Extension beginning farmer program was developed to fulfill three objectives: 1) Increase infrastructure needed for beginning and military veteran farmers, 2) Improve access to information and support for beginning and military veteran farmers, and 3) Create a community within the state for beginning and military veteran farmers. A series of activities were conducted over three years to support this group of farmers and included: 1) Five out-of-state field trips (Wisconsin, Vermont/Maine, Michigan, New York/Quebec, Missouri/Illinois) where 43 educators were paired with 56 beginning farmers/ranchers in week-long visits to innovative farms producing a diversity of products, exploring on farm research projects with local farmers, and discussing soil health, production practices, farm viability, direct marketing, commercialization, labor issues, pest management, harvesting, packing houses, and government regulations. 2) More than 25 farm tours to innovative and successful small diversified farms across Indiana at different time periods to include farming practices related to spring, summer, and fall. Tours included farmer panels, resources, informational gatherings, and detailed practices of a successful and innovative farm, combining a learning opportunity with hands-on practical experience to encourage improvement in farming practices. 3) Training for 60 Extension Educators on working with beginning and military veteran farmers. The program was able to build a cohort of Extension Educators who were able and willing to meet the needs of beginning and military veteran farmers. 4) Ten regional (Central, Northwest, East, Southwest, and Southeast) all-day workshops for farmers over two years focused on needs of farmers in each region. Topics included farm viability and farm finance, farm safety, how to stay healthy while farming, and Farm Law 101. 5) A farm planning workbook, given to more than 250 participants, is used to assess assets, determine goals, and set concrete steps to get to the vision and mission, and has provided an important resource for both educators and farmers. 6) Two short courses at the annual Indiana Small Farm Conference, on Farm Planning and Farm Viability for beginning farmers. Topics included asset mapping (social, economic, and biophysical), break-out sessions with experienced farmers, case studies with farmer panels, farm planning, resources for beginning farmers, formulating goals for the farm, evaluating farming opportunities, assessing farming limitations, creation of mission and vision statements, financial statements, and good business management practices. Accomplished farmers were available to answer questions or to give testimonials as to how they planned out their farm, set their mission and vision statements, dealt with their financial statements, and set

goals based on their opportunities and limitations. 7) A website with access to information from Purdue specialists and educators.

Results

There are numerous positive results from the Beginning Farmer activities, but the main one has been the momentous change of support being offered to beginning and military veteran farmers across Indiana. New farmers now see Purdue Extension as a valid partner in helping them find resources and information, and are more likely to seek out that support to be more successful. More than 300 people attended the regional workshops. Overwhelmingly participants stated that they: 1) learned something from the sessions, 2) learned things that would help them meet their goals, and 3) planned to use the information to change what they are doing and improve their practices. In all of the workshops, more than 50% mentioned that they felt like the information learned would increase their revenue potential on their farm. Because of the field trips and farm tours, two new farmer organizations were created, the Hoosier Young Farmer Coalition, and the Hoosier Military Veteran Coalition. Purdue Extension has created successful partnering with multiple local, state, and national organizations. The Purdue Beginning Farmer Program has been successful in bringing together many people concerned about maintaining farmers in farming and helping new farmers get started.

4. Associated Knowledge Areas

KA Code	Knowledge Area
604	Marketing and Distribution Practices
805	Community Institutions, Health, and Social Services

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.
Outcome # 2 - Lab and greenhouse research on plants to assess phloem system distribution of nutrients
Outcome # 15 - Pre- and post- evaluation of training participant confidence in and knowledge gain of urban ag practices
Outcome # 16 - Economic analysis of hydroponic and aquaponic methods for vegetable production
Outcome # 17 - Genetic and field research analyses of orange color of grain and indication of carotenoid levels
Outcome # 18 - Economic analysis of agricultural practices for drought-tolerance and for water conservation and quality
Outcome # 19 - Post and follow-up evaluations of beginning farmer knowledge gain, plans for operations, building of networks, and application of recommended practices

Key Items of Evaluation

Outcome # 16 - Hydroponics shows a 3.13 payback on the investment. Aquaponics can generate better revenue than Hydroponics when prices for organic production are considered.
Outcome # 19 - Beginning and new farmers across Indiana formed 2 coalitions to provide structure, support, and networking of agriculture producers

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: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	5.9	0.0	12.3	0.0
Actual Paid	1.7	0.0	7.3	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**
1009049	0	349773	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2120955	0	1543842	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
366488	0	868388	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

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	821	494	0	10

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

Patent Applications Submitted

Year: 2017

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	9	40	49

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of research projects

Year	Actual
2017	31

Output #2

Output Measure

- Number of consultations

Year	Actual
2017	80

Output #3

Output Measure

- Number of education workshops

Year	Actual
2017	13

Output #4

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	CC 1.2 - # Current year climate relevant education programs
2	CC 1.3 - # Current year climate relevant research programs
3	CC 1.6 - # New assessment and management tools developed, including models and measurements of greenhouse gas emissions
4	CC 1.7 - # Climate relevant social media products, web-based products and communication tools
5	CC 1.8 - # New climate relevant databases, monitoring systems, and inventories managed or under development
6	NRE 1.16 - # Projects that incorporate ecosystem services and/or biodiversity considerations
7	GF 1.3 - # Of increased efficiencies (i.e., (% pregnant), or increases in yield/unit (bushels/acre); or lbs. product (meat, protein, milk) per animal; or lbs. feed per gain).
8	NRE 1.1 - # New assessment, management and decision tools developed, including models and measurements
9	FME 1.2 - # of discoveries, innovations, technologies and technology transferred related to understanding the key demographics, decisions-making processes, business relationships and economic situations of retail input suppliers

Outcome #1

1. **Outcome Measures**

CC 1.2 - # Current year climate relevant education programs

Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

CC 1.3 - # Current year climate relevant research programs

Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

CC 1.6 - # New assessment and management tools developed, including models and measurements of greenhouse gas emissions

Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

CC 1.7 - # Climate relevant social media products, web-based products and communication tools

Not Reporting on this Outcome Measure

Outcome #5

1. **Outcome Measures**

CC 1.8 - # New climate relevant databases, monitoring systems, and inventories managed or under development

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

NRE 1.16 - # Projects that incorporate ecosystem services and/or biodiversity considerations

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

GF 1.3 - # Of increased efficiencies (i.e., (% pregnant), or increases in yield/unit (bushels/acre); or lbs. product (meat, protein, milk) per animal; or lbs. feed per gain).

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	278

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Lack of diversity in crop rotations and intensive tillage practices impair both field crop productivity and soil quality. Overall sustainability of corn production in the Midwest can be enhanced via continuing refinements of management systems and by achieving better scientific understanding of the underlying reasons for the genotype environment management interactions as climate, crop inputs or equipment change. Corn production systems are changing rapidly, and cropping systems research can help drive good decision making at the farm level. Previous research findings conclude that modern corn hybrids take up proportionately more Nitrogen (N) following the silk emergence state. This has brought a need to better understand changing dynamics of corn nutrient uptake and how to better match the timing of N application to coincide with better plant uptake. Better corn utilization of N fertilizers should help improve N recovery efficiency and simultaneously, reduce N losses to the environment.

What has been done
The overall goal of cropping systems research was to enhance the agronomic efficiency, resiliency, and environmental sustainability of corn production. Objectives included: 1) assess modifications to no-till practices (e.g., fall strip, vertical, or rotational tillage) for effectiveness in enhancing corn growth while conserving soil quality, 2) assess nitrous oxide (N2O) emissions

associated with integrated conservation tillage and Nitrogen (N) fertilizer management systems in high yield corn production, and 3) improve understanding of corn genetic and physiological factors in achieving greater yield resiliency to drought stress and to higher N use efficiency. Research activities focused on a continuous corn system, assessing tillage treatments (no-till, strip-till, chisel, and moldboard plow), N source effects on N2O emission, and relationships between N2O losses and N recovery efficiency (NRE) and N use efficiency (NUE).

Results
Grain yield averaged 6.5% greater for moldboard plow, compared to chisel plow and no-till. Tillage affected N2O emission in 2 of 3 years, when emissions decreased most for moldboard plow, followed by chisel plow, then strip-till, then no-till. Decreased N2O emissions with strip-till and no-till were associated with per unit increases of N recovery efficiency and N use efficiency. Overall environmental sustainability of corn production systems can be enhanced if soil erosion is prevented, if nutrient losses to ground/surface waters are minimized and if N application can be modified to minimize N2O emissions to the atmosphere. Reaching that goal involves the adoption of integrated technologies taking into consideration combined impacts of changing corn production systems, new products, and new equipment for fertilizer application. If crop input costs were reduced via adoption of strip tillage or other less intensive alternatives to conventional tillage systems before corn, input cost savings could exceed $20 per acre. If that savings could be realized on even half of presently tilled corn fields, cost savings to agriculture would exceed $45 million annually before any additional benefits to society including more atmospheric carbon sequestered, less soil erosion loss, improved water quality and improved sustainability of food production.

4. Associated Knowledge Areas

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

Outcome #8

1. Outcome Measures

NRE 1.1 - # New assessment, management and decision tools developed, including models and measurements

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	49

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Excess nutrients have become a worldwide environmental challenge posing risks to the environment and to human and animal health. Better management of the Nitrogen (N) cycle has been identified by the National Academy of Engineering as one of the major environmental challenges of the 21st century. N in the atmosphere can be a potent greenhouse gas. Projected changes in climate towards more extreme and variable rainfall patterns have the promise of moving greater amounts of reactive nitrogen down major river systems to large water bodies already suffering from low oxygen due to nutrient over-enrichment. N fertilizer is the largest single source (32%) of N introduced in the environment. Current regulation of pollutants in the U.S. has successfully reduced reactive N from point sources like power plants and automobiles. The major remaining N problem is reactive N from non-point sources-especially agriculture. Only 30-40% of N applied to a field may end up in the corn plant, with some portion being held by the soil system, and the remainder released into waterways or the air. The dilemma is how to better manage this N so there is less excess not utilized by the crop or retained as part of the soil system. Critical questions are how best technically to mitigate or control this flow of excess N, what practices or on the ground measures will likely accomplish this in a cost-effective manner, and what institution approaches (voluntary action, invectives, etc.) are likely to be successful.

What has been done

Overall objective was to identify and comprehensively assess alternative policies that would lead to reductions in negative environmental impacts of agriculture, with focus on nutrients, primarily N, on working agricultural lands in the U.S. Specific objectives are: 1) Link negative environmental impacts with alternative policies that are appropriate stimuli for actions well-suited to mitigate environmental impacts. 2) Assess the extent to which existing biophysical knowledge about natural processes and potential interventions are sufficient for economic and policy analysis of alternative approaches to mitigating negative environmental impacts. This includes indentifying gaps and setting priorities of work necessary to allow valid economic and policy analysis. 3) Assess cost effectiveness of policies and actions for technical effectiveness in mitigation and/or control of negative environmental impacts. 4) Identify appropriate institutional approaches to carry out mitigation policies and increasing institutional effectiveness of those concerned with negative environmental impacts from agriculture.

Results

A synthesis of economic and institution issues relating to nutrient pollution from agriculture was provided to policy makers and regulators. Several opportunities helped in sharing this economic information to policy makers: 1) The International Nitrogen Initiative provided an opportunity on a broader stage with international comparisons for both stakeholders and policy makers. 2) Appointment to the EPA Science Advisory Board as Chair of the Agricultural Science Committee provided opportunity to reinforce good practices for economic analysis. 3) Protocols developed in the National Research Council review of the economic analysis of water quality standards for nutrients in Florida. 4) Both EPA and the USDA have continued to consider nutrient pollution in a multi-media, multi-sector context following our recommendations from EPA Integrated Nitrogen Committee. These opportunities make possible the ability to share economic analysis to decision

makers to improve policies focused on reducing excess reactive N from U.S. Agriculture and across the globe.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
132	Weather and Climate
201	Plant Genome, Genetics, and Genetic Mechanisms
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
605	Natural Resource and Environmental Economics

Outcome #9

1. Outcome Measures

FME 1.2 - # of discoveries, innovations, technologies and technology transferred related to understanding the key demographics, decisions-making processes, business relationships and economic situations of retail input suppliers

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Hydro-climatic extremes cause fatalities and billions of dollars in losses to society. Studies that can help understand how to improve the prediction of these high impact events can aid the remedial adaptive/mitigative actions. The global landscape has been experiencing unprecedented rates of transformation through agricultural intensification and urbanization. Representing these human modifications within the natural energetic/dynamics framework for predicting high impact hydro-climatic extremes is an important but poorly understood topic.

What has been done
This research goal was to develop a framework for coupling land transformations and human impact on multi-scale hydro-climatic hazards. Research objectives were: 1) synthesize select past hydro-climatic extremes using a variety of multi-sensor data sets, models, and analyses to

develop a process-scale understanding of multi-scale interactions including the role of coupled land and atmosphere processes. 2) Evaluate improvements in representing regional hydro-climatology by downscaling regional climatic analyses and integration of multisensory observations from in place or satellite sources within land surface models. 3) Assess impact of improved land state and land atmosphere couplings within regional-sale models on simulation of regional precipitation and hydro-meteorology.

Results

First, with a focus on past droughts and heavy rain events over different landscapes agricultural to urban, a drought assessment technique was developed using remote sensing products. Second, satellite remote sensing data and computational models were combined with land surface modeling systems to develop assimilation approaches that integrate land structures (such as agriculture crops and urban structures). The impact of these land improvements on the model outcome of hydro-climatic datasets were evaluated against field observations available as part of the Ameriflux / FLUZNET data set using radar and surface datasets (http://fluxnet.fluxdata.org/about/regional-networks/). Third, crop and urban features were integrated in weather research forecast advanced research version and the hurricane weather research forecast to study coupled feedback for different storm cases and hydrological extreme events. These findings, contribute to the development of scientific understanding and prediction models that can ultimately lead to the overall goal of improved storm-ready and drought-resilient societies. These efforts pertain to a wide range of societal applications, but more urgently toward the development of better prediction pathways and models that can improve predictability of these hydro-climatic extremes.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
132	Weather and Climate
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
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. 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 # 7 - Field studies comparing cropping systems impact on soil health and grain yield
Outcome # 8 - Economic assessment of nutrient pollution from agriculture for decision- and policy-makers
Outcome # 9 - Analysis of historic weather data for enhancing future weather predictions

Key Items of Evaluation

Outcome #7 - Identification of reduced crop inputs resulting in savings exceeding $20 per acre

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: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	11.1	0.0	35.2	0.0
Actual Paid	3.7	0.0	17.6	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
1389135	0	655097	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2189432	0	3165641	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
388898	0	876045	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

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	2734	550	1439	335

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

Patent Applications Submitted

Year: 2017

Actual: 6

Patents listed
9,221,733
9,272,468
9,334,505
CN ZL201080046974.3
2,776,717
9,777,341

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	0	65	65

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

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

Output #2

Output Measure

- Number of consultations

Year	Actual
2017	29

Output #3

Output Measure

- Number of education workshops

Year	Actual
2017	53

Output #4

Output Measure

- Number of volunteers

Year	Actual

2017 10

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	SE 5.4 - # Alternative uses of feedstock identified
2	SE 4.4 - # New production/logistic practices developed
3	SE 4.1 - # New technologies developed
4	SE 5.1 - # Decision tools available
5	FME 2.2 - # of discoveries, innovations, technologies and technology transfer related to performance management of suppliers (retail, commercial, other)
6	NRE 1.15 - # Projects characterizing social, economic, and/or cultural practices
7	Data 1.1 - # of discoveries, innovations, technologies related to improving data, data reconciliation, improving insights, enhancing data collaboration

Outcome #1

1. **Outcome Measures**

   SE 5.4 - # Alternative uses of feedstock identified

   Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

   SE 4.4 - # New production/logistic practices developed

   Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

   SE 4.1 - # New technologies developed

   Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

   SE 5.1 - # Decision tools available

   Not Reporting on this Outcome Measure

Outcome #5

1. **Outcome Measures**

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

2. **Associated Institution Types**

   - 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	9

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Technologies associated with generating fermentable sugars from plant biomass, e.g. pretreatment and hydrolysis, can have immediate and substantial impacts like reducing costs and improving efficiencies for cellulose-to-fuel production processes. Costs associated with cellulose hydrolyzing enzymes are an order of magnitude more expensive than starch-degrading enzymes.

What has been done
The overall research goal is to develop fundamental knowledge of molecular and engineering processes for sustainable conversion of renewable resources to transportation fuels and value-added products that reduce the carbon footprint of U.S. agriculture and industry. Three objectives were: 1) Study the impact of plant cell wall structure on its catalytic or biocatalytic processing into molecules that serve as precursors or end products for use as transportation fuels, 2) Carry out fundamental studies on catalytic mechanisms by which transformations may occur using either enzyme, chemical or microbial (fermentative) catalyst, and 3) Develop biochemical processes for the effective transformation of plant cell tissues into identifiable alcohol, aldehyde, and aromatic molecules. These same bioseparation and enzyme technologies, also were applied to rapid and cost-effective detection of food pathogens.

Results
First, researchers developed an enzyme process that can feasibly convert corn pericarp (outer layer of the kernel) from corn mills to sugars for enhanced biofuel production. This process optimized the chemical conversion of forage-chopped, commercially collect corn stover to a chemical intermediate with potential value for bioplastics production. In a different application, based on similar principles, further development combined enzyme mediated bioseparation processes that detect human pathogens in biofilms found on fresh produce and in eggs and meat.
Second, researchers developed new approaches: 1) a method using an advanced analytical technique to study changes in cellulose structure at a greater level of detail after delignification and related to chemical and enzyme conversion; and 2) a rapid method utilizing bioseparations processing (liquid chromatography) to study and model the binding of enzyme to lignocellulose surfaces before and after pretreatment.
Finally, researchers: 1) Developed a new use for phenolics (biofuel building block molecules that are produced by plants) derived from wood during pulp and paper production as a catalyst for making cellulose nanomaterials in a more sustainable and less costly way. 2) Completed analysis of the economics of integrating a process to remove and recover acetic acid from lignocellulose (lignin and cellulose are primary components of plant cell walls) processing streams in a biofuel facility. This process both enhances the biofuel production efficiency and generates a new product stream for sale by the biorefinery. 3) Used advanced modeling techniques to predict the behavior of complex biomolecules in solution. This technique has the potential to speed up the development of bioseparations technologies for recovering valuable chemicals from plant

biomass that are present in low amounts but could contribute significantly to the economic success of converting lignocellulose to fuels and chemicals. These new methods provide fundamental knowledge that can enable producing renewable and sustainable biofuels and bioproducts.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
402	Engineering Systems and Equipment

Outcome #6

1. Outcome Measures

NRE 1.15 - # Projects characterizing social, economic, and/or cultural practices

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	52

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Electric energy is fundamental to economic activity. Projecting future demand, and understanding the adequacy of generating resources is fundamental to ensuring a reliable electricity supply system with reasonable costs. The State Utility Forecasting Group has been in existence since 1985 when the Indiana Regulatory Commission (IURC) contracted with Purdue and Indiana Universities to develop and keep current a methodology for forecasting the probable future growth of the use of electricity within Indiana and within this region of the nation. (Indiana Code 8-1-8.5).Through the years SUFG has provided analytical support to the Indiana Utility Regulatory Commission on various issues. Recent reports focused on renewable energy and on electricity for Indiana.

What has been done
The State Utility Forecasting Group (SUFG) has been assisting the State of Indiana for over 30 years through its forecasts of electricity consumption, prices, and resource requirements. Purdue researchers developed this modeling system to capture the dynamic interactions between customer demand, the utility operating and investment decisions, and customer rates. In the past

year, Purdue researchers completed economic research in decision analysis and mathematical modeling relating to the use of energy across Indiana. 1) Produced a forecast of electricity demand, resource needs and pricing for the state of Indiana. 2) Summarized the current status of the use of renewable energy in the state. 3) Studied the structure of electricity markets. Report on electricity for Indiana:
http://www.purdue.edu/discoverypark/sufg/docs/publications/2017%20SUFG%20forecast%20final

Results
The forecast of electricity demand, pricing and resource needs was provided to the Indiana Utility Regulatory Commission (IURC), information that will inform their decisions regarding consumer pricing of electricity. A current status report on renewable energy use in Indiana provided to the IURC and state legislature regarding the need for policies to foster the growth of renewable energy use in the state. Research on the structure of electricity markets identified financial transactions allowed under current market rules that are of questionable benefit to electric energy consumers. The model shows increases in demand and costs of electricity in the next decades. In 2021, Indiana would need to be looking for other resources to meet the demand. This report provides decision-makers for Indiana the information needs to help plan for resources supporting electricity use across Indiana.

4. Associated Knowledge Areas

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

Outcome #7

1. Outcome Measures

Data 1.1 - # 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
2017	10

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Water is a focal point of science, economics and policy debates in the western U.S., and a resource of growing concern in the southeast and central U.S. With the depletion of major

aquifers, urban growth in water-scarce areas and increasing demand for environmental goods and services, creative approaches are needed for reallocating water efficiently among competing uses. Without innovation in water management policies and techniques, water-related conflicts between nations, states, agricultural, urban and environmental uses will continue to intensify and expand.

What has been done
The major goal of this economic research is to develop quantitative methods to address emerging water management issues. Dynamic techniques for detecting complex structural patterns in hydrologic data were explored. Evaluations of seasonal and regional trends were conducted for long-term and short-term precipitation, stream flow, and water quality to discern patterns and driving factors indicated by variations and constants in the data.

Results
Results showed linkages among precipitation patterns, historical management, and water quality in the West Lake Erie Basin. Past management practices were implicated, hence the need for further work to quantify impacts in relation to changing precipitation patterns. These economic methods and approaches were shown to be applicable to other areas for detecting patterns and linkages in hydrologic data. Insights gained improve the design of existing tools that empower stakeholders to objectively dissect complex water issues and correctly weigh benefits and costs of alternative options. Policy recommendations can help alleviate water conflicts.

4. Associated Knowledge Areas

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

{No Data Entered}

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 # 5 - Lab research to separate lignan from plant tissue for biofuels and bioproducts
Outcome # 6 - Economic modeling for electric energy use, projecting future demand, and adequacy of resources
Outcome # 7 - Economic research to assess benefits and costs of water management approaches

Key Items of Evaluation

Outcome # 7 - Insights of analysis objectively dissect complex water issues for management policy recommendations

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: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	4.5	0.0	7.0	0.0
Actual Paid	2.7	0.0	12.0	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**
1134541	0	347942	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2138419	0	2274432	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
394243	0	974767	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research-based programs will focus on conducting research experiments and programs emphasizing our key interest areas including detection and control of foodborne pathogens.A wide variety of programs will be delivered to our targeted audiences. Some programs will include a complete development of curriculum, while others will involve the use of readily available programs used in other states and/or available for purchase through different organizations. Our output effort will include:

- partnering with important stakeholders
- ServSafe training
- Good Agricultural Practices (GAPS)
- development of workshop materials and curricula
- conducting workshops
- development of web-based and distance education materials
- working with the media

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

2. Brief description of the target audience

Commercial and local foods producers, including 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

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	8067	416186	4372	29460

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

Patent Applications Submitted

Year: 2017

Actual: 7

Patents listed

2829704
9,363,880
9,408,930
9,539,352
9,546,100
9,651,551
9,750,833

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	3	19	22

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of education workshops

Year	Actual
2017	452

Output #2

Output Measure

- Number of research projects

Year	Actual

2017	24

Output #3

Output Measure

- Number of volunteers

Year	Actual
2017	149

Output #4

Output Measure

- Number of consultations

Year	Actual
2017	3308

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	FS 1.1 - # Viable technologies developed or modified for detection and characterization of food supply contamination from foodborne threats
2	FS 1.2 - # Viable prevention, control and intervention strategies for all food production scales for foodborne threats along the food production continuum
3	FS 3.2 - # Food handlers receiving food safety training and education in safe food handling practices
4	FS 4.2 - # Projects focused on increased safety of any inputs into the food chain
5	FS 1.4 - # Improved prevention, detection, control and intervention technologies adopted
6	GSFH 4.5, 4.7, 4.8; FCS 1.3 - # of discoveries, innovations, technologies that relate to human health (including cancer), nutrition and well-being (including bioactivies and botanicals), chronic Diseases, and impacts of environmental factors on health
7	FS 3.1 - # Growers, producers, and food workers completing GAPs, GMPs, HACCP, food safety certification an on-farm BMP programs to increase food safety

Outcome #1

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
There are major gaps in understanding of how well human pathogenic bacteria persist as members of plant-associated microbial communities and what factors influence their survival. Fungal metagenomic data for fresh produce are lacking, as are datasets that combine both fungal and bacterial communities from leafy greens. Analysis of the community will allow for the identification of changes that are associated with the presence of human pathogens. In addition, the fresh produce industry currently does not have a method to rapidly screen samples for spoilage and/or pathogenic microorganisms that may be associated with the product. Creating a database of BEAM scatter patterns and DNA barcodes from microbes that are associated with lettuce will provide the industry with a means to identify and prevent the distribution of contaminated product to consumers. The research is generating baseline data for the bacterial and fungal communities that are present on lettuce and how this influences the entry and persistence of human pathogenic bacteria into the plant phylloplane. This approach may also identify species that increase or decrease when pathogens are present. These indicator organisms may then be used to predict the presence of human pathogenic bacteria, even if the number of the pathogens is low. In addition, the BEAM technology has primarily been used for identifying specific pathogenic species of interest. The work described here will extend the technology to characterize an entire bacterial community through the production of an extensive library backed by DNA sequence based taxonomic identification.

What has been done
The overall goal of this work is to use next generation sequencing coupled with BEAM, to identify the bacteria and fungi that are present on romaine lettuce. Changes in the microbial communities will be characterized following the addition of bacterial pathogens. This will help establish possible indicator organisms that can be used to detect contamination if present, as well as establish a library for BEAM that can be used by the leafy green industry to rapidly sample products to

determine the spoilage and/or pathogenic organisms present. Objective 1: Develop a BEAM library of bacterial and fungal genera associated with romaine lettuce and validate BEAM as a tool for making taxonomic assignments at the genus level. Objective 2: Determine the effect of lettuce bacterial community composition and spatial distribution on the ability of human pathogens to establish themselves in the community and survive treatment with chemical sanitizers. This objective will also identify organisms that are possible indicators for the presence of human pathogens.

Results
A library of over 600 bacterial strains isolated from various commercial samples of organic and nonorganic lettuce has been established. These strains have been identified taxonomically by sequencing a variable fragment of the 16S RNA gene and are being used to establish a library of BEAM scatter patterns that can be used to identify them when grown in mixed cultures on solid media. Preliminary experiments have been carried out that optimize the next generation sequencing protocols for efficiently characterizing the spatial distribution of these different types of bacteria across lettuce leaves.

4. Associated Knowledge Areas

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

Outcome #2

1. Outcome Measures

FS 1.2 - # Viable prevention, control and intervention strategies for all food production scales for foodborne threats along the food production continuum

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

FS 3.2 - # Food handlers receiving food safety training and education in safe food handling practices

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

FS 4.2 - # Projects focused on increased safety of any inputs into the food chain

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	6

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Arsenic is a naturally occurring metalloid that is toxic to most organisms. It is a contaminant of soils and ground water in many regions of the world, including the U.S. Arsenic exists in two main forms in the environment, as arsenate (As(V)) or arsenite (As(III)), depending on the reduction-oxidation reaction (redox) potential of the surrounding environment. Arsenate (AsO4-3), an analog of phosphate, is the predominant form of arsenic in aerobic soils and aquifers, although numerous other organic arsenic forms exist in the biosphere. In humans, chronic exposure to arsenic causes developmental defects, cancers, cardiovascular disease and mortality in young adults. In addition to being an environmental problem, for which Pteris vittata, a species of fern, can be used to reduce arsenic levels in soils by 6-13%, arsenic is used in the treatment of leukemia and parasitic diseases. Arsenic trioxide, for example, has recently become a drug of choice in treating acute leukemia. Given its unique and remarkable ability to tolerate and accumulate very high levels of arsenic in its tissues, P. vittata is an exceptional system for understanding natural mechanisms responsible for arsenic metabolism, toxicity, and resistance in a multicellular organism, which is the long-term goal of the research. Using this knowledge to reduce arsenic contamination in the food chain is a long-term application of the research project.

What has been done
Two genes that play important roles in arsenic tolerance in the fern P. vittata have been successfully identified and characterized. One gene (PvACR2) encodes an arsenic-specific arsenate reductase, and another gene (PvACR3) encodes a vacuolar arsenic transporter. More recently, a small number of genes have been identified whose expression is up-regulated after treatment with arsenate. The three P. vittata genes that are the focus during the duration of the project include: glyceraldehyde-3-phosphate dehydrogenase (PvGAPDH), glutathione S-transferase (PvGST) and organic cation/carnitine transporter (PvOCT). All three are up-regulated at least 50 fold by arsenate in P. vittata. The goal of the project is to understand their role in arsenic tolerance and accumulation in P. vittata.

The first objective tested the hypotheses that PvGAPDH, PvGST and PvOCT are necessary for arsenic tolerance and accumulation in P. vittata. To test this, each gene was knocked-down in P. vittata gametophyte by RNAi. Arsenic accumulation in the same gametophytes was assessed using scanning electron microscopy combined with energy dispersive X-ray spectroscopy (SEM-EDS). To test whether GAPDH, GST and OCT are sufficient for arsenic tolerance and accumulation, each gene was ectopically expressed in Arabidopsis and the growth and arsenic levels in transgenic plants measured. The second objective addressed the biochemical functions of the proteins encoded by PvGAPDH and PvOCT using a variety of physiological and biochemical approaches.

Results

The major goals of the project were accomplished by demonstrating that PvGAPDH, PvGST and PvOCT are necessary for arsenic tolerance in P. vittata. The expression of each gene was knocked-down by RNAi, then transgenic plants cultured on media either with or without arsenic. The down-regulation of the expression of each gene in the appropriate transgenic plants was validated by quantitative polymerase chain reaction (PCR). Compared to wild type control plants, the growth rate of transgenic plants was severely affected by arsenic. These same genes are being overexpressed in Arabidopsis to see if they are also sufficient for arsenic tolerance in a non-arsenic tolerant plant. Arsenate and the PvOCT and PvGST proteins localize to speckles within the cell, suggesting that arsenate may be safely trafficked through the cytoplasm on its way to the vacuole. Once inside the vacuole, arsenic is sequestered and can no longer cause cellular damage.

4. Associated Knowledge Areas

KA Code	Knowledge Area
212	Diseases and Nematodes Affecting Plants
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 #5

1. Outcome Measures

FS 1.4 - # Improved prevention, detection, control and intervention technologies adopted

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	86

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Natural products are a proven source of agricultural insecticides, herbicides, fungicides and antibiotics, with natural products from Actinobacteria being one of the best. These natural products can dramatically increase yields by disrupting predation or infections and are also used to protect crops in storage. For example, Spinosad an Actinobacterial derived insecticide has sales that approach U.S. $200 million/year and is used on numerous crops. A widely used herbicide is Glufosinate, which is expected to be worth billions in annual sales. It is a synthetic molecule based on a simplified structure of the Actinobacterial derived natural product phosphinothricin/bialaphos. The resistance trait for Glufosinate used in plants also comes from these Acintobacteria. Natural products are also widely used for disease prevention, treatment and weight gain in livestock. Many antiparasitics are natural products from Actinobacteria, including avermectin (yearly sales of over U.S. $1 billion). Numerous ruminant growth stimulants are also from Actinobacteria, such as monensin, lincomycin, erythromycin, and tetracyclines to name only a few. However, many of these antibiotics are also used in human medicine and some have proposed that the spread of antibiotic drug resistance is due to overuse in livestock. This research seeks to replace traditional synthetic compounds and natural products that have suboptimal agricultural properties or are used in human medicine with versions from organisms harvested from relatively extreme environments that will have superior properties in the agricultural setting. As an example, microbes from the ocean produce numerous natural product analogs bearing halogens, which correlates with the fact that halogens are more prevalent in ocean water than on land. This research is pursuing Actinobacteria from the air, captured as spores rather than actively growing mycelia. The organisms isolated from the air are expected to produce natural products that are more stable than their counterparts found dwelling in the soil. Completion of the goals will lead to the discovery of agrochemicals that are derived from nature that are superior to versions currently in use. Natural product based agrochemicals suffer from environmental inactivation, such as light induced degradation. Mining microbes that spend part of their lives in the sky are a promising source of natural products that are significantly more environmentally stable.

What has been done

The overall goal is to find organisms that produce natural products with superior agricultural utility over analogs currently in use. 1) Develop techniques and methods to extract microbes from the air. Car cabin filters are the initial focus, as they are readily available as trash from auto repair shops, and contain microbes from a large sample area. 2) Optimization isolation of microbes and their DNA from the air filter matrix. Comparison of the raw environmental DNA from the sample and genomic DNA of microbes that grow under laboratory conditions will allow us to determine which types of microbes are lost during isolation. 3) Build a library of microbes and characterize their properties in comparison to traditionally isolated microbes. This will address the hypothesis that natural product producing microbes from the air are more hearty and diverse than those isolated from soils. 4) Isolate natural product extracts from the microbes and test them for cytotoxic, antibacterial and antifungal activity. Collaborators will be identified to test the extracts for insecticide and herbicide activity. This will reveal which organisms are to be further pursued for the isolation of individual natural products. 5) Examine individual natural products to determine if

they are superior to currently used versions. Nuclear magnetic resonance (NMR) spectroscopy will be used to reveal how the natural product structures relate to known compounds, and subsequently they will be analyzed for chemical and physical stability.

Results
The team has been successful in recovering microbes from car HEPA filters and are continuing to determine survival rates via DNA extraction and sequencing. Determining survival rates will allow understanding of how well the isolation procedure works and to determine which species are recoverable. Using the current protocol, 370 strains were isolated, 96 of which are from car filters. Genomic DNA exists for each of these strains and natural product extracts from 48 control strains and 48 filter strains. These procedures and strain collections will support the remaining goals. Taken together there has been significant progress.

4. Associated Knowledge Areas

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

Outcome #6

1. Outcome Measures

GSFH 4.5, 4.7, 4.8; FCS 1.3 - # of discoveries, innovations, technologies that relate to human health (including cancer), nutrition and well-being (including bioactivies 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
2017	68

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Over 9 million people suffer some form of foodborne illness each year in the U.Sl alone. These illnesses result in over 55,000 hospitalizations and 1,351 deaths. At the same time, the FDA has been reducing the number and type of antibiotics available for use in livestock and poultry production. According to the CDC, bacteria will always find ways of resisting antibiotics and that aggressive action is needed to keep new resistance from developing and to prevent the resistance that already exists from spreading. The purpose of this project is to harness the antibacterial properties of bacteriophages, natural predators of bacteria, to develop technologies that: 1) reduce foodborne pathogen contamination in agriculture and food processing

environments; and 2) prevent bacterial infections in live animals as an alternative to antibiotics. Taken together, these technologies have great potential to practically and effectively improve animal health while assuring that the U.S. food supply remains among the safest in the world.

What has been done

The primary goal is to develop phage-based therapeutics to limit bacterial pathogens in livestock and food processing environments. The lab focused on 1) Determining if phage-based therapies can prevent diarrheal infections caused by bacterial. Such infections are often predicted to increase with the reduction in antibiotic use in food animal production; 2) Measure the efficacy of phage-based treatments in reducing or eliminating foodborne bacterial contamination in food processing environments; and 3) Comprehensively examine the safety of phage-based therapies in terms of impact on the host (e.g., gut microbiome, deleterious immune responses, etc.), development of phage resistance, and impact of long-term use of bacteriophages as biocontrol measures.

Results

The lab research results indicate that phage therapy, unlike traditional antibiotic therapy, may have minimal impact on the gut microbiome. Likewise, it was shown that phage treatment does not result in strong acute immune responses in pigs. Together, these two findings help to answer outstanding questions regarding phage therapy safety. Other research from the team, however, has shown that bacteria may rapidly become resistant to phages under some conditions. Surprisingly, resistance development may be influenced by the surrounding microbial environment and may be less likely to occur in more complex microbial environments (e.g., ground meat) and more likely to occur in environments with fewer competing bacteria (e.g., egg contents [not shell]). Two key manuscripts were published describing the impact of phage treatment on the gut microbiome in pigs as well as the role phage resistance may play in treatment efficacy. These results were also detailed in a book chapter focused on alternatives to antibiotics in swine production.

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 #7

1. Outcome Measures

FS 3.1 - # Growers, producers, and food workers completing GAPs, GMPs, HACCP, food safety certification an on-farm BMP programs to increase food safety

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	538

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, indicates 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 Extension Educators to deliver the program. In addition to a prepared 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. The training was delivered to over 200 people in 22 counties at 26 events.

Results
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 U.S. 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 were 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 public 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
504	Home and Commercial Food Service
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

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 #1 - Microscopic research on bacteria and fungi on lettuce
Outcome #4 - Genetic research of fern traits tolerant to arsenic
Outcome #5 - Genetic research comparing microbes from air and soil to identify naturally occurring agrochemicals compared to synthetically made chemicals

Outcome #6 - Lab research to determine effectiveness of phage-based treatment of livestock (as compared to antibiotic treatment)
Outcome #7 - Post evaluation of training participant intentions to adopt food safety practices and follow-up evaluation on changes in practices that occurred

Key Items of Evaluation

Outcome #7 - Farmers intended to adopt food safe practices upon completing training; in follow-up, participants reported that they had adopted recommended safety practices.

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: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	1.2	0.0	11.0	0.0
Actual Paid	0.2	0.0	3.5	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**
932716	0	231143	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1972941	0	1316756	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
366829	0	811462	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

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1479	35290	14029	12428

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

Patent Applications Submitted

Year: 2017

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	0	15	15

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of research projects

Year	Actual
2017	18

Output #2

Output Measure

- Number of consultations

Year	Actual
2017	895

Output #3

Output Measure

- Number of education workshops

Year	Actual
2017	360

Output #4

Output Measure

- Number of volunteers

Year	Actual
2017	309

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	CO 3.3 - # Of discoveries, innovations, technologies that relate to how food is enhanced, processed, or prepared that impacts childhood obesity (including sensory qualities)
2	CO 4 - # Of discoveries, innovations, technologies that relate to understanding the causes of childhood obesity
3	# of youth understand the benefits of physical activity
4	# of youth reduce sedentary activity
5	GSFH 4.5, 4.7, 4.8; FCS 1.3 - # of discoveries, innovations, technologies that relate to human health (including cancer), nutrition and well-being (including bioactives and botanicals), chronic diseases, and impacts of environmental factors on health
6	$ value of grants for Community Health Coalitions across Indiana

Outcome #1

1. **Outcome Measures**

CO 3.3 - # Of discoveries, innovations, technologies that relate to how food is enhanced, processed, or prepared that impacts childhood obesity (including sensory qualities)

Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

CO 4 - # Of discoveries, innovations, technologies that relate to understanding the causes of childhood obesity

Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

# of youth understand the benefits of physical activity

Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

# of youth reduce sedentary activity

Not Reporting on this Outcome Measure

Outcome #5

1. **Outcome Measures**

GSFH 4.5, 4.7, 4.8; FCS 1.3 - # of discoveries, innovations, technologies that relate to human health (including cancer), nutrition and well-being (including bioactives 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
2017	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Obesity, one of the leading preventable diseases in the U.S., is associated with 70% of cardiovascular disease cases. Obesity is characterized by increased amounts of fat in tissues that do not normally act as major reservoirs of fat storage, such as muscle. This increased fat storage in muscle, specifically, leads to metabolic changes that disrupt the regular cellular function and increase disease risk. Skeletal muscle dysfunction may be causative in the onset and progression of obesity and type 2 diabetes, disease states that affect more than one third of American adults. Exercise improves obesity, type 2 diabetes and cardio-metabolic outcomes. The benefits of exercise may be attributed to its ability to improve skeletal muscle function.

What has been done
The focus of this study was to determine if acute exercise improves skeletal muscle function in overweight and obese individuals, similar to that seen in lean individuals and determine molecular mechanisms that contribute to the beneficial effects of exercise in overweight/obese individuals. Screened, recruited individuals and completed molecular experiments in skeletal muscle samples.

Results
Findings showed acute exercise is just as beneficial in overweight/obese people as in normal weight people in altering mitochondrial and insulin signaling pathways in skeletal muscle. It also increases cellular response in skeletal muscle completeness of beta oxidation (breaking down fatty acid molecules). Analysis identified several genes that are similarly regulated in overweight/obese and lean individuals, and these may provide targets for treatment of obesity and type 2 diabetes. Findings support that modifications to specific genes are involved in development of obesity and that their reversal is involved in producing the beneficial effects of exercise on obesity-associated disease risk.

4. Associated Knowledge Areas

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

Outcome #6

1. Outcome Measures

$ value of grants for Community Health Coalitions across Indiana

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	1200000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Indiana ranks high for many health issues including obesity, diabetes, and physical inactivity. To address health concerns on a community, state, or even national level, organizations have been coming together to form Community Health Coalitions to address health needs on a larger, broader scale. Coalitions can be a means of conserving and utilizing resources more efficiently, and a powerful vehicle in impacting health though policy, systems and environmental changes. In Indiana, in 2012, Jackson and Lawrence Counties had the highest rates of adult obesity (> 40%). Obesity is linked to negative health outcomes like diabetes, heart disease and some cancers. Regular physical activity and healthy eating can help reduce these risks but, citizens of rural areas and from low-income backgrounds are less likely to have access to recreation opportunities, and fresh and healthy food retail. The seclusion of rural communities restricts the reach of health interventions available in nearby urban centers. Therefore, amenities and services that promote healthy behaviors tend to be primarily available to residents in particular geographic areas. Rural communities often have limited resources (e.g., capital, leadership) which may fuel negative perceptions that there is little support to improve health outcomes or improve health promotion efforts.

What has been done
Purdue Extension plays a major role in connecting the community through partnerships and coalitions to impact health throughout Indiana. Through the work of the Purdue Extension Community Health Coalition Capacity Building Team, Extension Educators are gaining skills and support to work with their local coalitions. Educator involvement with coalitions is happening in over 60 counties, including: 1) 43 reported local coalition accomplishments and activities, and 2) 28 were involved in more than one coalition. The top five focus areas for coalitions were: wellness (38), substance use (23), tobacco (16), local foods (15) and mental health (14). For their primary coalition, 16 (37%) educators reported providing leadership to some aspect of the coalition, and

an additional 12 (28%) reported providing primary leadership or co-leadership of the coalition. With coalitions providing a foundation of collaboration, one example is the project focusing on Jackson and Lawrence County citizens. Healthy Jackson County (est. 2011) and Live Well Lawrence County (est. 2012), are community-based coalitions focused on improving the health of their neighbors by increasing healthy food access and consumption, increasing physical activity opportunities, and offering education and promotional support to improve health. By partnering with Purdue Extension, these coalitions will be positioned to lead sustainable, community driven efforts that leverage existing resources to improve health in their counties. These efforts helped secure a CDC grant to support programming for those communities. Researchers from Purdue University are implementing a model designed to build community leadership and support resources to address local health needs.

Results

Community Health Coalitions are active in 42 Indiana counties, an increase of 10 in the past year. Activities of those counties are at different levels, including: 1) 12% have coalitions involved in health interventions with evaluations in place; 2) 22% are actively conducting interventions; 3) 21% have active coalitions with key partners; and 4) 26% indicated new, stagnant or no coalition in place. Top three ways Purdue Extension involvement enhanced the work of the local coalition were: increasing awareness of community needs, increasing the awareness of the community for an issue, and facilitating the group to work together toward a common goal. Participation by Purdue Extension also increased not only the number of partners but also added to diversity such as police, minority health coalition, job readiness group, parks, and others. Top three ways that participating in local coalitions enhanced Purdue Extension effectiveness included: enhancing the role of Extension in the community, broadening the network of community partners and increasing new partners for programs. Grants were awarded for 21 counties, ranging from $250 to $800,000, with a total over $1.2 million.

For Jackson and Lawrence Counties, five months into the project, great strides have been made to meet coalition goals. In Jackson County, partnerships with schools, food pantries, and the parks and recreation department will improve access to healthier foods for approximately 38,000 young people and their families. That means providing healthier choices in concession stands throughout the county at high schools, middle and elementary schools, parks and community pools, community agencies and summer sports programs. In Lawrence County, the coalition is advocating for new walking trails, active transportation to school, and a farmers market. In both counties, interactive maps highlight physical activity opportunities across the county, and community gardens offer healthy food and education opportunities. Residents in both counties will see new coalition logos that indicate coalition support at community events. With more than a year to go, this initial momentum bodes well for the long-term success of the coalition. The partnership between the CDC, Purdue Extension, and the Jackson and Lawrence County Coalitions has laid the groundwork for a long-lasting, community-driven effort that promotes health. By the end of the funding opportunity, each coalition will have successfully implemented health interventions, established strong leadership, become a recognized and respected community health organization, and built robust community ties. Since their inception, the coalitions focused on low-cost, community supported and initiated interventions that meet the needs of their citizens. As indicated by initial, successful partnerships with local schools, government agencies, and non-profits, the coalitions are positioned for lasting success.

4. Associated Knowledge Areas

KA Code	Knowledge Area
610	Domestic Policy Analysis
703	Nutrition Education and Behavior

806 Youth Development

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

{No Data Entered}

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 # 5 - Lab research on mice for molecular analysis of skeletal muscle breaking down fatty acids
Outcome # 6 - Post evaluations of community health coalition activities

Key Items of Evaluation

Outcome # 5 - Specific genes were identified in the development of obesity

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: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	16.9	0.0	29.6	0.0
Actual Paid	10.2	0.0	31.2	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
1657616	0	691470	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2425828	0	4664557	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
498167	0	925386	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, commercial and individual producers in the local foods value chain.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	112740	3119641	245679	1067932

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

Patent Applications Submitted

Year: 2017

Actual: 6

Patents listed

9,228,154
9,354,237
9,353,072
9,677,065
9,821,055
9,829,482

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	19	209	228

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of education workshops

Year	Actual
2017	8452

Output #2

Output Measure

- Number of community collaborations, coalitions, partnerships

Year	Actual
2017	5460

Output #3

Output Measure

- Number of volunteers

Year	Actual
2017	7838

Output #4

Output Measure

- Number of research projects

Year	Actual
2017	138

Output #5

Output Measure

- Number of consultations

Year	Actual
2017	70431

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	# of youth demonstrate their ability to work effectively in teams
2	# of youth express interest and be engaged in Science related activities
3	# of youth demonstrate a capacity for science process skills
4	# of youth demonstrate leadership efficacy
5	# of key stakeholders engaged and active in community and economic development locally, countywide and regionally
6	NC - # of participants reporting new leadership roles and opportunities undertaken
7	NC - $ value of grants and resources leveraged/generated by communities
8	# of food councils and institutes created to promote practical food systems policies
9	# of participants adopted one or more practices to improve food choices and/or activity levels
10	# of childcare providers who reported adoption of recommended practices for math, science and vocabulary development in children
11	# of childcare providers who reported intention to adopt best practices for nutrition education activities with children, parents, families
12	# of childcare providers reported ability to apply strategies to improve quality of early childhood classrooms
13	# of participants reported plans to apply money management strategies to their personal finances
14	# youth made changes in knowledge and behavior about financial literacy
15	# of participants evaluating new business ventures
16	# of discoveries that relate to human nutrition and chronic conditions
17	# of discoveries that relate to human health

18	# of discoveries that relate to human nutrition and well-being
19	# of technologies that relate to human nutrition and well-being
20	# of youth will see science in their futures and recognize the relevance of Science
21	# of youth will demonstrate responsibility, critical thinking and problem solving skills through informed decision making
22	NC 23 - $ value of organization and/or community-generated volunteer hours (based on Independent Sector hrs. value)
23	# of discoveries of dietary outcomes among food insecure populations
24	% of participants sufficiently active at completion of walking program
25	% of parents indicated they work together with their youth to solve problems that come up at home
26	# of new and existing farmers markets offering, expanding, or improving offering of healthy foods

Outcome #1

1. **Outcome Measures**

   # of youth demonstrate their ability to work effectively in teams

   Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

   # of youth express interest and be engaged in Science related activities

   Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

   # of youth demonstrate a capacity for science process skills

   Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

# of youth demonstrate leadership efficacy

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	1559

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Positive youth development should not be left to chance. Youth today are impacted significantly by their family situation in addition to the influences of school, peer groups and technology.

What has been done
Purdue's 4-H Youth Development programs provide opportunities for youth to acquire skills necessary to meet the challenges of adolescence and adulthood. 4-H Youth Development uses hands-on, research-based educational opportunities that help youth become competent, caring, confident, connected, and contributing members of society. As a result, they are better positioned to become well-rounded and healthy individuals that are able to accept new challenges, expect success, establish and maintain relationships at many levels, and respond to the needs and concerns of others. The Indiana 4-H Program also enhances opportunities for teens to develop their leadership abilities by participating in programs where they learn how to work with younger youth as they serve as camp counselors or teach others about the science of biotechnology and biosecurity. These young leaders are provided with training in leadership, communication, personalities, learning styles, youth development, and team building. This is often paired with Science (STEM), Healthy Living concepts and education.

Results
400 Indiana 4-H teens in grades 7-12 who had participated in 4-H for 3 years or more were surveyed with the following findings. As a result of their experience in 4-H programming, 81% indicated they are respectful of others and are encouraged to volunteer more; 79% indicated a plan to continue working to better their community post- high school while 78% identify themselves as someone who wants to help others. 75% reported accepting responsibility for their personal actions and that they are able to lead groups in making decisions. 73% indicated they stand up for things that are important to them, help make sure everyone has an opportunity to say what they think and that they have the ability to make a difference in their community through

community service. These results for youth participating in Purdue's 4-H Youth Development programs show the leadership traits they are developing to help them become competent, contributing members of society.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #5

1. Outcome Measures

# of key stakeholders engaged and active in community and economic development locally, countywide and regionally

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

NC - # of participants reporting new leadership roles and opportunities undertaken

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

NC - $ value of grants and resources leveraged/generated by communities

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	900000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Competitive grant proposals are an increasing revenue source for nonprofits, educational institutions, and local governmental units. According to the National Center for Charitable Statistics 13.3% of all nonprofit revenues came from private charitable giving, and from government contracts (24%) and grants (8%). For Human Services nonprofits, 65% of revenue came from government contracts or grants. 81% of nonprofits receive some kind of government grant. Many people working in nonprofits and local governments find themselves in positions in which they need or want to write grants but have little or no training to do so. Writers who understand the grant writing process and can communicate their ideas clearly to potential funders can leverage funding to improve the quality of life in Indiana communities.

What has been done

A new and improved version of Purdue Extension's Beginner's Guide to Grant Writing was first piloted in five communities in the fall 2016, and then offered at another eight workshops in spring 2017 across Indiana. A total of 210 participants attended the first year, and programs are on track for almost 300 attendees in the second year. The workshop is two full days of instruction and activities, and geared toward novice grant writers with an idea or a program in mind that will help their community. Participants included staff and volunteers from local governments, nonprofits and educational organizations as well as members of community groups, clubs and concerned citizens who see a need in their communities that they want to help address. Purdue Extension received a private grant for $6,000 to provide scholarships for nonprofit attendees. Several workshops received local community foundation sponsorships. Participants learn how to write effective grant proposals and navigate the grant process. These grant writers learn to develop ideas into winning proposals, identify potential funders and understand the full proposal development, submission and review process. Participants come with an idea and leave with a proposal outline and all the resources needed to expand the outline into a full proposal. Participants return several weeks later for the second workshop day with their full proposal ready for peer review, and they learn strategies for finding funding. Then they have the opportunity to polish their proposals and get feedback from grant writing professionals.

Results

Respondents from the Pilot Fall 2016 cohort 6- and 12- month follow-up surveys plus the Spring 2017 cohort 6-month surveys (20% response rate) show: 1) Participants submitted 46 proposals after attending the workshop, 2) 27 proposals received funding, 3) A combined total of $900,000 in grant funding awarded to attendees since attending the workshop. As a result of the workshop, volunteer actions and investments included: 1) 13 participants undertook grant writing as a volunteer, reporting 351 volunteer hours which totals $8,206 using the Independent Sector value for Indiana ($23.38). 2) Ten participants took on new leadership roles. For the communities and businesses: 1) Five organizations engaged in strategic planning, 2) 35 partnerships were formed, and 5) Three jobs were created. Participants (97%) rated the workshop moderately to extremely beneficial with most (78%) rating it very/extremely beneficial. Participant comments included: 1) ...one of the better workshops I've ever attended. I've always felt that I was a strong grant writer, but this training helped me see grant writing from the perspective of many other organizations and fields rather than just my own. One of the key components I took from this training was the ability to identify short, medium, and long-term goals that an organization should have when pursuing and securing grant funding. 2) If anyone asks please convince them that this workshop is very, very important to many people who wants to pursue a grant but are too intimidated by formal processes and expensive trainings. Your venue, teachers and information were perfect for my needs. Anecdotal evidence also shows that this program helps deepen connections and build positive relationships between Extension and local governments, nonprofits, and community foundations that can lead to future collaboration and outreach for communities across Indiana.

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
805	Community Institutions, Health, and Social Services

Outcome #8

1. **Outcome Measures**

# of food councils and institutes created to promote practical food systems policies

Not Reporting on this Outcome Measure

Outcome #9

1. **Outcome Measures**

# of participants adopted one or more practices to improve food choices and/or activity levels

Not Reporting on this Outcome Measure

Outcome #10

1. **Outcome Measures**

# of childcare providers who reported adoption of recommended practices for math, science and vocabulary development in children

Not Reporting on this Outcome Measure

Outcome #11

1. **Outcome Measures**

# of childcare providers who reported intention to adopt best practices for nutrition education activities with children, parents, families

Not Reporting on this Outcome Measure

Outcome #12

1. **Outcome Measures**

# of childcare providers reported ability to apply strategies to improve quality of early childhood classrooms

Not Reporting on this Outcome Measure

Outcome #13

1. **Outcome Measures**

# of participants reported plans to apply money management strategies to their personal finances

Not Reporting on this Outcome Measure

Outcome #14

1. **Outcome Measures**

youth made changes in knowledge and behavior about financial literacy

Not Reporting on this Outcome Measure

Outcome #15

1. **Outcome Measures**

# of participants evaluating new business ventures

Not Reporting on this Outcome Measure

Outcome #16

1. **Outcome Measures**

# of discoveries that relate to human nutrition and chronic conditions

Not Reporting on this Outcome Measure

Outcome #17

1. **Outcome Measures**

# of discoveries that relate to human health

Not Reporting on this Outcome Measure

Outcome #18

1. **Outcome Measures**

# of discoveries that relate to human nutrition and well-being

Not Reporting on this Outcome Measure

Outcome #19

1. **Outcome Measures**

# of technologies that relate to human nutrition and well-being

Not Reporting on this Outcome Measure

Outcome #20

1. **Outcome Measures**

# of youth will see science in their futures and recognize the relevance of Science

2. **Associated Institution Types**

- 1862 Extension

3a. **Outcome Type:**

Change in Knowledge Outcome Measure

3b. **Quantitative Outcome**

Year	Actual
2017	3853

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

Issue (Who cares and Why)
In the U.S., students are falling behind in science and math education. According to the 2015 Program for International Student Assessment, the average U.S. science literacy for 15 year old students ranked 24th out of 71 countries and math literacy for the same group ranked even lower at 38th out of 71 countries. In order for the U.S. to be competitive in the global market, students need to become excited about science as an interest and a potential career choice. The maker movement, which is focused on creating, designing, and inventing, sparks an interest in creativity, collaboration, and STEM learning. According to Hill, Frances, and Peterson (2015), Maker projects are cut from the same cloth as any other 4-H project. The process of making allows youth to follow their own interests and passions and master a variety of technical skills.Indiana is ranked

in the top 10 of manufacturing jobs, and is listed as number one in manufacturing resurgence. The need to prepare youth in STEM, especially in engineering and technology, is at high priority for not only formal education, but for all educational entities in Indiana.

What has been done

Building over two years, 4-H engaged in creating a 4-H Maker movement across Indiana to expose youth to integrated STEM learning and STEM skill development, to prepare youth for STEM careers and continuing education in the STEM field. Partnership with Toyota Motor Manufacturing Indiana, in Southern Indiana, started the initiative with funding 11 mobile maker kits that could be used to facilitate STEM maker opportunities with pop-up maker spaces in all 11 counties. Following Toyota's lead, Subaru funded nine mobile maker kits in counties surrounding Subaru in Lafayette. Duke Energy and Arcelor Mittal also came on board at the end of the year funding ten and four counties respectively. Creating these mobile maker kits have given educators the opportunity to not only reach more and under-served youth, but also to reach out to a new volunteer pool as well. Part of each grant consisted of training volunteers to lead the programs in each of the 34 counties. Over the last 12 months, volunteer trainings have been conducted prior to kicking off initiatives in each county to create a base for the learning and skill development of the Mobile Maker Kit program. Also each county has hosted a kickoff event in which has showcased the new program and drew in new audiences.

Results

In the first year of mobile maker kits, the number of counties participating in the initiative went from 0 to 34, with more counties interested in starting the program in 2018. Through the use of the kits, youth were exposed to learning in integrated STEM, and 80% expressed an interest in science related activities. 60% of the youth that participated also saw Science as a possible career for their future. Through experiences in 34 counties, educators and volunteers have reached over 3,000 youth, with approximately 1,400 of those youth new to 4-H experiences. In the past year volunteers and educators have delivered over 225 hours of STEM skill development programming which not only develops skill that youth will need in industry, but engages them in exposure to STEM careers. In 2017, 162 volunteers were trained in STEM teaching through mobile maker experiences. This newly trained group, has helped quickly spread the learning and experiences youth can have throughout Indiana in 2017, but will continue to spread that information in the years to come.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #21

1. Outcome Measures

# of youth will demonstrate responsibility, critical thinking and problem solving skills through informed decision making

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	3091

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Food insecurity and hunger issues are prevalent in countries around the world and throughout the U.S. Teens in Indiana may have had little to no exposure to the severity of these issues, how these issues affect them, or how to respond in a positive manner.

What has been done
Indiana 4-H organized a trip for 44 youth and 12 adults from 11 counties to attend the Global Gateway Experience at the Heifer Ranch in Perryville, Arkansas. While on the trip, youth participated in a poverty simulation to help them learn firsthand how a significant portion of the world lives on a daily basis. Youth lived in various global villages such as Thailand, Guatemala, a refugee camp, and the urban slums. The youth worked in teams to prepare an evening meal, given only a portion of the resources they would need. The youth needed to interact with members of other teams to share, barter, or otherwise convince others to allow them to have some of the items they would need to prepare their meal. Prior to this experience 4-H Extension Staff and Volunteers led the youth through team building and diversity exercises to help them better understand themselves and each other. Following the experience, Educators helped the county teams of four youth and one adult to develop county action plans that they can implement in their home communities upon their return home.

Results
Survey results showed: 1) youth (82%) rated their overall experience at the Heifer Ranch as excellent, 2) 85% strongly agreed that they learned valuable information about cultures, 3) 81% can now describe the importance of livestock as a resource for ending hunger and poverty, 4) 86% understand the difference between standard of living and quality of life, 5) 89% can describe the difference between malnutrition and starvation. Over 96% strongly agree that they are now more accepting of different cultures of people. Comments shared by youth participants related to their trip to the Heifer Ranch included: 1) Our cultures differ but we are all people. We could look poor to one culture but very rich to another. People need a chance! 2) The Global Challenge made me back up and look at the whole world differently. It made me feel like I wanted to make a change by helping. I feel like I could make the whole world a different place. 3) It has caused me to see the good in people for what they are on the outside and inside. I no longer judge people and have a more descriptive understanding of our world. 4) I have experienced and learned about the cultures that work together with Heifer. I am willing to listen to others and be open-minded. 5) Hunger is not just around the world. It is also in our community. We don't always know it, but it is there and the little things we can do to change it can have a big impact. In the participating counties, action plans were: a canned food drive, starting a backpack program, donating 4-H

gardening projects, holding a hunger awareness day event, helping at a local food pantry, and offering a food drive competition. Representatives from the Heifer Ranch trip shared their experiences in local 4-H and community meetings and at the annual meeting of the Indiana 4-H Foundation.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #22

1. Outcome Measures

NC 23 - $ value of organization and/or community-generated volunteer hours (based on Independent Sector hrs. value)

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	61400

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Nearly 700 Indiana communities have populations of 25,000 or less. Many are struggling to survive, especially those located some distance away from the state's metropolitan areas. Members of the community 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. HCI was founded on three core values: promoting collaboration among local stakeholders, ensuring inclusion of diverse sectors and demographic groups, and promoting & fostering community buy-in. HCI is an 18-month program to help hometowns take control of their destiny by re-energizing the civic spirit and tackling key issues that are essential to their long-term survival. During phase one, 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 two, 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 the community's physical and natural resource assets. During the final phase, HCI teams work with key partners to propose a Pathway 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. In 2017 across Indiana, 2,305 individuals from communities completed the HCI survey assessing local needs. A total of 247 community forum participants have been involved in the process.

Results

In 2017, 13 Indiana communities have been actively planning, and logged over 2,545 volunteer hours with an Independent Sector value of nearly $61,400. Communities progress at their own pace as they address their community plan. Each project is unique to the community assets, input, and goals. Community efforts can be found here: http://www.indianahci.org/communities/index.php. One example of an HCI community is Rush County. Members of the Rush County HCI group built rushcountybiz.com website which gives current and budding business owners the tools to develop business plans, obtain loans or funding, network with peers, and expand operations. This website includes an inventory they coordinated and compiled with 63 small businesses /agencies that service entrepreneurs and small business. Rush County is supporting entrepreneurs to open new businesses in the community, including youth. Each year Rush County nominates a high school student for the Purdue Entrepreneurship Academy led by Indiana 4-H, a three-day training on Purdue University campus. Rush County is making tools and resources available to these students and other entrepreneurs in the community to support them in launching successful new small businesses.

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development

Outcome #23

1. Outcome Measures

# of discoveries of dietary outcomes among food insecure populations

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Food insecurity estimates are among the highest since monitoring in 1995 (Coleman-Jensen, et al, 2014). Disparities in dietary intake, nutrient intake, short-term and long-term health outcomes are prevalent among food insecure populations including children, adults, and the elderly (previous research and others). Specific sub-populations, such as those living in rural areas, pregnant women, and others may have more dramatic dietary and health outcomes associated with food insecurity compared with other groups and may also be under-monitored compared with the general population. Previous research identified positive association of food insecurity with iron deficiency and inverse association to bone mineral content among U.S. children, establishing the basis for continued monitoring and national intervention efforts to improve iron status and healthy bone development. The federal budget to reduce food insecurity in the U.S. (estimated at 15% of households in 2012), was greater than $114 billion in 2012. Effective budgetary decisions rely on continuous evaluation, monitoring, and evidence-based research to determine the disparities among this population compared with the food secure population and should continue to support programs and policies that improve food insecurity and diet.

What has been done
Research focused on improving the public health problem of food insecurity, a situation of inadequate resources and/or access to food that is associated with immediate and chronic negative dietary and health outcomes. Research goal was to monitor and discover emerging nutritional disparities among food insecure, diverse sub-populations. Specifically to characterize and compare the dietary intake of U.S. sub-groups by food security status, including under-documented national (pregnant females and children) and regional (food pantry participants) sub-groups. The hypothesis that food insecure pregnant females 13-54 years and children 1-19 years from a nationally representative sample and food insecure food pantry participants 21 years or older from a central northwestern Indiana sample will have less appropriate intake of nutrients of concern as outlined by the 2010 Dietary Guidelines (DG) (fiber, cholesterol, saturated fatty acids, K, Na, vitamin D, Ca, and Fe) compared with their food secure counterparts was investigated.

Results
Determined food pantry participants in regional sample of food pantry clients from rural, poor, Midwestern counties were prevalently (78%) and severely (47% very low) food insecure. Dietary quality among the sample was very low, (a score of 44 on the Healthy Eating Index) compared with the general U.S. population (59). When comparisons by food security status among pantry clients were made, low food secure had significantly higher intakes of magnesium, potassium, vitamin A, choline, fiber, caffeine, total fruit, whole fruit, and whole grains compared with very low food secure pantry clients. However, few differences between food secure and low food secure groups were observed. Results for U.S. children stratified by age group determined from a review of the literature found evidence for a strong, consistent, and dose-responsive relationship of food

insecurity with lower vegetable intake compared with food security among children 1-5 years and strong and consistent evidence for high added sugar intake among food insecure children 6-11 years compared with food secure children. Adolescent focused evidence was sparse and further investigation is needed to determine dietary gaps related to food insecurity among this age group. The evidence gained will inform programs and policies directed to improve health and food insecurity in these populations.

4. Associated Knowledge Areas

KA Code	Knowledge Area
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior
805	Community Institutions, Health, and Social Services

Outcome #24

1. Outcome Measures

% of participants sufficiently active at completion of walking program

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	69

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Even though promotion of physical activity has been a public health priority for decades, key U.S. public health agencies, such as the Centers for Disease Control and Prevention (CDC), routinely collect data indicating that most Americans are not meeting physical activity guidelines. Physical inactivity is directly related to the prevalence of adult and childhood obesity, and obesity is a major underlying factor in the development of many chronic diseases. In addition, participation in regular physical activity decreases the risk of coronary heart disease, hypertension, type 2 diabetes, osteoporosis, depression, obesity, breast and colon cancers, and falls in older adults. Being physically active can reduce symptoms of anxiety and depression and improve cognitive function in older adults. There is also strong evidence that active adults have a 30% lower risk of dying from any cause than inactive adults. In 2013, 67% of Indiana adults were considered overweight or obese and less than 44% self-reported meeting physical activity guidelines (CDC, 2013). When physical activity is assessed with objective measures (i.e. accelerometer), the

outcomes are much worse. For example, a 2008 study using NHANES data found that less than 4% of Americans were meeting National Physical Activity Guidelines. Recently, the Surgeon General released a Call to Action to Promote Walking and Walkable Communities (U.S. DHHS, 2015). Walking is an excellent way for most people to increase their physical activity and a powerful public health strategy. Walking is an easy way to start and maintain a physically active lifestyle. Walking is accessible to almost anyone, does not require specific skills or abilities to perform, can be performed alone or with others, and is adaptable. Walking can serve many purposes, can be a way to exercise, have fun, or get to school, work, or other nearby destinations. Importantly, making walking easier can help communities by improving safety, social cohesion, and local economies and reducing air pollution.

What has been done

In collaboration with Purdue School of Nursing, Extension developed an email-based walking program. Get WalkIN spans 12 weeks, with e-mail messages sent to participants twice weekly for the first 4 weeks, and then weekly for the next 8 weeks. These messages target principles of self-efficacy, social support, and goal setting, with the intention of increased walking among adults. Get WalkIN aims to promote increased physical activity through walking in communities by equipping Extension Educators with reliable and shareable information for participants about the health benefits of walking, tailorable walking program e-mail messages, as well as several practical resources guides and strategies for starting and maintaining a walking routine. Extension Educators across Indiana determine start date, recruit participants, and then send email messages to participants according to the program's schedule over a 12-week period. Materials are available in English and Spanish.

Results

Participants in this pilot year, on average, agreed that the emails were easy to read and easy to understand. Participants also reported that the frequency of emails was acceptable and receipt of the emails encouraged an increase in walking. Most participants reported reading the email messages. Participants reported: 1) always reading the emails (63%), 2) reading the emails quite often (25%), 3) reading the emails sometimes (10%), and 4) rarely reading the emails (2%). When asked what features of the emails were most helpful, participants stated: 1) all, and 2) tips on how to incorporate more walking. Participants stated the emails provided encouragement and reminders to increase walking. Participants indicated they would recommend the intervention to a friend. Participants were classified as obese with an average BMI of 30.4. At baseline, participants reported an average of 3.4 poor physical health days, and 4.8 poor mental health days in the past 30 days. Participant physical activity levels were: 1) 15% inactive, 2) 24% insufficiently active; and 60% sufficiently active. At end of the program, participant activity levels changed: 1) inactive increased to 23%; 2) insufficient active significantly decreased to 7%, and 3) sufficiently active significantly increased to 69%. Based on results, improvements and adjustments in program were completed as the program was made available across Indiana. This email-based program can help contribute to increases in physical activity critical to health and reducing obesity and chronic conditions.

4. Associated Knowledge Areas

KA Code	Knowledge Area
805	Community Institutions, Health, and Social Services

Outcome #25

1. Outcome Measures

% of parents indicated they work together with their youth to solve problems that come up at home

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	94

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In Indiana, there are 535,364 youth between the ages of 9 to 14 years old. This age cohort is subject to social and emotional changes, greater academic challenges, and biological changes. They face more academic challenges, seek more independence from their families, and experience increased episodes of sadness or depression which could lead to poor grades, alcohol/drug use, unsafe sex, and other risky behaviors. It is vital for strong family connections to be established, for family values to be communicated, and for youth to be comfortable talking with their parents and family members as these young people seek to resist peer pressures and reduce their levels of stress. Parenting can be a very stressful responsibility, however, high levels of stress that persist for extended periods can negatively affect a child. In Indiana, 11.9% of parents report usually/always feeling stress from parenting. 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. They also are more likely to struggle with depressive symptoms. Over half of Indiana high school students (51.3%) live in a family that argues repetitively, more than a third live in a family that has serious arguments (39.7%), and 39.4% live in a family that insults each other.

What has been done
Purdue Extension conducted community forums in 2015 and residents of Indiana identified a need for programs to strengthen families, and as a result, selected Strengthening Families Program: For Parents and Youth 10 to 14 (SFP: 10-14) from Iowa State University Extension. SFP: 10-14 is an evidence-based parent, youth and family skills-building curriculum that: prevents teen substance abuse and other behavior problems; strengthens parent/youth communication skills; increases academic success in youth; and prevents violence and aggressive behavior at home and at school. In seven two-hour sessions, separate sessions for youth and parents are followed by joint family sessions. Parents learned what it is like to be a current youth, how to love but set limits, develop family rules and establish consequences, encourage good behavior, build

bridges between youth and parents, and protect youth against substance use. Youth learned about peer pressure resistance, reducing stress, finding family values, problem solving, goal setting, and resisting substance use. The joint session allows families to bond by participating in learning game activities, and projects, such as making a family tree and identifying family member strengths, to strengthen communication and problem-solving skills. There were 44 adults and 78 youth who participant in six programs held in five counties during 2016-2017. Program post-/pre-reflective evaluations were completed by 33 adults and 40 youth.

Results

Results showed parents were more often: Trying to see things from my youth's point of view, Letting my youth know the reason for the rules we have, Working together with my youth to solve problems that come up at home, and Following through with consequences each time he or she breaks a rule. Parents were three times more likely to deal with their youth in a calm manner, include their youth more in family decisions, and spend more special time together. Parents commented on their experiences: 1) Getting to know my child a little better and this class was good for us both. 2) I have enjoyed a lot of the skills I have learned when it comes to dealing with or recognizing when I need to listen, cool down, and not lecture. The communication tools have been very helpful. The meals served helped with less to worry about at home for the day. My child and I have benefited greatly by this opportunity. 3) That they are experiencing the same things I am, even though they are teenagers, and I need to remember that.

Youth results showed the greatest increases in: 1) family meetings occurring to discuss plans, schedules, and rules, 2) knowing one step to take to reach one of their goals, and 3) knowing how to do things to help themselves feel better when under stress. The most valuable things youth learned as indicated in an open-ended question were: 1) my mom loves me more than I know. 2) I learned how to handle peer pressure. I also learned how to control stress. I would follow the steps of getting out of peer pressure and I would figure out how to control my stress. I also learned how to know if I have good friends. I would check if my friends would encourage me and not get me in trouble. 3) This was a great program. I learned a lot of things and know listening to my parents and you guys are awesome and I learned not to do drugs. I learned to be respectful and make new friends. If these changes made by parents and youth hold, there will be significant improvements in the time they spend together bonding; communicating; working to achieve individual, family and work goals; and establishing rules and consequences. Close relationships, working toward goals and dreams, and having skills to reduce peer pressure are important elements that help youth resist substance use and abuse. The information learned and shared about each other in families, and skills developed will help strengthen families and arm youth with valuable and much-needed skills. Strengthening Families is showing improved parent and youth interactions, and now going forward, as a result of the Purdue Extension collaborative efforts with and support from Indiana agencies and organizations to address the opioid epidemic, this program will be more widely available to communities across the state.

4. Associated Knowledge Areas

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

Outcome #26

1. Outcome Measures

of new and existing farmers markets offering, expanding, or improving offering of healthy foods

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	28

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Sources of healthy, local produce are important to many community members, especially for those in urban areas and food deserts. Area farmers also need options to market and sell their produce, meats, or other goods. Farmers markets bring together vendors and consumers. Yet, markets need to be properly managed to comply with food safety guidelines, sustain business, and successfully serve the community. Farmers markets will fail and without proper training and knowledge of new opportunities or challenges. Farmers Markets in Indiana have varying levels of governance and structure.

What has been done
Purdue Extension provides professional development training for market managers to offer valuable skill-building education and information to increase market efficacy. One example is a regional, day-long training with information from the USDA and Indiana State Health Department on: 1) how to accept SNAP/WIC at markets, 2) what can be paid for with SNAP/WIC benefits, and 3) how to sign up to accept these programs. Attendees learned about opportunities to improve markets through community partnerships, and about food safety concerns. An open discussion with a panel of county health department officials ended the session. Thirty-eight market managers or volunteers representing 12 local markets attended the training.
Another program example is Market Basket 360, a Purdue Extension Issue-Based Action Team project, with two-day workshops, followed by six, two-hour webinars over the next few weeks to cover more topics and to host speakers from around the U.S. The final in-person session was for market managers to present their annual project to improve their market. A total of 36 learning hours, in addition to out-of-classroom project development were required to complete the certificate. Training topics included: role of the market manager, establishing a mission and vision statement, market governance and stakeholders, developing a team to support your market, developing market policies and vendor applications, communication strategies to manage conflict, avoiding market downfalls and planning for success, earning financial support for your market,

collecting and sharing farmers market data, grant writing and financial management, Indiana licensing and regulations, developing and using an annual marketing plan, and planning for events, entertainment and emergencies. Twenty market managers from around Indiana attended the training and learned about best practices from professional market managers and Extension.

Results

Attendees in the Regional training indicated they gained knowledge on upcoming opportunities, local food bank partnerships, and SNAP/WIC acceptance. Eleven markets indicated interest in applying for SNAP/WIC acceptance. Participants greatly appreciated the opportunity to network with other area markets and communicate with local health departments. The County Health Department representative indicated that this program opened up communication with market masters and vendors, and market managers make contact year round with the Department to ensure compliance with code. Fewer violations have been occurring in area markets. The training also included collecting information for a farmers market guide of all markets and stands in a nine-county area. This brochure is updated annually and now includes an interactive map at www.tinyurl.com/2017fmg.

Market Basket 360 attendees (87%) reported leaving the program with greater confidence about managing their market, and that their participation in the program will make them a more effective market manager. Comments were: 1) Reflecting on the lessons I have learned through the program helped me identify what actions I will take as a result of participating in this program. 2) I am leaving the program with concrete ideas to improve my market. 3) Working and interacting with other program participants has helped me build a support network I can call upon in the future. Six months later, a follow up evaluation showed that market managers had made changes during the 2017 season, they: 1) Created or improved mission and vision statements, 2) Added an event to the season, 3) Established or enhanced volunteer engagement for the market, 4) Reached out for new market partnerships, 4) Invited elected officials to tour the market, 5) Took data on attendance, market prices, consumer surveys, and 6) Added vendors to the market. Sustainable farmers markets have a mission, vision, community support, a board, rules and manager. Training of market managers can enhance the attendance at market, increasing sales for farmers, and value of the market to the community.

4. Associated Knowledge Areas

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

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

{No Data Entered}

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 # 4 - Monitoring evaluation of program offering and participant involvement
Outcome # 7 - Follow-up evaluation of grant training participants for actions taken and grants awarded
Outcome # 20 - 4-H Common Measures assessment of youth science knowledge and interests
Outcome # 21 - Post evaluation of youth participants related to knowledge gained about hunger in our society
Outcome # 22 - Post and follow-up evaluations of Hometown Collaboration Initiative participants for community development
Outcome # 23 - Survey research of food pantry participant nutrition via healthy eating index
Outcome # 24 - Post evaluation of participant self-reported physical activity in email-based program for walking
Outcome # 25 - Post and follow-up evaluation of parents in changes in communication and interactions with their children
Outcome #26 - Post and 6-month follow-up evaluations on knowledge and confidence gained in operating farmers markets; and application of recommended practices for farmers markets

Key Items of Evaluation

Outcome # 22 - HCI communication had $61,400 in volunteer activity for community involvement and improvement

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: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	1.4	0.0	6.7	0.0
Actual Paid	7.0	0.0	33.4	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
1330148	0	1006893	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2313809	0	4292160	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
518072	0	1089827	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

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	62404	388964	63083	47099

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

Patent Applications Submitted

Year:	2017
Actual:	1

Patents listed
2,729,162

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	14	244	258

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of education workshops

Year	Actual
2017	1179

Output #2

Output Measure

- Number of research projects

Year	Actual
2017	240

Output #3

Output Measure

- Number of consultations

Year	Actual
2017	10157

Output #4

Output Measure

- Number of volunteers

Year	Actual
2017	1416

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	NRE 1.2 - # New relevant databases, monitoring systems, and inventories managed or under development
2	NRE 1.11 - # New production/logistic practices developed and tested
3	NRE 1.8 - # Relevant social media products, web-based products and communication tools
4	NRE 1.3 - # Viable technologies developed or modified for detection and characterization
5	NRE 1.4 - # Viable prevention, control and intervention strategies
6	NRE 1.15 - # Projects characterizing social, economic, and/or cultural practices
7	NRE 1.6 - # New diagnostic technologies
8	# new discoveries of species/cultivars for sustainable systems
9	NRE 1.13 - # Projects focused on understanding of the roles of humans, plants and/or animals

Outcome #1

1. Outcome Measures

NRE 1.2 - # New relevant databases, monitoring systems, and inventories managed or under development

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

NRE 1.11 - # New production/logistic practices developed and tested

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

NRE 1.8 - # Relevant social media products, web-based products and communication tools

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	116

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Turfgrasses are estimated to cover over 16 million hectares in the U.S. with an estimated value of $75 billion annually. In Indiana, production and maintenance of amenity turf is an estimated $2 billion industry and includes golf courses, athletic fields, sod farms, commercial lawns and residential turf managed professionally or by homeowners. Turf is maintained under a broad range of environmental regimes with equally diverse budgets and expectations, by individuals ranging from seasoned professionals to inexperienced homeowners. Ultimately turf quality, durability, and vigor are determined by decisions made before (establishment decisions) and after

(management decisions) the turf stand is planted. Establishment decisions often determine the long-term performance of the turf stand. Results of poor establishment are inherited by future managers and may limit the ability to maintain turf without significant expenditures in labor, irrigation, fertilizer and chemicals. Selection of proper specie(s) and cultivar(s) when establishing turf is critical for long-term performance with the fewest possible inputs (Patton, 2009). Improved genetics and changing functional, aesthetic and climatic demands are driving the need for reevaluation of turfgrass establishment and maintenance recommendations for Indiana and the Midwest. Improved winter tolerance of warm-season grasses, new zoysiagrass and bermudagrass germplasm, increased turf quality in turf-type tall fescue, and improved drought tolerance and endophyte-mediated pest resistance in a variety of species are a few of the more recent advancements in this area. Emerging issues facing the turf industry today and in the future are addressed by this project including the following: biological control, carbon sequestration, climate change, nutrient use, organic agriculture, pest resistance, sustainability and water quality. Water use management decisions regarding irrigation, fertilizer use, pesticide applications, and mechanical maintenance practices influence turf quality and vigor on a day-to-day basis. These management decisions carry significant economic costs, raise environmental concerns, and influence the long-term vigor of the turf sward. This research is designed to investigate economically and environmentally sustainable practices for the establishment and maintenance of high quality amenity turf. The overall goal of these research studies and outreach events are to provide fact-based information for managers to preserve and protect the environment by using fewer chemical and cultural inputs while maximizing turfgrass appearance to primarily protect water quality and enhancing our quality of life (e.g. provide healthy, safe recreational turf areas).

What has been done

The overarching goal of this multi-disciplinary project is to enhance the sustainability of managed turfgrass systems by reducing the environmental footprint from inputs and developing novel strategies to maintain persistent turf that provides functional, social, and aesthetic benefits. In working toward this goal, the research and Extension plan broadly focuses on the following two objectives: 1) Identification of turf species and cultivars that require fewer inputs than currently used systems and then refine establishment practices for those species. 2) Refine maintenance and pest management practices that minimize inputs, and optimize management outcomes.

Results

Turf species and cultivars that require fewer inputs than currently used systems were identified and establishment practices for those species were refined. Management outcomes were optimized by refining maintenance and pest management practices that minimize inputs. For example, in the discipline of Entomology, the combined research and Extension efforts provide turfgrass managers and the general public with science-based recommendations for sound insect pest management and are laying the groundwork for the development of environmentally sustainable, next-generation pest management tools useful for managing turfgrass insect pests. The chemical ecology work with billbugs is opening the door for exploiting chemical communication as a way to manage this important pest complex while efforts to understand the biogeochemical dimensions of white grub larval ecology are providing new insights into the factors driving the ecology of soil insects. A peer-reviewed article related to the graduate work of a student who evaluated how turf species and cultivar (slow, medium and fast growing) affecting mowing requirements for lawns in the region was published. For herbicide resistant weed management, an analysis of different populations of buckhorn plantain was conducted (Plantago lanceolate) and a paper was published on the first report of 2,4-D herbicide resistance in turfgrass in the U.S. For improving herbicide efficacy, the team continues to identify and disseminate data related to the importance of water quality characteristics and the influence on the efficacy of the spray application. Efficient use of water in the landscape continues as a high priority. The approach uses both molecular and applied research techniques, such as identifying specific

peroxidases which are closely associated with drought tolerance traits in wild grass species. Finally, the team continues to evaluate germplasm (species and cultivars) for turf species (both warm and cool season) that may be adapted and persist in this cool-humid/transitional climate through active participation in testing programs like the National Turfgrass Evaluation Program, the Turfgrass Water Conservation Alliance, and cooperation/collaboration with various turfgrass breeders across the U.S.
Several major educational events were held including the Indiana Green Expo (>1,600 participants), Turf and Landscape Field Day (>550 participants), Turf and Landscape Seminar (>70 participants), Turf Herbicide Workshop (>120 participants), Lawn Diagnostic Workshop (>40 participants), Turf Equipment Technician Workshop (>20) and well as several other events like the Purdue Pesticide Programs events.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships
104	Protect Soil from Harmful Effects of Natural Elements
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
121	Management of Range Resources
123	Management and Sustainability of Forest Resources
125	Agroforestry
131	Alternative Uses of Land
132	Weather and Climate
133	Pollution Prevention and Mitigation
135	Aquatic and Terrestrial Wildlife

Outcome #4

1. Outcome Measures

NRE 1.3 - # Viable technologies developed or modified for detection and characterization

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

NRE 1.4 - # Viable prevention, control and intervention strategies

Not Reporting on this Outcome Measure

Outcome #6

1. **Outcome Measures**

NRE 1.15 - # Projects characterizing social, economic, and/or cultural practices

Not Reporting on this Outcome Measure

Outcome #7

1. **Outcome Measures**

NRE 1.6 - # New diagnostic technologies

Not Reporting on this Outcome Measure

Outcome #8

1. **Outcome Measures**

new discoveries of species/cultivars for sustainable systems

Not Reporting on this Outcome Measure

Outcome #9

1. **Outcome Measures**

NRE 1.13 - # Projects focused on understanding of the roles of humans, plants and/or animals

2. **Associated Institution Types**

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	88

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Annual economic loss due to invasive species in the U.S. is estimated at over $120 billion, one-fifth of which is due to nonnative invasive plants. In the North Central Region of the U.S., invasive plant control has proven to be costly to land managers. A recent survey conducted by the Invasive Plant Advisory Committee of the Indiana Invasive Species Council (2013) found that in 2012, $5.85 million was spent by public agencies, land trusts, municipalities, and contractors to manage invasive plants in the state. A number of studies have documented that invasive plant species are capable of competitively overrunning an entire ecosystem, diminishing or displacing native plant species, and establishing monocultures of invasive plants. Invasive annual grasses can provide a dense and continuous source of fuel that extends the season for fires and increases the frequency of forest fires. As a result, some wildlife species dependent on native plant ecosystems, including a significant portion of threatened or endangered species under the Endangered Species Act, have been reduced or eliminated. The long-term ecological, social, and economic health of forest ecosystems requires effective prevention and control of the establishment and spread of invasive plants. In order to do so, it is important but not sufficient to focus on specific invasive plant control practices that can be adopted by public and private land managers and strategies to engage the general public to detect and report sightings of invasive plants. More importantly, effort is needed to reduce new introductions and spread of invasive plants into forest ecosystems. Previous studies have shown that the majority of woody invasive plants in the U.S. were introduced by the horticultural sector for landscaping or conservation purposes. Invasive plants are still being sold and new cultivars are being introduced, yet limited research has been done to document how the ornamental horticultural industry perceives invasive plants and the associated impacts on forest ecosystems and what opportunities may exist to reduce the spread of invasive plants from the ornamental horticultural sector. Thus, there is a critical need to assess the ornamental horticultural industry's knowledge, attitudes, beliefs, and behaviors with respect to the production and distribution of invasive plants that affect forest ecosystems in the U.S. and to determine their willingness and capacity to reduce the spread of invasive plants from ornamental horticultural sources into forest ecosystems.

What has been done

The overall goal of this proposed project is to improve the understanding of the ornamental horticultural industry perspectives on invasive plants that affect forest ecosystems in the U.S. and to identify and assess potential strategies for reducing invasive plant spread from ornamental horticultural sources into forest ecosystems. This addresses three objectives which pertain to the overall goal. Generally speaking, within the ornamental horticultural industry most landscaping and conservation plants are grown and distributed by nurseries, whole sale businesses, and retailing stores, although overlap exists among these three types of entities. For this project, the research focus is on nurseries and wholesale businesses.

Objective 1: Assess the knowledge, attitudes, beliefs, and behaviors of ornamental horticultural entities in the North Central Region of the U.S. with respect to the production and distribution of invasive plants that affect forest ecosystems; Objective 2: Determine the reasons for ornamental horticultural entities to engage in the production and distribution of invasive plants (e.g., lack of information, perceived consumer demand, lack of regulation, etc.); Objective 3: Identify and evaluate the opportunities for and barriers to reducing the production and distribution of invasive plants within the ornamental horticultural industry and promoting native plants for landscaping and conservation purposes.

Results

Within the larger context of invasive plant management challenges in the U.S. and the ornamental horticultural industry, it is important to first understand private landowner perceptions of invasive plants, their interest in invasive plant control, and their views on the role of ornamental

horticultural industry in controlling invasive plants. A survey of 1,422 family forest owners in Indiana and Illinois reported moderate familiarity with, concern about, and interest in invasive plant control on and around their properties. They also reported low confidence in their ability to manage invasives but have taken actions to such as inspecting their woodlands, talking to families and other landowners, and removing invasive plants, without much consultation from natural resource professionals. In fact, they had little or no interest in working with professionals. This suggests a need for natural resource professionals to partner with organizations that these forest owners trust and create multi-pronged communication information and strategies to enable these forest owners to manage invasives properly.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
104	Protect Soil from Harmful Effects of Natural Elements
123	Management and Sustainability of Forest Resources

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

{No Data Entered}

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 #3 - Greenhouse and field research of turfgrass systems for minimizing inputs for maintenance and pest management
Outcome #9 - Survey research of private landowners regarding attitudes relating to invasive plant management

Key Items of Evaluation

Outcome #3 - Identification of turfgrass management using environmentally sustainable pest management

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

Childhood Obesity (Outcome 1, Indicator 1.c)	
5139	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)	
24459	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)	
593	Number of new or improved innovations developed for food enterprises.
Food Safety (Outcome 1, Indicator 1)	
15	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.