2018 Purdue University Combined Research and Extension Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

EXECUTIVE SUMMARY

Our Executive Summary continues to be an opportunity to showcase unique combinations of impact statements that don't fit neatly into a single impact statement or outcome. For the past several years, Purdue's College of Agriculture (CoA) has been reporting the 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. In 2017 we 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. 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 the world.

1. SUSTAINABLE INTENSIFICATION OF AGRICULTURAL PRODUCTION

1.1 Fishing Out Bad Chemicals

Purdue University's 2018 Agriculture Research Award, the highest award for the College of Agriculture (CoA), went to Dr. Marisol Sepulveda, professor of ecology and natural systems and associate head of research for the Department of Forestry and Natural Resources. She has made significant contributions to agriculture, natural resources, and the quality of Hoosier lives. In her career, she has published 140 peer-reviewed publications, researched in 30 countries, and mentored more than 50 Purdue students. As an international leader in the area of ecotoxicology and aquatic animal health, Sepulveda and her team have been examining the non-lethal effects of contaminants in the environment. The effects include changes in development such as reproduction and growth. These methods utilize molecular tools to understand how chemicals exert their effects. Recent research results have focused on Per- and Polyfluoroalkyl Substances (PFASs), man-made chemicals that persist in the environment and can cause adverse health effects in an ecosystem. Toxicity reference values for PFASs are being determined in amphibians such as frogs, toads and salamanders to document how the chemicals alter growth, metamorphosis, and survival. These bonds, carbon and fluorine, are indestructible and the strongest bond in nature. It's not known how long they persist in the environment. Unfortunately, they are final products, so bacteria cannot get rid of them and current research doesn't know how to remove them either. A recent study involving zebrafish and atrazine exposed parent zebrafish to atrazine. They discovered that atrazine has lasting effects on zebrafish populations from generation to generation and in a unique way. While the first-generation offspring were unaffected, adverse health effects from atrazine manifested in the second generation. This research shows that some impacts from chemicals can have unexpected results to future generations.

1.2 Tools For Seeing Plant Health Better Than The Naked Eye

An innovative handheld sensor has been built that gives plant scientists and farmers a more precise way of measuring the health of crops. This hyperspectral-imaging device scans a plant for physiological features, such as moisture, nutrient and chlorophyll levels, as well as different chemical spraying effects and disease symptoms to determine if it is healthy or under stress. The device will be able to help farmers

in the field detect changes in plant health before they are visible to the naked eye. The sensor scans a plant in less than 5 seconds and sends the data to a smartphone. The sensor can detect hundreds of bands of color in each pixel (hyperspectral) versus rgb (red, blue, green) camera detection. To make this happen, an advanced image processing algorithm and plant features prediction models, based on years of Purdue research, were integrated into the sensor. This lightweight, easy to use sensor has the capacity to significantly impact crop productivity.

1.3 Big Changes Require Big Data

Agricultural researchers generate vast amounts of data and for many reasons very little of it is shared with peers or is accessible to the public. Solving the world's grand challenges - feeding nearly 10 billion people by 2050, reducing greenhouse gas emissions that cause climate change and ensuring access to clean water - depends heavily upon agricultural research and advances. Individual studies chip away at these issues, but combining data from multiple efforts offers opportunities to produce global change. Sharing results is critical. Currently, the lack of a standardized method of organizing agricultural data makes it difficult to combine the data from many small studies to see the bigger picture. Also, many scientific journals keep data from the public and researchers who cannot afford to access the dozens or even hundreds of journals relevant to their fields. Open data and open access have big implications for how we do science as many farmers want to keep their data private. Purdue researchers worked with colleagues from the Environmental Defense Fund, the U.S. Department of Agriculture's Agricultural Research Service, Washington State University, Texas A&M University, and Agriculture and Agri-Food Canada to develop a data sharing concept. The paper argues for developing best practices for data workflow and standards for federally funded projects, offering incentives to making data not presented in peer-reviewed journals available, coordinating among data networks and repositories, and curating and preserving data for use beyond its original intention. Institutions are in a unique place to begin to bridge gaps between agricultural researchers and data scientists, as well as shift to more of a team science approach that prioritizes data sharing. Building this infrastructure will require coordination among researchers, universities, journal publishers and funding agencies plus lawmakers support for making substantial changes. The final paper was presented to lawmakers in early 2019 on Capitol Hill.

1.4 Purdue Moves: Moving Faster to Find Better Plants

Home to the only field phenotyping facility of its kind at an American university, the Controlled Environment Phenotyping Facility (CEPF) is just one way we are helping our researchers and students gain access to cutting-edge technologies. The goal is to find plants that offer higher yields, better nutritional value, make efficient use of water and nutrients, and can tolerate a range of environmental conditions. Purdue has increased emphasis on research and education in plant biology and building capabilities to assess crop characteristics and performance through automated field phenotyping that will provide measurements to assess plant traits important for both research and commercialization. The work is geared toward discovering improved plants and plant products and moving them through the commercialization pipeline to the world's fields. In addition to providing access to novel phenotyping platforms, Purdue is working with Hewlett Packard Enterprises (HPE) to create a data pipeline at the CEPF and the Agronomy Center for Research and Education (ACRE). The College has joined forces with the HPE company Aruba to mobilize Aruba Wi-Fi and HPE Edgeline technologies in a project that will capture hundreds of terabytes of data daily from sensors, cameras and human inputs. With the help of MicroFocus, a data pipeline is being developed - using such languages as Hadoop, Kafka and PSTL to build a robust data-management platform that will enable us to manage the data generated by the CEPF, ACRE and other data-intensive projects. The end goal for digital agriculture is faster, deeper and more complete research results. The CEPF is also working to establish the automatic communication between the growth chamber control software and the overall logistic control software. The Zegami software has been tested and demonstrated capability in data visualization, and staff are working on the automation of the Zegami operation.

2. RESPONDING TO CLIMATE AND ENERGY NEEDS

2.1 Saving The Central Hardwood Forest

The Central Hardwood Forest is one of the most important forest ecosystems in the eastern U.S.,

harboring high diversity of native species and providing valuable economic and recreational opportunities to the residents of the region. Long-term invasion of exotic plants can alter composition and reduce diversity of these ecosystems, especially those mast-bearing, fire mediated oak and hickory species. Such a compositional change could result in dramatic declines in wildlife population and diminished economic opportunities for the human inhabitants of these largely rural regions. Moreover, forests play an important role in U.S. economy. In the Central Hardwood Forest region alone, over 255,000 individuals are employed in forestry-related jobs. On the other hand, invasive species cost the American public about $1,300 per household each year based on an earlier estimation. Therefore, research on the impact of invasive species on forest health and strategies to remediate the impact will have huge economic implications. The health and longevity of these forest ecosystems are at risk. Our findings, reported in the journal Nature Communications, reveal that relationships between biodiversity and forest productivity depend strongly on climate. Researchers demonstrated there is a positive biodiversity-productivity relationship in dry, especially warm climates. Forests in dry, warm climates show a positive linear relationship between biodiversity and productivity, meaning the forest becomes increasingly productive as more species are introduced. As humidity rises, the relationship changes and productivity rises and then declines as species richness increases. But in areas that are humid, the relationship between biodiversity and productivity curves. Biodiversity and productivity increase together until a point at which more species begin to cause productivity declines. The findings are important for management, restoration and conservation of forests, many of which provide important ecosystem services but are threatened by deforestation, climate change and invasive species. Climate change needs to be considered when making these management decisions. A cool, wet forest today could look much different in the coming decades. Climate change is going to push these forests into a different climate zone, potentially changing the biodiversity-productivity relationship. Climatic variation is an underlying determinant of contrasting biodiversity-productivity relationships (BPRs) observed across a large spatial extent, while both biotic factors (e.g., stand age and density) and abiotic factors (e.g., soil properties) can impact BPRs within a given climate unit. These findings suggest that tradeoffs need to be made when considering whether to maximize productivity versus conserve biodiversity.

3. SUSTAINABLE USE OF NATURAL RESOURCES

3.1 Filling the Pipeline: Transforming Drainage

Indiana gets more than enough water throughout the year to nourish commodity crops, however, that rainfall doesn't always come when crops need it the most. A team of researchers have been participating for more than 15 years on Hatch Multi-state project NCERA-217 "Drainage Design and Management Practices to Improve Water Quality" and a Purdue-led competitive multi-state Transforming Drainage project for the past 4 years. The NCERA-217 team was awarded the 2018 National Excellence in Multistate Research Award. The team has taken significant strides for providing technologies for farmers to control and store excess rainwater allowing them access to much needed water during the hot, rain-free summer months. Controlled drainage, also known as drainage water management, is the practice of using a water control structure to raise the depth of the drainage outlet, holding water in the field during periods when drainage is not needed. Unlike conventional free-draining systems that remove excess soil water to the drain depth, controlled drainage increases water retention and storage within the soil profile. This practice has been shown to be effective in reducing the total drainage volume and associated nutrient loads from tile-drained agriculture, while also providing an opportunity for improved crop yields in certain years. Saturated buffers store water within the soil of field buffers, by diverting tile water into shallow laterals that raise the water table within the buffer and slow outflow. Early results for saturated buffers indicate that they can be very effective for removing nitrate from tile drain water before it is discharged into surface waters by diverting a fraction of the tile flow through riparian buffers as shallow groundwater. As a consequence of the diversion, saturated buffers also help reduce the peak flow in streams, acting as detention structures that delay discharge and flatten the stream hydrograph, although little research has occurred on their potential ability to temporarily store water. Drainage water recycling is the practice of capturing excess water drained from fields, storing the drained water in a pond, a reservoir, or a drainage ditch, and using the stored water to irrigate crops when there is a water deficit. Relative to conventional

drainage, drainage water recycling has two major benefits: (1) increased crop yield resulting from supplemental irrigation and (2) improved downstream water quality. This practice holds great promise within the U.S. Midwest where tile-drainage is prevalent and the crop season can often be punctuated by both excessively wet and excessively dry periods.

4.NUTRITION AND CHILDHOOD OBESITY

4.1 Revitalizing Health Coalitions

Residents of rural areas and from low-income backgrounds are less likely to have access to recreation opportunities, and fresh and healthy food retailers that impact health and well being. Indiana developed active health coalitions--now in 48 counties. In 2012, Jackson and Lawrence Counties had an adult obesity rate over 40%, the highest in Indiana. Both coalitions were motivated to pursue projects and programs but, general support had waned over the past few years. Both coalitions were poised for a revitalization and redirection to pursue policy, system, and environmental (PSE) changes to foster long-lasting health benefits in their communities. To avoid common pitfalls of coalitions and to support a long-lasting coalition that initiates sustainable change, considerable time and resources were devoted to supporting coalition function, partnerships, and leadership. The work of these coalitions provided the context to seek Centers for Disease Control and Prevention (CDC) funding for the health of Jackson and Lawrence County citizens. Community accomplishments for Healthy Jackson County Coalition included: 1) Safety activities: new downtown crosswalks and bike lanes in Seymour, updated and additional crosswalks near schools and public pool in Brownstown, and, purchase of the comprehensive CATCH health promotion curriculum for after-school and preschool nutrition and physical activity programs in Seymour, Brownstown, Medora and Crothersville. 2) Increasing healthy food consumption activities: School wellness policy for over 6,900 students in Seymour, Medora, Brownstown, and Crothersville schools, Farmer's Market SNAP benefit promotion, distribution of healthy food donation guidelines, gardening projects led at youth clubs, healthy concession stands at schools and youth sport leagues for over 32,000 residents and at city recreation facilities for over 76,000. 3) Physical activity efforts: exercise ideas signage on Refuge Trails with 170,000 annual visitors, "walk your city" signage in Seymour with 48,000 visitors per year, and improved crosswalks, bike lanes, and new fitness equipment in Seymour for over 48,000 potential users. Community accomplishments for Live Well Lawrence Coalition included: 1) Safety activities: National Walk to School Day, active routes to school, and reflective paint on crosswalks in Mitchell, complete streets policy in Bedford, and continued work to establish Mitchell as a Trail town. 2) Increasing healthy food consumption activities: school wellness policy for 6,200 students, healthy concession stands for over 6,000 participants, and healthy food pantry donation guidelines for facility with 19,000 people served. 3) Physical activity efforts: established the Blue Jacket Trail for 45,000 residents with 1.1 miles of marked walking trail with signage, online map of trail system, adult outdoor exercise equipment for Mitchell, Judah, Fayetteville, and Springville, and installation of bike racks, benches, and active transportation signage on Main Street in Mitchell. As demonstrated by the reach and leveraged funds, the coalition influence extends beyond the activity and serves as a mobilizer of new people and places to support the health of citizens.

5. FOOD SAFETY

5.1 Smartphone Outsmarts Food Pathogens

Researchers have developed detection technology that allows a typical smartphone to analyze produce for foodborne pathogens such as E. coli O157:H7, which has been linked to a deadly outbreak in romaine lettuce. The technology involves both hardware - a smartphone cradle - and software in the form of an application that is downloaded on the phone. The combination allows the smartphone to be used as an on-site luminometer, an instrument used to measure light. The lettuce or other produce is rinsed with an enrichment liquid containing a modified phage, a virus for bacteria. The phage then infects harmful foodborne bacteria so that when a substrate is added, they emit light, which is detected by the smartphone's camera through the downloaded app and a green dot appears on the screen. The cradle on the phone maximizes the photon collection by using diffusive reflection material to help capture a maximum amount of light, which may not be visible by the naked eye. This technology could be used on a farm or in a food processing factory to provide on-the-spot detection which is critical for rapid detection

when getting safe produce to consumers. The smartphone technology, coupled with the phage, helps reduce the typical amount of time it takes to test food samples for possible foodborne illnesses. The current process involves gathering a physical sample and then shipping it to a lab and waiting several days for the results. The special phage used with the smartphone technology was developed by a Purdue professor, Bruce Applegate and is being commercialized by Phicrobe, a Purdue University-affiliated startup founded by Applegate.

6. EDUCATION AND SCIENCE LITERACY

6.1 Interactive SPECA Grant Impacts Kids' Dairy Knowledge

A unique Purdue partnership with Indiana Agriculture in the Classroom (AITC) program reached high school age audiences through the development of interactive learning modules that can either be used by AITC volunteers, or teachers that want to use agriculture as the context for teaching science concepts. The decreasing number of people engaged in agriculture has resulted not only in a decrease of understanding of agriculture's role in everyday life, but also a deficit of people seeking employment in food, agriculture and natural resources. A study commissioned by NIFA in 2015 found that there will be a 41% shortfall of US graduates for projected jobs available in the agricultural sector between 2015 and 2020. The National Academy of Sciences, in their publication Transforming Agricultural Education for a Changing World recommended that "Colleges and universities should reach out to elementary school and secondary school students and teachers to expose students to agricultural topics and generate interest in agricultural careers." Eight online modules were developed that can be used either independently by students, or as part of a planned educational program, to increase student knowledge of career opportunities in the dairy industry, and the science of dairy production. The modules were easily accessible by non-agriculture teachers through the Teacher Resources tab on the Agricultural Sciences Education and Communication website. Approximately 165 students participated in a pre-test/post-test design study showed an increase in knowledge about dairy product production.

6.2 The Nature of Teaching K-12 Teacher Workshops

Youth are spending less time outdoors compared to previous generations. Since youth spend much of their time in school, school teachers have a good opportunity to provide beneficial time outdoors to their students. Unfortunately, there are perceived barriers to taking students outside including not having access to outdoor space, no curricula, lack of time, having to adhere to academic standards, and not being knowledgeable about nature. A Purdue Extension team created the Nature of Teaching workshops for K-12 teachers to provide natural resource and standards-based curricula that is easy to use in natural settings in and around schools. The workshops provided training to 329 teachers in Indiana/Maine (292), Wisconsin (7) and Missouri (30). Post-workshop surveys overall showed an increase by teachers in knowing the connection between nature and food waste, feeling confident incorporating food waste into a curriculum, how to utilize the outdoors with students, and increased confidence including nature topics such as health and wellness and wildlife topics. The good news is that more students in these states are more likely to be exposed to nature topics and spend time outdoors, even for brief amounts of time, to enhance their classroom experience.

6.3 The Marriage of STEM and FANR (Food, Agriculture, and Natural Resources)

This project developed formal partnerships and engaged K-12 teachers and students to learn agricultural topics and to develop interest in agricultural careers. Significant progress was made on all 3 objectives of the project: 1) develop teachers and Teacher Professional Development (TPD) model includes teacher leaders; 2) engage teachers and students with integrated and immersive place-based STEM learning experiences; and, 3) develop a local land-grant model of teacher professional development for integrated agricultural STEM education. Highlights from the first objective are reported here. The team developed a year-long TPD program to increase STEM teaching capacity. Nine teachers from three high schools were recruited to participate in a year-long TPD. The TPD was a one-week immersive learning experience at Pinney Purdue Agriculture Center (PPAC) and engaged teachers in pertinent topics, such as introduction of integrated STEM through FANR, introduction of hydroponic and hydroponic design challenge, integrated STEM through biology, physics and chemistry that related to a hydroponic design challenge. The three

teachers representing LaPorte High School were an agriculture teacher, physics/chemistry teacher, and communications and special education teacher. Four teachers from South Central Junior and Senior High School included two middle school mathematics teachers, a high school biology teacher, and an agriculture teacher. Two teachers representing Westville High School included an agriculture teacher and a biology teacher. These teachers worked as a team learning the concept of integrated STEM through FANR, and brainstormed the idea of how they could work as a team to co-develop and co-teach the integrated STEM through FANR curriculum. The training was delivered by several faculty from Purdue University and two scientists from the PPAC, representing Agricultural Education, STEM Education, Agricultural Engineering, Physics, Chemistry, Horticulture and Hydroponics, and Engineering Design. Five professional learning community (PLC) meeting guidelines were created to provide support for teachers to implement what they learned in the TPD. Teacher outcomes from the workshop were positive. All the teachers agreed they: 1) planned to make changes to their instruction; 2) had a better understanding of how to implement an integrated STEM/FANR unit; 3) identified potential barriers that would keep me from effectively implementing an integrated STEM/FANR unit; 4) were more confident in my ability to use integrated STEM/FANR curricula in my classroom; 5) believed integrating STEM/FANR in my classroom will help me become a better teacher; and, 6) were more open to try innovative teaching strategies. Upon completion of the TPD workshop, all of the teachers agreed (quite-a-bit and absolutely) they valued the benefits of interdisciplinary work. Moreover, all of the teachers agreed (quite-a-bit and absolutely) developing the integrated STEM/FANR unit would be valuable to students, their school, and to the teachers personally.

7. RURAL PROSPERITY/ RURAL-URBAN INTERFACE

7.1 Small Farms Make Big Impact

Small farms, based on area (acres), are significant in Indiana. Many are beginning farmers with limited knowledge of basic agricultural practices and limited connection to traditional farming communities and organizations. There is also an increasing number of commercially significant small-scale and diversified farms supplying to the local food systems in communities and regions across Indiana that want educational and networking opportunities. Purdue Extension's Indiana Small Farm Conference supports networking, educational activities and peer-to-peer interactions to develop and strengthen relationships and knowledge. Follow-up survey respondents found the following conference activities "very useful": 1) meeting other small-scale farmers (59%), 2) organized sessions (58%), 3) overall conference (57%), and 4) meeting agricultural professionals and educators interested in helping small-scale farmers (56%). Returning attendees from the 2017 conference said they had applied what they learned to their farm or operation in the nine months following the event. Most respondents (64%, n=71) had used information learned at the conference to help them start a farm or improve their farm operation. Many respondents (61%, n=68) had applied ideas learned at the conference to their farm operation. Some respondents (39%, n=43) reported using the information learned at the 2017 conference to develop or make changes to their farm business plan. In all of these, a few respondents (24% to 26%) indicated that these practices did not apply to them, as they had not started or operated a farm in the nine months following the conference.

7.2 Helping Rural Businesses Compete in the Digital Economy

Purdue Extension, in partnership with the Purdue Center for Regional Development (PCRD), is providing critical information and technical support that is designed to expand broadband access and adoption by rural households, businesses and rural communities in Indiana. Over the past year, the Purdue Extension and PCRD partnership has realized a number of significant achievements. First, the team completed one of the most extensive studies ever conducted on the benefits/costs of providing broadband to rural households in Indiana. It is this study that prompted Indiana Governor Holcomb to pursue a $100M investment to expand broadband to unserved areas of the state. Second, in-depth state of broadband reports produced for four regions (encompassing over 24 counties), resulted in formation of broadband task forces working to address gaps in broadband access and utilization in targeted geographic areas of Indiana. Third, Extension and PCRD have teamed up with the Indiana Office of Community and Rural Affairs to develop and implement $45,550 in Rural Broadband Planning Grants for five communities.

Extension also secured a $65,000 USDA grant to provide and support training and technical assistance for businesses in three counties to implement digital strategies. Fourth, with Digital Ready Business helping small Indiana businesses and entrepreneurs expand their online presence, knowledge gained by participants exceeded 90% for all eight curriculum modules, including business intelligence, email marketing, planning a website, and social media analytics. Likewise, more than 75% of participants reported they were likely/very likely to apply knowledge learned.

8. EMERGING TRENDS/ISSUES

8.1 Flying The Agricultural Skyline

Purdue research and Extension staff are leading the way in unmanned aerial vehicles ((UAVs) technology outreach in Indiana. This rapidly growing technology has the power to revolutionize agriculture. As with any new technology, there is a wide range of issues to address including regulations for aerial applications of chemicals, air traffic control issues and the simplest of issues--how to fly without crashing. After flying is complete and data is collected, a new set of issues and opportunities arise including what to do with all the data, how to protect private data, and how to leverage this data to make farming decisions. Purdue Extension is training and equipping 17 Agriculture and Natural Resources Educators to fly UAVs over crop fields across Indiana. These efforts include 1) identifying best flight practices and camera settings that maximize the quality of images and videos captured with UAVs, 2) comparing the relative merits of standard RGB-based imagery from consumer grade UAVs versus multispectral imagery from higher-end UAVs and sensors for identifying problem areas in fields or comparing treatments effects in field trials, 3) comparing the relative merits of individual images/videos versus stitched whole-field images for identifying problem areas in fields or comparing treatments effects in field trials, and 4) developing crop decision-making strategies that utilize UAV imagery and videos. By word of mouth, people in the community are hearing about the UAVs and seeking out Purdue Extension. Many have been using UAVs (maybe without a license) and others are interested in applying the use of UAVs to their business/organization. Some examples include police, emergency management, Office of the Indiana State Chemist (investigators are now getting trained to use UAVs in their work) and real estate.

8.2 Navigating Complex Land-Use Issues For Better Community Planning

The Conservation through Community Leadership (CCL) program serves as a roadmap for communities tackling complex land use and natural resource management challenges. Following discovery activities, the community planning process results in a local or regional action plan and strategies for implementation projects for use with invasive species management working groups, county or municipal comprehensive plan updates, watershed management plans, and fundraising initiatives for specific projects. Curriculum materials were finalized by Extension in 2018 and pilot programs were delivered in Dearborn County Soil and Water Conservation District and Owen County Soil and Water Conservation District. In Dearborn County, 26 participants completed an education and visioning session and received coaching for completing their land-use action plan. Feedback showed 83% reported the process was useful or very useful for making decision about their community garden effort, 91% reported the process was useful or very useful to take actions for the next steps in their community garden effort, and 88% reported the program was excellent for making connections to resources to implement their action plan activities. Owen County launched a Cooperative Invasive Species Management Area (CISMA) action plan. Feedback at the conclusion of Owen County's planning revealed: favorable or very favorable response that CCL increased confidence in ability to plan for the new invasive species collaboration efforts, favorable or very favorable response in desire to get involved, or increase involvement, in the new invasive species collaborative efforts, better understanding of the natural resources issues facing their community, and plans to apply knowledge gained and tools within six months. Several counties will offer the program in 2019 - Putnam, Tippecanoe, Starke/Pulaski, Daviess, Randolph, Fountain, and Madison.

8.3 Expanding Workforce Development

Across all program areas, Purdue Extension is focusing on workforce development training, and expanding capacity and opportunities. Industry leaders have communicated that they are looking for training for new hires. One effort to address that stakeholder feedback is the reintroduction of short courses in the agricultural and green sectors. By connecting with the Indiana Department of Workforce

Development, Purdue Extension has received approval of two courses recognized for the state Employer Training Grant program. In this program, Indiana employers can receive grants to pay for the training their employees complete (https://www.nextleveljobs.org/). More Extension short courses and other programs are under development. In another approach a 2018 a pilot program called INWork - INnovate, INvest, INspire - Skills for Tomorrow's Workforce was delivered to high school students and young adults. The program provides instruction on life skills necessary to increase the number of qualified applicants for Indiana job openings. Sessions include: SMART goal setting, decision making, personal accountability, professional dress, teamwork, problem solving, conflict resolution, time management, safe and professional social media, fiscal literacy, career exploration, preparing resumes and cover letters, and interviewing. INWork was piloted with community probation programs. In some communities the program was made available to Jobs for America Graduates funded through the WorkOne program. Extension joined forces with local educational institutions to offer the program. There were 386 youth that completed the program offered in 9 counties. Results of the training included: 97% of youth have thought about pursuing post-secondary education, 92% recognized the importance of being on time to work, being trusted by their employer, doing their job well, and to respect others in the workplace; 66% of youth reported understanding the importance of having a professional image on social media. For careers, 81% successfully explored career options, 62% of the surveyed youth identified jumping into the workforce as another viable option within the first year of high school completion, and 61% were able to identify a career that they would like to pursue. The development of these skills and aspirations of youth will help contribute to the future workforce in Indiana. This training program in 2019, will take on a broader reach as Purdue Extension expands this into a work-ready program.

8.4 Enhancing The Value of Public Spaces: Creating Healthy Communities (EVPS:CHC)

Enhancing the Value of Public Spaces: Creating Healthy Communities (EVPS:CHC) was developed by a multidisciplinary Purdue Extension team from Health and Human Sciences, Nutrition Education Program, Community Development, Agriculture and Natural Resources, and Illinois-Indiana Sea Grant. Using EVPS: CHC, facilitators coach communities through the development of a high-quality action plan for their public spaces. The plan can guide decisions and better position communities to take advantage of opportunities to promote healthy eating and active living. The Indiana-based curriculum is designed for use by decision-makers and local leaders who have oversight and management of community public spaces, such as parks boards and plan commission members, public officials and their staff, and members of organizations whose missions relate to services, programs, or management of public spaces. The program combines data collection and analysis with inclusive public deliberation to design high-quality action plans toward meaningful, sustainable improvements for public spaces focused on community health. Using a science-driven, participatory approach, this curriculum includes applications of community design coupled with information resources, case studies, and strategies to enhance food access and active living through community-based programs and improvements to public spaces. The goal is to strategically guide policy, systems, and environmental changes relevant to how high-value public spaces promote healthy communities. As a result, communities that are prepared with a public spaces action plan can boost economic development, improve the quality of life, and create a healthier place for individuals and families. The program was piloted in three communities (Gaston, Connersville, and Terre Haute) in the spring/summer. All three communities completed the development of action plans. Delaware County focused on working with the town of Gaston to develop a public spaces action plan for use with the development of a new community center, trails, and community wellness activities. The action plan in Connersville in Fayette County focused on integrating health and wellness into several community initiatives such as downtown public space revitalization, and contributing to a comprehensive update of the city plan. Efforts in Terre Haute in Vigo County are supporting the completion of an updated parks and recreation master plan for the Department of Parks and Recreation.

9. DIVERSITY

9.1 Extending Extension

Purdue Extension is restructuring its approach to urban agriculture programming, sharing experiences and offerings and working together to share resources across locations. Programs will move beyond local

impact and build into a model of broad topics to create more inclusive, diverse and equitable programs. Leveraging a three-year SARE grant, Purdue Extension is working with many black and other minority urban farmers in Lake County (City of Gary) and a network of farmers is growing. Bringing them together with urban agriculture in Marion County (City of Indianapolis) has resulted in shared information, and now field trips to Cincinnati and Detroit are planned for 2019 to build more connections. The Indiana Small Farm Conference, https://www.purdue.edu/dffs/smallfarms/, has been an annual opportunity for many interested in farming, gardening, and local food to gather and learn about agricultural practices, and business and marketing approaches. In 2018, conference participants made recommendations that are being incorporated into Extension programming activities. The Indiana Farmers Union has been in existence for quite some time, but has experienced a resurgence in leadership for Indiana. Participants of the Purdue Extension 2018 Beginning Farmer tours formed the Hoosier Young Farmer Network. Recently, urban farmers/gardeners in Indianapolis created the Indiana Black Farmer Cooperative to connect urban farmers and share resources. Purdue Extension has supported local food summits which bring those interested in agriculture together to focus on assets, needs, and opportunities for the community. Across Indiana, farmers are collaborating and advocating, finding their voice and expressing what it is they want, and creating opportunities.

9.2 AgDiscovery Camp Prepares High Schoolers for College

In its second year, the 2018 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 USDA Agriculture Research Services (ARS). This two-week program allowed 25 high school 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 United States. Ag Discovery students with strong academic records, 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 (PASA). Students accepted into either program can receive a partial scholarship to further explore a particular discipline in veterinary medicine and or agriculture sciences. Rising 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.

9.3 Promoting Health and Well-being of Latino Youth

Adolescents can be vulnerable to mental health problems, and this appears especially so for Latino youth in the U.S. Also, Latino youth in rural communities remain woefully understudied and may be particularly vulnerable to health disparities such as poor mental health. Additionally, identifying protective factors that have potential to mitigate the magnitude of the stress response may reduce the probability of experiencing mental health problems during adolescence. Mitigating consequences of such challenges, and fostering systems that promote positive mental health, may be one of the most significant ways to promote well-being and long-term success of Latino youth. Results of a study with Latino families with a fifth-grade child living in the Midwest suggest that effortful control (a resilience factor which is related to self-regulation of emotional reaction or behavior) may help counteract contextual risks commonly experienced by Latino youth. The study of ego-resiliency (how individuals adapt to environmental stressors, conflict, and change), showed that a supportive family (resilience factor) helped youth develop stronger ego-resiliency and reduced incidence of depressive problems, and, this persisted over time, suggesting it may have long-term effects on reducing depressive problems in Latino youth. Researchers studied the cortisol awakening response (which is an increase in production of the hormone cortisol within 30 minutes after awakening, and believed to be a preparation for stress for the day) of the hypothalamic-pituitary-adrenal system in 119 preadolescent Latino youth and found that youth with both stronger cortisol awakening response and

effortful control, had fewer depressive programs. Hence, physiological processes and individual resilience traits were shown to help counter depressive problems in Latino youth. These results may have a positive impact on public health issues relating to Latino youth through informing policy and directing future intervention efforts targeted at reducing stress and health disparities in this population.

9.4 A Catalyst For Diversity: Office Of Multicultural Programs
The College of Agriculture's Office of Multicultural Programs (OMP) continues to find innovative ways to increase recruitment and retention of undergraduate and graduate student enrollment in the college through strong partnerships with all eleven departments and other colleges on campus. A partial list of accomplishments includes: Membership of the National Ag Diversity Council -- increasing diversity and inclusion throughout agricultural higher education and industry.
We have 208 underrepresented minority (URM) undergraduates and 48 URM graduate students. URM enrollment is up 28% since 2013, with 57 new undergraduates and 8 new graduate students in 2017-18. 59% of our undergraduates are women. Our college has 26 Emerging Leaders Scholars whose leadership potential is being encouraged. Our Communicating Across Cultures course broadens multicultural awareness and better prepares students for careers and participatory citizenship. Our college is home to 9 Diversity Catalyst faculty.
OMP administrators are certified in important training and evaluation tools used to improve the cultural conversations and evaluate progress toward our goals. These include: Intercultural Development Inventory, Belief, Events and Values Inventory, Attitudes, Skills and Knowledge Short Scales, Cultural Intelligence. We collaborate across campus with groups such as Asian American and Asian Resource and Cultural Center, Black Cultural Center, Disability Resource Center, Latino Cultural Center, LGBTQ Center and the Native American Educational and Cultural Center.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	78.2	0.0	273.2	0.0
Actual	71.8	0.0	231.0	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 2018, 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. In addition to the Field Days, the PACs host a wide variety of workshops, tours and trainings. From October 2017 to September 2018, the PACs held more than 150 activities and hosted almost 10,000 visitors. Topics ranged from forestry, to turkey markets, to bull production and countless numbers of teachers learning more about agriculture. 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 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 2018:
Workforce Development -- The Purdue College of Agriculture Dean's Advisory Council (https://ag.purdue.edu/Pages/dac.aspx) is comprised of individuals who represent the breadth of the food, life sciences, agriculture and natural resource system. Council members come from across the state (and beyond) and have a wide range of occupations and professional/personal backgrounds. The diverse expertise and capabilities of our Council members ensure that many perspectives are heard as we address the challenges and opportunities of an increasingly global economy and agriculture industry. During the spring 2018 Council meeting, a focus group was conducted on Extension and agriculture. Input from these Council members identified that workforce development was needed for professional skills, not on technical skills. Recommendations were for the College of Agriculture and Purdue Extension to incorporate professional skill development into training programs. Purdue Extension has also been connecting with agriculture-related industries to ask about their needs for employee training. For example, in a discussion session with industry leaders on workforce development, Purdue Extension received feedback that employers did not need technical training for their employees, but managerial and leadership training for managers to reduce turnover.
Mental Health -- Purdue Extension partnered with the Indiana Rural Health Association and the AgrIInstitue for three regional opioid symposium events in Indiana in 2018. https://www.indianaruralhealth.org/irha-and-agriinstitute-opioid-symposium-events. These events led to discussion of current understanding about the full spectrum of issues and services relating to substance abuse. Topics were on the current drug situation in Indiana, legal issues, healthcare, treatment, behavioral health, mental health, job skills, transition training, return to work, skill development and other issues. Attendees were from many community sectors, from agencies, organizations, employers, police departments, emergency management, healthcare providers and professionals, school personnel, faith-based leaders, farmers, and concerned family members or friends. This holistic structure of the program helped attendees understand the complexity of working with substance abuse for communities and employers, and the breadth and depth of

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.
Workforce Development -- Through the reintroduction of the short course in the agriculture and green sectors, Purdue Extension is looking ahead to ways it can help Indiana work better. Efforts in 2018 allowed for the first two courses to be created in 2019 to address controlled environment agriculture and landscape management. Others are under development. In 2019, Purdue Extension will be piloting a program, Becoming the Employer of Choice, for farm managers. Course instructors will be from University of Wisconsin Extension, which developed the program, but Purdue Extension Educators will be trained to facilitate in the future. Attendees will gain effective and practical approaches to managing human resource challenges on the farm. There are seven modules addressing how different leadership styles are used on the farm; reducing mis-hires and turnover through hiring best practices; learning about organizational culture and how it impacts employee motivation and engagement; identifying keys to create a motivating environment; learning how to effectively communicate expectations to employees; developing skills to provide effective feedback; and learning ways to address and work through conflict. Purdue Extension will use results of this program to develop and enhance more programs across Indiana.
https://www.purdue.edu/newsroom/releases/2019/Q1/program-to-help-farm-managers-become-employer-of-choice.html._Purdue Extension Annual report, a marketing piece that is distributed to stakeholders, for 2018 the theme was "all in a day's work."
https://extension.purdue.edu/annualreport/
Mental Health - Purdue Extension shared prevention approaches, and featured two programs: Strengthening Families Program: For Parents and Youth 10 - 14 (SFP: 10-14), and Mental Health First Aid (MHFA). The SFP: 10-14 helps to reduce or delay onset of drug use by youth. MHFA courses educate adults on signs and symptoms of mental health disorders such as anxiety, depression, substance use (including opioids), trauma and deliberate self-injury. Participants will learn how to assist those in need during specific situations in an attempt to get an individual appropriate help from a health professional. Both programs started in the last year, and will continue to grow capacity and expand availability in the future. Also, Purdue Extension is leveraging grants, including a Substance Abuse Mental Health Services Administration (SAMHSA) grant, to deliver more MHFA across Indiana, and to expand into youth programs in collaboration with 4-H Youth Development. In addition, educators attended a Farm Stress Conference by Michigan State Extension in 2018, and future collaborations with Health Human Services and Agriculture and

Brief Explanation of what you learned from your Stakeholders

Workforce Development - Industry leaders are interested in leadership and management skill training for their current employees. For new employees, industry leaders are looking for soft skills or life skills training. Purdue Extension is continuing to plan, develop, pilot, and expand programs to address the interests of these stakeholders.
Mental Health - For communities and employers dealing with substance abuse, including opioids, there is a continuum of activities and support to address: prevention, treatment, transition/re-entry, re-training/job skills, etc. Many communities and employers are not aware of this spectrum and the related services/support available locally and across the region and state. Purdue Extension is continuing to expand programming capacity and availability for prevention through Strengthening Families and Mental Health First Aid.

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	10888866	0	6203949	0
Actual Matching	20731735	0	40216007	0
Actual All Other	4052669	0	6994538	0
Total Actual Expended	35673270	0	53414494	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

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

V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Global Food Security and Hunger

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships	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: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	37.2	0.0	171.4	0.0
Actual Paid	40.6	0.0	116.3	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**
3136937	0	2906620	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
5362355	0	14928273	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
1348780	0	1928292	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

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	243402	3854674	79097	1083106

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

Patent Applications Submitted

Year: 2018
Actual: 18

Patents listed
2558858 (Germany)
2558858(France)
2558858 (United Kingdom)
2,795,919 (Canada)
9,938,537 (United States)
9,944,949 (United States)
10,023,902 (United States)
2831577 (Germany)
2831577 (France)
2831577 (United Kingdom)
10,051,858 (United States)
10,060,929 (United States)
2,683,416 (European Patent)
10,113,168 (United States)
1896822 (European Patent)
10,125,454 (United States)
10,138,908 (United States)
10,144,785 (United States)

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	90	277	367

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of education workshops

Year	Actual
2018	2385

Output #2

Output Measure

- Number of volunteers

Year	Actual
2018	2998

Output #3

Output Measure

- Number of consultations

Year	Actual
2018	35401

Output #4

Output Measure

- Number of research projects

Year	Actual
2018	346

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	DISEASES 1.6 - # of projects related to preventing poultry diseases and disease management
16	Data 2.1 - # of discoveries, innovations, technologies and technology transfer related to improving data, data reconciliation, improving insights, enhancing data collaboration
17	GF 2.5 - # New diagnostic systems

18	GF 1.3a - # Of increased efficiencies (i.e.. (% pregnant), or increases in yield/unit (bushels/acre; lbs. product (meat, protein, milk) per animal ; lbs. feed per gain).
19	ANR Horticulture - NIFA GF 1.4 - # of participants adopting best practices and technologies resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources
20	GF 1.4.a - # Of producers indicating adoption of recommended practices
21	GF 2.7 - # People trained in early detection and rapid response of plant pest, animal pests and diseases

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 Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	120

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Foundational information is needed to improve the efficiency of swine oocyte activation methods especially in assisted reproductive technologies such as in vitro fertilization or somatic cell nuclear transfer. Despite its significance, the complete mechanism of the fertilization calcium signal has never been characterized--in particular, repetitive calcium signaling. Cloning by nuclear transfer of genetically modified cells is the only method on hand for making pigs with specific genetic

modifications. However, our inability to properly activate the oocyte reconstructed during nuclear transfer is one of the reasons for the extreme inefficiency of nuclear transfer procedures. Because we don't know the underlying mechanism that mediates calcium signaling in fertilized oocytes we are not able to artificially induce the repetitive signals. Increasing our knowledge of how the sperm triggers the oscillatory calcium signals will enhance our abilities to more precisely control the process of signaling during embryo production in the laboratory.

What has been done

The project has focused on how to trigger repetitive calcium signaling in the oocyte's cytoplasm. Each elevation in the intracellular calcium concentration is followed by a calcium influx across the oocyte's plasma membrane. The team has been investigating the molecular identity of the components of the entry pathway to identify the molecules that are responsible for the generation of calcium entry across the plasma membrane. They have also been determining whether the calcium influx serves simply to replenish the calcium stores or whether it is also responsible for the activation of critical signaling pathways required for complete oocyte activation. Defining the mechanism and functions of calcium entry has deepened the knowledge about oocyte physiology and may also help improve the efficiency of a number of assisted reproductive technologies such as in vitro fertilization and somatic cell nuclear transfer.

Results

The team previously demonstrated that store-operated calcium entry across the egg plasma membrane is essential for normal fertilization. STIM1 was shown to be a protein located in the membrane of the intracellular stores known as the endoplasmic reticulum, and it is able to detect calcium levels in the stores. The calcium influx channels were shown to be made of Orai1 proteins. Using Fluorescence Resonance Energy Transfer (FRET) it was shown that changes occur in the eggs following sperm-egg fusion, indicating that fertilization is associated with repetitive interaction between STIM1 and Orai1. Appropriate inhibitors were applied to strengthen the notion that STIM1 and Orai1 proteins are essential to sustain the fertilization calcium signal in pig oocytes. In addition, the role of magnesium in the regulation of the calcium signal was demonstrated. A series of experiments showed that magnesium blocks calcium entry, probably by inhibiting the kinase domain of the TRPM channel, which in turn blocks store-operated calcium entry. This supports the major hypothesis that store-operated calcium entry mediated by STIM1 and Orai1 proteins is essential to sustain the sperm-induced calcium signal during fertilization in pig eggs.

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	303

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Food dispersions, such as gels, foams and emulsions, are major components of the human and animal diet. Examples of common food dispersions are jam, beer, whipped cream, dressings, mayonnaise, butter, spreads, and margarine. Food dispersions constitute a multi-billion dollar part of the modern food industry that will benefit from advancing the understanding of the properties, dynamics and rheology of interfaces. New knowledge and innovative computational tools that result from this effort will help address some of the most critical issues regarding interfacial processes that are essential to control the creation and stabilization of structures in food dispersions. It can also have a direct impact in the area of nutrition and health because interfacial properties strongly influence the dynamics by which foods interact with the gastrointestinal tract. By expanding our fundamental knowledge of interfacial phenomena, and improving the realistic representation of important interfacial processes in computer models, it is expected that this research will help design formulation and processing strategies for the production of food dispersions with higher nutritive value manufactured with greater efficiency benefiting human health and enhancing food security.

What has been done

The project focused on foams (dispersion of bubbles), emulsions (dispersion of droplets), and suspensions (dispersion of solids), which are major components of the human diet.
1) Research efforts focused on assessing the influence of formulation on the interfacial dynamics of food dispersions in order to enhance their stability and processability. The team completed and published new findings on the effects of surface-active molecules (surfactants) adsorbed on the surface of foam bubbles and emulsion droplets. These studies were carried on using formulations representative of both commercial surfactant additives (e.g. sorbitan and sucrose esters) and surfactant naturally present in foods (e.g. lecithin, proteins and polysaccharides).
2) Investigations continue on the bulk and interfacial rheology of food dispersion in order to assess the extent to which rheology can be modulated to optimize food processing. In 2018 new findings were published on the rheological properties of starch suspensions.
3) Another study on the importance of structural changes during the formation of nanoparticles made from maize amylose/beta-lactoglobulin/alpha-linoleic acid was developed and published.

Results

1) Surfactant results: The findings show that surfactant properties can be modulated to extend the lifespan of micropores nucleated at fluid-fluid interfaces because surfactants render the interfaces more elastic in their response to stresses (1 publication). Ultimately these results may enable food processors to design surfactant formulations to delay the coarsening of foams and emulsions improving their processability and increasing their shelf-life (1 publication).
2) Rheological results: The findings demonstrate that the swelling of starch granules is modulated by the degree of crosslinking in the starch network (1 publication). The gained knowledge enabled the formulation of an accurate mechanistic models to predict and control the swelling kinetics of starch suspensions (1 publication). The proposed model for starch swelling accounts for entropy of mixing, enthalpy of water-starch interaction and viscoelastic rheological forces.
3) The new insight into the structure of this amphipathic ternary nanoparticle is important to technologies for encapsulation of bioactive and aromatic compounds in food suspensions. Encapsulation cloaks the bioactive and aromatic compounds with a protective food-grade shell barrier that preserves them during processing, provides the ability to control their release for maximum effectiveness, and increases their solubility and bioavailability enhancing their health and nutritional value (1 book chapter).

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 #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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Indiana has a vibrant and growing wine industry that contributes significantly to the economic wealth of our State and enhances the lives and livelihoods of its residents and visitors. Between 1991, when the program was established, and 2018, more than 100 new wineries opened statewide. As wine grape production has increased in Indiana, growers and vintners demand up-to-date information on new grape cultivars, sustainability and pest management, winemaking techniques and marketing strategies.

What has been done
The Purdue Wine Grape Team (PWGT) conducted research that led to the selection of grape cultivars that match Indiana's growing conditions while exhibiting improved fruit quality. Wine production practices have been improved through winery consultations and analytical services. Extension workshops have been designed to engage stakeholders across the state and deliver the latest scientific information in viticulture and enology. The PWGT teaches Wine Appreciation to 250+ students as well as the upper level classes Commercial Grape and Wine Production and Commercial Food and Beverage Fermentations. The integrated Extension campaign Try on Traminette created an Indiana signature wine by utilizing the team's winegrowing, winemaking

and wine marketing expertise. In 2018, the PWGT organized the 14th Vintage Indiana wine festival in Indianapolis, which attracted more than 8,000 wine consumers, and the 27th Indy International Wine Competition. With almost 2,000 entries it is the largest scientifically organized event of its kind in the U.S. In 2018, the PWGT led the preparation of an independent Economic Impact Study of the Indiana wine industry that documented the significance of the team's efforts.

Results

According to the latest estimates, the Indiana wine industry now contributes more than $600 million annually to the State's economy. Grape and wine production continues to be the fastest growing segment of Indiana value-added agriculture and agri-tourism. The Purdue Wine Grape Team engages with the Midwestern wine industries through Extension, research, marketing and promotion activities. Through Purdue's leadership, Indiana's wine grape acreage has increased 50% in the past ten years. Annual wine production surpassed 1.5 million gallons (8 million bottles) in 2018, a 30-fold increase since the PWGT began its efforts. Indiana wine sales are growing by more than 18% every year. The PWGT provides transformational Extension and research leadership for viticulture and enology programs nationwide. Wineries are the number one agri-tourism destination in Indiana with 630,000 annual visitors who spend $94 million, while wine has emerged as a showcase for a valued-added agricultural product crafted in Indiana that sustains 3,900 jobs and $120 million in paid wages.

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
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 #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

DISEASES 1.6 - # of projects related to preventing poultry diseases and disease management

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	5

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Public and consumer interest in animal well-being continues to increase along with concerns over food safety. A major welfare concern in the commercial turkey industry is that of skeletal integrity and footpad condition, specifically footpad dermatitis (lesions or inflammation of the footpad). Litter type and stocking density (the amount of space available per animal or average body weight per unit of space) are two major factors affecting footpad health and well-being of commercial turkeys. Although stocking density is recognized as an important factor influencing turkey well-being, there is little scientific evidence to support the use of a particular stocking density. Furthermore, the type of management protocol used also has a major impact on turkey well-being. In the commercial egg industry, there is movement away from conventional cage systems to alternative housing systems such as aviaries and enriched cages. However, scientific evidence regarding the impacts of these alternative systems on production, egg quality, food safety and animal well-being is lacking. Heat stress is an important poultry health and welfare issue, resulting in major economic losses. Little information is available regarding the effects of heat stress on broiler chicken behavior and core body temperature (CBT).

What has been done
The objectives of this study were to examine changes in broiler chicken behavior and CBT as a result of heat stress. Mixed-sex broiler chickens were housed in groups of 15 in 2 littered floor pens. At 34 days, data loggers (IButtons) were surgically implanted in 10 males and 10 females to continuously record CBT. Birds were maintained under thermoneutral conditions (22.5±0.1°C) until 42 days, when cyclic heat stress (HS) was imposed. The HS cycle consisted of increasing the temperature from thermoneutral conditions to a mild HS period (26.3±0.1°C), followed by a moderate (30.1±0.1°C) and hot (34.5±0.2°C) period. Each period was maintained for 1 h. Cyclic HS was repeated daily from days 42 to 45. Overhead video cameras recorded behavior on days 39 and 40 (pre-HS) and 42 and 43 (HS). Behavior (sitting, standing, drinking, eating, preening,

dustbathing, walking and out of view) was analyzed using 10-min instantaneous sampling for the 17 h light period for focal birds with iButtons (n=6 males, 5 females) and birds without iButtons (n=5 males, n=4 females). The occurrence of panting was also recorded. All procedures were carried out in accordance with the guidelines of the Purdue University Institutional Animal Care and Use Committee. Data were analyzed using the GLIMMIX and MIXED procedures (SAS 9.4).

Results

The proportion of observations in which birds preened was higher pre-Heat Stress (HS) (0.07±0.009) than during HS (0.05±0.009; P=0.01) and was higher for females (0.07±0.009) than males (0.05±0.009, P=0.048). Males (0.76±0.02) sat more than females (0.70±0.02, P=0.03) and birds with iButtons sat less than birds without iButtons (0.76±0.02 vs. 0.70±0.02, P=0.02). The proportion of observations that birds were out of view differed between pre-HS and HS periods (0.017±0.008 vs. 0.05±0.008, P=0.008), males and females (0.02±0.009 vs. 0.05±0.008, P=0.01), and birds with and without iButtons (0.05±0.007 vs. 0.02±0.009, P=0.03). Core body temperature (CBT) differed among HS periods, males and females, behavioral categories and when birds were panting vs. not. CBT increased with increasing ambient temperature (thermoneutral: 41.33± 0.05 degrees;C, mild: 41.92±0.08 degrees C, moderate: 42.46±0.08 degrees C, hot: 43.22±0.08 degrees C; P<0.001). Female CBT was higher than male CBT (42.53±0.06 vs. 42.17±0.06, P<0.0001). CBT was higher when birds were out of view, which typically occurred when birds were under the drinker (42.62±0.06 degrees C, P<0.001) than when birds were preening (42.35±0.06 degrees C), sitting (42.38±0.03 degrees C) and standing (42.28±0.06 degrees C). CBT was also higher when birds were panting (42.44±0.06 degrees C) than when birds were not panting (42.26±0.06 degrees C, P<0.0001). HS significantly affected broiler chicken behavior, with birds spending less time preening during HS. CBT differed depending on the behavior birds were performing. Further research is needed to identify early changes in behavior associated with increasing ambient temperature and CBT.

4. Associated Knowledge Areas

KA Code	Knowledge Area
305	Animal Physiological Processes
307	Animal Management Systems
315	Animal Welfare/Well-Being and Protection
402	Engineering Systems and Equipment
601	Economics of Agricultural Production and Farm Management

Outcome #16

1. Outcome Measures

Data 2.1 - # of discoveries, innovations, technologies and technology transfer related to improving data, data reconciliation, improving insights, enhancing data collaboration

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	5

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The European corn borer (ECB) (Ostrinia nubilalis) and western corn rootworm (WCR) (Diabrotica virgifera virgifera) account for over $1 billion each in control costs and grain losses annually. Research conducted by this multi-state committee was used to develop models predicting the rates of resistance evolution and efficacy of refuge in preventing resistance. This led to the Integrated Pest Management (IPM) approach that used a 20% independent refuge planting; however, as genetically modified (GM) technology has evolved, so has IPM. Recently deployed GM corn hybrids use multiple genes that target ECB and WCR. The IPM plan for these hybrids requires a smaller refuge, and seed mixtures (Bt and non-BT) are now being deployed. The models supporting these IRM modifications were constructed using the best information available, but a number of assumptions had to be made. These assumptions must be tested and research conducted to move them from assumptions to quantified variables. Furthermore, information is needed on the economics of this evolving technology at the field, farm, and regional levels. Addressing these knowledge gaps forms the basis for several objectives of the project. The long-term goal of our research is to develop sustainable ways to manage the corn insect pest complex.

What has been done
The relationship between pest management technologies and the agricultural environment was investigated. The committee worked on 3 objectives. First, they assessed the need, efficacy and pest management window of seed treatment insecticides, primarily neonicotinoids, to control secondary below-ground insect pests. They evaluated the possible effects of insecticidal seed coatings on non-target beneficial insects.

Second, they investigated the ecology, biology, evolution, genetics, and behavior of corn arthropods. In 2018, they characterized the dispersal of adult WCR and lepidopteran pests, and assessed its implications for integrated pest management (IPM) and for resistance development, spread, and mitigation.

Third, they employed diverse delivery methods to disseminate information related to sustainable management of corn arthropod pests. 1) Establish an NC-205 video library website with permanent high quality versions of IPM videos for open online access and download to computer and portable electronic devices. 2) Produce and deploy a comprehensive IPM system for cost-effective prevention, early detection, rapid diagnosis, and mitigation of new and emerging corn pests that links all stakeholders who have common interests in pest detection and management. 3) Develop an array of IPM and IRM distance education workshops.

Results
First, they found that neonicotinoids that were applied to corn are consistently found in nearby waterways and this has implications for the aquatic organisms that live there, including

unintended mortality. A publication in the Journal of Applied Ecology, demonstrated that dusts originating from seed treatments applied to corn seeds move over a wide proportion of the environment, covering most of the state of Indiana. This means that non-target exposure of honey bees and other pollinators is likely and in some cases lethal. Second, another publication demonstrated that WCR in refuge/Bt environments tend to mate close to where they feed and that the current levels of refuge beetles produced in fields are likely insufficient to contribute towards delaying resistance significantly. Third, a video was developed as a unique method to disseminate information. The video is meant to provide a jumping-off point for future work that reaches out to corn producers and pest managers in educating them about how and when to prevent resistance development.

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

Outcome #17

1. Outcome Measures

GF 2.5 - # New diagnostic systems

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	11

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Reflectance spectroscopy is emerging as a promising tool with potential applications in agricultural management because it is a non-destructive, rapid, and a relatively low-cost approach to monitoring vegetation status. In vegetation, reflectance spectroscopy relies on the interaction of light with plant chemical and structural composition and water content. Reflection of light in the visible (400-700 nm), near-infrared (NIR, 700-1100), and short-wave infrared (SWIR, 1100-2400 nm) can provide a comprehensive assessment of both shifts in visual symptoms (e.g., pigments, leaf color) and the underlying biochemical (e.g., nutrient composition, secondary metabolism) and

physiological (e.g., photosynthetic activity, water relations) responses to disease or stress. Spectroscopy can also aid in the retrieval of plant traits, and has been utilized to predict a wide range of plant biochemical constituents and physiological processes based on the optical properties of foliage, including concentrations of nutrients and secondary metabolites and leaf structural and morphological composition and plant physiological status or specific physiological processes. To date, the applications of spectroscopy in agriculture have largely focused on disease detection through classification strategies, development of narrow- or broad-band disease indices, or relating vegetation indices sensitive to plant stress with plant disease status. Hyperspectral data is also utilized for classification of plant varieties and genotypes. Less is known about the ability of hyperspectral data to classify differences in plant stress responses between stressors that produces similar physiological effects, an emergent outcome of the proposed research. The use of hyperspectral data to detect specific biochemical and physiological responses to disease in crop systems is less explored and represents a promising and novel approach for not only the classification of disease status via spectral profiles, but also non-destructively quantifying responses of plants to stress.

What has been done

The goal of this research is to evaluate the ability of hyperspectral data as a potential tool for plant management of agricultural and natural areas. Specifically, determine the ability of spectroscopy to: 1) Detect asymptomatic responses by plants to biotic and abiotic stress, i.e., before the occurrence of visual symptoms. 2) Identify specific biochemical and physiological responses by plants to biotic and abiotic stress that allow spectral information to detect stress. 3) Determine the ability of hyperspectral data to accurately classify multiple different stressors, alone and in combination. 4) Determine that ability of hyperspectral data to achieve points 1, 2, and 3 accurately across multiple plant developmental stages. 4) Evaluate the ability of field-based approaches for points 1, 2, 3, and 4 across multiple measurement scales.

Results

The following has been accomplished through the use of hyperspectral data: 1) Monitored seasonal variation in wheat nitrogen under different fertilization application rates; 2) Monitored nitrogen in wheat as a breeding tool to assess nitrogen use efficiency; 3) Tracked wheat defense responses to Hessian fly infestation; 4) Quantified specific physiological responses of maize to water stress and are working to use these data in a high-throughput, trait-based breeding approach for yield-stability under water stress; 5) Detected western corn root worm infestation in maize, with implications for the monitoring development of Bt-resistance; 6) Quantified specific physiological responses of high-value hardwood species in response to biotic and abiotic stress; 7) Quantified physiological responses of lettuce to common stressors in a protected agrosystem; and 8) Quantified the impact of different agronomic management practices on the chemical profiles of industrial hemp (THC, CBD, etc.).

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
402	Engineering Systems and Equipment

Outcome #18

1. Outcome Measures

GF 1.3a - # 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
2018	120

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Nitrogen (N) is generally the most limiting nutrient in specialty crop systems and growers apply substantial amounts of fertilizer to meet plant needs. Only 50 percent of N is utilized by most crops. The unused N leaches to the environment causing serious environmental problems. This leaching is a major contributor to the growing hypoxic zone in the Gulf of Mexico. Organic fertility amendments (ie. compost and cover crops) have potential to help reduce N loss, though meeting crop N needs with these amendments is more challenging. The soil N cycle is largely mediated by microorganisms, and learning more about the ecology of this system and how it is impacted by alternative fertility amendments has potential to increase crop N uptake and reduce N loss.

What has been done
Soil quality (or health) is now widely regarded as essential for maintaining plant and environmental health, but the direct mechanisms mediating these beneficial relationships are less clear. Research conducted as a part of this project supports the results of previous studies demonstrating that soil quality can be improved by amending soil with organic substrates. Moreover, results demonstrate that the composition and amount of these substrates can alter the structure of soil microbial communities that interact with plants to help them withstand biotic and abiotic stress.

Results
Over the course of this project, several experiments were conducted at Purdue research stations and on-farm trials throughout the Midwest to quantify the effects of various types of fertility amendments on N cycling and crop productivity in vegetable cropping systems. Results of these studies confirm that both amendment composition and site-specific soil and environmental factors are key factors affecting the soil N cycle. In particular, amendments derived from organic sources increased microbial activity and the activity of key microbial genes steering the N cycle relative to

amendments derived from inorganic sources. This indicates that application of organic amendments could reduce nutrient loss if incorporation of the amendments are timed appropriately. Microbes with genes controlling the N cycle were also more abundant in the plant rhizosphere than bulk soil, indicating that plants can play a significant role in steering the soil N cycle. Finally, in addition to affecting plant growth, nutrient availability also affected the susceptibility of plants to pathogens and insect pests, indicating that pest dynamics are intimately related to nutrient management strategies.

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

Outcome #19

1. Outcome Measures

ANR Horticulture - NIFA GF 1.4 - # of participants adopting best practices and technologies resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	19381

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Many herbicide-resistant weeds affect soybean production. Johnson (2018) estimates costs to control marestail is $20/acre, giant ragweed $30/acre, and waterhemp and Palmer Amaranth $50/acre. Many growers are reluctant to return to more intensive, tillage practices. In some situations, cover crops can help reduce over wintering weed populations, but results can be erratic. Some growers are migrating to short-term solutions strictly through utilizing new GMO seed technologies, versus adopting longer-term best management practices, which might include cover crops, pre-emergent residual herbicide applications, and utilizing a variety of herbicide mode of actions along with post emergent herbicide applications.

Dicamba containing herbicides are good for managing these weeds but these herbicides have been under review by pesticide regulatory officials in Indiana and other states for damage related to chemical drift. In 2017, 2,708 dicamba drift issues had been reported to State Departments of Agriculture or Chemists Office across 25 soybean-growing states (Bradley, 2017). In Indiana the State Chemist Office conducted 257 drift investigations, compared to between 74 and 92 in the previous four years. Of the investigations, 129 (50%) were related to dicamba, as compared to just 3 to 8 dicamba investigations in the previous four years.

In the fall of 2017, the Indiana Pesticide Review Board classified all pesticide products containing at least 6.5% dicamba, as Restricted Use Pesticides (RUPs) in Indiana and can only be sold to certified applicators. At the same time, the Environment Protection Agency (EPA) reached an agreement with Monsanto, BASF and DuPont on measures to further minimize the potential for drift to damage neighboring crops from the use of dicamba formulations used to control weeds in genetically modified cotton and soybeans. New requirements for the use of dicamba over the top (application to growing plants) will allow farmers to make informed choices for seed purchases for the 2018 growing season. As a result of steep increases in drift complaints across the country, the EPA and the manufacturers of dicamba products created federal label-mandated training requirements for 2018 for users of Engenia, FeXapan, or Xtendimax in 2018.

What has been done

The Office of the Indiana State Chemist and Purdue Extension delivered 193 one-hour training sessions in person and via webinar from January 1 to April 30, 2018 to users of dicamba products and other interested in the dicamba regulations. Instruction focused on practices to reduce drift and volatilization, including buffers, wind direction and speed, application timing, temperature, rain, recordkeeping, nozzles, boom height, ground speed, sprayer cleaning and spray volumes for application of dicamba products. There were 5,669 private pesticide applicators, currently certified in Indiana, who attended the training.

Results

In many of the training sessions, program evaluations were conducted. A survey was distributed at the end of the training for attendees to complete. A total of 3,898 evaluations were collected for statewide compilation. Evaluations were from 78 counties, across the 10 geographic areas and 5 districts of Indiana. Responses (n=3722) on acreage showed that half of the attendees (50%) reported having over 1,000 acres which they farm or advise.

Based on paired t-test analysis of the retrospective pretest evaluation data, gains in knowledge of the dicamba issues and practices among the attendees were statistically significant regarding dicamba application: 1) decreasing drift, 2) decreasing volatilization, 3) buffers of at least 110 feet, 4) wind direction toward sensitive crops, 5) wind speed between 3 and 10 mph, 6) rainfall forecast within 24 hours, and 7) regulatory authority of drift complaints. Responses about knowledge for all topics showed a shift from before to after. The knowledge levels of none and some decreased, and the knowledge levels of much to expert increased. At the conclusion of the training, attendees (n=3,579) showed accurate knowledge of: 1) proper boom height (98.8%), 2) causes and effects of dicamba volatilization (85.7%), and 3) locating dicamba sensitive crops (82%).

Attendees indicated actions they are planning to take in 2018. The largest number of attendees indicated that they would: 1) Maintain required records (75.6%), 2) Review updated dicamba regulations (75.4%), 3) Prepare a checklist for spray day (72.4%), 4) Inventory sprayer nozzles (63.4%), and 5) Survey nearby dicamba sensitive crops (62.2%). On each of these items there were 10%-18% of responses from attendees who indicated these actions did not apply to them.

Training attendees were asked about the importance of dicamba. From 3,662 attendees, 69.8% indicated that having dicamba technology available is very to extremely important. Attendees indicated how what they learned in the training would benefit them and their operation. They found the training helpful to them. Many expressed desire to do it right, be more aware, be careful, follow the label and regulations, communicate with neighbors, and apply what they learned in their operation this year or in the future. Others expressed that it confirmed their feelings or convinced them to avoid applying dicamba.

These increases in knowledge and intentions to adopt recommended practices related to dicamba among Indiana's private pesticide applicators and others in agriculture may contribute to improved safety and compliance with regulations and containing drift complaints and other issues related to dicamba use in current and future growing seasons.

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
601	Economics of Agricultural Production and Farm Management

Outcome #20

1. Outcome Measures

GF 1.4.a - # 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
2018	17466

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
There are 56,800 farming operations in Indiana. 97% of Indiana farms are family-owned. Of

Indiana's roughly 23.3 million acres of land, 84% of it is farms, forests and woodland. Corn ($3.16 billion) and soybeans ($2.84 billion) account for the largest value of sales for Indiana's commodities. Successful and sustainable production requires attention to a vast array of variables, including, but not limited to, soil health, water availability and access, prevalence of weeds, insects, invasive species, and diseases, and seasonal and weather variability. The need for access to and understanding of new technologies and management is great for Indiana's producers and the future of crop production. It is prudent for Indiana to protect its resources and support productivity of the land, farms, and operations.

What has been done
Seven Purdue Agricultural Centers (PACs) Field Day events provided 35 hours of educational activities on many topics, including wildlife and woodlot management, forage and beef cow management, corn and soybeans, herbicide and weed management, putting a sprayer on the road, UAVs/drones, soil fertility economic outlook, cash rent options, integrated pest management, pollinator protection, and crops pathology. Continuing Education Units (CEUs) for Certified Crop Advisors, Continuing Certification Hours (CCHs) for Indiana Commercial Pesticide Applicators, and Private Applicator Recertification Program (PARP) credits were available. 12 external partners and 44 funders provided a total of $15,525 in support of the events.

A total of 1,032 adults participated in the seven events. 437 (42% response rate) participants completed the post-survey. 34% indicated they currently farm/advise over 1,000 acres, 24% farm 101 to 500 acres, 17% don't farm, 13% farm 501 to 1,000 acres, and 10% farm 100 acres or less. Respondents live in 63 of Indiana's counties, and 9 from out of state. Largest numbers were from these counties with 10 or more each: Randolph, LaPorte, Tippecanoe, Porter, St. Joseph, Ripley, Whitley, Wayne, Huntington, Jay, Jasper, Jennings, Kosciusko, Jefferson, Pulaski, and White.

Results
Participants found Field Day useful, with 75% indicating it was extremely or very useful. Participants indicated they would apply information to their farm/operation. Most common included: 1) drones/UAVs, 2) equipment, 3) weed management, 4) diseases, 5) pesticides, and 6) insects. A few comments of information participants planned to apply to their operation included: the different uses of UAVs and the possible future use of them, doing a better job of taking care of equipment, water hemp control options, difference between sudden death syndrome and brown stem rot, and being more careful of over spray to protect bee population.

There were 35% (n=73) of returning respondents who indicated they had adopted a new, recommended practice for their farm/operation since last year's event. Most frequently reported practices that were adopted included: 1) using sulfur on beans, 2) pesticide application, 3) no till / cover crops, 4) scouting, and 5) seeds. Some 19% (n=39) indicated their operation's financial position since last year's event had improved. Improvements were: 1) 46% (n=21) had increased dollar return per acre due to adopted recommended practices, and 2) 50% (n=24) had reduced costs per acre due to adopted recommended practices.

Field Days, as reported by participants are useful and applicable, and by returning participants reporting adoption of new, recommended practices, can help contribute to improved productivity, yield, environmental stewardship, and financial management for farms and operations across Indiana.

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
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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 #21

1. Outcome Measures

GF 2.7 - # People trained in early detection and rapid response of plant pest, animal pests and diseases

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	3483

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

In 2016, Indiana had 57,500 farms with 14,700,000 acres of land. (Indiana Agricultural Statistics 2016-2017, USDA, NASS). Corn was the leading source of income for Indiana farmers and amounted to $3.16 billion. Soybeans were second at $2.84 billion. Farmers and agribusiness personnel including fertilizer and chemical dealers, seed and company agronomists and crop consultants, need up-to-date information on pest populations, outbreaks, and management strategies, pesticide label changes, safety and environmental issues related to pest control, and the use and application of pesticides, for safe use of pesticides and herbicides. Appropriate application of pesticides is extremely important for our food systems, environment, health, wildlife, and water supply.

What has been done

PARP (Private Applicator Recertification Program) is a training program for private pesticide applicators who need to keep their certification current. Private applicator permits last five years. In that five years, private applicators are required to attend three recertification programs or take the pesticide or fertilizer certification exam. A private applicator may attend recertification programs hosted by Purdue Extension based in the counties across Indiana. Recertification programs are at least two hours in length and include presentations on fertilizer and/or pesticide-related topics. Each program includes an approved regulatory topic. A private applicator can attend and receive credit for a recertification program in any county, not just their home county. There are 11,784 PARP certificates managed per year in Indiana by the Purdue Pesticide Program. Purdue Extension provided 208 PARP trainings in the past year. To keep PARP certification current, 6,390 farmers attended these trainings. Regulatory and elective training topics were selected and presented to match local needs at the county. Topics included dicamba, pollinator protection, herbicides, weeds, drift watch, recordkeeping, cover crops, soil health, pests, nitrogen, plus many others. The Office of the Indiana State Chemist, charged with administering several agricultural laws involving animal feeds, fertilizers, pesticides and seeds to ensure truth-in-labeling, food safety, user safety and the protection of our environment, manages the 14,930 commercial applicator certificates in all categories. In the past year, for the agricultural pest management category there were 2,702 certified commercial applicators, and 2,158 for agricultural fertilizer application. A total of 700 training programs were approved last year for commercial applicator continuing certification hours (CCHs).Purdue Extension provided many of these trainings. While agriculture is a large part of those programs, it is not nearly the whole. Turf management, ornamental pest management, right of way, forest pest management and professional pest control all benefit from Purdue Extension (and Extension programs all over the country). Extension is not only a part of the initial training programs but plays a huge part in recertification programs. Extension Specialists in weed science, entomology, turfgrass and many others are critical to the recertification programs for commercial applicators.

Results

Application of pesticides is regulated to ensure safe and appropriate use. Those who administer pesticides, herbicides, and fertilizers, must complete training and pass tests to be certified. They obtain certification initially and then participate in ongoing training to keep current. Purdue Extension provides training opportunities throughout the year at locations across the state. Depending on the training program, participants may receive credit toward their recertification for private applicator (PARP), or commercial applicator continuing credit hours (CCHs).

Responses of the training participants reflect the variety of topics provided across Indiana. Here is a sampling of actions they plan to take as a result of the training: 1) they will be making changes to their farm practices, 2) they will adopt agronomic practices to assist in reducing cost and increasing dollar return per acre, 3) they will take precautions and safety measures recommended

in the program, 4) they will likely have more group discussions with farm co-owners, and with people who rent the farm, 5) they intend to utilize herbicide mode-of-action charts to make herbicide decisions, and 6) they will monitor weed height more closely to ensure effectiveness of herbicide applications.

Participants stated the benefits they received: 1) the training helped their understanding of safety practices, 2) the program helped them understand the importance of recordkeeping, 3) they learned something new about temperature inversions, droplet size and drift, rust, grain storage insects, keeping records, and soybean cyst nematode races, 4) they increased their knowledge of management strategies for weed control, disease control, insect control, and pesticide control related to pollinators, and 5) they feel comfortable knowing how and when to plant cover crops correctly.

The availability and delivery of ongoing training provided by Purdue Extension makes it possible for individuals to keep their certification and helps Indiana to have better informed farmers and agribusiness personnel more likely to make economically and environmentally sound decisions for safe and appropriate application of pesticides.

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
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Extension programs conduct evaluation surveys to measure change in knowledge and intentions of participants, and follow-up surveys to assess change in behavior or practice and results of actions. Field, lab, and survey research projects monitor progress, testing of efficiencies, growth and success rates, economic mechanisms and new technologies, completion of study objectives and tasks, and publications/presentations of findings, to determine effectiveness and accomplishment.
Evaluation results included:
Outcome #2 - Analysis of cellular and molecular mechanisms of early embryonic development in swine
Outcome #4 - Lab analysis of food dispersions (gels, foams, emulsions) for lengthening shelf-life
Outcome #13 - Economic impact of wine grape agriculture and agri-tourism
Outcome #15 - Measuring poultry physical responses and behaviors to heat stress
Outcome #16 - Analysis of pest management in corn including seed treatment insecticides, primarily neonicotinoids, and arthropods
Outcome #17 - Reflectance spectroscopy of plant (wheat, maize, hardwoods, lettuce) reaction to stresses
Outcome #18 - On-farm trials of fertility amendments on Nitrogen cycling and crop productivity in vegetable cropping systems
Outcome #19 - Post-assessment of knowledge gained from dicamba training
Outcome #20 - Post-assessment of knowledge and intention to adopt, and one-year follow-up on practices adopted since last year's PAC Field Day events
Outcome #21 - Private and Commercial Pesticide applicator training post-surveys on information learned and intended actions

Key Items of Evaluation

Outcome #13 - Wineries are number one agri-tourism destination in Indiana with 630,000 annual visitors who spend $94 million, while wine has emerged as a showcase for a valued-added agricultural product crafted in Indiana that sustains 3,900 jobs and $120 million in paid wages.

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: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	5.9	0.0	12.3	0.0
Actual Paid	1.4	0.0	7.7	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
1183805	0	383869	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2362016	0	3093086	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
378028	0	794639	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

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	477	1366	530	0

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

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	3	16	19

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of research projects

Year	Actual
2018	8

Output #2

Output Measure

- Number of consultations

Year	Actual
2018	50

Output #3

Output Measure

- Number of education workshops

Year	Actual
2018	19

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	GFSH 2.13 - # of projects related to managing impacts from large-scale operations: non-point source pollution, water use & allocation, watershed impacts, model development
8	FME 2.1 - # of discoveries, innovations, technologies and technology transfer related to performance management of farms

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

2. **Associated Institution Types**

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

It is estimated that agriculture is responsible for 6% of total U.S. greenhouse gas emissions: primarily from methane (CH4) and nitrous oxide (N2O) (USEPA, 2014). The largest single source of CH4 is enteric fermentation (USEPA, 2014). Fertilizer application and other cropping practices account for 68% of estimated emissions of N2O. CO2 emissions from land surface and agricultural operations must be evaluated to understand carbon cycling (Riveros-Iregui and McGlynn, 2009). Among three greenhouse gases (GHG), the Intergovernmental Panel on Climate Change (IPCC, 2001) specified methods for nations to estimate the GHG emissions of each sector of the economy (IPCC, 1997), which is to multiply an activity (for example, tons of manure

applied to cropland) by an associated emission factor (Kebreab et al 2006). While NH3 is not a GHG, it is considered to be a secondary GHG because N2O is often produced through oxidation of NH3. Livestock management and fertilizer application contributed about 85% of total ammonia emissions in 1998 (USEPA, 2002). The USEPA inventory indicated typical N losses as NH3 of 38% for dairies and 63% for swine operations (USEPA, 2004). Recently emissions estimation methods for livestock operations and land surfaces at farm-scale have been promulgated by the USDA (Eve et al, 2014), but there remain significant gaps in our ability to estimate GHG and NH3 emissions.

What has been done

This study evaluates emissions from many agricultural operations where little is known, such as N2O and NH3 emissions from fields with applied manure or inorganic fertilizer and CO2 and CH4 emissions from pastureland. Project objectives are: 1) Develop methodologies to measure NH3, CO2, CH4, and N2O emissions from landscapes and fugitive sources including agricultural and natural gas production operations. 2) Measure NH3, CO2, CH4, and N2O emissions from cropping and livestock agricultural operations spanning a range of management practices and geographic/ climatological zones. 3) Determine the effect of animal type and management regime on livestock greenhouse gas (GHG) emissions and the effect of crop and soil type, and weather on cropped-land GHG emissions.

Results

Measurements of NH3 were made in June 2018 using open-path tunable diode laser (TDL) NH3 concentrations across a single fertilized field for a total of 272 half-hour periods. Measurements of N2O emissions were made between May and July 2018 using cavity ring-down laser N2O concentration measurements of line-sampled air collected around the edge of two adjacent fertilized fields for a total of 1692 half-hour periods. Measurements are being completed as part of a proof-of-concept of high-throughput processing of the diverse set of measurements (Internet of things) using edge-of-cloud preprocessing and a parallel stream transformational loader in combination with high performance computing of the final emissions. Swine waste storage is a major source of agricultural NH3 emissions. Hog manure is stored in slurry pits, tanks, or lagoons. Ammonia emissions from a ground-level midwestern hog finisher manure tank collecting manure from a mean of 3508 animals was measured for 8 to 20 days each quarter of the year for two years. Emissions from the tank were greater on an area basis but comparable on an animal basis relative to emissions from much larger anaerobic lagoons. Emissions were correlated with air temperature and manure composition, but not wind speed or friction velocity, probably due to the turbulence created by the tank structure under all winds. Crusting of the manure surface in the tank corresponded with a non-significant 10% increase in NH3 emissions. Manure on dairies is the second largest agricultural source of NH3 emissions. Ongoing analyses of ammonia emissions at a western open-lot dairy were conducted. Ammonia concentrations measured by TDL concentration measurements and turbulence by sonic anemometers were analyzed. Both 30-minute and daily average emissions were influenced by air temperature. Emissions were also linearly related to wind speed. A distinct daily pattern in NH3 emissions was consistent with daily patterns in both wind speed and air temperature. The mean daytime emissions were twice the mean nighttime emissions. Daily emissions varied over the year with summer emissions twice that of winter. Annual emission for the farm was estimated with summer emissions twice that of the fall and winter. Additional studies are needed to evaluate the frequency of high emission days during the summer.

4. Associated Knowledge Areas

KA Code	Knowledge Area
132	Weather and Climate

306 Environmental Stress in Animals

605 Natural Resource and Environmental Economics

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	24

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The Central Hardwood Forest is one of the most important forest ecosystems in the eastern U.S., harboring high diversity of native species and providing valuable economic and recreational opportunities to the citizens of the region. With ongoing fragmentation, new fire regimes, modern land-use and forest management practices, and other factors, invasive exotic plants are moving into these economically and ecologically important forest ecosystems, in some places reaching epidemic proportions. The health and longevity of these forest ecosystems are at risk. Long-term invasion of exotic plants can alter composition and reduce diversity of these ecosystems, especially those mast-bearing, fire mediated oak and hickory species. Such a compositional change could result in dramatic declines in wildlife population and diminished economic opportunities for the human inhabitants of these largely rural regions. Moreover, forests play an important role in U.S. economy. In the Central Hardwood Forest region alone, over 255,000 individuals are employed in forestry-related jobs (AFPA 2012). On the other hand, invasive species cost the American public about $1,300 per household each year based on an earlier estimation (Pimentel et al. 2005). Therefore, research on the impact of invasive species on forest health and strategies in order to remediate the impact will have huge economic implications.

What has been done

The overarching goal is to understand impacts of invasive plants on forest ecosystem dynamics at the regional level by including spatial heterogeneity and system stochasticity. Understanding biodiversity-productivity relationships (BPRs) is of theoretical importance, and has important management implications. Most work on BPRs has focused on simple and/or experimentally assembled communities, and it is unclear how these observed BPRs can be extended to complex natural forest ecosystems. Research objectives are: 1) Evaluate the extent and severity of invasive plants impact on tree growth, mortality, and recruitment. 2) Understand the impact of plant invasions on soil organic carbon pools and temperature sensitivity. Researchers analyzed U.S. Forest Inventory and plant data from 2012-16 including species composition, diameter, height, age, and other attributes from more than 115,000 forest plots from the 48 contiguous states.

Results

Findings, reported in the journal Nature Communications (https://www.nature.com/articles/s41467-018-07880-w), reveal that relationships between biodiversity and forest productivity depend strongly on climate. Researchers demonstrated there is a positive biodiversity-productivity relationship in dry, especially warm climates. Forests in dry, warm climates show a positive linear relationship between biodiversity and productivity, meaning the forest becomes increasingly productive as more species are introduced. As humidity rises, the relationship changes and productivity rises and then declines as species richness increases. But in areas that are humid, the relationship between biodiversity and productivity curves. Biodiversity and productivity increase together until a point at which more species begin to cause productivity declines. The findings are important for management, restoration and conservation of forests, many of which provide important ecosystem services but are threatened by deforestation, climate change and invasive species. Climate change needs to be considered when making these management decisions. A cool, wet forest today could look much different in the coming decades. Climate change is going to push these forests into a different climate zone, potentially changing the biodiversity-productivity relationship. Climatic variation is an underlying determinant of contrasting BPRs observed across a large spatial extent, while both biotic factors (e.g., stand age and density) and abiotic factors (e.g., soil properties) can impact BPRs within a given climate unit. These findings suggest that tradeoffs need to be made when considering whether to maximize productivity versus conserve biodiversity.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
132	Weather and Climate
605	Natural Resource and Environmental Economics

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

GFSH 2.13 - # of projects related to managing impacts from large-scale operations: non-point source pollution, water use & allocation, watershed impacts, model development

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Within the Upper Mississippi River Basin, the autonomy of farmers in making nutrient management decisions for their row crop agricultural fields continues to be threatened due to the loss of nitrate via tile drainage that contributes to impairments in the Gulf of Mexico and local drinking water sources. Nutrient loading the Gulf of Mexico from tile-drained agricultural land continues to be an environmental issue that threatens the sustainability of row crop agriculture. In the future, farmers may be required to comply with federal regulations concerning surface and subsurface runoff leaving their fields. Whether specific conservation practices remain voluntary or become mandated in the Midwest, data from this research program will be a source of information for farmers to use to make critical management decisions. Strategies are needed to better enable subsurface tile drainage to perform its critical function in removing excess water in spring, while reducing the unwanted loss of nitrate in the drainage waters.

What has been done
This program identifies and investigates adaptive agriculture management practices that improve sustainability and resilience of cropping and nitrogen management systems to climate variation through increased soil health, water quality, and crop production. Understanding cover crop impacts on N availability and rate and soil health are vital in increasing cover crop adoption, reducing nitrate loading, and maintaining sustained profitable yield in the Upper Mississippi River basin. Project investigations are: 1) ability of cover crops to conserve N within corn and soybean cropping systems and reduce nitrate loading via tile drainage; 2) decomposition of cover crop residue after termination and the synchronization of cover crop N release with cash crop N demand; 3) cash crop utilization of N release from cover crop residue; 4) impact of cover crops on the diversity of the soil microbiome over time; and 5) impacts of cover crops on soil health and crop production. Soil samples were taken to characterize long-term changes in properties from subsurface drainage installation 35 years ago. Long-term tile drainage/water quality studies at Southeast Purdue Agriculture Center had drainage tiles installed at 5, 10, 20, and 40 m spacing in

1983, and changes in flow characteristics have been observed over time. Samples were taken at multiple depths and distances from the drains, to characterize bulk density, water retention, aggregate stability, carbon, nitrogen, and penetration resistance. Samples are being analyzed. Cover crop studies were continued at three Purdue research centers and 14 farmer cooperator sites, in collaboration with the Conservation Cropping Systems Initiative (CCSI) and other conservation partners in Indiana. A final soil health sampling occurred in summer 2018, to evaluate changes in soil health over a 5-year period from the baseline sampling in 2013. Individual farmer reports were prepared for each site through the 2016 sampling, and a report of the more limited 2017 data was prepared. These reports are available on CCSI website: http://ccsin.iaswcd.org/

Results

Findings quantified the impact of different N management timings and the inclusion of cover crops on nitrate-nitrogen loading and determined that cover crops had the ability to significantly reduce the loss of nitrate-nitrogen from a tile-drained field despite the nitrogen application timing. Cover crops reduced the leaching of dissolved reactive phosphorus. A major accomplishment was characterizing the dynamic and extent of soil bacteria microbiome response to inclusion of different cover crop species. The soil microbiome is the driver of nitrogen availability, thus understanding its response to cover crop adoption will help inform farmers to alter nitrogen fertilizer management following adoption of cover crops for optimum production. Another significant accomplishment was the development of methodology allowing cover crop adopting farmers the ability to perform in-season cover crop stand surveys of biomass and nitrogen uptake with only limited field sampling. This in-season survey is critical because it informs the cover crop management (termination) and cash crop management (nitrogen application timing and rate and residue management setting on the planter). Other findings quantified the synchrony of cover crop carbon and nitrogen release with corn and soybean critical nitrogen demanding growth stages. Quantified actual nitrogen uptake by corn and soybean planted subsequent to a cereal cover crop. This accomplishment is critical because it will help educate farmers and associated community on what percentage of N from the cover crop residue is used by the following cash crop, which could lead to adaptive management. Significant advances were made toward determining short-term economic benefit and risk of cover crop adoption. Data generated from these studies have the potential to help farmers better understand how cover crops interact with fertilizer and soil inorganic N, the relationship between cover crop species, termination timing and N release from cover crop residue in the cash crop growing season, the availability of N from cover crop residue, and the range of improvements in soil health that can be expected from cover crops.

4. Associated Knowledge Areas

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

Outcome #8

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
2018	25

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In livestock industries, the primary objective is efficient production of high quality, nutritious and wholesome meat, egg and dairy products for health-conscious consumers at reasonable cost. In addition, accumulation of N and P in soils and the threat to quality of surface water are major livestock production sustainability issues. The need is great to minimize the flow of detrimental levels of dietary nutrients through animal manure for an environmentally-sustainable animal production practice. Therefore, the efficiency of dietary nutrient utilization to minimize the flow of detrimental levels of dietary nutrients through animal manure to the environment is an important research goal. Understanding the role of manure storage, treatment and application with respect to nutrients and GHG dynamics across air-soil-water interfaces and its impacts on local microbial function is expected to lead to substantial improvements in managing manure application and predicting its environmental impacts. Effective manure treatment and methods of application can have significant impact on N and P cycling, and gas emissions in agriculture and ecosystems.

What has been done
Research goals are: 1) determine the influence of exogenous enzymes and modified feed ingredients on ileal and total tract digestibility of N and P, and nutrient excretion and gaseous emissions. 2) Evaluate effects of diet on health status and environmental footprint of swine and broiler production. 3) Reduce impact of odor, particulate matter, and noxious gases emitted from confined animal facilities. 4) Improve understanding of the impacts of manure storage, treatment, and land-application on N, P, and greenhouse gas transformations and losses across air-soil-water interfaces.

Results
Thirty-two barrows were used in a 35 day experiment to evaluate effects of supplemental soluble fiber (dextrin) pre- and post-weaning on growth performance and volatile fatty acids (VFA) production. Fiber was suspended in chocolate milk and administered orally through a syringe

from 14 days prior to weaning until 4 days post-weaning, after which it was included in the diet at 1%. At weaning, pigs were group housed by treatment and allowed ad libitum access to a common starter diet. On day 4 post-weaning, pigs were moved to individual pens and fed diets with or without 1% fiber. Weights and feed intake were recorded 14 and 3 days prior to weaning, and on day 0, 4, 11, and 21 post-weaning. On day 21 post-weaning, pigs were euthanized, and large intestine contents were collected for VFA analysis. Growth performance was not affected by treatment. A trend for an interaction of pre- and post-weaning fiber supplementation was observed for acetate and butyrate concentrations in large intestine contents. Pigs fed fiber only in the nursey had the highest acetate concentration, while pigs never receiving fiber had the lowest concentration. Pre-weaning fiber supplementation followed by no fiber in the nursery resulted in the highest butyrate concentrations with all other treatments being similar. Fiber supplementation pre-weaning tended to reduce isobutyrate concentrations. Pigs not receiving fiber post-weaning had increased valerate concentrations. Fiber supplementation caused alterations in VFA concentrations when fed during pre- and post-weaning, indicating possible shifts in the microbiome, immune status and barrier function of the intestinal tract.

Researchers completed: 1) diet manipulation and air quality in an experimental swine building, and 2) effects of dairy manure anaerobic treatment on nutrient flow in the environment. A model to predict thermal environment inside sow gestation barns was completed. Model inputs are weather, building orientation, dimensions and materials, geographical location, and sow herd characteristics, and outputs are daily means of inside temperatures and ventilation rates, and annual costs of electricity and supplement heat. The model showed that total energy costs are influenced significantly by temperature set point, thickness of ceiling insulation, and minimum ventilation rate. For an indoor recirculation aquaculture systems study, 3 Tilapia and 2 shrimp buildings were surveyed in winter and summer, and temperatures were recorded for at least 2 weeks. Recommendations were made to remedy observed inadequate ventilation rates and air distribution, excessive surface condensation, excessive heat loss, improper attic ventilation, inadequately sized heat exchangers, ill-advised use of expensive dehumidifiers, improper vapor barrier installation, and ill-advised use of ceiling inlets. A spreadsheet model was developed to calculate building heat loss factors and heat and moisture balances, predict surface condensation, determine proper ventilation rates, and estimate energy usage. Calculations showed ventilation is more efficient for removing humidity than dehumidification, and uninsulated floors are responsible for a significant amount of building heat loss. Results and conclusions from these studies can provide supporting information to assist research-based decision making and lead to more eco-friendly manure management practices, which will effectively reduce environmental pollution from agriculture and preserve a sustainable environment.

4. Associated Knowledge Areas

KA Code	Knowledge Area
306	Environmental Stress in Animals

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 # 3 - Field studies of emissions from animal production systems
Outcome # 5 - Analysis of forest inventory and plant data
Outcome # 7 - Field research of soil analysis for nutrient content
Outcome # 8 - Environmental analysis of animal facilities

Key Items of Evaluation

Outcome #5 - Regional and larger views of forests showed differences in resilience to climate change based on the moisture level and the amount of biodiversity.

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: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	11.1	0.0	35.2	0.0
Actual Paid	3.4	0.0	16.7	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
1351561	0	716982	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2480936	0	4159940	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
460947	0	743040	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

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	512	123200213	911	65

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

Patent Applications Submitted

Year: 2018

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	42	42

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of research projects

Year	Actual
2018	25

Output #2

Output Measure

- Number of consultations

Year	Actual
2018	158

Output #3

Output Measure

- Number of education workshops

Year	Actual
2018	1290

Output #4

Output Measure

- Number of volunteers

Year	Actual
2018	26

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	SE 5.6 - # Policy makers increased knowledge of decision models

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

2. **Associated Institution Types**

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	6

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Federal mandates for the production and use of advanced biofuels has increased the importance of developing technologies to reduce costs and improve efficiencies for cellulose-to-fuel production processes. Technologies that reduce the costs associated with generating fermentable sugars from plant biomass, (e.g., pretreatment and hydrolysis), can have immediate and substantial impacts. Costs associated with cellulose hydrolyzing enzymes are an order of magnitude more expensive than starch-degrading enzymes.

What has been done

The project goal is to develop fundamental knowledge of molecular and engineering processes required for sustainable conversion of renewable resources to transportation fuels and value-added products reducing the carbon footprint of agriculture and industry. The research is identifying lower cost technologies and enhancing the economics of transforming renewable resources to value-added and low carbon footprint molecules. A second objective relates to the application of bio-separation and enzyme technologies, developed for conversion of cellulose to biofuels to the rapid and cost-effective detection of food pathogens. Researchers are studying the impact of plant cell wall structure on its catalytic or bio-catalytic processing into molecules that serve as precursors or end products for use as transportation fuels; carrying out fundamental studies on catalytic mechanisms by which transformations may occur using either enzyme, chemical or microbial (fermentative) catalysts, and developing biochemical processes for effective transformation of plant cell tissues into identifiable alcohol, aldehyde, and aromatic molecules.

Results

For cellulose conversion, liquefaction of biomass that combines modeling of particulate material into pellets and pellets into liquefied biomass material has been initiated. A combination of fluid, solids and particles systems computational models, together with fundamental measurements of innate properties of corn stover particles are being used to define an envelope of processing conditions that lead to pumpable slurries of biomass materials at concentrations between 20% and 30%. For catalytic process, further research has proven beneficial effects of using non-catalytic proteins to block adsorption of enzymes onto lignin, thereby reducing the amount of cellulases by a factor of 5x to 10x required to carry out hydrolysis of cellulose in liquid hot water pretreated corn stover, hardwood and sugarcane bagasse. For biochemical processes, researchers developed a method to recover lactic acid from food waste at optimized conditions and accounted for understudied factors that influence yield (RedCorn and Engelberth 2018). Researchers quantified glycogen production potential from waste activated sludge employing enhanced biophosphorus removal techniques (RedCorn and Engelberth, 2018). In terms of food processing, researchers compared potential avenues for upgrading food waste and determined that higher value potential could be achieved from recovering a niche product rather than processing the waste via anaerobic digestion (RedCorn, Fatemi, and Engelberth, 2018). Researchers quantified the volume of lutein and zeaxanthin in distiller's dried grains with solubles (DDGS) and determined there was a non-trivial quantity and that further study is required to determine a cost-effective recovery method (Li and Engelberth, 2018). These research findings can help build understanding for more cost-effective technologies for biofuel production.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
402	Engineering Systems and Equipment
605	Natural Resource and Environmental Economics

Outcome #4

1. Outcome Measures

SE 5.1 - # Decision tools available

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

SE 5.6 - # Policy makers increased knowledge of decision models

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	74

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Since the 2007/2008 commodity crisis, there has been a resurgence of interest in sustainability of the world food system and its contributions to feeding the population and ensuring environmental sustainability of the planet. The number of people which the world must feed is expected to increase by another 2 billion by 2050 (Bloom 2011). When coupled with significant nutritional improvements for the 2.1 billion people currently living on less than $2/day (World Bank 2008, p.1), this translates into a very substantial rise in the demand for agricultural production. Food and Agriculture Organization of the United Nations (FAO) estimates increased demand at 70% of current production, with a figure nearer 100% in developing countries (Bruinsma 2009, p.2). Over the past century, global agriculture has managed to offer a growing population an improved diet, primarily by increasing productivity on existing cropland. In addition, agriculture and forestry are increasingly envisioned as key sectors for climate change mitigation policy. When combined, farming and land use change - much of it induced by agriculture - currently account for about one-third of global greenhouse gas emissions (Baumert, Herzog, and Pershing 2005). If incorporated into global climate policy, these sectors could contribute up to half of all mitigation in the near term, at modest carbon prices (Golub et al. 2009). Any serious attempt to curtail these emissions will involve changes in the way farming is conducted and place limits on expansion of farming - particularly in the tropics, where most of the agricultural land conversion has come at the expense of forests. Limiting the conversion of forests to agricultural lands is critical to preserving biodiversity on the planet (Green et al. 2005). These factors will restrict the potential for agricultural expansion with growing global demands. Finally, agriculture and forestry are likely to be the economic sectors whose productivity is most sharply affected by climate change (Lobell, Schlenker, and Costa-Roberts 2011; Schlenker and Roberts 2009). This will shift the pattern of global comparative advantage in agriculture (Reilly et al. 2007) and may reduce productivity of farming in precisely those regions of the world where poverty and malnutrition are most prevalent (Hertel, Burke, and Lobell, 2010), while increasing yield variability and vulnerability of the poor (Ahmed, Diffenbaugh, and Hertel, 2009).

What has been done

The broad objective of this project is to improve our understanding of the interplay between population and income growth, biofuels policy and production, international trade, climate impacts and policy in determining future food security, land use change and greenhouse gas (GHG) emissions at global and regional scales. Land-based GHG emissions account for about one-third of total GHG emissions and could offer up to 50% of efficient abatement potential at modest carbon prices. Yet current predictions of land use change and GHG emissions over the coming century are highly uncertain and often ignore economic factors altogether. Improving predictions and developing coherent policy recommendations which account for dynamic interplay between these forces is a high priority. To improve on the current state of knowledge and policies, the project has these objectives: 1) Understand and quantify the drivers of global changes in land use and GHG emissions, project such changes forward to 2050 or 2100, and formulate optimal policy responses to such changes. 2) Evaluate impact of uncertainty in climate impacts, change mitigation policies and energy prices on both optimal and observed land use change at global scale. 3) Assess impact of future water shortages on global food production, trade and land use. 4) Assess impacts of these global changes on world food prices, food security, livelihoods and poverty in developing countries.

Results

Researchers assessed the need for public investments in research and development (R&D) over the 21st century in light of the very long lag between such investments and U.S. agricultural productivity outcomes, and considerable uncertainty in future population, income and bioenergy growth, and climate impact. R&D has been the major driver of U.S. farm productivity growth since WWII, yet spending has recently leveled off and has even been declining. Failing to invest today in improvements of agricultural productivity cannot be simply corrected a few decades later if the world finds itself short of food. Researchers computed the optimal path of agricultural R&D spending over the 21st century for each Shared Socioeconomic Pathway, along with valuation of regrets associated with investment decision-making. Regret is minimized to find a robust optimal R&D pathway that factors in key uncertainties and the lag in productivity response to R&D. Results indicate that the whole of impact by uncertainty on R&D is greater than the sum of its individual parts. Uncertainty in future population was the dominant impact on optimal R&D expenditure path. The robust solution suggests that the optimal R&D spending strategy is very close to the one that will increase agricultural productivity fast enough to feed the world under the most populous scenario. It also suggests that society should accelerate R&D spending up to mid-century, thereafter moderating this growth rate. These computation results may help in decision-making to support R&D for agriculture productivity to feed the population of the planet.

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Extension programs conduct evaluation surveys to measure change in knowledge and intentions of participants, and follow-up surveys to assess change in behavior or practice and results of actions. Field and lab research projects monitor progress and completion of study objectives and tasks, testing of simulations, models and new technologies, and publications of findings, to determine effectiveness and accomplishment.
Evaluation results included:
Outcome # 3 - Lab research to separate lignan from plant tissue for biofuels and bioproducts
Outcome # 5 - Economic modeling for research and development funding supporting food production for the population in 2050

Key Items of Evaluation

Outcome # 7 - Research methods defined for efficiently creating fuel from plant cell tissue

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: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	4.5	0.0	7.0	0.0
Actual Paid	3.4	0.0	11.7	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
1160659	0	419990	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2560408	0	3367581	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
412648	0	812565	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

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	9245	128792	13076	171091

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

Patent Applications Submitted

Year:	2018
Actual:	3

Patents listed
ZL20161221567.0 (China)
10,117,937 (United Sates)
104379175 (United States)

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	8	39	47

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of education workshops

Year	Actual
2018	497

Output #2

Output Measure

- Number of research projects

Year	Actual
2018	48

Output #3

Output Measure

- Number of volunteers

Year	Actual
2018	177

Output #4

Output Measure

- Number of consultations

Year	Actual
2018	6057

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 1.2 # Viable prevention, control and intervention strategies for all food production scales for foodborne threats along the food production continuum
5	FS 4.1 # Projects focused on increased understanding of the ecology of fecal indicators and pathogens
6	FS 3.1 # Growers, producers, and food workers completing GAPs, GMPs, HACCP, food safety certification an onfarm 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

Not Reporting on this Outcome Measure

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	5373

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Foodborne illnesses are common, costly, yet preventable, public health problems. CDC estimates that 1 in 6 Americans gets sick from contaminated foods or beverages and 3,000 die each year. The USDA estimates that food borne illnesses cost $15.6 billion each year. Reducing foodborne illness by 10% would keep 5 million American from getting sick each year. Preventing a single fatal case of E. coli infection would save an estimated $7 million.

What has been done

Purdue Extension Health and Human Science (HHS) Educators have become certified instructors and proctors for the ServSafe curriculum. Purdue Extension partners with the National Restaurant Association, Indiana Restaurant and Lodging, ServSafe, State and Local Boards of Health, and Ivy Tech community college to provide one- and two-day trainings, recertification training, proctoring of exams, and the Food Handler training for those in the food service industry needing certification to meet Indiana Food Code requirements. Other partnerships are with local area restaurants, hospitals, country clubs, schools, senior living facilities, food trucks and Illinois business owners.

Results

27 Health and Human Sciences educators and one specialist have become certified as dual instructors and proctors for the ServSafe curriculum for Manager Certification. In 2017-2018, 44 one-day, 12 two-day, 10 Recertification trainings and 278 Exam-Only sessions were taught and proctored across Indiana. There were 688 participants in the one- or two-day trainings with 602 (88%) achieving certification on the exam (average score 84%). 88 individuals participated in the recertification training with 77 (89%) receiving certification (average score 85%). 278 took the exam either online or on paper with 218 (78%) receiving certification (average score 81%). A total of 1,052 attempted the exam either with direct training and 897 (85%) received certification. The Food Handler program was offered 4 times with 36 participants and 29 (80%) received a certificate of completion (average score 78%). A total of 123 participants completed the end of session surveys: 1) 74% found the program valuable, 2) 95% felt the objectives were realistic, 3) 93% thought they learned more than reading on their own, 4) 93% felt the resource people were well prepared, and 5) 93% found the materials were presented at the proper level of difficulty. As a result of the training: 1) 74% were washing hands more frequently during food preparation of and service, 2) 80% were checking temperature of food to make sure it had cooked to a safe temperature, 3) 84% were taking temperatures of food to make sure it cooled quickly to a safe temperature, 4) 81% were keeping raw foods separate from ready-to-eat foods, and 5) 79% were making sure all work surfaces, equipment and utensils were cleaned and sanitized before preparing and serving foods. Having workers trained, certified, and adopting safe practices in food preparation will help contribute to reducing risk of food borne illnesses in Indiana.

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
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #4

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	6

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Cell death resulting from pore formation in cell membranes by peptides has important consequences in biology. An important function of pore forming peptides is in the defense of plants and animals against invading microbes. These antimicrobial peptides could also be very useful for combating drug resistant microbes. The exact mechanism of pore formation and cell death is not well understood. Elucidation of this mechanism can be applied to arrive at guidelines for design of antimicrobial peptides to replace antibiotics. Much lower intensity ultrasound can deactivate a microorganism by thinning the cell membranes as a result of regular oscillations of bubbles produced by cavitation. Ultrasound has found recent applications in sterilization of food when used in combination with heating or high pressure (or both) by increasing the efficiency of the process. It is of interest to lower processing cost of food products to improve quality and safety at lower cost. For conventional sterilization processes, energy input required to produce products with impeccable safety is very high. It is believed that pore formation by antimicrobial peptides (AMP) will be assisted by thinning of the cell membranes that are caused by low intensity ultrasound. Combined use of antimicrobial peptides with low intensity ultrasound is expected to be more energy efficient than conventional processes with minimum loss of quality. Pathogenic bacteria are known to develop resistance to antibiotic which is its biggest limitation. As compared to the traditional antibiotics, AMPs kill bacteria rapidly and can involve multiple targets. Naturally occurring AMPs are expensive and are of limited availability. Currently, there are no rational methodology for design of synthetic peptides (SP) with antimicrobial activity. Selection of SP for specific activity would require screening of large number of potential candidates. Such a screening by experimental investigation of kill rates of microorganism is currently empirical and is therefore not feasible. For example, synthesis of one gram of an AMP can cost up to $400, whereas for a conventional antibiotic, this price can be under $1. Thus, commercial-scale production platforms to synthesize AMPs are urgently needed.

What has been done
Curcumin (CUR) is a natural food ingredient with known ability of targeting microbial cell membrane. In this study, the interaction of CUR with different types of model lipid bilayer (POPE, POPG, POPC, DOPC, and DPPE), mixture of model lipid bilayer (POPE/POPG), and biological membrane mimics (E. coli and yeast) were investigated by all atom explicit solvent molecular dynamics (MD) simulation. CUR readily inserts into different types of model lipid bilayer systems in liquid crystalline state, staying in the lipid tails region near the interface of lipid head and lipid tail. Parallel orientation to the membrane surface is found to be more probable than perpendicular for CUR as indicated by the tilt angle distribution. This orientation preference is less significant as the fraction of POPE is increased in the system, likely due to the better water solvation of

perpendicular orientation in POPE bilayer. In E. coli and yeast bilayers, tilt angle distributions were similar to that for POPE/POPG mixed bilayer with water hydration number around CUR for the former being higher. Insertion of CUR resulted in membrane thinning.

Results

The results from these simulations can provide insights into the possible differences in membrane disrupting activity of CUR against different types of microorganisms. Recent studies have shown that both low frequency (20-100 kHz) ultrasonication and antimicrobial peptides (AMPs) treatment processes have a significant advantage in inactivating bacterial cells than the conventional heat treatment due to higher food texture quality of the final product. However, the effect of the combined process has not been fully investigated in complex matrices such as food. In this study, deactivation of Escherichia coli in different concentrations of milk and orange juice were performed using three different treatments: low frequency ultrasonication (20 kHz) at different power levels, antimicrobial peptide Cecropin P1 at different concentrations, and combination of both. The results of all samples showed that the combined treatment is more efficient, reducing the cell density of E. coli up to four orders of magnitude, compared to individual treatments. However, the milk concentration results in lower synergistic effect. This is believed to be due to complexation of milk proteins with Cecropin P1 thus resulting in less availability of the latter for antimicrobial action. This dependence was not observed in orange juice samples.

4. Associated Knowledge Areas

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

Outcome #5

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

There are major gaps in our 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 us to identify 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.
Research is needed to generate 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 (leaf surface habitat for microorganisms). This research 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. 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 overarching goal of this project is to try and better understand the role that the natural bacterial community associated with romaine lettuce plays in the establishment and persistence of human pathogenic bacteria on commercially grown lettuce. To accomplish this goal we are adapting an existing technology (BEAM optical light scattering) to address a new type of problem: providing taxonomic identification of a wide range of bacterial species in a mixed community isolated from nature. 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.
This has not been without its challenges, but additional work on both the protocols and the software can most likely meet these challenges. The team is beginning to directly look at how the composition of the native bacterial community affects the growth of the human pathogens on the lettuce leaf. These effects turn out to be highly sensitive to the environment in which the lettuce plants are growing and so additional work will be required to identify the critical factors involved. A photographic library of the colony morphology of the identified bacterial genera associated with romaine lettuce is also being created as a web-based tool to be used as an identification guide for the fresh produce industry.

Results

Objective 1: Develop and test 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.
Four BEAM libraries of the lettuce microbial community by collecting scatter patterns of 31 bacterial strains representing the 10 most abundant genera of bacteria found on romaine lettuce have been. These strains were divided into 4 libraries based on the optimal incubation time for a well resolved scatter pattern. Training sets were created with these data, and the Positive Predicted Values (PPV) of the cross-validation (CV) matrix were above 90% for all but one of the genera. Validation with pure cultures achieved PPVs of greater than 80%, but some genera showed misclassification rates up to 44% when grown in mixed cultures. Five bacterial genera

were identified that produce similar scatter patterns. This issue will be addressed by increasing the number of features differentiating these bacterial genera in order to decrease their misclassification rates as well as by using a two-step classification system that allows clearer distinctions to be made between a smaller number of closely related scatter patterns.
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.
Inoculation experiments have been carried out using small numbers of human pathogenic bacteria (100-200 cells) on lettuce leaves either removed from the plant and kept in a controlled environment or on intact lettuce plants growing in the greenhouse. Inoculated leaves grown in highly humid environments demonstrated that the pathogens are able to persist and replicate at variable rates under these conditions, with the growth rate observed depending on the age of the lettuce leaf. Pathogenic bacteria inoculated on plants in the greenhouse proved to be eliminated rapidly, probably due to the very low humidity found in this environment. A controlled set of experiments at varying temperatures and humidity's is currently underway in growth chambers.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
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 #6

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	268

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The Food Safety Modernization Act (FSMA) was signed into law in 2011. The law shifted the role of the FDA from reaction to prevention. This shift required all states to evaluate their programs and regulations regarding the production and sale of food along the entire food supply chain. The Produce Safety Rule was the newest and one of the more complex rules introduced and little was available with regards to consistent or mandatory training. In response to the Produce Safety Rule, an increased number of wholesale buyers are asking more fruit and vegetable growers to have a third-party audit before they will purchase produce from their farms. The third-party audits are very expensive ($900-$10,000 depending on the size of the farm and the number of different crops grown) and this cost is mostly associated with travel and travel time as there are no Indiana based auditors.

What has been done

The Indiana State Department of Health, in collaboration with Purdue University developed extensive training protocols to meet FDAs new Standards for the Growing, Harvesting, Packing, and Holding of Produce for Human Consumption. To address the possibility of establishing an Indiana based third party audit system, Purdue worked with consultants (New Venture Advisors) to conduct a needs and feasibility study. This study involved growers, regulatory agencies (ISDH, ISDA), buyers, and Purdue Extension and the results indicated that a third-party audit system was feasible in Indiana.

By combining several Hatch projects and previously funded USDA research with FDA funding, Indiana was able to administer the regulatory compliance of the Produce Rule of FSMA. Part of this training included an educational component to help growers learn about FSMA and the Produce Rule as well as teaching the Produce Safety Alliance Good Agricultural Practices Training that all growers who are covered by the Produce Rule need to take to be compliant (this replaced the previous GAPs A-Z training that was developed and offered by Purdue Extension).

Results

A total of 22 PSA GAPs trainings with a total of 260 people receiving certificates of completion from the Association of Food and Drug Officials were delivered since November 2016. Although funding has not been received to make a third-party audit system viable in Indiana, Purdue has been offering on-site farm visits and performing mock audits on farms to help them prepare for a third party audit. To date, Purdue has assisted 7 farms (who were doing a third-party audit for the first time) to pass their audit on the first attempt.

4. Associated Knowledge Areas

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

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

{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 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 #3 - ServSafe food handler certification knowledge test and follow-up survey on adopted practices
Outcome #4 - Comparison of heat versus ultrasonic treatment on bacterial cells in milk and orange juice
Outcome #5 - BEAM optical light scattering of bacterial and fungal species on lettuce
Outcome #6 - Indiana producer certification and compliance with the 2011 Food Safety Modernization Act via GAPS training and farm visits

Key Items of Evaluation

Outcome #3 - 897 individuals completed certification for safe food handling

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: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	1.2	0.0	11.0	0.0
Actual Paid	0.3	0.0	3.1	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
1043682	0	213763	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2275409	0	2652951	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
403912	0	789152	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

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1249	32112	14706	15540

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

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	33	33

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of research projects

Year	Actual
2018	3

Output #2

Output Measure

- Number of consultations

Year	Actual
2018	777

Output #3

Output Measure

- Number of education workshops

Year	Actual
2018	258

Output #4

Output Measure

- Number of volunteers

Year	Actual
2018	226

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 bioactivies and botanicals), chronic Diseases, and impacts of environmental factors on health
6	CO 1.9 - # Of discoveries, innovations, technologies that relate to economic and/or community policies that impact childhood obesity (e.g. serving sizes/products available in schools, legislation regulating drink sizes/refills such as in NY, etc.)
7	# of counties that have active health coalitions
8	HHS 1.3 - # of discoveries, innovations, technologies relation to Health Disparities

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 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
2018	50

3c. Qualitative Outcome or Impact Statement

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

What has been done
Collectively, four research studies are focused on these important aspects of the Dietary Guidelines Advisory Report, to assess the impact of dietary protein intake and protein-rich animal-based agricultural food commodities on the effectiveness of healthy diet patterns. Specific objectives include: 1) To assess the effects of within-day patterning of dietary protein intake (even vs. skewed) on energy-restriction and strength training-induced changes in body composition, skeletal muscle size, appetite, glucose response, and metabolic syndrome parameters. 2) To assess the health effects associated with the inclusion of greater amounts of red meat (pork and beef) versus poultry and fish into a healthy Mediterranean-style dietary pattern, which recommends restricting red meat consumption. 3) To assess associations between the quantity and sources of protein intake and body composition in a nationally representative sample of U.S. adults aged 50 years and older.

Results
For the within-day dietary protein patterning study, findings showed: 1) The effectiveness of dietary energy restriction combined with resistance training to improve body composition is not influenced by the within-day distribution of protein when adequate total protein is consumed; 2) Consuming a rapidly digested whey protein snack two hours after a slowly digested, lower protein breakfast resulted in a greater peak plasma essential amino acids (EAA) concentration but comparable plasma EAA availability than consuming a single higher protein breakfast. Further analyses showed: 1) Concurrently with resistance training, consuming protein supplements with meals, rather than between meals, may more effectively promote weight control and reduce fat mass without influencing improvements in lean mass; 2) Whey protein (WP) supplementation

improves body composition of women by modestly increasing lean mass without influencing changes in fat mass. Body composition improvements from WP are more robust when combined with energy restriction. The Mediterranean-style dietary pattern study results supported that adults who are overweight or moderately obese may improve multiple cardiometabolic disease risk factors by adopting a Mediterranean-style eating pattern with or without reductions in red meat intake when red meats are lean and unprocessed. A review of dietary recommendations regarding consumption of muscle foods, such as red meat, processed meat, poultry or fish, found studies largely rely on current dietary intake assessment methods, including: 1) food frequency questionnaires; 2) food disappearance data from the USDA Economic Research Service; and 3) dietary recall information from the National Health and Nutrition Examination Survey data. These reported methods inconsistently classify muscle foods into groups, which creates discrepancies in estimated intakes. Researchers who classify muscle foods into these groups do not consistently consider nutrient content, leading to implications of scientific conclusions and dietary recommendations. These factors demonstrate the need for a more universal muscle food classification system. Further specification would improve accuracy and precision to classify muscle foods in nutrition research. Dietary protein intake and body composition results in elderly men who consumed diets containing at or below recommended dietary allowance (RDA) for protein and had skeletal muscle dysfunction were: controlled protein intake for six months exceeding the RDA did not increase lean body mass (LBM), muscle performance, physical function, or well-being measures. The RDA for protein is sufficient to maintain lean body mass, and protein intake exceeding the RDA does not promote lean body mass increase or augment anabolic response to testosterone. Also, findings from a study of older men and women who consumed a high-protein diet with whole eggs or a normal protein diet without eggs for 12 weeks showed a high-protein diet promotes lean mass retention with modest weight loss, but does not positively influence muscle composition, cardiometabolic health or systemic inflammation, compared to a normal protein diet void of eggs. The important, novel findings may be used by scientists, health practitioners, and nutrition and health policy and program officials to develop and implement dietary guidelines to help people improve their health by consuming within-day and infradian patterns of healthy foods and beverages.

4. Associated Knowledge Areas

KA Code	Knowledge Area
701	Nutrient Composition of Food
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior

Outcome #6

1. Outcome Measures

CO 1.9 - # Of discoveries, innovations, technologies that relate to economic and/or community policies that impact childhood obesity (e.g. serving sizes/products available in schools, legislation regulating drink sizes/refills such as in NY, etc.)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	4

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A rigorous study of modern food marketing requires agricultural economists to adopt and make methodological improvements to economic tools, such as contract theory (the study of incentive and pricing design). The methodological toolkit currently used is based on older models appropriate for studying small producers and consumers. Modern agribusinesses are large, sophisticated and characterized by substantial strategic interaction with suppliers and customers. Contracting is pervasive and essentially incentive mechanisms to coordinate marketing strategies. Contracting models are useful for studying strategic pricing schemes that provide incentives to consumers to purchase more or to self-select into different market segments. According to MacDonald and Korb (2011), use of contracts in agriculture has been increasing over the last several decades. In 1969, contracts governed only 12% of the total value of U.S. agricultural production, but this has increased to 39% in 2008. For specific commodities such as hogs, poultry, and many fruits and vegetables, contracts dominate most production. Contracts are pervasive between food manufacturers and wholesalers and/or retailers, yet agricultural economists have not studied these downstream contracts in a rigorous manner (Myers, Sexton, and Tomek 2010). Food retailers are using increasingly sophisticated marketing and strategic pricing schemes to market food to consumers. Lack of methodological development in contract theory within the agricultural economics community has limited ability of agricultural economists to study important contemporary policy issues.

What has been done
This research focused on food marketing and contract theory (the study of how incentives and strategic pricing mechanisms should be designed to induce people to enhance productivity, minimize costs, purchase products, and/or achieve social objectives in policy making). However, contract theory has limited real-world application. Activities were to: 1) Make methodology improvements to theoretical contracting models to be more robust for applied work - that is, imposing minimal critical assumptions. 2) Test the models and their robustness using experimental economics. 3) Use the models that have been successfully stress tested to investigate relevant contemporary agribusiness or food policy issues.

Results
The main accomplishment was completion of a theoretical model that makes predictions about how people will structure contracts across different contract enforcement institutions. A key distinguisher of different enforcement institutions is the availability of performance measurement technologies that can enable third-party verifiability (e.g. by courts or arbitrators) of contractual performance. Next, researchers examined how people structure contracts in different trading

environments, including several thousand longitudinal trade observations. A key finding was that the contracting party with stronger bargaining position will design contracts that shift more risk onto the weaker party. Also, people tend to contract for lower performance objectives when they worry about counter-party risk. These results lend insight into how contracts should be structured to minimize counter-party risk especially when there is market power. Finally, research examined contracting models related to the New York City ban on sodas in large containers, taxes on soda, and who gains and who loses from the restriction. The key finding is that the size-restriction predicted to reduce the size of sodas across all size categories, actually caused a decrease in size of the large soft-drink only. Sellers will keep the size of smaller drinks unchanged. This should lead to a reduction in consumption only by heavy soda consumers, which appears politically desirable. Low-consumption consumers will largely be unaffected. Soft-drink consumers will suffer more welfare losses under the tax than the size restrictions because the price per ounce will increase under the tax. Not surprisingly, soft-drink sellers are likely to have their profits reduced. These studies provide insight into the marketing and contracting related to agribusinesses.

4. Associated Knowledge Areas

KA Code	Knowledge Area
607	Consumer Economics
610	Domestic Policy Analysis

Outcome #7

1. Outcome Measures

# of counties that have active health coalitions

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	48

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In 2012, Jackson and Lawrence Counties had an adult obesity rate over 40%, the highest in Indiana. 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. Amenities and services that promote healthy

behaviors tend to be primarily available 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

With six counties added in 2018, now Indiana has a total of 48 counties with one or more active health coalitions. In Jackson County, the Healthy Jackson County Coalition, and in Lawrence County, the Live Well Lawrence Coalition, represented small groups of individuals who saw a need to develop new opportunities for health in their communities. The Healthy Jackson County Coalition aims to: 1) lead efforts focusing on communication, education, access, sustainability, and collaboration among community members, 2) provide and promote access to healthy foods, 3) provide education and promotion on how to use and consume healthier foods, and 4) provide opportunities for all community members to participate in physical activity. The Live Well Lawrence Coalition aims to: 1) establish a community voice for health across the entire county, 2) enable and support local organizations to integrate healthier food options, and 3) promote the many free physical activity opportunities across the county to community members. Both coalitions were motivated to pursue projects and programs but, general support had waned over the past few years. Both coalitions were poised for a revitalization and redirection to pursue policy, system, and environmental (PSE) changes to foster long-lasting health benefits in their communities. To avoid common pitfalls of coalitions (members focus on leading single, short-term activities and programs, and ignoring operating structures and processes) and to support a long-lasting coalition that initiates sustainable change, considerable time and resources were devoted to supporting coalition function, partnerships, and leadership. The work of these coalitions provided the context to seek Centers for Disease Control and Prevention (CDC) funding for the health of Jackson and Lawrence County citizens. A vital aspect of the partnership between the CDC and Purdue was to ready citizens in both counties to support healthy lifestyles in their hometowns long after the grant period ended. Purdue Extension team members focused on building coalitions that used evidence-based practices to pursue their aims. Purdue Extension led initial meetings on establishing trust, building partnership, and learning about organizations and people that share common interests and goals, focusing members on sustainability by educating them on the importance of PSE changes, facilitating transition to more community-led leaders by establishing committee chairs and mentoring potential leaders, and building momentum for coalition activities by pursuing quick victories to keep members energized and committed. Many activities required onboarding of new partners and community leaders. The coalitions steered clear of hosting single events (e.g., half marathons) and, instead, worked to educate the public, change environments, and make policy changes to instigate longer lasting change.

Results

Community accomplishments for Healthy Jackson County Coalition included: 1) Safety activities: new downtown crosswalks and bike lanes in Seymour, updated and additional crosswalks near schools and public pool in Brownstown, and, purchase of the comprehensive CATCH health promotion curriculum for after-school and preschool nutrition and physical activity programs in Seymour, Brownstown, Medora and Crothersville. 2) Increasing healthy food consumption activities: School wellness policy for over 6,900 students in Seymour, Medora, Brownstown, and Crothersville schools, Farmers Market SNAP benefit promotion, distribution of healthy food donation guidelines, gardening projects led at youth clubs, healthy concession stands at schools and youth sport leagues for over 32,000 residents and at city recreation facilities for over 76,000. 3) Physical activity efforts: exercise ideas signage on Refuge Trails with 170,000 annual visitors, ?walk your city? signage in Seymour with 48,000 visitors per year, and improved crosswalks, bike lanes, and new fitness equipment in Seymour for over 48,000 potential users. Community accomplishments for Live Well Lawrence Coalition included: 1) Safety activities: National Walk to

School Day, active routes to school, and reflective paint on crosswalks in Mitchell, complete streets policy in Bedford, and continued work to establish Mitchell as a Trail town. 2) Increasing healthy food consumption activities: school wellness policy for 6,200 students, healthy concession stands for over 6,000 participants, and healthy food pantry donation guidelines for facility with 19,000 people served. 3) Physical activity efforts: established the Blue Jacket Trail for 45,000 residents with 1.1 miles of marked walking trail with signage, online map of trail system, adult outdoor exercise equipment for Mitchell, Judah, Fayetteville, and Springville, and installation of bike racks, benches, and active transportation signage on Main Street in Mitchell. As demonstrated by the reach and leveraged funds, the coalition influence extends beyond the activity and serves as a mobilizer of new people and places to support the health of citizens.

4. Associated Knowledge Areas

KA Code	Knowledge Area
701	Nutrient Composition of Food
703	Nutrition Education and Behavior
806	Youth Development

Outcome #8

1. Outcome Measures

HHS 1.3 - # of discoveries, innovations, technologies relation to Health Disparities

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	5

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Major health issues arise from the American food system, as prevalence reports show food-related issues: chronic disease (such as diabetes, cancer, and heart disease), obesity and food insecurity. Understanding why and how obesity rates are stabilizing among some groups while increasing in others is key to developing strategies for decreasing obesity across populations. One link is the connection between obesity and food insecurity. Nearly 15% of households (over 50 million people) were food insecure in 2008 (up from 11% in 2007), meaning that at times they did not have enough money for food. Many food-related health problems disproportionately affect

children, women, ethnic minorities, and low-income people. Addressing food insecurity, nutrition, and food-related diseases, requires understanding of the processes of institutional change, structural conditions, perceptions, and decision-making. As the obesity epidemic dominates healthcare, prevention and treatment, and as food insecurity increases, nutritionists are beginning to understand that efforts must move beyond individual behavior change. New and community-engaged approaches to conceptualization, study, outreach and integration are needed to address constraints to health and well-being including obesity, food insecurity, diabetes and other chronic diseases.

What has been done

This project examines family, community, and institutional dynamics to better understand how the food system influences individual and population health. This includes investigating the interaction between food consumption by families and how family food selections are influenced by interactions family members have with one another and with their food environments. Activities included: 1) Analyze best practices proven effective at increasing individual, household, and community food and nutrition security, and identify individual and systemic strategies for developing and disseminating initiatives to improve food and nutrition security. 2) Utilize food systems approaches to assess and address nutrition, health, and wellness challenges of vulnerable population groups (e.g., children, elderly, low income, immigrant, minority) with focus on food availability, appropriate policy systems and environmental changes. 3) Assess key strengths and weaknesses of current public and private emergency food assistance systems relevant to improving food security and addressing the health and nutritional needs of program participants.

Results

Researchers developed an innovative, reliable, and validated tool to measure perceptions of participants of direct education programs that affect their access to food and physical activity. Results showed a classroom nutrition education program was able to increase student knowledge about fruits and vegetables, recognition and nutrition content, but there was no effect on increasing consumption of fruits and vegetables. For individual perception of the environment on health outcomes, Extension educators collected data from 1,743 SNAP-Ed participants from seven Northern and Central states about food, physical environment, and self-reported health characteristics. Participants were: 78% females, average age 44.43 years. 42% married, 41% employed, 55% reside in urban areas, and 59% non-Hispanic white. There were 43% classified as obese and 74% overweight. More than 68% agreed there is a large selection of fresh fruits and vegetables available, while 82% agreed there are plenty of opportunities for purchasing fast food. 75% shop for most of groceries at supermarkets or super stores, and these stores were, on average, 4.5 miles from their homes. Preliminary analysis shows individual perception about food environment is associated with health outcomes (obesity and BMI). For SNAP effect on nutrition, several groups of participants and non-participants were studied. Findings do not suggest a large impact of SNAP on food choice, and do not support a claim that SNAP has a negative effect on nutrition. For a study on effectiveness of an unobtrusive method (nudge) to encourage choice of healthier food items in a client-choice food pantry, food items were given a zero to three stars for nutritional value. Before entering, clients were randomly assigned to treatment or control groups. Treatment group clients completed a survey with nutritional rating sheet for pantry items, and clients indicated likelihood of selecting them. Control group clients completed the survey only. After clients selected pantry items, researchers recorded selected food items. All of these research activities will help to increase understanding of problems and solutions in systems of the food, nutrition and health in our communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior

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 human consumption of protein in the diet
Outcome # 6 - Economic analysis of effect of policy on costs to sellers and consumers of soda
Outcome # 7 - Post survey of community participants in health coalition activities
Outcome # 8 - SNAP participant interviews, surveys, and tracking of food accessibility and selection

Key Items of Evaluation

Outcome # 5 - Research identified effective protein consumption approaches related to weight management.

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: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	16.9	0.0	29.6	0.0
Actual Paid	14.6	0.0	34.0	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**
1634271	0	585238	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2871303	0	5854083	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
564032	0	1022066	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

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	119214	2717173	279349	949619

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

Patent Applications Submitted

Year: 2018
Actual: 4

Patents listed
All United States
9,861,707
9,969,964
10,087,190
10,138,252

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	27	273	300

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of education workshops

Year	Actual
2018	8575

Output #2

Output Measure

- Number of community collaborations, coalitions, partnerships

Year	Actual
2018	4785

Output #3

Output Measure

- Number of volunteers

Year	Actual
2018	8291

Output #4

Output Measure

- Number of research projects

Year	Actual
2018	104

Output #5

Output Measure

- Number of consultations

Year	Actual
2018	93610

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	NIFA FCS1.HCFD1 - # of individuals who learn about healthy child and/or family development
21	# of participants identified dietary recommendations for eating and preparing more heart-healthy meals
22	# of youth that would like a job that uses science
23	# of youth certified in Youth for the Quality Care of Animals (YQCA)
24	NC 13 - $ value of grants and resources leveraged/generated by communities
25	HHS 3.1 - # of discoveries, innovations, technologies related to Culture and Diversity

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

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	357

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Existing businesses and the local workforce are key barometers of community economic health (as a place to live, work and play). Research shows that small businesses are the major drivers of job growth. In Indiana, 85% of all existing businesses employ less than 100 people. They are the often-overlooked growth machine of the state and the ones most likely to add new jobs to their portfolio. Business retention and expansion is critical for communities as it provides the cultural aspect, quality of life, and longevity necessary for the economy.

What has been done
Purdue Extension Business Retention and Expansion (BR&E) is intended to help focus the energies of community stakeholders on economic assets that exist in their cities, counties and regions, making them stronger and more resilient over time. The program helps local communities understand issues related to their economy, and makes local officials aware of business needs and resulting expansion strategies. A strong relationship among community stakeholders (businesses, residents, local leaders/officials) helps communities understand local business needs and respond, so that businesses grow, stay and become more committed to the community. Special attention is given to small businesses that employ between two to 99

employees, otherwise known as Stage 1 and Stage 2 firms. BR&E communities learn: 1) How to approach business retention and expansion, 2) Models for business visitations and surveys, 3) Tracking feedback and response, and 4) Fostering and strengthening business alliances. In 12-18 months building capacity among local leadership is key and is accomplished through development and implementation of a local task force. Purdue Extension supports these communities throughout, including developing survey questions, analyzing results, writing final reports and helping to present findings to the community. Research and data are provided to the local task force to help them identify, design, implement and evaluate strategies to strengthen businesses and industries. Purdue Extension takes the lead for the first cycle, then after 12-18 months, the local task force coordinator takes the lead and begins a second cycle of BR&E, targeting a different business sector (e.g., agriculture, manufacturing, retail sector or downtown businesses). Which companies are targeted in each cycle is up to the local task force. BR&E started a couple years ago with a pilot program in Parke County. During 2018, more communities have been added, and Purdue Extension delivered over 30 sessions in Knox, Owen, Fulton, Posey and Vanderburgh Counties.

Results

From the pilot program in Parke County, BR&E has harnessed community support of ten task force members and one full-time coordinator. Members conducted business visits and will complete the results report on identifying red flags and opportunities for growth. During the process, a community readiness assessment was conducted to gauge the support of the community and leverage additional resources as needed. Parke County completed the first cycle of BR&E, and the coordinator stated The company visits allowed insight for the task force which is creating more energy in the community to support local businesses. A strong relationship with the businesses is invaluable. The task force coordinator, began Cycle 2 of the BR&E program, with support from Purdue Extension with curriculum, data, resources and monthly connection. In Owen County, BR&E participants organized a task force, studied data about their county, identified local business participants, conducted interviews, analyzed results and responded to opportunities that resulted from the interviews. They compiled their final report to communicate the story of the local economy to the public. They will wrap up their first BR&E cycle in January 2019. Other Counties are in process of reviewing data and compiling results. Each local BR&E program runs in cycles to continue the dialogue with businesses in the community, in an ongoing effort toward economic sustainability.

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development
610	Domestic Policy Analysis
611	Foreign Policy and Programs
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
801	Individual and Family Resource Management
802	Human Development and Family Well-Being
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
805	Community Institutions, Health, and Social Services
806	Youth Development

Outcome #6

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	821

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Community professionals in fields such as Extension, philanthropy, local government, state government, and natural resources seek facilitation skills training to be able to lead participatory meetings, discussions, and decision-making processes.

What has been done
Purdue Extension taught the Facilitative Leadership workshop twice in Indiana to 37 participants. Each workshop includes a 90-minute webinar and 27 hours of face-to-face instruction scheduled over three days. Participants lead a 10-minute discussion. They plan and lead a 45-minute group facilitation using tools taught in the workshop. Each participant gives and receives feedback to fellow classmates in their small group.

Results
The one-year follow-up survey was completed by 11 of 22 participants. As a result of the training, and in the year following: 1) Eight participants took on new leadership roles, 2) 117 volunteer hours were completed using facilitation skills, a $2,776 value based on Independent Sector for 2017, 3) participants facilitated groups for the creation of five plans, four of which were adopted and three implemented, 4) 14 partnerships were created, and 5) $68,000 was leveraged as a result of facilitating activities. 100% of participants said the workshop was extremely or very valuable to their work, community, or volunteer efforts.

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #7

1. **Outcome Measures**

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

Not Reporting on this Outcome Measure

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**

   NIFA FCS1.HCFD1 - # of individuals who learn about healthy child and/or family development

2. **Associated Institution Types**

   - 1862 Extension

3a. **Outcome Type:**

   Change in Knowledge Outcome Measure

3b. **Quantitative Outcome**

Year	Actual
2018	6517

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

Issue (Who cares and Why)

In Indiana, there are over 400,000 youth ages 10 to 14. This age cohort is subject to social and emotional changes, greater academic challenges, and biological changes. They face 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. Parenting can be a very stressful responsibility, however, high levels of stress that persist for extended periods in families can negatively affect a child.

What has been done

Focusing on one of the human development programs provided by Purdue Extension, Strengthening Families Program: For Parents and Youth 10 to 14 (SFP: 10-14), is an evidence-based parent, youth and family skills-building curriculum that: 1) prevents teen substance abuse and other behavior problems, 2) strengthens parent/youth communication skills, 3) increases academic success in youth, and 4) 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. Youth learn about peer pressure resistance, reducing stress, finding family values, problem solving, goal setting, and resisting substance use. Parents learn 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. The joint session allows families to bond by participating in learning game activities, and projects, such as making a family, identifying family members strengths, strengthening communication skills, and increasing problem-solving skills. There were 96 adults and 92 youth enrolled in 12 programs held in 12 counties during 2017-2018. Program post-/pre-reflective evaluations were completed and data collected from 49 adults and 50 youth.

Results

Post-/pre-reflective assessments for youth showed positive changes in knowledge and actions. Almost twice as many youth indicated they had family meetings (a tool introduced in the program)some or most of the time after the program. There was a 54% increase in youth who indicated they could do things to help themselves feel better when under stress, and in knowing a step to take to reach their goals. 96% of youth responded positively to these: 1) appreciating things parents/caregivers do for me, 2) knowing qualities important in a true friend, 3) feeling truly loved and respected by parents/caregivers. 94% of youth know what their parents/caregiver think about drugs and alcohol. Youth indicated the most valuable things they learned were: 1) how to handle stress, 2) choosing friends, and 2) resisting peer pressure. Sample comments were: 1) I have learned how I could get out of being peer pressured. I now also know how to deal with stress without yelling and getting mad. I also know now how my parents feel when they have to deal with me. I now know what a good friend is like. 2) To understand my decisions not only affect myself but others as well. Parent assessments showed improvements from pre to post for: 1) I often tell my child how I feel when he or she misbehaves (79% increase). 2) I wait to deal with problems with my child until I have cooled down (73% increase). Parent most valuable things learned were: using I messages, listening to their youth, and understanding their youths stress. Parent comments included: 1) I have been practicing the things that I learned during the Strengthening Families classes and it works! 2) My kids are listening better and responding to my coaching, and I am able to no longer lose my temper. Our home is much calmer and peaceful. 3) One parent stated, Everything has been amazing! The change in my home has made life so much better. I am going to make sure my family never goes back to how we use to function. 4) The program contained many valuable lessons about enhancing our understanding of our youths perspective in order to use ways to make our relationships better and in turn, improve our family. We also really like the family meeting time, especially writing down what was agreed upon. Positive changes made by parents and youth involved in SFP: 10-14 will help improve the time they spend together communicating, working to achieve individual and family goals, and establishing rules and consequences. These skills will help strengthen families and arm youth

Close relationships, working toward goals and dreams, and having skills to reduce peer pressure are important elements that can help youth resist substance use and abuse. When parents are actively engaged in their children's lives, children are likely to have better academic performance, higher graduation rates, and fewer behavioral problems.

4. Associated Knowledge Areas

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

Outcome #21

1. Outcome Measures

# of participants identified dietary recommendations for eating and preparing more heart-healthy meals

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	179

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Heart disease is the number one cause of death among men and women across the nation. Each year, about 610,000 Americans die from heart disease, accounting for nearly 1 out of every 4 deaths. Heart disease and stroke cost the U.S. an estimated $1 billion each day in health care services, medications costs and lost productivity. Heart disease is also the number one cause of death for Indiana. 39% of adults in Indiana have had their cholesterol checked and been told by a healthcare professional that it is high, 32% have had their blood pressure checked by a healthcare professional and been told it is high, and 33% are considered obese, a body mass index (BMI) greater than 30. High cholesterol, high blood pressure, and being overweight or obese are all risk factors for heart disease.

What has been done
Purdue Extension provides education to adults about heart disease and ways to reduce risk for this and other chronic health conditions. Through delivery of Be Heart Smart, Extension Educators help participants identify and monitor controllable risk factors for heart disease, encouraging them to make simple changes to their daily routine that can improve their heart health. Be Heart Smart is offered as a series of four, 1-hour classes. Topics covered during the program include risk factors, cholesterol and blood pressure guidelines, heart-healthy eating plan,

stress reduction techniques, and tips on to talk to your healthcare provider. Each lesson provides participants with suggested action items to incorporate heart-healthy behaviors to start making a difference. Be Heart Smart was presented 32 times during the 2017-2018 program year, reaching 286 individuals. Of those reporting, participants of the program were mainly female (72%), aged 61 years or older (40%), and White (89%). The majority (69%) of Be Heart Smart participants are concerned they are at-risk for heart problems. Over half (58%) indicated having a family history of heart disease. More than one in ten (13%) participants has been diagnosed with heart disease, indicating that they are still in need of education on how to improve their heart health and manage/monitor their risk factors.

Results

There was a statistically significant improvement in knowledge by participants on these topics: identifying the most common cause of heart disease, categorizing risk factors as controllable versus uncontrollable, defining a healthy blood pressure and body mass index, understanding how to decrease sodium in the diet including the DASH Eating Plan, describing benefits of physical activity, and practicing techniques to reduce stress. Prior to the first lesson, 69% could correctly identify controllable risk factors for heart disease. At the conclusion of the program, 86% could correctly identify such risk factors. As a result of the program, participants indicated they intend to make behavior changes to help reduce their risk for heart disease: 1) 92% said they would monitor controllable risk factors for heart disease such as blood pressure and cholesterol, 2) 85% said they intend to increase daily physical activity, and 3) 87% intend to employ stress reduction techniques when needed. Participant feedback indicates the program was well-received and beneficial. Comments included: 1) the education received helped me realize how important being aware of any [health] problems can help me live a longer and healthy life, 2) the content increased my understanding of many of the terms and words I have heard all of the time, 3) it was motivating to take more control of my health, and 4) the program gives me more ideas on eating better and [increasing] physical activity. The findings suggest that after the program, adults are more knowledgeable about risk factors for heart disease, strategies to prevent or reduce personal risk of heart disease, and can incorporate heart-healthy behaviors into their daily activities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
723	Hazards to Human Health and Safety

Outcome #22

1. Outcome Measures

# of youth that would like a job that uses science

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	666

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
U.S. youth are lacking in the fields of science and mathematics. Data from the 2015 Program for International Student Assessment (PISA), show U.S. 15-year-olds as just above average in science literacy and below average in math literacy compared to 72 countries. STEM education is very important, and youth need more opportunities to be involved to increase their mastery level in science and mathematics.

What has been done
Indiana 4-H Youth Development provides educational programming focused on STEM learning and potential future careers. With over 800 youth in 38 different programs across the state participating in a variety of learning opportunities, Indiana youth were provided diverse experiences to excite them to learn and explore via STEM. During the FY 2017-18 program year, 40% (300 youth) of STEM program participants were new to 4-H, noting that this was their first time attending a 4-H event.

Results
Indiana 4-H offers STEM programming that interests and engages youth beyond the classroom. Over 80% of STEM program participants reported learning new things about engineering and over 90% learned new things about science during 4-H programs. As we look toward our youth becoming the future workforce, 76% of 4-H STEM program participants said they would like a job that uses science (666 youth grades 4-12) and 70% would like a job that uses engineering (605 youth grades 4-12). It is through Indiana 4-H programs that youth learn how science can help solve everyday problem - with 80% of participants identifying that they learned this skill during their program. Indiana 2017-2018 4-H STEM program participants reported the following: 1) 73% Ask questions about how things work, 2) 85% Try new things to see how they will work, 3) 69% Compare how different things work, 4) 60% Take things apart to see how they work, 5) 76% Come up with ideas for how to build new things. The future workplace and occupations need not only content competent employees, but also employees who have the critical skills to identify problems, construct solutions, and innovate. Indiana 4-H STEM programs provided a learning environment to develop and foster these skills.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #23

1. Outcome Measures

of youth certified in Youth for the Quality Care of Animals (YQCA)

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	19540

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Youth may not be aware of practices for maintaining a healthy animal. It is important that with 4-H programming involving animals, the youth are armed with knowledge of quality care for animal well-being and for the safety of our food.

What has been done
Youth for the Quality Care of Animals (YQCA) is a national multi-species quality assurance program for youth ages 8 to 21 that was implemented by the Indiana 4-H Youth Development Program in 2018 after pilot testing during 2017. YQCA is designed as an annual education and certification program focused on food safety, animal well-being and character awareness for youth producing and/or showing pigs, beef cattle, dairy cattle, sheep, goats, market rabbits, and poultry. The program was been designed by extension specialists and national livestock program managers to ensure it is accurate, current and relevant to the needs of the animal industry and shows and is appropriate for youth.
There were 98 Purdue Extension staff certified to provide training and they conducted programs across Indiana's 92 counties. Certification was also possible via web-based instruction.

Results
YQCA was added as a programmatic expectation for all Indiana 4-H members in grades 3-12 who exhibited any livestock species addressed by the training. At the end of the instruction period there were 19,540 Indiana 4-H members certified in YQCA. A total of 13,280 participated in instructor-led face-to-face meetings which often included hands-on activities to enhance participant experiences. There were 6,260 youth who opted to complete the program via web-based instruction which required passing a series of three quizzes to earn the YQCA certification. Acquiring these skills help the youth and their animal, but also address the safety of available meat products in the community.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #24

1. Outcome Measures

NC 13 - $ value of grants and resources leveraged/generated by communities

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	2845980

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
As the digital economy continues to expand, having an online presence is critical for any business to remain competitive. Rural businesses and entrepreneurs are no exception. A robust, well designed online presence helps rural businesses compete and expand their markets beyond their small local communities/regions.

What has been done
Purdue Extension, in partnership with the Purdue Center for Regional Development (PCRD), is providing critical information and technical support that is designed to expand broadband access and adoption by rural households, business and rural communities in Indiana. In order to help make rural entrepreneurs and small businesses more competitive, Purdue Extension developed the Digital Ready Business curriculum. This curriculum consists of eight face-to-face 1-hour workshops. During 2018, seventeen educators were trained to launch the program delivering 32 workshops reaching 92 entrepreneurs, business owners, and employees throughout Indiana. Expansion is under development to add an online version which will be available initially through an app, and later on a website.

Results
Over the past year, the Purdue Extension and PCRD partnership has realized a number of significant achievements. First, the team completed one of the most extensive studies ever conducted on the benefits/costs of providing broadband to rural households in Indiana. It is this study that prompted Indiana Governor Holcomb to pursue a $100M investment to expand broadband to unserved areas of the state. Second, in-depth state of broadband reports produced

for four regions (encompassing over 24 counties), resulted in formation of broadband task forces working to address gaps in broadband access and utilization in targeted geographic areas of Indiana. Third, Extension and PCRD have teamed up with the Indiana Office of Community and Rural Affairs to develop and implement $45,550 in Rural Broadband Planning Grants for five communities. Extension also secured a $65,000 USDA grant to provide and support training and technical assistance for businesses in three counties to implement digital strategies. Fourth, with Digital Ready Business helping small Indiana businesses and entrepreneurs expand their online presence, knowledge gained by participants exceeded 90% for all eight curriculum modules, including business intelligence, email marketing, planning a website, and social media analytics. Likewise, more than 75% of participants reported they were likely/very likely to apply knowledge learned.

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 #25

1. Outcome Measures

HHS 3.1 - # of discoveries, innovations, technologies related to Culture and Diversity

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	5

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Adolescents can be vulnerable to mental health problems, and this appears especially so for Latino in the U.S. Also, Latino youth in rural communities remain woefully understudied and may be particularly vulnerable to health disparities such as poor mental health (Umaña-Taylor, 2009; Wickrama, Elder, & Abraham, 2007). Additionally, identifying protective factors that have potential to mitigate the magnitude of the stress response may reduce the probability of experiencing mental health problems during adolescence (Shonkoff, Boyce, & McEwen, 2009). Mitigating consequences of such challenges, and fostering systems that promote positive mental health,

may be one of the most significant ways to promote well-being and long-term success of Latino youth.

What has been done
The objective of the research is to document the effects of contextual stressors (e.g., discrimination, poverty) on the mental health and well-being of Latino youth in the Midwest, to identify resilience factors (e.g., self-regulation and supportive parenting) that have the potential to buffer or counteract such stressors, and measure the effect of stress on the hypothalamus, pituitary gland and adrenal glands, which are the organs that produce hormones that control the human physiological reaction to stress.

Results
Results of the study with Latino families with a fifth-grade child living in the Midwest suggest that effortful control (a resilience factor which is related to self-regulation of emotional reaction or behavior) may help counteract contextual risks commonly experienced by Latino youth. The study of ego-resiliency (how individuals adapt to environmental stressors, conflict, and change), showed that a supportive family (resilience factor) helped youth develop stronger ego-resiliency and reduced incidence of depressive problems, and, this persisted over time, suggesting it may have long-term effects on reducing depressive problems in Latino youth. Researchers studied the cortisol awakening response (which is an increase in production of the hormone cortisol within 30 minutes after awakening, and believed to be a preparation for stress for the day) of the hypothalamic-pituitary-adrenal system in 119 preadolescent Latino youth and found that youth with both stronger cortisol awakening response and effortful control, had fewer depressive programs. Hence, physiological processes and individual resilience traits were shown to help counter depressive problems in Latino youth. These results may have a positive impact on public health issues relating to Latino youth through informing policy and directing future intervention efforts targeted at reducing stress and health disparities in this population.

4. Associated Knowledge Areas

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

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.
Outcome # 5 - Compilation of a county profile with economic data
Outcome # 6 - One-year follow-up survey of program participants about leadership roles, hours of volunteering, and grants.
Outcome # 20 - Pre- and Post-reflective evaluation of parent and youth changes in communication and interactions.
Outcome # 21 - Post-survey of knowledge gained.
Outcome # 22 - National 4-H Common Measures survey for Science at completion of 6 hours of instruction.
Outcome # 23 - Tracking of data on training and certification completion.
Outcome # 24 - Post-survey of participant knowledge gain and intention to apply what they learned in their community.
Outcome #25 - Research survey of pre-adolescent traits related to stress and lab research measuring cortisol levels.

Key Items of Evaluation

Outcome # 22 - Youth participating in STEM programming expressed interest in having a job in Science.

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: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	1.4	0.0	6.7	0.0
Actual Paid	8.0	0.0	41.6	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**
1377951	0	977487	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2819308	0	6160093	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
484322	0	904784	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

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	71191	1340529	54546	44242

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

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	221	229	450

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of education workshops

Year	Actual
2018	1290

Output #2

Output Measure

- Number of research projects

Year	Actual
2018	253

Output #3

Output Measure

- Number of consultations

Year	Actual
2018	12931

Output #4

Output Measure

- Number of volunteers

Year	Actual

2018	1437

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
10	NIFA CC 2.3 - # of participants adopt recommended adaptation strategies for natural resources management

Outcome #1

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	21

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Understanding the impacts that humans have on ecosystems is challenging. Central to this challenge has been the inability of researchers to develop a universal measure of both ecosystem health and human activities for a place. Soundscape measures have the potential to capture a locations' biodiversity, behavioral patterns of animals, the short-term and long-term dynamics of weather and climate, and various human activities simultaneously. Past work in the area of acoustics has focused on how animals use sound to communicate or how noise impacts human health and behavior. This work will characterize, for the first time, how soundscapes vary across time, space and human disturbance intensities. This will lead to better understanding of ecosystem dynamics, spatial variability of ecosystems and potentially how humans might affect ecosystem quality.

What has been done
The research project focused on 1) converting soundscape recordings to acoustic metrics that reflect the diversity and intensity of sounds occurring at a location; 2) using these metrics to analyze spatial-temporal patterns that are reflective of human disturbance (e.g., land use patterns) at a location and 3) providing this information to potential users via online database management tools. Within ecosystem and across ecosystem analyses formed a majority of the research proposed here. The impact of this work can be summarized by focusing on three main target audiences that our project has focused on: a) the general public; b) the scientific community and c) natural resource managers. Goal 1 (metrics) focused on the scientific community, goal 2 (application of our metrics) focused on natural resource managers and goal 3 (provide information to users) focused on all three. These goals were accomplished through a) creation of high quality educational materials such as an IMAX film, citizen science project, summer camp program and online learning web site; b) development of new software tools that are provided to researchers in a hands-on workshop environment and c) the formation of

partnerships with parks and research facilities around the world that use information for management decisions.

Results

Through a citizen scientist app, there are now over 2500 users that upload their soundscapes and sentiment data to the website for use in a) building an understanding of the importance of listening/observing our surroundings and b) for the team to understand the linkages between the types of sounds people hear and their emotional reaction to them. The website contains millions of recordings which are available online for people to listen to and this is an easy to use, easily accessible form for many to connect to our research. The team's work has also been showcased on major news media outlets during this reporting period, including CNN, New York Times Magazine, Science News, Business Week, Nova, NPR Science Friday, BBC WorldNews Service, and NBC Today Show as well as numerous online news outlets (e.g., Wired Magazine, Huffington Post). Our IMAX film, Global Soundscapes: A Mission to Record the Earth is now in 14 theaters in the U.S., Canada and Germany. An outside evaluator has ranked the film second among 12 assessed in the area of science education. More than 10 journal articles have been published per year on various aspects of soundscape dynamics and their linkages to natural (e.g., hurricanes) and anthropogenic stressors (e.g., deforestation). This team is helping to define this very new field in terms basic and applied areas of research. Publication venues are top tier in the field, including: Landscape Ecology, Global Environmental Change, Ecological Informatics, Freshwater Biology, Auk, Journal of Biogeography, Biotropica, International Journal of Science Education, Journal of the Acoustical Society of America, among others. Over 7 keynote addresses have been delivered during this reporting period that summarize the work. We have also hosted 11 hands-on workshops that have involved over 117 scientists from 15 universities in the US, Canada, Costa Rica, Brunei, Australia and Mongolia. Natural Resource Managers. We have now partnered with over 25 natural resource parks and protected areas around the country and world. These include: Hustai National Park (Mongolia), Chingaza Natural National Park (Colombia), Le Selva Research Station (Costa Rica), Chiricahua National Monument (Arizona), Crane Trust (Nebraska), and the Wells National Estuarine Research Reserve. Our partnerships have also included those in national or regional offices of the National Park Service and NOAA and some national/international conservation groups (Conservation International, Institute Alexander von Humboldt, Colombia). These partnerships have evolved into many separate projects including some that are not Purdue driven (thus they adopt the technologies and paradigms) and this to us represents a change in behavior which we sought.

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 #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

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	11

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Biosolids can be extremely beneficial to enhance soil quality and soil fertility. Use of these organic materials, derived from wastewater treatment operations, for agriculture, raise concerns among public and regulatory community. Sound science is needed in order to properly evaluate the risks to the ecosystem and human health so that biosolids may continue to serve a beneficial purpose rather than be destined for landfills. Our ability to assess such risks is often hindered by a lack of data typically used for evaluating risk or an inappropriate use of the data typically used because

the behavior of many potentially toxic inorganic trace elements, and pharmaceuticals and personal care products (TOrCs) do not follow previously used paradigms for predicting risk. The primary goal of this research is to optimize the use of municipal biosolid for land reclamation and provide the needed environmental fate data (leaching, persistence, and plant uptake) on the trace organics towards enhancing risk assessment protective of human and environmental health.

What has been done

1) An evaluation is being conducted of the short- and long-term chemistry and bioavailability of nutrients, potentially toxic inorganic trace elements, and pharmaceuticals and personal care products (TOrCs) in residuals, reclaimed water, and amended soils in order to assess the environmental and health risk-based effects of their application at a watershed scale. 2) The team also evaluated the uses and associated agronomic and environmental benefits for residuals in agricultural and urban systems. The team conducted an evaluation on the fate of perfluoroalkyl acids (PFAAs) in waste-based fertilizers including biosolid-based materials and composted city wastes (yard trimmings, food wastes, food packaging, etc.). PFAA occurrence was quantified in numerous waste-based fertilizers. The concentration of PFAAs present in the pore-water that can be transported or taken up by plants was quantified. 3) Additional pot studies were initiated this past year with basil, green bean, kale, Swiss chard and turnip grown in soils mixed with a subset of composted materials and analyzed for azithromycin (antibiotic), carbamazepine (anticonvulsant), miconazole (antifungal), triclocarban and triclosan (antimicrobials) and some selected PFAAs.

Results

1) On the fate of perfluoroalkyl acids (PFAAs) in waste-based fertilizers: On average about 50% or more of the PFAA present in the fertilizers was found in the pore-water. PFAA pore-water concentrations were generally proportional to the initial concentration in the fertilizer. 2) As to how PFAA levels change with different post treatment processes: PFAA concentration tended to be decrease in fertilizers where biosolids were blended with other materials, most likely due to a dilution effect. Fertilizer exposed to either composting or heat-treatment appeared to have increased PFAA concentrations after the treatment process. 3) In the pot studies initiated this past year with basil, green bean, kale, Swiss chard and turnip, a preliminary greenhouse study showed that for the five trace organics targeted, (all personal care products and pharmaceuticals), all were taken up into all of the edible parts of plants to some extent at a high application rate (8X recommended rate). Of the four compounds targeted, only triclosan degraded substantially with a half-life of approximately 115 days. The other compounds showed little or essentially no degradation within the 180-day period. Preliminary comparisons with previous literature suggest that the biosolids matrix limits the bioavailability, thus microbial degradation, of these compounds relative to systems where the compounds of interest is added artificially.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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121	Management of Range Resources
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132	Weather and Climate
133	Pollution Prevention and Mitigation
135	Aquatic and Terrestrial Wildlife

Outcome #5

1. Outcome Measures

NRE 1.4 - # Viable prevention, control and intervention strategies

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	7

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Oak species have been on the decline for several decades due in part to harvesting practices, failure of nut production (mast), increased wildlife pressure (deer), land-use change, and invasive species. Many scientists have concluded that we are dangerously close to the large-scale loss of oak species by more shade-tolerant tree species such as maple species and American beech. Silvicultural systems have been developed to successfully regenerate oak in uniform age distributions. While these systems are effective, they are often done in areas that go beyond the spatial scale of management activities on many private holdings.

New regeneration systems that can be applied at smaller, sub-stand-level spatial scales and that may be more attractive to private landowners are needed. Hybrid silvicultural systems based on natural disturbance dynamics, may be one such alternative. One such hybrid system, an expanding group shelterwood system, is commonly used in Europe for oak regeneration, has been successfully applied to Northeastern mixed-conifer forests, and is now being utilized in several parts of the eastern oak forest by the U.S. Forest Service and other researchers. However, none of these efforts include the use of prescribed fire, which is a key ecological process that promoted oak dominance in these stands over the past two centuries, but has been generally avoided by private landowners because of liability concerns and misinformation regarding its effect on stand timber values.

What has been done
Two ongoing long-term, forest management experiments, NWSC Crane experiment and the Hardwood Ecosystem Experiment, are incorporating the use of prescribed fire to not only track regeneration response to prescribed fire, but also quantify the damage to overstory trees resulting from its use. In addition, over 100 U.S. Forest Service stands, from Missouri to eastern Kentucky, have been inventoried in a retrospective study of prescribed fire on overstory timber volume and value.

The team has been 1. Comparing the interacting effects of prescribed fire and expanding gap-based harvesting on short-term tree regeneration response; and 2. Monitoring the influence of prescribed fire, used as a regeneration tool, on residual overstory tree timber quality within shelterwood regeneration systems; and 3. Developing empirical models of expected damage to timber value with increasing prescribed fire intensity and/or frequency.

Results
1) Early results suggest that the combination of prescribed fire and gap-based harvesting techniques hold promise to increase regeneration of oak species, but the benefit will depend highly upon site conditions. The technique is likely to be more successful on dry sites, often with south- or west-facing aspects, than more moist north- or east-facing sites, and regeneration response will vary spatially. Competitive oak regeneration, in the short-term, is likely not going to occur inside gaps, but on the northern, western and eastern flanks of gaps. Prescribed fires offer an additional benefit to create understory conditions that favor germination of acorns from small mammal caches, which could lead to more oak recruitment in the longterm with repeated burnings.

2) In total, over 200 overstory trees are now being monitored across 16 sites that have had a single prescribed fire. There has been comprehensive analysis of the short-term effects, although the study design has been published and analysis for two sites has been completed. Those results suggested that there was minimal damage to overstory trees, as none died or received a reduction in U.S. Forest Service tree grade.

3) For empirical models of expected damage to timber value with prescribed fire, losses to overstory timber volume and value is likely to vary regionally with edaphic factors and the prescribed intent of the surface fire. Inventories from the Hoosier National Forest in Indiana suggest that prescribed fire will wound up to 50% of the trees, but the relative volume loss is <3% and grade changes are 2-7%. In the Mark Twain National Forest in Missouri (Mann, M.S. thesis, in prep.), prescribed fires are more intense leading to higher wounding rates (up to 70%) and grade loss (up to 45%). Economic damage is likely in this system, but further work is needed to verify patterns seen "on the stump" to actual lumber recovery and value at the timber mill.

4. Associated Knowledge Areas

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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

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	43

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
It is always good to know how programs impact actions and outcomes over time. Because forest management often happens over long timelines, many landowners will not immediately implement management practices after attending a course, so follow-up surveys, which may contact people several years after attending the course, provide a picture of the knowledge change and actions taken by attendees.

What has been done
The Forestry and Natural Resources Extension team surveyed 296 past participants (2007-2015) of the Forest Management for the Private Woodland Owner workshop presented by Ron Rathfon and Lenny Farlee. The workshop provides a broad overview of forest biology, management and sources of information and assistance for landowners. The course is composed of 8 three-hour evening sessions and two half-day field tours. Over 180 responses were received from past participants.

Results
As a result of taking the course in previous years, participants self-reported increases in: 1) knowledge about their woodlands (53%), 2) awareness of groups and organizations that offer information (80%), 3) understanding of where to find professionals who can help manage their woodlands (74%), 4) extent their woodland management decisions are informed by long-term planning (53%), and 5) trust in Purdue Extension as a source of information (34%). Three out of four respondents controlled invasive species on their woodlands in the previous 5 years. 97% indicated the course influenced them to control invasive plants in their woodlands with over half strongly influenced. Similarly, the course influenced 82% to some degree to use the services of a professional forester. Responses included: Participation in the Forest Management for the Private Woodland Owner course was important in helping me determine management objectives for my woodlands (Somewhat agree=35.7% Strongly agree=46.5%). Management of my woodlands improved because of what I learned in the Forest Management for the Private Woodland Owner course (Somewhat agree=34.6% Strongly agree=41.6%). In the last 5 years, these activities occurred on the woodlands they owned: 1) Hiked/walked (94.67%), 2) Viewed wildlife (90.53%), 3) Controlled invasive species (73.37%), 4) Applied herbicide, pesticides or fertilizers (56.8%), 5) Wildlife/fish habitat improvement projects (e.g., constructed brush piles, planted native shrubs or wildflowers) (53.25%), 6) Prepared land and/or planted trees (49%), 7) Conducted a timber harvest (25.44%), 8) Fished (23.67%), and 9) Controlled/prescribed fire (10.65%). Comments included: 1) This was a very good program for the beginning forest owner. We have learned a great deal from it and the materials that we received. Thanks! 2) The class I attended in Rochester, IN was excellent and the instructor was terrific. He did a great job. I give him an A+. 3) I would like to receive Indiana Woodland Steward and the class last year was excellent! 4) We really enjoyed this course. Our place is just a get way for us. All of the woods are on a hill. 5) I would eagerly attend more short classes on forestry management. 6) I am interested in returning my entire farm to woodland. 7) I now have the resources and renewed interest in maintaining our forest and passing that information on to my son and grandson. 8) I would recommend this class to other landowners. 9) Extremely grateful for this class. If I had to register a complaint it would

only be that I felt the whitetail deer was given a lot of blame for tree damage. If I had to put a value on this class I would say I've got $1000 worth. Thanks again.

4. Associated Knowledge Areas

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Outcome #10

1. Outcome Measures

NIFA CC 2.3 - # of participants adopt recommended adaptation strategies for natural resources management

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	220

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
USDA programs provide incentives and planning assistance for landowners wishing to implement conservation practices like tree planting, forest stand improvement, and invasive plant species management. USDA Natural Resources Conservation Service and Soil and Water Conservation District employees are often the first contact and a primary source of technical advice and assistance to these landowners. Providing training in science-based management techniques and strategies for these practices may improve the success rate for these practices, and provide the

employees more confidence to recommend these practices to landowners. Extension educators also are a primary contact point for local landowner questions regarding natural resource management. Providing training to extension educators expands their knowledge base and provides them with contact points to refer clients to sources of professional assistance.

What has been done
Purdue Forestry and Natural Resources Extension has provided natural resources management training to Indiana Conservation Partnership members for several years. In 2018, two Conservation Tree Planting training days were held at Martell Forest and NEPAC for Conservation Partnership members.

Results
68 Conservation Partnership members participated and 47 returned program surveys. 83 to 94% of participants indicated they planned to speak with landowners about information provided during the program. 100% indicated the program was useful or somewhat useful for making decisions or taking action on conservation tree planting. 33 to 35% reported improved knowledge for tree planting topics including site evaluation and preparation, planting techniques, weed control, and post-planting management. Comments included: 1) hands-on tree planting was a valuable learning experience, 2) hands-on tree planting was helpful and beneficial, 3) this was a fantastic training, 4) A+ it was great hands-on!!!

4. Associated Knowledge Areas

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V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Extension programs conduct evaluation surveys to measure change in knowledge and intentions of participants, and follow-up surveys to assess change in behavior or practice and results of actions. Field and lab research projects monitor progress and completion of study objectives and tasks, testing of new systems, best management practices, and impacts on wildlife, and publications of findings, to determine effectiveness and accomplishment.
Evaluation results included:
Outcome #1 - Soundscape analysis for biodiversity, behavioral patterns of animals, dynamics of weather and climate, and human activities
Outcome #4 - Analysis of presence of perfluoroalkyl acids (PFAAs) in soil and water where waste-based fertilizers are applied
Outcome #5 - Assessment of prescribed fires to track oak regeneration response and quantify damage to
Outcome #9 - Follow-up survey of the Private Woodland Owner Workshops from 2007-2015 on participant use of knowledge gained and practices adopted
Outcome #10 - Post-assessment of Indiana Conservation Partnership member knowledge gain from natural resources management training
overstory trees

Key Items of Evaluation

Outcome #1 - Over 2500 users of the citizen scientist app are helping contribute recordings from across the globe and millions of compiled recordings are posted on the website for access to all

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

Childhood Obesity (Outcome 1, Indicator 1.c)	
0	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)	
110057	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)	
434	Number of new or improved innovations developed for food enterprises.
Food Safety (Outcome 1, Indicator 1)	
5	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.