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

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I. Report Overview

1. Executive Summary

The University of Illinois at Urbana-Champaign [UIUC]

The University of Illinois is a preeminent public university, recognized worldwide, and the College of Agricultural, Consumer and Environmental Sciences [ACES] has contributed to building this legacy from day one. In ACES, we use what we discover through cutting-edge research to ensure nutritious and safe food, sustainable and innovative agriculture, strong families and communities, and environmentally sound use of natural resources. The result is betterment of the lives of people, not only in Illinois but also around the world. That is the essence of our land-grant experience.

Illinois is among the world's leading institutions in disciplines and programs that constitute ACES domains. To keep our leading edge, we must: [1] Provide excellent education so our students realize exceptional career outcomes; [2] Attract and retain the highest caliber faculty, sufficient to grow enrollment and build our research enterprise; [3] Empower our scientists with adequate resources to achieve widely recognized, transformational research; and [4] Keep promising talent in Illinois.

The College of Agricultural, Consumer and Environmental Sciences [ACES]

ACES is changing to meet the challenges of our time and the realities of our situation. We are making strategic investments of cash and recurring resources to capture opportunities that support our discovery, education, and engagement missions. At the same time, we are emphasizing performance criteria across units for enrollment, research productivity, and return on investment in our budget management processes. Our strategic intent is to lead in our university and among our peers with vibrant approaches to fulfill our land-grant ideals.

ACES administration has aggressively implemented adaptive budget management strategies intended to generate more sustainable funding platforms for research, teaching and extension activities by improving the return on state funding investments and expanding non-state funding streams. By emphasizing advancement and elevating our investment, we seek to grow the college's $142M endowment to provide consistent funding sources for critical positions, operating expenses, scholarships, and infrastructure.

The Illinois Agricultural Experiment Station [IAES]

Exceptional research with high impact is core to our identity as a research university. ACES research mission aligns with the IAES, a state-federal investment in research on the forefront of discovery, balanced with application, relevant to Illinois' food, agricultural, environmental, and human interests, and impactful for the world's scientific community. Some 250 scientists contribute to our diverse and impressive portfolio. Our research and education facilities provide a vital testing-ground where research can generate data and practical applications to benefit consumers, producers, interest organizations, public agencies, and business.

ACES investigators are successful in obtaining competitive funding, and are major contributors to large interdisciplinary grants and programs that are associated with campus institutes. Total grant and contract expenditures were approximately $42M in ACES, with ICR generation exceeding $9.5M last year. Investigators receive funding from a diverse set of federal and private grants and contracts. Federal competitive contract expenditures attributed to ACES varied in the $14-18M range over the past decade, whereas state contracts declined from over $4M to less than $1M during the same period. ACES enjoys excellent private sector support, research contracts, and industry collaboration. Aggregate private research support peaked in FY12, about the time that the agricultural economy began to turn down. Private gifts for research vary annually between $4.5M to $5.5M, but private contracts declined since FY12, from $8.2M in FY12 to $4.4M in FY18, partly due to cyclical industry contraction and redirection of priorities by commodity organizations. Over the past year, the Office of Research reorganized to focus on service and strategic deployment of our research assets, adding grant support and related services for ACES investigators.

University of Illinois Extension

Based in the College of Agricultural, Consumer and Environmental Sciences (ACES), University of Illinois Extension remains the university's premier means of educational outreach to the public. Despite serious financial uncertainty in recent years, Illinois Extension sustained a thriving professional workforce, which continued to deliver high quality programs while maintaining strong local support across Illinois. In 2018, Extension offered educational programming and technical assistance at more than 3000 different sites across the state. An essential network to fulfill the University's land-grant mission to enhance the lives of residents in our state, Extension staff logged over 2 million travel miles in 2018 to educate, listen, engage, partner, empower, and impact.

This year, Illinois Extension made more than 1.4 million teaching contacts, including almost 600,000 SNAP-Education nutrition education contacts to improve the health outcomes of low income residents. Extension programs helped Illinois businesses leverage almost $1.4 million and provided continuing education to more than 20,000 professionals for certification and compliance purposes. Using digitally-delivered methods, we brought programs and research-based information to phones, tablets and computers where and when people needed credible information from a source they can trust. Almost 200,000 young people participated in 4-H, making it the largest youth program in many counties, including Cook County. The work of Illinois Extension is made possible by an engaged and educated corps of nearly 20,000 volunteers who contributed hours equivalent to more than 1,100 FTEs and valued at over $58 million.

The Extension 3.0 Task Force Report, released in February 2018, called for a strategic process that moves us closer to the "ideal Extension". In response, Extension undertook an intensive visioning process under the new leadership of Dr. Shelly Nickols-Richardson, Interim Associate Dean and Director of Extension, to better align Extension in the College of ACES with a statewide public engagement initiative. The core elements of this vision include: [1] Focusing on a systems approach to engaging and solving societal grand challenges; [2] Balancing efforts to strategically address rural and metropolitan needs and issues; [3] Drawing upon traditional strengths, while incentivizing creative thinking and entrepreneurship and rewarding innovations to tactically address contemporary issues; and [4] Aligning both competing and complimentary interests to facilitate the generation of collaborative outcomes with high impact.

To incentivize innovation and partnerships between University of Illinois Extension personnel and faculty in the College of ACES, Dr. Nickols-Richardson launched a new Interdisciplinary Collaboration Extension [ICE] grant program in July of 2018. Out of twenty-two proposals submitted, seven awards were made in October of 2018. Themes ranging from improving school nutrition programs to helping farmers manage nitrogen application; all focused on intentionally bridging research with practical applications for Illinois

residents.

One barrier to innovation and impact has been related to limitations in our tracking systems. Moving from a personnel-based time tracking system in favor of a results-focused approach for tracking our work, Extension adopted the new Program Evaluation and Reporting System [PEARS] in October of 2017. Although transitional hurdles were confronted and there is much room for improvement, we are able to better document, reflect, and communicate more authentically and consistently about what we do and why it matters. To complement the new data capacity through PEARS, Extension data analysts designed several Tableau dashboards to help us better visualize and tell our story to local, state, and federal stakeholders.

For the first time in many years, overall funding for Illinois Extension increased 7.5% in FY 2018 versus FY 2017. This, in most part, is due to the state restoring payments for its matching funds. All other funding sources remained mostly steady. Overall expenditures increased by 2.3% for the same period, mostly due to increase in payroll. Although there was an increase in funding, Illinois Extension still is not at the funding levels seen in FY 2011 and before. Illinois Extension will continue to be careful stewards of its funding, while investing in areas that allow for future growth as outlined in Dr. Nickols-Richardson's visioning documents.

Changes In The College of ACES

In February of 2019 Dr. Shelly Nickols-Richardson became Associate Dean and Director of Extension and Outreach. Dr. Nickols-Richardson had served as Interim Associate Dean and Director of Extension and Outreach since March of 2018. In addition to serving as the head of the Department of Food Science and Human Nutrition [FSHN] for the previous five years, Dr. Nickols-Richardson served as a member of the Extension 3.0 Task Force, which familiarized her with many of the opportunities and challenges Extension is facing. As the head of FSHN, she also had the opportunity to work with Extension faculty and staff on a regular basis.

In August of 2018 Dr. Adam Davis became head of the Department of Crop Science, replacing Dr. Pat Tranel who had been serving as interim head since early in 2018 when Dr. German Bollero became Associate Dean for Research and Director of the Illinois Agricultural Experiment Station. Dr. Davis has spent fourteen years as a member of the USDA-ARS Global Change and Photosynthesis Research Unit and led a highly visible research program designed to advance understanding of the interactions among weed communities, crops, and the environment.

In August of 2018 Dr. Anna Dilger, associate professor in animal sciences, and Dr. Dave Rosch, associate professor in agricultural education and leadership, were appointed co-interim associate deans of academic programs for the academic year. Dr. Dilger and Dr. Rosch replace Dr. Prasanta Kalita, who was named a University of Illinois presidential fellow. A national search for the next permanent associate dean of academic programs was initiated in early 2019.

DCC Incorporated, a marketing firm from Decatur, Illinois, was hired to work with the College of ACES in May of 2018 to help in creating a collective vision for marketing and communications efforts across the College of ACES. Information Technology and Communication Services [ITCS] was reorganized to elevate efforts in marketing and communications across the college and to provide a centralized marketing and communications support team that will work closely with each department and unit in the college.

In November of 2018 Dr. Alex Winter-Nelson agreed to serve as the Associate Dean of International Programs. Dr. Winter-Nelson stepped into this new role after a 27-year career as a faculty member in the Department of Agricultural and Consumer Economics, which included serving as the director of

International Programs for ACES for the last five years, as well as serving as the director of the ADM Institute for the Prevention of Post-Harvest Loss since fall of 2017. Dr. Winter-Nelson has extensive experience in the international programs arena and has successfully engaged in a diverse portfolio of international projects around the globe with particular interest in addressing agricultural issues in Africa.

The Planned Programs

Agricultural and Biological Engineering - Research activities in 2018 included research aimed at increasing corn yield by aiding the breeding process using an agricultural engineering perspective, work that seeks to refine and improve the practice of denitrifying bioreactors to mitigate agricultural drainage nitrogen losses for societally-desired clean water outcomes, a project with the objective of testing a newly developed crop sensing system for field chemical applications and to develop a practical procedure of using a UAS mapping system for major crop herbicide variable-rate applications, work to better understand the impacts of environmental management on poultry, and work to develop practices and tools that help growers manage controlled environment resources efficiently. Extension activities in 2018 continued to demonstrate the pivotal role we play as a partner to state regulatory agencies. The **Certified Livestock Manager [CLM] Program** provided training to certify more than 460 livestock managers to meet the requirements of Illinois Livestock Management Facilities Act. New this year, livestock producers were offered a workshop focused on new technologies available for **Animal Mortality Composting**.

Agricultural and Consumer Economics - Extension activities in 2018 targeted individuals of all ages to build literacy in personal finance and promote positive consumer behavior. **Welcome to the Real World** taught middle and high school students strategies for balancing income and expenses. **Financial Wellness for College Students** programs resulted in positive steps toward saving for the future. Through workshops and online resources adults of all ages learned to protect their credit, stretch their income, prepare for retirement, and plan for their estate. Agricultural producers and stakeholders attended the **2017 Illinois Farm Economics Summit** offered in three regional sites and **Annie's Project**, offered in nine counties. **WILLag.org**, a partnership of Extension and Illinois Public Media, broadcast three daily market reports and a weekly Commodity Week to more than three million listeners or viewers each week. Research activities in 2018 included a project that investigates short-run forecasts in the soybean futures market complex to more clearly identify the predictive content and the sources of forecast errors, research that seeks provide valuable, effective outreach and education to producers, agribusinesses, and those involved in natural resource conservation efforts, the publication of results analyzing the local, state, federal, and international laws forming the legal environment for agriculture and the resulting impact on agribusiness supply chains, and an examination of the behavioral factors that influence the adoption of low carbon, renewable energy technologies and the design of policy incentives to accelerate adoption and cost effectively achieve various environmental outcomes.

Animal Health and Production - Research activities in 2018 included a trial that seeks to determine the effect of hydromorphone on equine behavior, intestinal motility, cardiopulmonary function, hematologic variables, and body temperature, a project with the long-term goal of establishing a role for nerve growth factor as a tool for improving pregnancy rates in cattle artificial insemination programs, research that seeks to provide novel insights into the parasite biology that can be exploited for the development of novel drugs and vaccines for disease intervention in agricultural animals, and research characterizing the chemical composition and nutritional adequacy of alternative and sustainable protein sources. Extension activities in 2018 focused on providing leadership for several statewide conferences and seminars including the **Annual Sire Selection and Reproduction Management Seminar** and the **Northwest Grazing Conference**. Efforts to promote quality assurance in livestock management included **Beef Quality Assurance Training** and **4-H Quality Assurance and Ethics Certification**. New in 2018, Extension delivered a series of presentations across nine counties on the increased incidence of anaplasmosis

and recommended practices for limiting transmission in beef cattle.

Community Resource Planning and Development - Extension activities in 2018 included technical support to promote planning for community development, disaster mitigation, and economic vitality. Extension educators and specialists trained professionals to improve their capacity to interact, serve, and lead within their organizations through programs such as **Real Colors**, **Teacher Tuesdays**, and **On the Front Line Customer Service Training**. Elected and appointed government officials from 91 of Illinois' 102 counties attended the **Local Government Education Webinar Series**. Programs incubating innovation and entrepreneurship included the **Fast Pitch Competition**, modeled after the "Shark Tank" television program, and programs targeting Kindergarten through 12th grade to cultivate visioning **[iDREAM]** and innovation **[iCREATE]** at a young age. Research activities in 2018 included a project that seeks to provide new evidence on how households react to the investment incentives for energy efficiency improvements and speaks to the ongoing debate about the causes of the "energy efficiency gap", a study that found that the federal recognition of same-sex marriage was related to improved well-being in individuals in same-sex relationships, and an examination of the meaning of school readiness, expectations for child school readiness, expectations for parent involvement in school readiness preparation, expectations concerning the role of preschool teachers in facilitating school readiness, and related home and school practices that facilitate school readiness.

Food Safety and Food Security - Research activities in 2018 included the development of new tools that apply engineering and statistical approaches to problems in food safety microbiology, the development of a novel technique for a microencapsulation that can be applied to a wide range of applications, an investigation into the use of acoustic energy as a physical biofortification method to enhance the endogenous nutritional values of food crops, and research with the long-term goal of describing unsaturated transport mechanisms for food science applications and solving the modeling equations to improve the quality of foods and efficiency of processes. Extension activities in 2018 focused on promoting food safety from source to service through training food producers to meet the standards of the **Food Safety Modernization Act Produce Rule**, building capacity of retail food managers to pass the **Certified Food Protection Manager Certification**, and educating non-retail food servers through **Serve it Safely** and **Yes, You Can - Preserve it Safely**. Activities targeting food security included support for crop producers and specialty crop growers to learn best management practices to improve production through conferences such as the annual **Crop Management Conference** and through online options such as the **Southern Illinois Summer Twilight Series** and the **Small Farms Winter Webinar Series**. Extension initiated a new partnership this year between Master Gardener volunteers and SNAP-Ed educators, **Growing Illinois Food Access Allocation**, to increase fresh produce at local pantries and promote selection and use of the produce among pantry patrons. The project is off to an excellent start with over 8,000 pounds of produce donated in 2018 to pantries within communities targeted by the GIFAA project. The **Illinois 4-H Feeding and Growing Our Committees** program held meal packaging events throughout the state and celebrated the threshold of packaging and distributing over **one million meals** since 2014.

Human Health and Human Development - Extension activities in 2018 focused on physical, mental, emotional, and social aspects of health and human development across ages and issues. Programs in the **Brain Health Series** continued to draw adults to explore ways to nurture their brains and exercise their memory. Other social and emotional wellness programs targeted **Being Mindful in a Busy World**, **Someday is Today - Live Your Bucket List**, and **Looking for the Funny Side**. Nutrition programs offered in 2018 spanned a diverse array of issues including weight management, mindful eating, healthy shopping on a budget, food and drug interactions, practical strategies to integrate organic foods, food label literacy, ways to use new and unusual foods, and seasonal favorites targeting healthy holiday meals. Two signature youth nutrition and healthy eating programs offered again in 2018 include the **4-H Food Challenge** and **Illinois Junior Chefs**. Additional programming related to youth health and wellness focused on bullying, drug use prevention, sexuality education, and coping with anxiety. Extension

programs targeted individuals, families, teachers, school food service personnel, and community environments like food pantries. Research activities in 2018 included research into the extraction of hydroxycinnamic acids from maize for use as a food-additive in processed food products as a way to make the health benefits of hydroxycinnamic acids available to all people regardless of socioeconomic class, an effort to improve our understanding of the influence of interpersonal relationships on the mental health outcomes of African-American adolescents who have experienced racial discrimination, work to determine the intention and actual use of diabetes-related apps by diabetes clinicians and health care administrators, and an evaluation of the effects of dietary botanical estrogens on breast cancer growth and progression using preclinical animal models.

Natural Resources and the Environment - Research activities in 2018 included a project that seeks to generate tools, datasets, and guidelines for use by managers to detect, predict, and mitigate the individual and interactive ecological effects of climate change, land use practices, stakeholder use, and invasive species on fish communities and aquatic ecosystems, a recent study looking at the history of the Missouri River, damages and changes from the 2011 flood, and its current post-flood condition, an effort to better understand the influence of environmental conditions and time since invasion on forests ecosystem structure and function, and efforts to improve our understanding of how the use of habitats change over time and why species use different habitats to improve conservation strategies. Extension activities in 2018 focused on training and support of 887 active **Illinois Master Naturalists,** who devoted more than 83,000 hours [valued at more than $2 million of economic value to local communities], to promote awareness and action for citizens of all ages to be better stewards of the environment. Young people participated in **Youth Conservation Days** and school-based programs like **I Think Green** and **Monarchs on the Move** to learn about ways they can protect living things. Overall, environmentally-related projects in 4-H had more than 60,000 enrollments statewide. The **Gateway Green Industry Conference** drew participants across southern Illinois to learn about how to approach personal and commercial landscaping in environmentally sustainable ways. Northern Illinois residents and schools in Cook County learned how to adopt practices to qualify for certification in the **Conservation@Hom**e and, new in 2018, **Conservation@School** programs. To strategically address nitrogen runoff mitigation in support of **Illinois' Nitrogen Loss Reduction Strategy**, two water quality specialists were hired in 2018, providing workshops and podcasts to educate producers and residents about practices to reduce nitrogen loss.

Plant Health, Systems and Production - Extension activities in 2018 resulted in a new online training option for **Master Gardeners** to gain the knowledge and skills they need to provide education and consult with local gardeners. Core training and continuing education was provided to support the 2,622 active Master Gardeners in 2018. The **Four Seasons Gardening Webinar**, **Ask Extension - Hort Corner**, and **Gardener's Corner** online resources were popular ways for people to access reliable and trusted information around horticulture. A weekly podcast, **Green Side Up**, covered a wide variety of timely and seasonal topics for those who prefer a digitally-delivered approach. More than 2,700 youth learned how to preserve pollinator habitats through the 4-H **Honey Bee Challenge** program. In 2018, the **University of Illinois Plant Clinic** provided 2,645 diagnoses for 1,557 plant samples submitted for disease diagnosis, phytosanitary certification, plant identification, or insect identification. Research activities in 2018 focused on the development of additional methods for control of H. glycines to supplement existing control strategies, ongoing implementation of genomic selection to Illinois breeding programs, the identification of leaf traits, and the genes that control these traits, in maize and related grasses that alter photosynthesis and transpiration, a wheat breeding program that seeks to evaluate experimental genotypes for agronomic performance and disease resistance, and the development of strategies to effectively manage X. cucurbitae in pumpkins.

Sustainable Energy - Research activities in 2018 included several studies for improving biofuels production from corn and biomass feedstocks, the development of strategies to recover value added products and characterize components of corn, other cereal grains, and biomass, an examination of the effects of

riskiness of energy crops compared to conventional crops and its implications for crop, contract, and location choices for refineries, and efforts to obtain, plant, cultivate, and evaluate new woody plant germplasm for landscape and bioenergy purposes. Extension activities in 2018 included the launch of the **Smart Grid/Smart Meter** grant activities to provide educational workshops about smart meters and energy efficiency. The primary target population of this program is rural areas with limited-resource populations. During the first year of the grant, 41 workshops were delivered by Extension, serving over 700 residents. Other activities in this planned program included a focus on energy-efficient landscaping and two wind/solar seminars.

4-H Youth Development - In 2018, 4-H Club enrollment in Illinois totaled 24,408 members. Recruitment efforts resulted in 8,563 new first year members in 2018. Nearly 200,000 youth were involved in some type of 4-H program such as clubs or programs offered at the community level to address a special interest, during school, at a partner site, or at a military installation. Efforts continued to focus on expanding these 4-H opportunities to underserved youth including those in metro areas of 100,000 or more, to meet the needs of urban youth. Modest gains have been made to engage minority youth, and specifically youth of Hispanic ethnicity. Over the past six years, 4-H minority club membership is up 59% and 4-H Hispanic club membership is up 176%. This past year over 11,000 adult volunteers gave their time and talents to the 4-H Youth Development program in Illinois with approximately 3,506 unique adults serving as club leaders. Youth career exploration and workforce preparation activities included the **Illinois Summer Academies** conference, held on the University of Illinois campus, and **Welcome to the Real World**, a multi-disciplinary curriculum and simulation to explore careers and money management. STEM-related projects and programs included more than 37,000 enrollments in 2018 and regional robotics events drew more than 1,300 youth across nine counties in Illinois. As stewards of the environment, youth participated in popular programs such as **Monarchs on the Move**, **4-H Honey Bee Challenge**, **Citizen Scientist**, and **4-H Healthy Soils CSI**. Volunteerism and community service to address food insecurity remained important features of 4-H program, including maintaining community gardens, food drives, meal packaging events, and creating mobile pantries for those living in food deserts. Leadership opportunities were prevalent to function in roles such as **Teen Teachers**, advocates trained to tell their 4-H story to legislative officials through **Speaking for Illinois 4-H**, and statewide **4-H Leadership Conferences**.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	150.0	0.0	180.0	0.0
Actual	191.3	0.0	211.9	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 Panel
- Expert Peer Review
- Other (Extension Staff Program Teams)

2. Brief Explanation

In the Department of Crop Sciences the merit review process for Hatch proposals is based on the review of the proposal by two faculty members [in addition, the department head reviews this process]. In the Department of Animal Sciences all Hatch proposals are reviewed and evaluated by a standing research committee [the committee members are asked to review the proposals and submit questions to the committee chair; the PI makes the appropriate revisions and the committee then determines approval or non-approval]. In the Department of Agricultural and Consumer Economics [ACE] proposals are reviewed by two peer reviewers familiar with the subject area. In the Department of Agricultural and Biological Engineering [ABE] every proposal is reviewed by two external peers with knowledge in the subject area [the reviewers are provided with specific instructions regarding their purpose of enhancing the proposal as opposed to seeking the recommendation to accept or reject the proposal]. In the Department of Food Science and Human Nutrition [FSHN] proposals are reviewed internally by two peers. The department head reviews proposals as needed for any further input.

In the Department of Human Development and Family Studies [HDFS] when faculty submit Hatch proposals they are typically reviewed by the department head. For unique circumstances [such as for a highly specialized field of study] the department head would request input or review by another full professor in the department. Each review ensures that the proposed research addresses an issue of scientific and societal significance, rests on a firm foundation of existing scholarship, uses appropriate research methods, includes some focus on non-metropolitan or rural populations, and would have applied or practical implications. The review also confirms that the PI is capable of conducting the proposed project and will produce products of high quality and it ensures that the timeline for the project is feasible. In the Department of Natural Resources and Environmental Sciences [NRES] faculty members submitting Hatch proposals are asked to provide the names of two or three individuals to conduct a peer review. While the majority of the reviewers are within the department, other colleagues may serve as reviewers. Reviewers are asked to comment on the following six areas with recommendations and suggestions as well as a final remark on how the proposal could be improved: [1] Is the subject of the proposal important? Is the proposed research adequately justified?; [2] Are the objectives well-focused and subject to easy measurement of progress?; [3] Can the objectives be attained within the proposed duration of the research?; [4] Are the best sources of fruitful collaboration, within and outside of the department, identified?; [5] Does the proposed research duplicate other projects of which you have knowledge? If so, is the duplication warranted?; and [6] Are the users of the results identified and how will they access results of the proposed work?

For all departments, approved projects are submitted to USDA-NIFA for final approval via the REEport system.

Extension program leaders oversee the process for review of new programs for adherence to expectations for research base and quality. A state level committee of educators conduct promotion reviews that include demonstration that a promotion candidate's program development process, products, and evaluation meet high quality standards of practice.

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

- Survey of traditional stakeholder groups
- Survey of traditional stakeholder individuals
- Survey of the general public
- Other (Department Advisory Committees)

Brief explanation.

Researchers in NRES continue to work with state and federal environmental agencies to discuss research areas and learn of needs within the organizations. In addition, input is received from industry officials and the general agricultural community. ACE faculty members interact to varying degrees with stakeholders. For projects that are directly relevant to stakeholder interests, particularly in the area of commercial agriculture, faculty are encouraged to consult with and to seek input and support from those stakeholders. The Department of Crop Sciences meets annually with its state advisory committee that consists of representatives from industry, non-profit organizations, and farms that are involved in the future of the crop sciences discipline. After hearing input on the status of crop sciences, the committee creates a report with suggestions on the direction and future of the discipline. Committee members are invited based on faculty recommendations and other interactions. FSHN undergoes an external review of programs, including research, once every seven years. Annually, the department asks the external advisory committee to provide formal feedback on departmental activities, including research. The department head reviews the priority areas of NIFA and offers comment as requested via the college and/or USDA-NIFA. In ABE stakeholders' needs are very important factors in guiding the development of their mission-oriented projects. Faculty members interact actively on issues that may be addressed using engineering and technical methods. ABE research receives significant support from industrial partners and so engagement with industry is very important. ABE participates in several projects that involve institutions in other countries, and they have become very important international stakeholders. ABE faculty have frequent opportunities to meet with stakeholders in formal and informal settings and encourage them to provide input regarding ABE research, education, and outreach activities. ABE faculty also participate in meetings with broader stakeholders of the College of Agricultural, Consumer and Environmental Sciences, College of Engineering, campus, and the university system.

State level Extension staff [such as faculty, specialists, educators, and program leaders] regularly seek out opportunities to reach new stakeholders and expand networks, given their connections with diverse leaders and organizations at the state level. Through memberships in committees, boards, task forces, and advisory groups, Extension hears emerging trends and needs. Local unit directors continuously recruit local experts and community members to maintain vibrant, active, and inclusive Executive Councils, 4-H Expansion and Review Committees, program committees, and volunteer committees that meet regularly to review and discuss programming needs and evaluation results. Every three years, each local unit is reviewed to assure that actions are taken to seek input from new stakeholders that represent Civil Rights protected audiences.

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
- Open Listening Sessions
- Needs Assessments
- Use Surveys

Brief explanation.

The Department of Animal Sciences has ongoing relationship with the major commodity groups and industry partners that are the stakeholders to their research, outreach and teaching programs. Faculty regularly participate as liaison or ex-official board members for the beef, swine, dairy and equine state associations. The department also interacts with the Illinois Department of Agriculture and cooperates on their state-wide educational programs and applied research. In addition, the department hosted a meeting of the Illinois Livestock Development Group, which includes representation from the Farm Bureau and major commodity groups representing corn, soybeans, pork, beef, and dairy. In addition, the department underwent a comprehensive review by an external committee in 2018. The committee included members from Cornel University, Penn State University, Virginia Tech, Iowa State University, and Kansas State University. Faculty participate in numerous Extension meetings each year and receive input identifying important topics to be addressed in educational programs and ideas for research from surveys of attendees. Stakeholders also speak in classes and serve on graduate research committees and on faculty search committees.

ABE seeks input from faculty members who have been in frequent contact with stakeholders. The departmental external advisory committee is also a very important link to stakeholders. The development, corporate relations, and public engagement offices in our colleges and on campus also provide assistance in engaging with stakeholders. ABE faculty are very active in attending regional, national, and international conferences [oftentimes by invitation] where stakeholders and their high priority issues can be identified. NRES faculty participate in national and statewide events and committees throughout the year. In addition, local contact with various organizations continues. Increased capacity and outreach at the Dixon Springs Agricultural Center have significantly increase interactions with stakeholders in southern Illinois. Researchers studying the development of indicators to assess the long-term impacts of forest conservation and management programs have also increased the use of Twitter and associated social media. Members of the FSHN external advisory committee represent academia, government, industry, and small businesses. Individual faculty members in FSHN are asked to comment on stakeholder input solicitations.

Extension Council members and local Extension volunteers play a key role in helping Extension identify and connect with stakeholders. Annually, county directors report on the number of grass roots organizations they have engaged that serve an underserved, Civil Rights-protected class. Extension staff also periodically meet to brainstorm ways to engage input from new stakeholders and/or new audiences. Extension staff members also use their membership in local partnerships and meetings to identify new individuals or organizations to engage. Extension's community planning and economic development activities also, by their very nature involve stakeholder input through surveys and community discussions. Extension's web-based volunteer client management system provided access in contacting individuals and groups of volunteers and the registration data system provides contact information to reach out to program participants.

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
- Meeting specifically with non-traditional individuals
- Survey specifically with non-traditional individuals
- Meeting with invited selected individuals from the general public

Brief explanation.

Stakeholder input in ACE is collected primarily via direct interactions with faculty. ABE invites stakeholder input through direct interactions between faculty and stakeholders and through publication of department newsletters. Stakeholders are also invited to provide input through attending the professional, technical, and social events hosted by ABE. Input is also provided to ABE through their external advisory committee. Each year commodity groups, Extension educators, and other stakeholder groups are engaged to establish priorities for upcoming research and educational programs related to animal sciences. Part of this process is to share current research results, part of it is to identify emerging research areas of common interest, and part of it is to address the stakeholders' most pressing needs for information. This is accomplished through surveys, individual contacts, and discussion sessions with other animal sciences faculty from across the U.S. Non-traditional groups are also included if they have interests in current topics being addressed in animal sciences. The NRES external advisory committee is comprised of four representatives from environmental agencies including state government, consulting, and conservation. The group includes personnel from the Illinois Farm Bureau. These committee members work with the department to provide input from their individual constituent base. For FSHN input is collected through in-person meetings with external stakeholders. Feedback is sought from industry via one-on-one meetings with the department head and industry representatives. Graduates of the program are asked for input on research and emerging key issues.

The Dean of the College of ACES [Dr. Kimberlee Kidwell] and the Associate Deans for Research [Dr. Germán Bollero] and Extension [Dr. Shelly Nickols-Richardson] interact frequently and significantly with a number of stakeholders, both individual and organizational, external to the College of ACES. Key stakeholders include groups within Illinois and across the nation. In general, stakeholders include individual producers, commodity organizations, state and federal legislators, academic and corporate partners, international partners, and other individuals and organizations within the University of Illinois. The dean and associate deans provide reports to the College of ACES external advisory committee; this diverse group includes participants from the agricultural production community, natural resources management groups, human sciences, and agribusiness. The group meets annually and creates an excellent opportunity for presentation and review of the activities of ACES to a broad external audience.

Specific interactions in FFY2018 of the Associate Dean for Research/Director of AES with stakeholders included: [1] Served on the board of the Illinois Nutrient Research and Education Council; [2] Attended the meetings of the Future of Long Term Experiments at Rothamsted Research, England in May 2018; [3] Met or videoconferenced on multiple occasions with leadership and members of the Illinois Farm Bureau, Corn Marketing Board, Corn Growers, Soybean Association, Pork Producers, Illinois Beef, and other organizations; [4] Invested much time in the development of collaborative activities with corporate partners. Major contacts included Bayer, Syngenta, Wyffels, GDM, Burrus, ADM, Tate and Lyle, Growmark, Agrible, and Kraft Heinz; [5] Served as a member of the joint steering committee of the University of Illinois/Corteva partnership to coordinate collaborative efforts in research, education, and outreach between the two organizations; [6] Participated in the meeting of the Illinois Agricultural Legislative Roundtable in January 2018 [this meeting included representation from the IFB, multiple commodity organizations,

and other educational institutions in Illinois that have agricultural programs]; [7] Met and worked with representatives of the Illinois Corn Growers Association on development of an internal seed grant program associated with an award from the Regional Conservation Partnership Program; [8] Participated in meetings of the Illinois-Indiana Sea Grant advisory committee; [9] Met with members or their staff of the Illinois House Delegation in Washington, D.C. on issues of importance in agricultural research in March 2018; [10] Participated in Agriculture Technology Innovation Summit at UIUC Research Park; [11] Participated in meetings of the north central region AES directors in April 2018 in St. Louis, Missouri; [12] Met with external advisory committee members from the Division of Nutritional Sciences in the College of ACES; [13] Participated with research and Extension staff at the Dixon Springs Agricultural Center in meeting with stakeholders to discuss the future of research and education programs at DSAC; [14] Tour of the Northwestern Illinois Agricultural Research and Education Center with Representative Cheri Bustos [U.S. Representative for the 17th congressional district]; [15] Attended the Illinois State Fair agriculture day and visited with multiple stakeholders, August, 2018; [16] Participated in the Integrated Bioprocessing Research Laboratory advisory committee meeting, September 2018; [17] Extensive involvement in activities of the Dudley Smith Research Program [this is an endowed program in sustainable agricultural production centered on the Dudley Smith Farm in Christian County, Illinois]; and [18] Met with the Dudley Smith External Advisory Committee in November 2018.

Extension unit leaders and field staff collect input through formal and informal methods from key community leaders, community organization representations, local elected officials, school administrators, Extension Council members, Extension volunteers, and program participants. In some instances, Extension educators from the community and economic development team assist with developing and distributing surveys that reveal needs and opportunities to develop an educational response. All units seek out key informants from organizations they partner with to seek input about emerging trends and local priorities. The majority of Extension programs include end-of-program evaluations and surveys that ask for suggestions for additional topics and improvements for future programs. County directors and field staff are often invited to participate in community and regional planning processes. This provides a unique opportunity to benefit from the collective work of these groups to surface potential areas of focus for local plans of work.

3. A statement of how the input will be considered

- In the Budget Process
- To Identify Emerging Issues
- Redirect Extension Programs
- Redirect Research Programs
- In the Staff Hiring Process
- In the Action Plans
- To Set Priorities

Brief explanation.

In ACE stakeholder input is shared at various departmental meetings including regular faculty meetings and meetings of the departmental faculty advisory committee. The Animal Sciences external review committee that met in late 2018 provided a written report with recommendations for improvement. Many of these recommendations will be implemented by department administration and the department will provide a written progress report to the Office of the Provost in spring of 2019. ABE has regular departmental meetings, such as Monday lunch meetings, faculty/staff meetings, administrative committee meetings, faculty advisory committee meetings, and external advisory committee meetings. Discussions include stakeholder input and the development

of plans of action at these meetings. The discussions frequently help to shape the decisions of future research activities. Individual faculty/staff members also bring stakeholder input to the attention of the head and appropriate colleagues. The recommendations from Crop Sciences' stakeholders are considered by faculty and the department head during advisory and faculty meetings. Crop Sciences also maintains close relationships with commodity groups, community colleges, and high schools actively seeking input and feedback from these constituents as well. Feedback received is incorporated into various programs and curriculum where appropriate. Input was used to reallocate resources within NRES and to modify research questions to better address scientific and stakeholder needs. The input received from NRES stakeholders allows the department the opportunity to evaluate current programs within teaching, research, and Extension. As an added benefit, stakeholder input provides a guideline for trends that impacts course content for our undergraduate and graduate students. In FSHN external advisory committee input, graduate survey data, informal stakeholder feedback, and external program reviewer comments are incorporated into discussions during department faculty meetings and advisory committee meetings. The strategic planning committee also uses stakeholder input to make decisions on strategic directions.

Extension field staff integrate Extension Council feedback into decisions about priorities in their multi-county local plans of work. Program evaluation results have been used by Extension staff to make adjustments in both the content and program delivery methods to better meet the needs of participants. Consequently, staff have learned to more effectively market and deliver programming through new technologies such as Facebook Live. Extension Councils in some areas provide input on hiring priorities when vacancies occur. Results of the planning process conducted by Extension administrators, program leaders, and planning ambassadors in 2017 were used to generate state-level logic models in order to strategically and collectively focus programs on the priority issues affecting Illinois citizens.

Brief Explanation of what you learned from your Stakeholders

Stakeholders encouraged ACE to proceed with initiatives such as a new Certificate in Agriculture Focused Financial Planning. The Animal Sciences external review committee recommended the department develop a strategic plan, increase private funding, pursue large program project grants, activate the vision for the new feed technology center, and enhance interdisciplinary training for graduate students. Other stakeholders suggest the department take steps to create a labor pipeline for production animal agriculture. Historical findings learned from Crop Sciences stakeholders have been to increase alumni involvement in recruitment, cover out of state tuition fees, recruit more transfer students, implement a 3+2 Master's program, look for more applied research opportunities, and seek out external funding for applied research positions. The following key findings were learned from interactions with NRES stakeholders: [1] Growers, consultants, and certified crop advisors provided information regarding the resistance and spread of resistance in relation to ecology and management of arthropods in corn; [2] Participants at various outreach events learned of dynamic soil properties research to determine critical indicators of sustainability; [3] Consumers provided information related to preference of the presentation of GM information on food package labels; [4] Farmers, breeders, and consumers participated in a workshop and two field days to gather input on attributes of interest and challenges and opportunities for high value specialty grains grown in Illinois; and [5] Interest in organic production methods in urban contexts is growing. ABE stakeholders view the most important current emerging issues to be: [1] Agricultural and Biological Systems and Technology - Precision and information agriculture; plant and animal production; sustainable agricultural intensification; big data, informatics, and analytics; health; and safety; [2] Food and Bioproducts - Processes and products; and security and safety; [3] Energy - Renewable energy and energy efficiency; [4] Water - Land and water resources and water quality and use; [5] Environment - Air, soil, and water quality and built environment; and [6] Biological Engineering - Biotechnology and biosensors.

Customer satisfaction surveys indicate that Extension stakeholders who serve as Extension volunteers believe strongly in the value of the programs they receive deliver. Expansion and Review Committees identify underserved populations that become intentionally targeted audiences in local plans of work. Their voice, through local and statewide committees, provide valuable insights into how needs in their communities are changing.

Responses to end-of-program evaluations indicate that participants are satisfied with the quality of the programs in which they participate and give high ratings to the presenters. Their comments and recommendations are used to adjust future content and, in many cases, provide direction for new topics and programming. One concrete example is the development of online Master Gardener core training piloted in 2018.

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	9082866	0	7316319	0
Actual Matching	9082866	0	7316319	0
Actual All Other	36988554	0	38657545	0
Total Actual Expended	55154286	0	53290183	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	9082866	0	1359081	0

V. Planned Program Table of Content

V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Agricultural And Biological Engineering

☑ 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
104	Protect Soil from Harmful Effects of Natural Elements	10%		0%	
112	Watershed Protection and Management	10%		15%	
133	Pollution Prevention and Mitigation	10%		15%	
141	Air Resource Protection and Management	10%		10%	
205	Plant Management Systems	0%		10%	
315	Animal Welfare/Well-Being and Protection	0%		10%	
401	Structures, Facilities, and General Purpose Farm Supplies	0%		10%	
402	Engineering Systems and Equipment	30%		10%	
403	Waste Disposal, Recycling, and Reuse	30%		10%	
405	Drainage and Irrigation Systems and Facilities	0%		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	0.0	0.0	4.0	0.0
Actual Paid	1.9	0.0	18.2	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
90829	0	533251	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
90829	0	533251	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
369886	0	1296504	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Activities under this Planned Program in FFY 2018 included efforts to test the effectiveness of biochar addition to swine bin composters to achieve quicker temperature increases and higher temperatures [reducing the risk of spreading diseases and addressing livestock producers' concerns], improved moisture control, and reduced ammonia emissions [which would increase fertilizer value of finished compost and decrease odor/indirect greenhouse gas emissions], research aimed at increasing corn yield by aiding the breeding process using an agricultural engineering perspective, an evaluation of the efficacy of using woodchips and fly ash pellets in flow-through tests for their abilities to remove nitrate and phosphate from agricultural runoff [the results of this study suggest that woodchip denitrification followed by fly ash pellet filtration can be an effective treatment technology for nitrate and phosphate removal in subsurface drainage], and an exploration of the effects of nitrogen fertilization alternatives on nitrate loss and crop yields using the **Root Zone Water Quality Model [RZWQM]** in tile-drained fields in central Illinois [this study presented the need of adaptive nitrogen fertilizer management due to the heterogeneity in agricultural systems, and raised the importance of timing and placement of nitrogen fertilizer as well as further reduction in fertilizer rate to devise a better in-field nitrogen management practice].

Activities also included the development of a new way of studying clinical and subclinical mastitis in dairy cows that will allow better antibiotic decision-making [this technology has led to a new collaboration with the U.S. Army Center for Environmental Health Research to look at the impact of contaminants on gut microbiota in soldiers in the field], work that seeks to refine and improve the practice of denitrifying bioreactors to mitigate agricultural drainage nitrogen losses for societally-desired clean water outcomes, research with the overall goal of evaluating the performance of conventional drainage, drainage water management, and combination drainage/subirrigation systems under projected climate scenarios [and to use this information to make recommendations on the most effective mid-century and end-of-century drainage designs for a specified soil in a given county in Illinois], a project with the objective of testing a newly developed crop sensing system for field chemical applications and to develop a practical procedure of using a UAS mapping system for major crop herbicide variable-rate applications, work to better understand the impacts of environmental management on poultry [with the information gained, poultry housing environments can be improved by defining environmental conditions and management practices that will result in production systems which promote bird welfare and performance], and work to develop practices and tools that help growers manage controlled environment resources efficiently.

Conference presentations included the American Society of Agricultural and Biological Engineers, International Livestock Environment Symposium, American Society of Chemistry, American Society of Chemical Engineers, and the Illinois Pork Producers Association.

In the state of Illinois, there are legislatively mandated [Illinois Livestock Management Facilities Act] requirements for the design, construction, and operation of livestock management and livestock waste-handling facilities. Extension's **Certified Livestock Manager [CLM] Program** continues to provide training and certification to enable producers to satisfy these requirements. Extension offered twelve onsite trainings to 429 and certified 426 livestock managers. In addition, 40 livestock managers certified through online training offered as an option to maximize the use of distance technology and expand access to training. Topics in the 2018 CLM Program covered farmstead and occupational safety, best management practices for livestock operations, updates to the Illinois regulations and rules related to livestock management, and nutrient management planning principles.

New in 2018, Extension offered a workshop on **Animal Mortality Composting** for livestock producers who use, or are considering, mortality composting. Twenty-seven [27] participants attended presentations that included different aspects of carcass composting, new technologies available to help producers, and general requirements for successful on-farm mortality composting. A portion of the workshop was held at the University of Illinois Orr Research Center, where attendees rotated through three hands-on demonstration stations.

Extension faculty and specialists integrated an informational website for Certified Livestock Manager Training into the newly developed Extension website on **Livestock Facilities and Manure Management** [http://web.extension.illinois.edu/lfmm/]. The link for the CLM Training site is located under "Training and Certification" [http://web.extension.illinois.edu/lfmm/clmt/]. The team implemented and began to utilize a twitter account [@uilfmm] for regular announcements.

Agricultural and on-farm safety are addressed in part through **Farm Safety Days** held throughout the state and through the **Illinois AgrAbility Unlimited [AU]** program. The Illinois AU program staff delivered training with inpatient and outpatient care staff at fifteen hospitals and staffed an exhibit at several professional conferences this year. AU staff assisted fifteen AgrAbility clients who qualified for state supported financial assistance to obtain needed adaptive technology. In total, the program maintains a caseload of 78 agricultural clients.

2. Brief description of the target audience

Members of the target audience included researchers in both agricultural robotics and crop sciences, students and the general public, farmers, agronomists, veterinarians, members of the U.S. military, scientists and engineers working to develop practical nitrate treatment technologies for agricultural effluents and drainage water, conservation professionals such as those working for the USDA Natural Resources Conservation Service and Soil and Water Conservation Districts, watershed organizations involved in meeting nutrient loss reduction goals, drainage contractors and crop advisors who can utilize our improved bioreactor design models and information to increase adoption of what will be a more effective bioreactor technology, Extension personnel, pork producers, the asphalt industry, the wastewater treatment industry, and researchers focusing on algae biomass. Extension target audiences included crop producers, certified crop advisers, livestock producers, custom manure haulers, landscapers, and individuals with disabilities resulting from an agriculture-related accident.

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	755	224423	0	0

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

Patent Applications Submitted

Year:	2018
Actual:	3

Patents listed

[2017-030-01 [PRO]] - Apparatus And Method For Agricultural Data Collection And Agricultural Operations; [2017-030-02 [PRO]] - Robot-Based Phenotyping Using Deep Learning; [2017-030-03 [PRO3] - Apparatus And Methods For Agricultural Data Collection And Agricultural Operations.

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	24	24

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number Of Completed Hatch Projects

Year	Actual
2018	2

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Maximizing Efficiency And Minimizing Drift For Agricultural Aerial Applications
2	Improving Emission Control Technologies For Livestock Buildings
3	Implementation Of Global Engineering Solutions Using Agricultural Machinery
4	Development And Use Of A Manure Management Plan
5	Reducing The Risks Associated With Bioactive Compounds In Wastewaters
6	Improved Understanding Of The Impacts Of Atmospheric Amonia Expression On Laying Hens
7	Converting Biowaste Into Biocrude Oil Via Hydrothermal Liquefaction
8	Developing Practices And Tools That Help Growers Manage Controlled Environment Resources Efficiently

Outcome #1

1. **Outcome Measures**

Maximizing Efficiency And Minimizing Drift For Agricultural Aerial Applications

Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

Improving Emission Control Technologies For Livestock Buildings

Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

Implementation Of Global Engineering Solutions Using Agricultural Machinery

Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

Development And Use Of A Manure Management Plan

2. **Associated Institution Types**

- 1862 Extension
- 1862 Research

3a. **Outcome Type:**

Change in Action Outcome Measure

3b. **Quantitative Outcome**

Year	Actual
2018	299

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

Issue (Who cares and Why)
The 1996 Illinois Livestock Management Facilities Act requires that all livestock producers and/or managers with 300 Animal Units [AU] or more complete a certification every three years to promote environmentally sustainable and safe management of their facilities. Improper manure management has negative societal impacts on neighboring communities and the environment. Livestock producers need access to training for legislatively mandated certification requirements and to minimize societal and environmental impacts of livestock waste.

What has been done
The Certified Livestock Manager [CLM] Training Program team conducted twelve onsite trainings with a total of 429 producers, contractors, educators and others. A total of 426 were certified at the workshops. An additional 40 individuals completed and successfully passed a five module online training and were issued completion certificates. The CLM curriculum includes key topics such as Farmstead and Occupational Safety, Best Management Practices for Livestock Operations, Nutrient Management Planning, and Livestock Manager Facilities Act regulations. The most commonly reported livestock commodity was swine [72%] and the majority of the participants were owners [65%] or managers [19%] of livestock facilities.

Results
Turning Point Technologies response software was used to anonymously poll the audience on a set of questions to better understand their technical knowledge and best management practices. The vast majority [79%] indicated they had a manure management plan [299 of 377 respondents] and 43% indicated their plans were written and updated annually and constantly used. In terms of updates to their practices in the past few years, 35% updated their operation to use nutrients as fertilizer and 19% updated mortality management operations. Extension is an essential partner to our state agency that has been charged with ensuring the statutory mandates for regular and ongoing training are met.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
403	Waste Disposal, Recycling, and Reuse

Outcome #5

1. Outcome Measures

Reducing The Risks Associated With Bioactive Compounds In Wastewaters

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Improved Understanding Of The Impacts Of Atmospheric Amonia Expression On Laying Hens

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
This project focused on gaining understanding about the impacts of atmospheric ammonia exposure on laying hens in order to better inform environmental management decisions. Ammonia is a gas generated from the feces in the barn, and ideally is diluted by fresh air brought in through ventilation. The concentration of ammonia within the barn varies throughout the day and year. The variations in housing type and arrangement have been shown to result in variations in environmental conditions within barns, including ammonia concentration. The goal of this project was to begin to set exposure thresholds for both concentration and duration of exposure of laying hens to atmospheric ammonia.

What has been done
The laboratory tests included both health and behavioral responses of hens to chronic exposure to laying hens, approximately 30 ppm for a year. Response measures were collected periodically over the year. The results revealed minor changes to immune function after several months of exposure and no responses after a year. This indicates that the hens were able to adapt to the chronic exposure to moderate [30 ppm] ammonia. No consistent health responses were observed based on tissues collected for the lungs, eyes, or trachea. No differences were observed for behavioral aversion to concentrations up to 120 ppm. No differences were observed for production parameters, such as egg production and feed disappearance. These results conflict with prior observations of ammonia impacts in a production setting. These discrepancies might be explained by: [1] Ammonia may not be the parameter causing the responses in previous studies, but may be correlated with another factor that is responsible, such as dust [air quality variables tend to respond in similar directions - for example, as ammonia concentrations increase, so to do dust concentrations]; [2] Ammonia may need to be combined with another factor, such as dust, in order to initiate the response; [3] The production environment may consist of multiple environmental challenges that result in compromised immunity, making hens less able to cope/adapt to the ammonia challenge [this multiple stressor syndrome has been documented in

pigs and has been shown to be multiplicative]; or [4] Exposure to a constant concentration may be easier for the hens to adapt to than a cycling or fluctuating concentration. Differences between our laboratory controls and a production setting may account for this discrepancy.

Results
A follow-up laboratory test focused on shorter exposures to higher concentrations, up to 120 ppm for two weeks. Some health and immune responses were observed for the highest concentrations, but most expected variables did not reveal a measurable response, still offering no clear threshold for exposure concentration/duration combination. Previous work in broiler chicks revealed that adaptations to exposure were realized as quickly as a few days to weeks of exposure, so it is possible that hens are also able to adapt quickly to a change in exposure.

The results of this project indicate that future focus should be placed on better understanding the impact of short-term fluctuations in ammonia concentrations. Additionally, a new tool was developed that can be deployed for on-farm research to better quantify the ammonia conditions in a production setting. The full evaluation of on-farm ammonia prevalence was thwarted by restricted farm access due to avian influenza. Nonetheless, of the monitoring completed, concentrations observed on-farm were in line with those previously reported.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
141	Air Resource Protection and Management
315	Animal Welfare/Well-Being and Protection
401	Structures, Facilities, and General Purpose Farm Supplies
402	Engineering Systems and Equipment

Outcome #7

1. Outcome Measures

Converting Biowaste Into Biocrude Oil Via Hydrothermal Liquefaction

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Agricultural production addictively relies on fossil fuel-derived fertilizer, which is the largest single source of reactive nitrogen in the biosphere contributing to climate change. However, single-cycle nature fertilizer use would not meet the increasing food and bioenergy demand. Renewable energy can be obtained via various viable sources such as solar, wind, and even geothermal. We propose a new paradigm, "Environment-Enhancing Energy [E2-Energy]", and a demonstration lab-scale system has been established at the University of Illinois which has a capacity of two gallons/day biocrude oil production from manure and algae grown in the manure water treatment system.

What has been done
In this approach, biowaste is first converted into biocrude oil via hydrothermal liquefaction [HTL]. Second, fast-growing algae are cultivated in the wastewaters from original liquid waste and an HTL reactor to uptake excess nutrients and capture carbon dioxide. Finally, the algae will be fed back to the HTL process to be converted into additional biocrude. The engineered E2-Energy technology mimics the natural process of forming fossil fuels, but reduces geologic time scales to less than an hour. This has shown that E2-Energy process can reuse nutrients three [by experiment] to ten [by modeling] times, which amplifies the original biomass by the same factor. As a result, the nitrogen efficiency is increased. For example, from a baseline of 35% to 105 - 350% based on corn for ethanol production.

The United States has an estimated 59 million dry tons of sustainably collectable livestock manure containing approximately 1.2 million tons of nitrogen. This alone can be used to enhance nitrogen efficiency and the production of biomass and bioenergy by deploying the E2-Energy technology. This amount of nitrogen in manure has the potential to be recycled multiple times to produce 180 - 600 million tons of mixed algal-bacteria feedstocks that can be subsequently converted into 54 - 300 million tons of biocrude oil via hydrothermal liquefaction while reducing nitrogen emissions to the atmosphere or waterways. It could revolutionize food and renewable fuel production and water reuse if we utilize the nutrient content and wastewater from other sources including municipal sanitary districts.

Results
Previously we have converted the biowaste [food processing waste and swine manure] into a biocrude oil via hydrothermal liquefaction. The major accomplishment in the past year was that we move forward to upgrade the HTL biocrude into a diesel blend and performed an engine test. The diesel blend demonstrated very much the same performance as petroleum diesel in terms of power output and air emissions [NOx, CO and soots]. The major result was published in Nature Sustainability in 2018. We are now focused on a pilot HTL reactor for biowaste conversion and on upgrading the biocrude into karosene [jet fuel]. We have developed an innovative process to upgrade such biocrude oil. To produce value-added transportation fuel from biowaste will make our Environment-Enhancing Energy paradigm more economically viable in addition to the environmental benefits.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
141	Air Resource Protection and Management
402	Engineering Systems and Equipment

403 Waste Disposal, Recycling, and Reuse

Outcome #8

1. Outcome Measures

Developing Practices And Tools That Help Growers Manage Controlled Environment Resources Efficiently

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Horticulture, including greenhouse production, is a vibrant and economically-important sector of agriculture. The wholesale value of horticulture specialty crops [defined as greenhouse, nursery, and related crops such as seeds and vegetable transplants] was $11.7 billion in 2009.

What has been done
Over the last decade, growers have been faced with resource management issues, particularly related to fuels for heat and water for irrigation, that have significantly impacted their livelihoods. Greenhouse and nursery facilities are high input systems using vast amounts of water, fertilizers, chemicals, plastics, and labor to produce crops. Our team proposes to address resource management issues related to water and nutrient applications, as well as to energy use. We propose to use sensors to collect improved information about the plant status, the growing environment, and outdoor conditions.

Results
As a member of the twenty-four researcher team from land-grant universities across the U.S. we worked together to develop practices and tools that help growers manage controlled environment resources efficiently. Growers who have adopted recommended facility designs, management practices, and tools have seen energy savings of 5% to 30% and average-sized businesses have saved $20,000 per year in operating and maintenance costs. Many of the technologies developed by members of this project are now industry standards and are widely used.

4. Associated Knowledge Areas

KA Code	Knowledge Area

401	Structures, Facilities, and General Purpose Farm Supplies
402	Engineering Systems and Equipment

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Competing Programmatic Challenges

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The **Certified Livestock Manager [CLM] Training Program** team conducted twelve onsite trainings for a total of 429 producers, contractors, educators, and others and 426 were certified through workshops. An additional forty individuals completed and successfully passed a five module online training and were issued completion certificates. The CLM curriculum includes key topics such as Farmstead and Occupational Safety, Best Management Practices for Livestock Operations, Nutrient Management Planning, and Livestock Manager Facilities Act regulations. The most commonly reported livestock commodity was swine [72%] and the majority of the participants were owners [65%] or managers [19%] of livestock facilities.

Turning Point Technologies response software was used to anonymously poll the audience on a set of questions to better understand their technical knowledge and best management practices. The vast majority [79%] indicated they had a manure management plan [299 of 377 respondents] and 43% indicated their plans were written and updated annually and constantly used. In terms of updates to their practices in the past few years, 35% updated their operation to use nutrients as fertilizer and 19% updated mortality management operations. Extension is an essential partner to our state agency that has been charged with ensuring the statutory mandates for regular and ongoing training are met.

Key Items of Evaluation

The **Certified Livestock Manager Program**, offered through classroom-based and online methods, successfully translated knowledge of manure management best practices to individuals and revealed that 79% of participants have a written nutrient [manure] management plan. In addition, nearly one-half reported that their plan is written, updated annually, and constantly used.

V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Agricultural And Consumer Economics

☑ 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
601	Economics of Agricultural Production and Farm Management	20%		10%	
602	Business Management, Finance, and Taxation	0%		15%	
603	Market Economics	0%		10%	
604	Marketing and Distribution Practices	0%		10%	
605	Natural Resource and Environmental Economics	0%		10%	
606	International Trade and Development	0%		10%	
607	Consumer Economics	40%		10%	
610	Domestic Policy Analysis	0%		10%	
801	Individual and Family Resource Management	40%		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	0.0	0.0	6.0	0.0
Actual Paid	5.7	0.0	20.4	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
272486	0	552785	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
272486	0	552785	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
1109657	0	4571457	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Activities in FFY 2018 included a project that investigates short-run forecasts in the soybean futures market complex to more clearly identify the predictive content and the sources of forecast errors [to shed light on how good soybean complex futures markets are when it comes to forecasting spot prices], research that seeks to evaluate the impact of climate change on agriculture in a spatial econometric framework and quantify the economic impact of extreme weather events and natural disasters, a needs assessment on buyers of soybean in Sub-Saharan Africa, a project that seeks to improve social mobility and to enhance financial and health wellbeing through a study of the intergenerational transmission of financial well-being and health and to investigate the genetic and environmental influences on finance and health, and the publication of results analyzing the local, state, federal, and international laws forming the legal environment for agriculture and the resulting impact on agribusiness supply chains, including consumers.

Activities also included research that seeks provide valuable, effective outreach and education to producers, agribusinesses, and those involved in natural resource conservation efforts [bridging differences and disconnects that exist among farmers, agribusinesses, conservation interests, and policymakers], an examination of the behavioral factors that influence the adoption of low carbon, renewable energy technologies and the design of policy incentives to accelerate adoption and cost effectively achieve various environmental outcomes, the development of a comprehensive and weighted measure of global financial inclusion [we will then test the robustness of this measure and the impacts that financial inclusion has on the financial stability and inclusive growth of households, businesses, and communities in developing countries], and a project that studies the economic impact of policies and interventions designed to help developing world small farmers cope with inefficiencies caused by poorly functioning input and output markets [exploring both the drivers and the consequences of these inefficiencies and the economic effects of public and private sector initiatives to resolve market failures].

Activities also included efforts to develop conservation tools that make efficient use of society's resources by managing uncertainty associated with climate change, managing threats to aquatic habitat from urban stormwater which have previously been neglected, and tailoring protected area policy to account for human responses that could cause intensified destruction in areas outside those which are protected, measurement of the impact on economic and environmental outcomes of new technologies in the food and agricultural system [it also seeks to identify pinch points in the food system where specific technical innovations could yield large positive effects on production efficiency, resource use, and/or farmer welfare], the development of greatly needed information on the causes, consequences, and likely future of farmland prices, research with the ultimate goal of gaining a better understanding of rural labor markets so that policymakers can improve the wellbeing of people living in rural areas, and an analysis of homeowner

willingness to pay for a pre-flood agreement to accept an expedited post-flood buyout if their home is severely damaged in a flood [this research has informed active policy formation in Congress].

Conference presentations in 2018 included the Agricultural and Applied Economics Association, Western Regional Science Association, Arizona Cooperative Extension WaterWise Workshops on the Climate, Water, Energy, and Agriculture Nexus, Arizona Agribusiness and Water Council, American Agricultural Economics Association, Academic Research Colloquium for Financial Planning and Related Disciplines, National Health Outreach Conference, Biennial Family Economics Resource Management Association Conference, American Council on Consumer Interests, Federation of European Risk Management Associations, CRISPRing: A New Beginning for the Genetic Improvement of Plants and Microbes, International Consortium of Applied Bioeconomy Research, Advanced Bioeconomy Leadership Conference on Next-Gen Technology, Coordinating Research Council Workshop on Life Cycle Analysis of Transportation Fuels, Coalition on Agricultural Greenhouse Gases, American Economics Association, Association for Environmental and Resource Economists, World Congress of Environmental and Resource Economists, Workshop on A Decade of Biofuel Policies - Lessons Learned, Chinese Economists Society, 6th Seminar on Asia and Pacific Economies, American Council on Consumer Interests, 12th Biennial Conference of the Asian Consumer and Family Economics Association, Chinese Academy of Financial Inclusion, Northeast Universities Development Conference, Northeastern Agricultural and Resource Economics Association Workshop on Climate Change and Land Conservation/Restoration, 18th Annual Bioecon Conference, 3rd Annual Association for Environmental and Resource Economists Summer Conference, 23rd Annual Meeting of the Society for Environmental Economics and Policy Studies, World Congress of Environmental and Resource Economics, Soil and Water Conservation Society, Southern Agricultural Economics Association, and Illinois-Indiana Sea Grant.

Extension educators implemented consumer economics outreach efforts to engage participants, across the lifespan and across economic levels, to maximize personal and family financial capacity building.

Financial literacy efforts targeted young consumers to promote personal finance competencies. In 2018, 3,385 Illinois teens participated in **Welcome to the Real World**, a simulation that gives middle and high school level students an opportunity to experience the required skills and challenges associated with balancing income and expenses [discussed in further detail in the evaluation section of this Planned Program].

Extension reached college students with specialized financial education as well. In 2018, Extension educators and trained peer interns provided financial education outreach through the **Financial Wellness for College Students Program** to 933 students on topics such as budgeting, credit management, and job benefits. In addition, more than 500 were reached at campus display/exhibit events and four e-Newsletters were sent to more than 3,000 subscribers. Customized personal consultation was provided to thirteen students. Extension partnered again with University Student Financial Services and Cashier Operations [USFSCO] Student Money Management Center [SMMC] in support of the **University of Illinois Saves [UISAVES] 2018 Campaign**. UISAVES is an annual campaign for the three universities in the University of Illinois system which gives us the opportunity to promote saving to both university employees and students. Over the course of the six-week campaign, 10 educational events were delivered and 1,055 people were reached online through digitally-delivered information and two webinars. Online events allowed participants to electronically share their saving goals and learn new saving tips.

Financial Planning for Young Adults, an online financial planning course co-developed by an Extension educator, was offered again in 2018. This course provides an introduction to basic financial planning concepts for individuals who are interested in the field of financial planning. In 2018, 5,620 learners accessed the course and one scholarship program [Daniel's Fund Scholarship Program] adopted a policy to require their 230 scholarship recipients to complete the course. Since the course went live, 534 learners demonstrated an improvement in financial literacy by increasing their pre- and post-quiz scores

from an average of 75% accurate to 90% accurate.

For those beyond their young adult years, Extension offered programs to build consumer knowledge and skills to plan for retirement and to protect the financial wellbeing of older adults. One popular program, **Senior Credit Scores** [attended by 55 participants], provided strategies for preserving credit and **Elder Financial Exploitation** educated participants about the ways older adults are subject to financial frauds. **Superpowers: Your Wishes Done Right** and **End of Life Decisions: A Conversation Worth Having** covered ways to communicate with family members and invoke powers of attorney to protect assets. Social and other electronic media were used to promote financial retirement planning through the **Plan Well, Retire Well** blog and through online resources such as blog postings to promote awareness during America Saves Week.

All My Money - Change for the Better, a train-the-trainer financial management curriculum, was delivered to professionals working with limited resource audiences. The curriculum is designed in a way that agency staff, social workers, and other educators can teach financial literacy topics without a formal financial management background. A total of 77 impactors were trained in the curriculum in 2018. **Money Mentors**, a volunteer program that matches volunteer mentors with individuals who need help with basic money management, was conducted with thirty new mentors in 2018 and provided continuing education for the mentors trained in 2017.

Extension also provided agricultural economics outreach and education to those who are engaged in the agricultural industry. **Annie's Project**, a multi-session farm management course for women, was delivered by Extension educators in nine counties with 254 participants. Workshops utilized experts in production, financial management, human resources, marketing, and legal issues. Topics included sessions related to business plans, marketing, farm leases, insurance, estate planning, property titles, and financial management.

The theme for the December **2017 Illinois Farm Economics Summit** was "The Profitability of Illinois Agriculture: Managing Financial Stress." Held in five locations, the summits addressed the farm profitability outlook and management challenges from several perspectives, including the 2018 outlook for crop and livestock prices, soybean yield trends, an update on the next farm bill, the financial position of Illinois farms, habits of financially resilient farm operations, and crop economics for 2018. Presentations were posted to **farmdoc**, a website hosted by the College of ACES Department of Agricultural and Consumer Economics.

Through a long-term partnership between Illinois Extension and WILL [a public radio station owned by Illinois Public Media], WILLag.org broadcasts three daily market reports to provide information and analysis of commodity markets and agricultural weather. **Commodity Week** is a weekly radio and television feed highlighting the people, the science, and the technology of Illinois agriculture. The feeds are picked up and used in one way or another by about seventy broadcast outlets reaching more than three million listeners or viewers each week. Podcasts of each broadcast are available to all subscribers. An Extension staff member manages the WILLag.org project, hosts all broadcasts, and generates social media posts to extend the reach of the feeds.

2. Brief description of the target audience

Members of the target audience included agricultural producers, food consumers, policy makers, the world's soybean markets, academics, industry professionals, ranchers and farmers, bankers, researchers and practitioners in the family and consumer science community, practicing lawyers and academic lawyers in the U.S. and abroad, government regulatory agencies, processors and retail distributors of agricultural inputs and products, consumers, private firms with agricultural interests, those interested in federal farm and conservation policy as contained in the farm bill, students, government agencies, NGOs, foundations,

world organizations [United Nations, OECD, World Bank, T20 Japan], central banks, development banks, rural credit cooperatives, microfinance institutions, private sector enterprises interested in efforts related to national and global issues related to economic and financial inclusion, USAID and USDA, water and land management agencies, researchers in agricultural sciences, economics, and public policy, international research institutions, producer organizations, state and federal governments, international agencies working on issues related to food and agriculture, professional farm managers, financial managers in the agricultural investment community, agricultural lenders, academic economists, agricultural production students, and workers in the trucking and health care professions.

Extension professionals focused on the crop insurance industry [agents and companies], the farm credit/banking industry, USDA officials, landowners, community groups, producer organizations, schools in the state of Illinois, graduate and undergraduate students, leaders in agricultural finance and members of institutions involved in providing credit to agricultural interests, farm managers, financial managers in the agricultural investment community, agricultural lenders, academic economists, and agricultural production students. Also targeted were crop and livestock producers, landowners, financial advisers, tax consultants, youth, college students, senior citizens, and consumers and families facing financial challenges.

3. How was eXtension used?

Three members of the Consumer Economics Team are members of one or more eXtension Communities of Practice.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	2576	802347	8616	442779

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	69	69

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number Of Completed Hatch Projects

Year	Actual
2018	5

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

Outcome #1

1. **Outcome Measures**

Page File Requests Made To Farmdoc

Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

Number Of Web Hits On The Varietal Information Program For Soybeans Website

Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

Toward A Better Understanding Of The Causes, Consequences, And Likely Future Of Farmland Prices

2. **Associated Institution Types**

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Farmland accounts for over 80% of the total value of all assets in the agricultural sector, valued at over $2.4 trillion, and farmland also serves as the principal source of collateral in farm loans. As a result, changes in farmland values can greatly affect the financial health of farmers, farmland owners, and agricultural lenders. In recent years, farmland prices have exhibited historically high appreciation rates in many areas throughout the United States, including Illinois, and farmland prices are now at record levels in both real and nominal terms. The price surge is driven by a number of factors, including high commodity prices and farm incomes, low interest rates, the

demand for agricultural products in rapidly developing countries such as China, and the emerging biofuels industry. The high appreciation rates have occurred while many sectors of the economy have struggled to overcome the effects of the recent economic downturn, and as a result many new investors have grown increasingly interested in acquiring farmland. This project will provided greatly needed information on the causes, consequences, and likely future of farmland prices.

What has been done
Over the course of the project we have published a number of peer reviewed academic journal articles and presented research findings along the way to Extension audiences of professional farm managers, real estate appraisers, farmland owners, and farm operators. At the outset of the project, farmland prices across the Corn Belt increased substantially following high commodity prices. However, over the course of the project, farm incomes declined, yet farmland prices plateaued.

Results
Throughout the course of the project, the supported research program examined the changes in the relative contribution of various farmland characteristics to observed farmland prices. Regression analysis of observed farmland prices demonstrated that farmland prices are determined by a complex set of agricultural and non-agricultural factors. During the commodity price boom, the relative productivity of agricultural land was a significant driver of farmland price appreciation, and the relative contribution of development potential declined as farmland conversion slowed following the 2008 financial crisis. Yet, non-agricultural factors remained an important determinant of farmland market values in many areas of the country, particularly in areas with high natural amenities or adjacent to urban areas.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
602	Business Management, Finance, and Taxation
603	Market Economics
605	Natural Resource and Environmental Economics
610	Domestic Policy Analysis
801	Individual and Family Resource Management

Outcome #4

1. Outcome Measures

Number Making Decisions To Reduce Risk In Agriculture Production

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Exploring The Impact Of Recent Commodity Market Developments On Market Efficiency

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Exploring The Impact Of Government Policy Decisions On Household Finance

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Throughout the world, policy makers are concerned about the impact that population aging will have on households' financial security, especially those groups most likely to be vulnerable - women, the less educated, and the poor. We used data from the 2014 World Bank Global Findex and supplement it with macroeconomic indicators of old-age security to investigate the financial security of households across both developed [OECD] and developing [non-OECD] countries with various aging populations. Five fundamental indicators of financial security were examined. Results show an aging effect for all measures. The aging effects are largest for those who report saving for old age. Older age groups living in countries with larger aging populations are more likely to save, regardless of OECD status. Also, those who are female, have less education, and lower incomes are particularly vulnerable, especially those living in developing countries. Further, the financial security of those living in non-OECD countries is significantly more likely to be affected by public pension spending and other key indicators of old-age security.

Financial inclusion and technological usage also have a significant and positive impact on financial security. These factors could play a key role in promoting savings and improving financial security in aging populations worldwide. The findings from this study have important policy implications given the pressures that some countries' social support and public transfer

systems will face in the coming years.

What has been done
Government leaders around the world are designing national strategies to improve financial inclusion for populations traditionally excluded from the financial markets. Financial literacy is a key tool being used to bring economically vulnerable populations into the financial mainstream. Data from the 2013 China Household Finance Survey [CHFS] were used to investigate the impacts of various dimensions of financial literacy on the usage of bank and non-bank loans among rural, illiterate, and migrant populations in China. The findings show that the most vulnerable groups may be less likely to benefit from financial literacy, especially when it comes to usage of formal bank loans. Other factors such as those related to social networks and infrastructure may matter more than financial literacy. Results were found to vary across measures of financial literacy and financial inclusion. The findings suggest that barriers to access likely need to be overcome so that financial literacy can be more effective. The current study provides important insights for policy makers and international organizations designing national strategies to improve financial inclusion via financial literacy, especially for populations that have been traditionally excluded. Researchers are encouraged to re-examine previous definitions and measures of financial literacy and inclusion to develop a better understanding of the relationship between the two dimensions.

Results
Financial inclusion plays an important role in giving households greater access to borrowing opportunities, which in turn can be used to improve human capital accumulation, socioeconomic status, and long-run economic development. One way to enhance households' access to and usage of the financial system, especially the formal banking system, is to ensure that adequate infrastructure exists within their community. This study uses data from the 2013 China Household Finance Survey to investigate how infrastructure affects the usage of both bank and non-bank loans for urban and rural households in China.

The results suggest that infrastructure, in a variety of forms [physical, financial, technological, social, and informational], is significantly associated with loan demand - most notably for urban households using formal bank loans. Further, those living in more urbanized areas and megacities are less likely to demand bank and non-bank loans even after controlling for other factors, suggesting that there may be an "urbanization effect" that is dampening credit access and usage. The potential for reverse causality between infrastructure and loan demand is also taken into consideration. The results show that decisions related to loan demand and infrastructure mostly appear to be made independently. The findings from this research have important implications for China and other countries working on national strategies aimed at improving financial inclusion, especially the expansion of bank credit in rapidly growing urbanized areas, where infrastructure may be reaching capacity.

4. Associated Knowledge Areas

KA Code	Knowledge Area
603	Market Economics
607	Consumer Economics
610	Domestic Policy Analysis
801	Individual and Family Resource Management

Outcome #7

1. Outcome Measures

Investigating The Communication Technologies Used To Share Information About Soy Protein Applications

Not Reporting on this Outcome Measure

Outcome #8

1. Outcome Measures

Number Of Youth, College Students, Or Adults That Increased Knowledge And Skills In Managing Income And Expenses

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	856

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Older youth need knowledge and skills to assist them in selecting careers and managing their income and expenses in order to live as an independent adult.

What has been done
Annually, Extension field staff members provide Welcome to the Real World training and curriculum materials for teachers and conduct a simulation for their middle and high school students. The simulation allows students to start with a monthly income and visit various booths to spend their income on items typically found in a family budget such as housing, utilities, food, transportation, insurance, and childcare. In 2018, 3,385 youth participated in the Welcome to the Read World training across 26 counties in Illinois.

Results
At the end of the Welcome to the Real World simulation, evaluation forms were completed and collected from 1,112 youth participants. The evaluation was designed to identify increased knowledge of financial management concepts. The evaluation asked students to evaluate five money management skills choosing between "learned how to do" or "already knew how to do". Of the 1,112 youth that responded to one or more financial management questions, 856 [77%]

indicated that they learned at least one of the six skills with the largest number reporting they learned how to balance income and expenses. Just over 25% indicated they learned five of the six skills taught as part of the curriculum.

4. Associated Knowledge Areas

KA Code	Knowledge Area
607	Consumer Economics
801	Individual and Family Resource Management

Outcome #9

1. Outcome Measures

Individuals Improving Financial Capability And/Or Adopting Consumer Behavior Skills

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	362

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In Illinois, many residents are financially ill-prepared for the future. A survey by the Employee Benefit Research Institute found that only 22% of American workers are confident they will have enough money for retirement and 64% know they are behind in what they should be saving for retirement. According the American Bankruptcy Institute, as of February 2019, Illinois ranked 6th out of 50 states for the greatest per capita personal bankruptcy filing rate. Through University of Illinois Extension efforts in financial literacy promotion, families can be better prepared to manage financial resources.

What has been done
Extension Educators on the Consumer Economics team implemented five All My Money programs in 2018. The All My Money curriculum is a train-the-trainer financial management program for persons working with limited-resource audiences. The curriculum is designed in a way that agency staff, social workers and other educators can teach financial literacy topics, even if they do not personally have expertise in financial management. A total of 77 participants completed the training of trainers in 2018.

Illinois Extension partnered again with University of Illinois USFSCO Student Money Management

Center [SMMC] in support of the University of Illinois Saves [UISAVES] 2018 campaign. UISAVES is an annual campaign for the three universities in the University of Illinois System which gives us the opportunity to promote saving to both university employees and students. Over the course of the six week campaign, ten educational events were delivered and 1,055 people were reached online through digitally-delivered information and two webinars. Online events allowed participants to electronically share their saving goals and learn new saving tips.

Results
A post-program evaluation of the All My Money Train the Trainer program was completed by 61 of the participants in 2018. Based on survey results, 56 respondents [92%] reported an increased likelihood to take at least two of the nine recommended actions to promote their own financial wellbeing. In addition, almost one out of five [19%] reported an increased likelihood to take all nine actions as a result of their training. Adopting these recommended practices are critically important consumer behaviors for individuals, particularly for those who have the potential to impact individuals and families with limited resources and are at the highest risk for financial instability.

During the UISAVES campaign in 2018, 306 students and staff were motivated to set savings goals [a key targeted consumer behavior for the campaign]; reflecting an increase of 100 individuals compared to 2017.

Collectively, across these two high impact consumer economics programs, 362 individuals reported actions to improve their consumer behavior and protect their financial assets.

4. Associated Knowledge Areas

KA Code	Knowledge Area
602	Business Management, Finance, and Taxation
607	Consumer Economics
801	Individual and Family Resource Management

Outcome #10

1. Outcome Measures

Examining The Social Welfare Impacts Of Government Policies

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual

2018 0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
We examined the welfare costs and greenhouse gas abatement achieved by the existing state Renewable Portfolio Standards [RPSs] relative to a hypothetical national RPS and a national GHG Cap policy. We undertook this analysis using a dynamic, multi-region, partial-equilibrium, price-endogenous model of the U.S. electricity, agricultural, and transportation sectors, called the Biofuel and Environmental Policy Analysis Model [BEPAM-E]. Our results showed that a hypothetical national RPS can induce an equivalent share of renewable-based electricity generation as the state RPSs but at a $61 billion lower welfare cost over the 2007-2030 period. The national RPS would also achieve greater GHG reductions than the state-level RPSs, as it induces a larger decrease in coal generation. We found that the national RPS and national GHG caps are 55% and 74% more cost-effective in reducing GHG emissions than the state RPSs.

What has been done
We analyzed the effects of community pressure induced by the public disclosure of toxic emissions information provided by the Toxic Release Inventory since 1990 in leading to relocation by toxic-releasing facilities. We compared the characteristics of the communities the relocating facilities move from with those they move to and examined the change in the facilities' emission level, employment, and emission per employee following relocation. We found toxic releasing facilities are more likely to relocate from communities with a high population density, high income, and high educational attainment, and into communities with lower population density, income, and educational attainment. There is also weak evidence that small facilities grow faster after relocating into the new communities. Thus, the relocation of toxic polluters has contributed to a worsening of environmental justice following the public release of emissions information.

Results
We examined the effectiveness of the Companies Act of 2013 which went into effect in India in 2014, making it the first law in the world to mandate that companies commit 2% of their profits on corporate social responsibility [CSR] initiatives. However, the act did not impose penalties on firms that failed to do so, requiring them only to disclose the reasons for non-compliance publicly. We used panel data for 39,736 firms with a difference-in-difference model to estimate the average treatment effect of the act on firms "eligible" for compliance with the act and in particular to investigate the role of peer pressure in influencing a firm's response to the act in 2015 and 2016. We also applied the Regression Discontinuity Design method to estimate the average effect of treatment assignment for firms near the threshold of eligibility for compliance with the act. We found that the act led to a statistically significant increase in the likelihood of reporting of CSR expenditures and in the level of CSR expenditures by eligible firms and this increase was not accompanied by crowding out of other charitable donations by firms. The effect of the act was also positive and statistically significant on firms at the threshold for compliance with the act. The positive and statistically significant effect of peer pressure in motivating CSR by firms diminishes after controlling for the requirement for CSR expenditures proportional to profits by the act, implying a crowding out of intrinsic motivations for CSR by extrinsic effects due to the regulation.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
602	Business Management, Finance, and Taxation

603	Market Economics
605	Natural Resource and Environmental Economics
610	Domestic Policy Analysis
801	Individual and Family Resource Management

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Welcome to the Real World Simulation

At the end of the **Welcome to the Real World** simulation, evaluation forms were completed by 1,112 of the youth participants. The evaluation was designed to identify increased knowledge of financial management. The evaluation asked students to evaluate five money management skills choosing between "learned how to do" and "already knew how to do". Of the 1,112 youth who responded to one or more money management skill questions, 856 [77%] indicated that they learned at least one of the six skills and 26.2% indicated they learned five of the six skills taught as part of the curriculum.

In addition, the post-program assessment asked participants to reflect on their opinions about financial and career relationship before and after the program. When asked how much they realize the importance of the following relationships BEFORE and AFTER participating in the program, a higher proportion of youth responded a lot at the end of the program in comparison to before the program. After participating in the program: [1] 63% realized the importance of the relationship between education and a job [compared with 35% before the program]; [2] 67% realized the importance of the relationship between a job and money [compared with 40% before the program]; and [3] 72% realized the importance of getting more education after high school [compared with 55% before the program].

Key Items of Evaluation

Welcome to the Real World Simulation

Simulations helped **Welcome to the Real World** youth participants recognize the challenges of independent living and impacted their knowledge of financial management.

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Animal Health And Production

☑ 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
301	Reproductive Performance of Animals	20%		15%	
302	Nutrient Utilization in Animals	0%		20%	
303	Genetic Improvement of Animals	0%		10%	
305	Animal Physiological Processes	10%		10%	
307	Animal Management Systems	30%		10%	
311	Animal Diseases	20%		15%	
315	Animal Welfare/Well-Being and Protection	0%		20%	
806	Youth Development	20%		0%	
	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	0.0	0.0	8.0	0.0
Actual Paid	1.9	0.0	26.3	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**
90829	0	1235288	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
90829	0	1235288	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
369886	0	8158243	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Activities under this Planned Program in FFY 2018 included a trial that seeks to determine the effect of hydromorphone on equine behavior, intestinal motility, cardiopulmonary function, hematologic variables, and body temperature and also to measure plasma concentrations of hydromorphone and its primary metabolite, hydromorphone-3-glucuronide, to determine its metabolism and pharmacokinetics in horses, a project that characterized and validated a potentially unique critical enzyme involved in the biosynthesis of an important major phospholipid [phosphatidylcholine] in the livestock parasite C. parvum [this has set the stage for future studies to identify specific chemical inhibitors targeting CPMT to effectively inhibit its enzymatic activity and kill the parasite and will provide a novel basis for developing a new class of effective remedies to control C. parvum infections in livestock], and the identification of a quantification method that consistently identifies cattle that are more attractive to horn flies [we consider those that are not attractive to have some innate resistance].

Activities also included work that seeks to investigate the expression of putative candidate genes in six anatomical regions of interest [four in the spinal cord, two in the cerebellum] to determine co-expression of putative candidate genes with doublesex and Mab-3 related transcription factor 3 [DMRT3] and to complete a preliminary differential expression analysis between pacers and trotters, an effort to generate crucial preliminary data and lay the foundation for future studies exploring the specific mechanisms by which altered gene expression results in functional changes within a joint [this is an important first step towards our long-term goal of identifying novel diagnostic markers and therapeutic targets that could lead to a reduction in both individual animal morbidity and the economic impact of osteoarthritis in agricultural species], an evaluation of the impact of the freeze-dried in vitro maturation medium on in vitro oocyte maturation [the in vitro production of bovine embryos has dramatically increased in recent years, and with it the demand for a stable media with a long shelf-life], and a project with the long-term goal of establishing a role for nerve growth factor [NGF] as a tool for improving pregnancy rates in cattle artificial insemination programs.

Activities also included efforts to identify policies for the successful control of antimicrobial resistance [upon completion we expect to have produced a dynamical framework for the spread of antimicrobial resistance [AMR] genes in swine environments and developed a validated surveillance system for AMR genetic elements in the microbiome], research that seeks to provide novel insights into the parasite biology that can be exploited for the development of novel drugs and vaccines for disease intervention in agricultural animals, efforts to determine the functionality of the microbiome across species to expand opportunities aimed at developing monocultures for application in health industries of animals and humans, harvesting enzymes or bacteria to use in improving livestock production and efficiency by developing novel feed additives and potential forage treatments, and targeting key organisms to reduce

greenhouse gas emissions and reduce the environmental impacts of fermentation, and a study that seeks to identify the molecular pathways involved in regulation of hypothalamic-pituitary-adrenal activity in foxes with the goal of ultimately providing new insight into regulation of stress-induced behaviors in other mammals including livestock species.

Activities also included a study of the antiviral role of type III interferons in pigs, specifically for enteric viral diseases [this information will be useful to design preventative measures for not only porcine epidemic diarrhea but also other enteric diseases of swine], work to better understand what fetal microglia do when activated during critical periods of fetal brain development [this issue is relevant to pig production as aberrant behavior reduces health, productivity, and overall wellbeing - issues key to sustainable production of high quality pork], the conducting of experiments on the use of water-cooled perches for laying hens kept in heat stress conditions [it is anticipated that this type of housing system will provide for improved bird comfort and a reduction of meat stress effects], a project with the ultimate goal of determining which measures of performance recorded on developing heifers are good indicators of their efficiency as brood cows, studies designed to determine the influence of maternal nutrition during gestation on adult health and reproductive success of dairy cows, research characterizing the chemical composition and nutritional adequacy of alternative and sustainable protein sources [this is of vital importance to creating viable solutions to feed livestock and to create nutritionally adequate and complete diets for companion animals while maintaining a sustainable food chain without direct competition with human food systems], and efforts to better understand the mechanisms whereby environmental and/or physiological stressors modulate immune responses to various pathogens as well as how stressors influence the pathogenesis of infection to influence disease pathogenesis and improve agricultural productivity.

Conference presentations included the American Dairy Science Association, American Society of Animal Science, West Indies Veterinary Conference, Animal Disease Research Workers, International Embryo Technology Society Meetings, Population, Evolutionary, and Quantitative Genetics International Behavioural and Neural Genetics Society, Canine Science Forum, Conference of the Society for Molecular Biology and Evolution, Chromosoma-2018, 25th International Pig Veterinary Society Congress, North American Porcine Reproductive and Respiratory Syndrome Conference, Poultry Science Association, Proceedings of the World Congress on Genetics Applied to Livestock Production, l'Institut National de la Recherche Agronomique-Rowett Conference on Gastrointestinal Microbiology, Seeon Conference on Gut Microbiology, Midwest Brain, Behavior, and Immunity Conference, Psychoneuroimmunology Research Society, American Angus Association, American International Charolais Association, and the Beef Improvement Federation.

Two Commercial Agriculture Extension Educators provided leadership for a number of programs that focused on beef production again this year including the following statewide conferences and seminars: **Beef Quality Assurance Training**, **Annual Sire Selection and Reproduction Management Seminar**, **Illinois Performance Tested Bull Sale**, **Illinois Forage Institute**, **Driftless Regional Beef Conference** [hosted in Iowa in 2018], **Northwest Illinois Grazing Conference**. Other local and regional programs included pasture walks, winter cattle feeders meetings, and research farm field days [the evaluation section of this planned program features impact findings for the **Beef Quality Assurance Certification** program].

Extension delivered a new **Beef Cattle Program** series, in partnership with livestock feed companies, reaching more than 400 attendees across 9 counties. In these sessions, information on recent anaplasmosis research was shared, including recent findings on increased incidence as well as recommended management practices for limiting transmission. These sessions also included education on limiting herd losses from predatory wildlife attacks, herd calving management, and hay saving measures.

The **Illinois Dairy Tour** led 32 international dairy producers and veterinarians from seven countries on a three day journey to showcase Illinois Dairy resources and research. The tour made a stop at the University of Illinois Dairy Research Unit to highlight research conducted by Extension's dairy specialist related to nutrition and reproduction. The **2018 Dairy Summits**, held in three locations throughout the state for dairy producers, included presentations on feeding strategies during unprofitable times and strategies to improve corn silage quality role of genomics.

A number of Extension campus faculty and staff members helped conduct the annual horse, poultry, dairy, meats, and livestock judging contests for 4-H members. In addition, 4,271 Illinois 4-H and FFA members completed the seven modules of the online **Quality Assurance and Ethics Certification** training and quiz for beef, dairy, goats, horses, sheep, swine, rabbits, and dogs covering topics related to care and administration of medicine for livestock. Youth who attended the **4-H Livestock Judging Contest** in 2018 learned to identify breeds of livestock and helped them make decisions which improve their local herds. Finally, a group of 8th-12th grade students in Cook County participated in a four-week summer workshop, **Animal Related Career Summer Intensive Field Trips**, led by an Extension educator with a specialty in small animal health.

2. Brief description of the target audience

Members of the target audience included veterinarians, animal scientists, parasitologists, livestock producers, farmers, graduate and undergraduate students, dairy farmers, the scientific community focusing on animal health and infectious diseases, swine Extension services, the pharmaceutical industry, poultry researchers that deal with nutrition, environment, management, and housing of poultry, immunologists, virologists, animal health workers, neuroimmunologists, the scientific community in animal sciences and veterinary medicine involved in companion animal and comparative nutrition, animal scientists working in the fields of nutrition, physiology, reproduction, and genetics, and breed associations. Extension targets livestock producers, regulatory agency representatives, livestock commodity group representatives, veterinarians, horse owners and breeders, the livestock feed industry, companion animal owners, and 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	2683	95017	31058	371702

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	47	47

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number Of Completed Hatch Research Projects

Year	Actual
2018	10

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

Outcome #1

1. Outcome Measures

Increased Knowledge Of Livestock Care And Management

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	348

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Priorities in livestock production focused on production management [addressing new issues involving health, feeding, reproduction, genetics, and risk management associated with production that enhances producers' profitability and provides quality and safe meat products for consumption]. Humane care of animals is a concern as is a safe food supply.

What has been done
Illinois Extension delivered certified Beef Quality Assurance training workshops to 708 participants in 16 locations addressing livestock care and management. Topics covered in the three-hour training included Animal Handling and Facilities, Non-Ambulatory Care, Biosecurity, Vaccine Handling, Use of Feed Additives, Weaning/Preconditioning, and Avoiding Blemishes. Youth attending the 4-H Youth Livestock Judging Contest in 2018 learned to identify breeds of livestock and helped them make decisions which improve their local herds.

Results
The majority [91%] of Beef Quality Assurance participants reported learning "quite a bit" or "a lot" in at least one of the training content areas. In addition, nearly three-fourths [73%] said they intend to make a change to their livestock management practices as a result of the training. Among a small sample [N=14] of participants who were previously trained in Beef Quality Assurance, 70% reported they made a change in practice since their past training.

When asked to share the impact of the 4-H Youth Livestock Judging Contest on attendees, 96% of the 160 respondents [N=154] agreed that, through the experience, they were more interested in a future career in the livestock industry and gained knowledge and skills they can use at home with their own livestock projects.

The reported quantitative outcome is based on the 194 + 154 = 348 participants who reported

changes in knowledge after participating in an educational event targeting livestock care and management.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
307	Animal Management Systems
311	Animal Diseases
315	Animal Welfare/Well-Being and Protection
806	Youth Development

Outcome #2

1. Outcome Measures

Improved Control Of Porcine Reproductive And Respiratory Syndrome

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Improving Our Understanding Of The Role Of Nutrition On Fertility

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Identifying Genes, Transcripts, And Pathways Associated With Health In Livestock

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Improving The Health Of Dairy Goats Through The Development Of New Genetic Resources

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Improving Control Methods Of Strangles Infection In Horses

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Enhancing The Efficiency Of Feed Utilization In Beef Production Systems

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The future of a viable, sustainable beef industry in the U.S. depends on continued improvements in production efficiency. The National Cattlemen's Beef Association identified cost efficiencies as a major profitability driver for beef production in the U.S., with a focus on programs to improve production efficiency that use benchmarking systems which allow objective comparisons of production costs and performance efficiencies among producers. Feed costs within an operation account for 40 to 70 percent of the total costs of the production of livestock. Therefore, obtaining a better understanding of feed efficiency across a spectrum of existing production operations can greatly impact overall feed costs of an operation. We sought to determine the relationship between feed intake and efficiency of heifer calves during the post-weaning period and measures of productivity and efficiency as a cow. We also sought to determine the relationship of feed intake and efficiency on different diet types and what the repeatability of feed intake and feed efficiency was at different timepoints in the post-weaning period.

What has been done
Results of our work demonstrated that feed intake and efficiency during the post-weaning period is correlated to intake and efficiency in the mature cow. We also determined that intake of a forage-based diet was related to intake of a grain-based diet. Prior to this work, there were concerns about how relevant the feed intake data of growing animals being fed a grain-based diet

was to mature cow intake of forage. The collective findings of our work suggest that the rapidly growing dataset of grain-based feed intake records could be meaningful in predicting forage intake of the cow herd.

Results
Additionally, we determined that intake was repeatable across two subsequent evaluation periods and that feed intake evaluation periods could be reduced from current standards. One of the most significant outcomes of this work was the shortening and redefining of the recommended intake evaluation periods and guidelines outlined by the Beef Improvement Federation. The shortening of the evaluation period will allow more cattle to have feed intake evaluations conducted in the currently available facilities across the nation. This has and will continue to contribute to increased feed intake records being submitted to breed associations.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
305	Animal Physiological Processes
307	Animal Management Systems
315	Animal Welfare/Well-Being and Protection

Outcome #8

1. Outcome Measures

Aspirations To Enhance Profitability Of Livestock Production And Management

Not Reporting on this Outcome Measure

Outcome #9

1. Outcome Measures

Aspirations To Reduce Risks In Livestock Production

Not Reporting on this Outcome Measure

Outcome #10

1. Outcome Measures

Extending The Shelf Life Of Bovine Embryos

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The in vitro production of bovine embryos has dramatically increased in recent years, and with it the demand for a stable media with a long shelf-life. In this experiment we evaluated the impact of the freeze-dried in vitro maturation [IVM] medium [Mdry] on in vitro oocyte maturation.

What has been done
We compared the standard IVM and the Mdry media. Medium M199 was used as base for the IVM medium. The percentage of metaphase II oocytes and embryo production were evaluated. Media solutions [10 mL] were aliquoted into 50-mL conical tubes and lyophilized to form a powder concentrate using a Genesis freeze-dryer. Lyophilization consisted of a constant cooling from 20 degrees C to -10 degrees C at a constant rate of 18 degrees C/minute with a two hour hold at -10 degrees C before sublimation at 0 degrees C. The Mdry medium was held at -80 degrees C for four months [only serum and hormones were added before the incubation]. When the IVM medium was rehydrated, the pH was adjusted to 7.4. The percentage of mature oocytes was evaluated after 24 hours of maturation. The oocytes were stained with Hoechst 33342, and only oocytes with metaphase and a polar body were evaluated as matured. Abattoir-derived Holstein oocytes [n=540] were in vitro matured [25-30/well in 400 mL] and fertilized with sexed semen, according to standard procedures. The oocytes were split for analysis [432 were used for IVP and 108 for maturation rate] over six replicates. Twenty hours after IVF, presumptive zygotes were cultured in SOF medium at 398 degrees C with 5% CO2, 7%O2, and 88% N2. On Day 7, embryo yields were assessed.

Results
All recorded parameters were subjected to a Student's t-test. The parameters compared were maturation rate, cleavage rate, blastocyst rate, and the percentage of embryos cleaved. The alpha level was set at 0.05. All data were expressed as quadratic means and mean standard deviations. The results showed no differences between the two groups [75.9% v. 74.1%] [t = 0.37; SD = 12.69; P = 0.36; df.5] when we compared the nuclear maturation. However, when we evaluated embryo production, we found the Mdry treatment had a higher cleavage percentage [t = 2.39; SD = 14.81; P=0.02; df = 5] and total embryos produced [t = 2.49; SD = 5.6; P = 0.02; df = 5] compared with the control. These results showed that lyophilization can be a valid method to increase the shelf life of IVP media. More replicates must be done in order to understand why the freeze-dried media produced more embryos.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
305	Animal Physiological Processes
307	Animal Management Systems

Outcome #11

1. Outcome Measures

Improving Our Understanding Of The Differences Between Domesticated And Wild Species

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Domesticated species are characterized by reduced fearfulness, increased social tolerance, and increased resistance to stress. These behaviors are closely linked to reduced reactivity of the hypothalamic-pituitary-adrenal [HPA] axis, the hormonal cascade associated with the stress response in mammals. Specifically, reductions in circulating levels of adrenocorticotrophic hormone [ACTH], released by the anterior pituitary, and glucocorticoids, released by the adrenals, have been demonstrated in several domesticated species. We used the tame and aggressive strains of the silver fox to explore mechanisms associated with the HPA axis reactivity.

What has been done
RNA extracted from the anterior pituitaries of six tame and six aggressive foxes and from the right adrenal glands of eleven tame and eleven aggressive foxes was sequenced on an Illumina HiSeq2500. The gene expression and network analyses looking at the differences in anterior pituitaries of tame and aggressive foxes indicated the importance of genes related to the regulation of exocytosis, specifically mediated by cAMP, the organization of pseudopodia, and cell motility. In adrenals, differential gene expression analysis suggested differences in ectodermal cell differentiation and interleukin-8 production, while weighted gene co-expression network analysis found differences in cholesterol biosynthesis and cell migration, suggesting that the biosynthesis of cholesterol [a steroid hormone precursor] rather than the biosynthesis of adrenal steroid hormones may differ between the two strains.

Results

These findings suggest that the tame and aggressive foxes may have differences in HPA reactivity due to differences in regulation of the hormone release. Although our findings are in the experimentally domesticated fox, the similarity of phenotypes across domesticated species suggest the possibility of selection on a shared set of gene pathways. Therefore, our findings may provide new avenues for investigation of the biological differences between domesticated and wild species.

4. Associated Knowledge Areas

KA Code	Knowledge Area
305	Animal Physiological Processes

Outcome #12

1. Outcome Measures

Assessing Effects Of Maternal Viral Infection On The Development Of Fetal Piglets

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Maternal infection during pregnancy increases the risk of neurobehavioral problems in offspring. Evidence from rodent models indicates that the maternal immune response to infection can alter fetal brain development, particularly in the hippocampus. However, information on the effects of maternal viral infection on fetal brain development in gyrencephalic species like pigs is limited. Thus, the objective of this study was to assess several effects of maternal viral infection in the last one-third of gestation on hippocampal gene expression and development in fetal piglets.

What has been done
Pregnant gilts were inoculated with porcine reproductive and respiratory syndrome virus [PRRSV] at gestational day [GD] 76 and the fetuses were removed by cesarean section at GD 111 [three days before anticipated parturition]. The gilts infected with PRRSV had elevated plasma interleukin-6 levels and developed transient febrile and anorectic responses lasting approximately 21 days. Despite having a similar overall body weight, fetuses from the PRRSV-infected gilts had a decreased brain weight and altered hippocampal gene expression compared to fetuses from

control gilts. Notably, maternal infection caused a reduction in estimated neuronal numbers in the fetal dentate gyrus and subiculum. The number of proliferative Ki-67+ cells was not altered, but the relative integrated density of GFAP+ staining was increased, in addition to an increase in GFAP gene expression, indicating astrocyte-specific gliosis. Maternal viral infection caused an increase in fetal hippocampal gene expression of the inflammatory cytokines TNF-alpha and IFN-gamma and the myelination marker myelin basic protein. MHCII protein, a classic monocyte activation marker, was reduced in microglia, while expression of the MHCII gene was decreased in hippocampal tissue of the fetuses from PRRSV-infected gilts.

Results
Together, these data suggest that maternal viral infection at the beginning of the last trimester results in a reduction in fetal hippocampal neurons that is evident five weeks after infection, when fetal piglets are near full term. The neuronal reduction was not accompanied by pronounced neuroinflammation at GD 111, indicating that any activation of classic neuroinflammatory pathways by maternal viral infection, if present, is mostly resolved by parturition.

4. Associated Knowledge Areas

KA Code	Knowledge Area
305	Animal Physiological Processes
311	Animal Diseases

Outcome #13

1. Outcome Measures

Improved Understanding Of The Interactions Between Animal Genetic Makeup And Animal Behavior

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Innovative analytical and visualization methods were developed to advance the understanding of the interaction between the genetic makeup of an animal [breed or line] and the brain region studied to uncover molecular mechanisms associated with behavior. Animal lines selectively bred for specific behaviors such as high physical activity are helpful models for uncovering gene

networks associated with increased motivation for these behaviors that can impact growth, reproduction, and health. The fact that multiple brain regions are hypothesized to contribute to distinct behavior components necessitates the simultaneous study of these regions. The goals of this study were to identify brain-region dependent and independent gene expression patterns, regulators, and networks associated with increased activity behavior.

What has been done
The cerebellum and striatum from a high activity line and a non-selected control line of mice were compared. Neuropeptide genes annotated to reward-dependent processes including neuropeptide S receptor 1 [Npsr1], neuropeptide Y [Npy], and proprotein convertase subtilisin/kexin type 9 [Pcsk9], and genes implicated in motor coordination including vitamin D receptor [Vdr] and keratin, type I cytoskeletal 25 [Krt25] were among the genes exhibiting activity line-by-region interaction effects.

Results
Genes annotated to the Parkinson pathway presented consistent line patterns, albeit at different orders of magnitude between brain regions, suggesting some parallel events in response to selection for the high activity behavior. The comparison of gene networks between brain regions highlighted genes including transcription factor AP-2-delta [Tfap2d], distal-less homeobox 5 gene [Dlx5], and sine oculis homeobox homolog 3 [Six3] that exhibited line differential expression in one brain region and are associated with reward-dependent behaviors. Transcription factors including En2, Stat6, and Eomes predominated among regulators of genes that differed in expression between lines. Results from the simultaneous study of striatum and cerebellum confirm the necessity to study molecular mechanisms associated with behaviors that can impact performance and health in consideration of brain region dependencies.

4. Associated Knowledge Areas

KA Code	Knowledge Area
303	Genetic Improvement of Animals
305	Animal Physiological Processes

Outcome #14

1. Outcome Measures

Uncovering The Role Of The Epigenome On Diseases Associated With Inflammation In Animals

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual

2018 0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The proteome changes that accompany inflammation-associated depression-related behaviors are incompletely understood. Original approaches were developed and applied to understand the networks of proteins associated with inflammation-associated diseases. These approaches enabled us to uncover an unexpected finding about the role of the epigenome [changes in molecules that regulate the expression of genes] on diseases associated with inflammation.

What has been done
In the present study, the changes in protein abundance and post-translational modifications in the microglia [the macrophage-like cells found in the brain] of wild type mice that exhibit an inflammation-associated behavioral disorder after recovery from bacterial [BCG] infection were studied. These mice were compared to mice that do not express the inflammation-associated behavior after bacterial challenge due to IDO1 deficiency [KO], and to control mice that are wild type and treated with saline [WT_Sal group]. Proteins were detected and quantified using a mass spectrometry-based label-free approach.

Results
The comparison between mice groups uncovered patterns of protein abundance and epigenetic histone acetylation among the histone families that could influence microglia signaling and transcriptional rates. The present study of histone acetylation and differential protein abundance furthers the understanding of the long lasting effects of peripheral immune challenges. Our findings offer insights into target proteins and mechanisms that provide clues for therapies to ameliorate inflammation-associated behaviors.

4. Associated Knowledge Areas

KA Code	Knowledge Area
305	Animal Physiological Processes
311	Animal Diseases

V(H). Planned Program (External Factors)

External factors which affected outcomes
- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Government Regulations
- Other (Public perceptions)

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Beef Quality Assurance Training

At the completion of the **Beef Quality Assurance Training**, 213 participants completed an end-of-program evaluation to provide feedback and measure self-reported knowledge gained in various aspects of livestock care and management during the conference. Overall, on a scale from 1 = "nothing" to 5 = "a lot", nearly all [194 out of 213] respondents self-reported a rating of 4 or higher reflecting an overall moderate to high self-reported knowledge gain. In addition, 73% [155 of 213] reported that they intended to use the knowledge gained to make a positive change in practices.

The proportion of participants that reported they learned "Quite a Bit" or "A Lot" about each of the following topical areas covered:

77% What is BQA?
66% Injection Site Blemishes
62% Animal Handling and Facilities
62% Biosecurity
62% Avoiding Bruising and Carcass Blemishes
57% Non-Ambulatory Care
56% Vaccine Handling
54% Use of Feed Additives
53% Weaning/Preconditioning

Key Items of Evaluation

Beef Quality Assurance Workshop

Knowledge gains were demonstrated for educational interventions targeting both youth and adult livestock management audiences. Additionally, 73% of Beef Quality Assurance training participants reported they intended to make a change in practices as a result of what they learned.

V(A). Planned Program (Summary)

Program # 4

1. Name of the Planned Program

Community Resource Planning And Development

☑ 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	50%		25%	
802	Human Development and Family Well-Being	0%		20%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	20%		15%	
805	Community Institutions, Health, and Social Services	20%		15%	
806	Youth Development	10%		25%	
	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	0.0	0.0	1.0	0.0
Actual Paid	21.0	0.0	6.3	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**
999115	0	210337	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
999115	0	210337	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
4068741	0	819409	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Activities under this Planned Program in FFY 2018 included a project that aims to provide new evidence on how households react to the investment incentives for energy efficiency improvements and speaks to the ongoing debate about the causes of the "energy efficiency gap", a study that found that the federal recognition of same-sex marriage was related to improved well-being in individuals in same-sex relationships [this was particularly true for those individuals who experienced the highest levels of minority stress; that is, the federal recognition of same-sex marriage appeared to benefit most those individuals who were at the highest risk], an ongoing study that seeks to take a domain-specific approach to examining the link between parenting behaviors and youth adjustment in the social and academic domains, assessing youths' psychological and physiological receptivity to parenting in the social and academic domains, and investigating the mediating and moderating processes of youths' receptivity in the parenting-youth adjustment link within the social and academic domains, and an investigation in which qualitative interviews with low-income African-American and Latina mothers of preschool children transitioning to kindergarten and the preschool teachers of these children were conducted to examine the meaning of school readiness, expectations for child school readiness, expectations for parent involvement in school readiness preparation, expectations concerning the role of preschool teachers in facilitating school readiness, and related home and school practices that facilitate school readiness.

Conference presentations included the National Council on Family Relations, International Association for Relationship Research, Society for Research in Child Development, Ecological-Community Psychology Conference, and the International Congress of Qualitative Inquiry.

Extension activities included a wide variety of methods focused on community planning, building entrepreneurial communities, leadership development, and workforce development. While the focus of the efforts vary, the one commonality is that all activities are directed toward impacting systems and individuals who play a pivotal role in creating change far beyond the focus of the intervention.

One example of Extension's multi-year, high intensity community planning assistance was demonstrated in one county, where a Community and Economic Development educator worked with community organizations to host eleven community forums with nearly 800 county residents attending. Under the direction of Extension, volunteers helped facilitate meetings, raise funds, promote the process, analyze data, and collect stories from residents about their history in Mercer County. They connected with residents through online surveys, a Facebook page, and a new website. Through these efforts, Mercer County residents shared their perspectives on potential projects, strategies, and goals that **Mercer County: Better Together [MCBT]** could pursue. To ensure that MCBT could serve as the lead organization to implement plans, University of Illinois Extension helped establish an organizational

structure for MCBT that included 501 c[3] certification, the development of bylaws, the establishment of a board of directors, and a plan for a continuing funding mechanism. Mercer County is on track to confirm a countywide strategic plan that will include input and actionable strategies, a result of Mercer County residents working collaboratively. To date, the project has leveraged $1,169,000 in additional funding for the planning process and to support county projects proposed by MCBT. Those projects include technology upgrades for two school districts, parks and recreation improvements, and a grant to the health department to provide mental health programming.

Extension community and economic development educators also provided capacity building via educational programming such as **Developing a Creative Community** in which community leaders learned how to foster a culture that appreciates and supports local creative talent, including those living in low-resource households. Creative entrepreneurs include artists, designers, musicians, boutique retailers, specialty food producers, and other creative enterprises. Extension educators also worked to nurture and cultivate entrepreneurship from a young age through the development of **iDREAM** and **iCREATE**, programs targeting Kindergarten through 12th graders. **iDREAM** was developed to encourage youth to start early and explore/connect to their passions, interests, and skill sets through comprehensive dreaming/goal-setting and action activities facilitated by local community leaders. **iCREATE** inspires innovation through encouraging exploration and connection to what being entrepreneurial really is through comprehensive activities facilitated by local community leaders. **A Lesson in Rural Economics** was delivered in ten rural counties to assist residents better understand the challenges facing our rural economies and the importance of an entrepreneurial approach to our economic future. The programming includes a variety of hands-on activities to demonstrate the connection between shopping local and strong rural economies. Youth elementary and high school audiences were targeted for the programming as they are our rural region's future community leaders, business owners, and local government officials.

Support for innovation and entrepreneurship was also provide through expansion of the **Fast Pitch Competition** program that was initially offered in two counties but opened to entrepreneurs in six counties in 2018. The program is a competition modeled on the TV show "Shark Tank". While prizes are awarded to the top contestants, Extension works with all who compete to help them fine tune their business plans and make those plans become realities. The objective of the competition is a collaboration with area economic developers and chamber executives to identify emerging entrepreneurs, new businesses, or individuals with ideas for inventions and through the process of having them prepare for the pitch, identify and muster resources that can help them achieve their business goals.

Extension also provides workforce programs to build the capacity of employees of businesses and organizations to maximize effective communication both with coworkers and customers. The **On the Front Line Customer Service Training** curriculum was used to educate employees of businesses, agencies, and government entities on customer service skills and best practices. **Age Matters**, a four-module program addressing generational values and historical information focused on building participants' skills to work effectively with consumers, employees, and volunteers of all ages. **Real Colors**, a leadership and organizational development workshop, provided participants with effective methods of building rapport and communicating with others who have diverse viewpoints and communication styles. The **Poverty Simulation** program was conducted in 46 groups with a total of 2,891 participants to increase knowledge and empathy for the experiences of those living in poverty, better equipping people with ways to adapt organizations and practices to reduce barriers.

Partnering with regional offices of education, school districts, and schools, Extension staff members offered professional development opportunities to support integration of research-based practices into classroom curricula and processes. One such program, **Teacher Tuesdays**, provided professional educators representing schools and out-of-school organizations in a multi-county area opportunities to foster peer support, introduce new resources, and provide networking with businesses and organizations promoting STEM education. In Cook County, a team of Extension educators provided 133 workshops with

more than 1,700 teachers to promote curricular integration of the Next Generation Science Standards in Illinois, diversity and inclusion, ways to use project-based learning as an educational method, and maximizing academic growth with social and emotional learning.

Leadership development activities in 2018 included programming for public officials and leaders through the University of Illinois Extension **Local Government Education Webinar Series**. Each year, county, township, and municipal elected and appointed officials and administrators from across the state learn through a webinar series provided by Extension's community and economic development team. Participants benefit from the advanced instruction and broad expertise that instructors bring to our programming, and from the question-and-answer sessions following each presentation. In 2018, 1,386 local government officials from 91 of 102 Illinois counties learned through the live webinars and program recordings on a variety of topics, including state and federal legislative updates, Opportunity Zones, Tax Increment Financing, Solar Energy, Community Sustainability, and Age-Friendly Community Initiatives. A six-session **Extension Leadership Academy** sponsored by United Counties Council of Illinois was conducted in 2018 for thirty elected and appointed officials including county board members and administrators.

2. Brief description of the target audience

Members of the target audience included academic researchers, public utility companies, policymakers, Head Start teachers, staff, and parents of children transitioning to kindergarten, and preschools and elementary schools. Community leaders, business leaders, agencies and organizations, and local government officials involved in community and economic development are key Extension target audiences. Other target audiences include residents interested in starting small businesses, professional educators, and youth.

3. How was eXtension used?

Four members of the Community and Economic Development Team are members of one or more Communities of Practice in eXtension.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	27545	126365	18196	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	0	1	1

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number Of Completed Hatch Research Projects

Year	Actual
2018	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number Of Individuals Reporting New Leadership Roles And Opportunities Taken
2	Number Of Plans Developed, Adopted, Or Adjusted By Communities Through Resident Engagement
3	Number And Dollar Value Of Volunteer Hours Invested In Community-Related Projects
4	Number Of Community Or Organization Programs Or Activities Initiated
5	Improving Programs For High School Students Through A Better Understanding Of The Strategies Used By Effective Program Leaders
6	Exploring The Extent To Which Different Types Of Intimate Partner Violence Are Associated With Different Patterns Of Judicial Involvement, Interventions, And Legal Outcomes
7	Examining The Complex Relationships Between Family Socioeconomic Conditions And Child Development
8	Dollar Value Of Resources Leveraged/Generated For Communities

Outcome #1

1. Outcome Measures

Number Of Individuals Reporting New Leadership Roles And Opportunities Taken

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Number Of Plans Developed, Adopted, Or Adjusted By Communities Through Resident Engagement

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Number And Dollar Value Of Volunteer Hours Invested In Community-Related Projects

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	58667840

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Extension volunteers play a vital role in expanding the reach and engagement in programs within the communities they serve throughout Illinois. Extension volunteers are highly valued and passionate partners who respond to requests for technical assistance, deliver educational programs, and create positive youth development environments. Investments made in volunteer training, support, and management can result in significant economic value.

What has been done
Extension staff expend dedicated effort every year to assuring our volunteers have the capacity, resources, and support to carry out their work on behalf of Extension. Highlights of new resources

for volunteer training include a new online Master Gardener training piloted in 2018 with 78 new volunteers. This option was developed to improve availability of training for Extension volunteers. Adult volunteers in the 4-H program have had access to online training resources for the past several years. The most popular format for volunteer training remains via a classroom-based setting where Extension staff spent more than 2,600 hours providing classroom-based training to Master Gardeners and Master Naturalists in 2018.

Results
During 2018, efforts devoted to build the Illinois Extension volunteer workforce included volunteer recruitment, training, support, and management across the established Master Gardener, Master Naturalist, and 4-H Adult volunteer program. More than 19,000 trained volunteers devoted more than 2.2 million total hours of service on behalf of Extension [which translates into an economic value of $58,667,840 of service delivery to Illinois residents]. The total number of volunteer FTEs is nearly double the number of total paid FTEs across Illinois Extension.

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

Number Of Community Or Organization Programs Or Activities Initiated

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Improving Programs For High School Students Through A Better Understanding Of The Strategies Used By Effective Program Leaders

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Exploring The Extent To Which Different Types Of Intimate Partner Violence Are Associated With Different Patterns Of Judicial Involvement, Interventions, And Legal Outcomes

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Examining The Complex Relationships Between Family Socioeconomic Conditions And Child Development

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The goal of this investigation is to conduct qualitative interviews with low-income African-American and Latina mothers of preschool children transitioning to kindergarten and the preschool teachers of these children to examine the meaning of school readiness, expectations for child school readiness, expectations for parent involvement in school readiness preparation, expectations concerning the role of preschool teachers in facilitating school readiness, and related home and school practices that facilitate school readiness. The project also considers the role of the community context [urban-rural] that families and children live in, and its impact on school readiness and parent involvement. We focus on low-income, African-American and Latina mothers of preschoolers transitioning to kindergarten because they are children's first teachers and influence how children are socialized for school. Using a resilience framework and qualitative methods, we seek to better understand first-hand the challenges faced in facilitating school readiness in these two contexts as well as the resources that parents and schools possess to promote school readiness.

A second and applied goal is to explore ways to further enrich the collaboration between homes and schools through the development of parent workshops that reflect parental/family strengths and cultural resources. Our findings have the potential to contribute to substantive and conceptual discussions of school readiness beliefs and practices, and to parent involvement. The application of the findings to the development of parent workshops suggests concrete ways to enhance collaborations between parents and preschools that can help low-income, African-American and Latino/a children to be better prepared for the kindergarten transition.

What has been done
Our qualitative analyses focused on data from our school readiness interviews. Key topics explored in the narrative and photo interviews included mothers' beliefs about school readiness, home-based literacy practices, expectations about the kindergarten transition, and the role of

Head Start in promoting children's transition to kindergarten.

Results
We examined mothers' and preschool teachers' understanding of school readiness. We found close alignment between parents' and preschool teachers about the skills necessary for children to be successful in kindergarten. However, based on the school readiness literature, mothers and preschool teachers' alignment with kindergarten teacher expectations varied, depending on the type of school [charter, Montessori, neighborhood]. Consequently, children's readiness for kindergarten would vary, depending on the type of school they transitioned to.

We also examined how children experienced the kindergarten transition. In many respects, Head Start provided children with academic and socio-emotional skills needed for the kindergarten transition. However, mothers expressed concerns with the Head Start curriculum: They believed that the program did not fully prepare children for the more structured and routinized kindergarten classroom. Finally, we considered parental involvement activities of low-income, African-American mothers of preschoolers. Mothers were actively engaged in home-based learning activities that focused on academic and socio-emotional abilities. Maternal role construction beliefs posited the important role of parents in preparing children for kindergarten, as well as the need to collaborate with schools. These analyses suggest the importance of schools taking into account the important contributions of home-based activities, and further supporting parental involvement for parents who are primed from their participation in Head Start.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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 #8

1. Outcome Measures

Dollar Value Of Resources Leveraged/Generated For Communities

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual

2018 1169000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Illinois communities face a host of challenging issues, such as declining populations and shrinking economies. To address these and other issues, community leaders and residents need assistance to identify strategies to engage residents in managing the rapidly changing social and economic landscape.

What has been done
In Mercer County, a University of Illinois Extension Community and Economic Development Educator worked with community organizations to host eleven community forums, with nearly 800 county residents attending. Under the direction of Extension, volunteers helped facilitate meetings, raise funds, promote the process, analyze data, and collect stories from residents about their history in Mercer County. They connected with residents through online surveys, a Facebook page, and a new website.

Results
Through these efforts, Mercer County residents shared their perspectives on potential projects, strategies, and goals that Mercer County: Better Together [MCBT] could pursue. To ensure that MCBT could serve as the lead organization to implement plans, University of Illinois Extension helped establish an organizational structure for MCBT that included 501 c[3] certification, the development of bylaws, the establishment of a board of directors, and a plan for a continuing funding mechanism. Mercer County is on track to confirm a countywide strategic plan that will include input and actionable strategies, a result of Mercer County residents working collaboratively. To date, the project has leveraged $1,169,000 in additional funding for the planning process and to support county projects proposed by MCBT. Those projects include technology upgrades for two school districts, parks and recreation improvements, and a grant to the health department to provide mental health programming.

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Competing Programmatic Challenges

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

There were no outcome evaluations conducted for this planned program.

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Food Safety And Food Security

☑ 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
205	Plant Management Systems	30%		10%	
501	New and Improved Food Processing Technologies	0%		10%	
502	New and Improved Food Products	0%		15%	
503	Quality Maintenance in Storing and Marketing Food Products	0%		10%	
504	Home and Commercial Food Service	10%		0%	
701	Nutrient Composition of Food	0%		10%	
702	Requirements and Function of Nutrients and Other Food Components	0%		5%	
703	Nutrition Education and Behavior	0%		10%	
704	Nutrition and Hunger in the Population	30%		10%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources	10%		10%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	10%		10%	
806	Youth Development	10%		0%	
	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	0.0	0.0	6.0	0.0
Actual Paid	26.8	0.0	7.9	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
1271601	0	331908	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1271601	0	331908	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
5178397	0	1990442	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Activities under this Planned Program in FFY 2018 included a study examining the influence of school-based nutrition policies on childhood obesity among American children with special health care needs, an investigation into cases where an individual's decision to waste food may be rational [or even optimal] and an exploration into the heterogeneity in waste behaviors across consumers and households, the development of new tools that apply engineering and statistical approaches to problems in food safety microbiology, work focusing on examining food microstructure and evaluating its changes due to food processing [new products expected to stem from this research are foods with increased nutrient bioavailability, foods with increased stability, dried foods with increased rehydration ability, and edible films with increased thermal and mechanical stability], and research with the goal of investigating the effects of amorphization method on the physicochemical properties and heat- and moisture-induced crystallization behaviors of amorphous sucrose [this research will produce advanced scientific knowledge useful for enhancing the stability of amorphous containing food and pharmaceutical products].

Activities also included work that seeks to promote the consumption of foods containing natural rather than all-rac vitamin E to increase the number of Americans that achieve the dietary recommendations for vitamin E, an examination of the policy, systems, and environmental factors that influence the consumption and waste behaviors of children and their families [particularly in a school setting], the development of a novel technique for a microencapsulation that can be applied to a wide range of applications, the development of strategies to make Hispanic-style fresh cheeses safer to help meet market demand and prevent Listeria outbreaks, the development of new and effective sanitation strategies as a way of reducing the risk of microbial hazards, an investigation into the use of acoustic energy as a physical biofortification method to enhance the endogenous nutritional values of food crops, an effort to develop and employ effective methods for the identification and measurement of potent odorants [aroma-active compounds] in foods, food ingredients, and various other complex materials [key to the success of the project is the development of efficient procedures for the isolation, separation, and identification of trace level volatile constituents from complex matrices], the design, evaluation, and implementation of strategies and technologies that will assess nutrition status of and maximize nutrition delivery to individuals and populations at different stages in the nutrient/energy adequacy continuum [technologies will be low-cost, stealth or culturally accepted, simple to use, adaptable to current deficiencies, of limited energy input, and environmentally friendly], and research with the long-term goal of describing unsaturated transport mechanisms for food science applications and solving the modeling equations to improve the quality of foods and efficiency of processes.

Conference presentations included the Agricultural and Applied Economics Association Annual Meeting, 30th International Conference of Agricultural Economists, Corn Utilization and Technology Conference, American Dairy Science Association, American Chemical Society, Institute of Food Technologists, 14th Conference of Food Engineering, and the American Society for Nutrition.

Food Safety

Extension programs, expert technical assistance services, and digitally-delivered information are designed to promote food safety along the spectrum of the food chain, from production through plating.

At the source of production, Extension educators on the local foods/small farms team delivered a nationally-recognized training program to teach Illinois food growers important agricultural sanitation practices legislated by the Food Safety Modernization Act Produce Rule of 2011. In 2018, 96 food growers attended a **Food Safety Modernization Act Produce Rule** training offered throughout Illinois, using required educational materials designed to reduce microbial contamination on the farm.

Extension's **Pesticide Safety Education Program** reached 13,000 private [farmer] and commercial pesticide applicators this past year, providing information on proper and safe use of pesticides that is vital to Illinois residents with respect to food safety and quality.

Extension nutrition and wellness educators offered food safety training for employees of establishments, foodbank managers, and volunteers that prepare or serve food to the public. In 2018, the **Certified Food Protection Manager Certification** course was conducted with over 300 participants to meet the five-year certification requirements for food service sanitation managers. In addition, Extension educators delivered Serve it Safely with 42 volunteers who handle food for fundraisers, community organizations, and family events. Finally, more than 300 participants learned safe ways to preserve food at home through online and supplemental programs entitled **Yes, You Can - Preserve It Safely**. The **Supplemental Nutrition Assistance Program - Education [SNAP-Ed]** curriculum for both youth and adults includes an emphasis on proper hand-washing and cleanliness habits when preparing food.

Food Security [Production]

Extension offers support to crop producers and advisors to improve the yield and sustainability of operations that contribute to the plentiful supply of crops for animal and human consumption.

State and regional Extension crop conferences/clinics and field days reached corn and soybean producers throughout the state with information to bridge the gap between research and practice. One example is the annual **Crop Management Conferences** [held in four locations throughout the state] that served 364 crop producers, certified crop advisors, and other agricultural professionals who farm, manage, or consult on a total of 8.8 million acres [see evaluation section for more details].

Extension educators also delivered conferences with specialty crop growers in 2018 including the **Gateway Green Industry Conference**, **Gateway Small Fruit and Vegetable Conference**, **Stateline Fruit and Vegetable Growers Conference**, and the **Illinois Specialty Crops Conference** to promote best management practices, marketing techniques, pest management, food safety, and production practices.

Extension educators offered seasonal opportunities for producers to learn the latest on production and management systems via in-person meetings and online technologies. The **2018 Southern Illinois Summer Twilight Series** offered a four-part series of meetings in southern Illinois for educators to provide research and demonstration outreach to the regional community. Extension educators discussed the different types of high tunnel structures on-site, as well as the various production and management

practices for each. Cucumbers, indeterminate tomatoes, strawberries, and various greens were demonstrated in a hydroponic production system. Tomatoes, peppers, cucumbers, greens, and various other vegetables and flowers were shown growing in ground beds. To meet the needs of producers who could not travel to attend a workshop, the **Small Farms Winter Webinar Series** reached 861 attendees via eleven live webinars, which were subsequently recorded and posted to the Extension website along with all prior series since 2015. The series provided online lunch-hour presentations filled with practical strategies relevant to small farm enterprises. Several Extension field offices hosted a webinar viewing site for potential audiences without access to broadband internet for streaming.

In 2018, the **Master Urban Farmer Training Program** trained sixteen new participants in Cook County [the most urban county in Illinois] to visualize a business plan and use research-based information to move forward with their urban farming goals. A one-year follow up evaluation with a small subset of program graduates from 2017 revealed that many had applied strategies they learned through their experience with the program.

The **Bulletin**, an online series [http://bulletin.ipm.illinois.edu/], remained an important source of integrated pest management information provided by entomologists, agronomists, and plant pathologists. Extension educators and specialists also developed bi-weekly online issues of the **Fruit and Vegetable News** [https://ipm.illinois.edu/ifvn/] covering research-based information relevant to commercial fruit and vegetable growers, regional reports from around Illinois, and announcements for upcoming programs offered by Extension. A final online resource updated regularly throughout 2018 was **Acres of Knowledge** [https://web.extension.illinois.edu/dmp/eb263/], dedicated to information regarding small farms, local food systems, and natural resources.

Food Security [Access]

Illinois 4-H responded in amazing ways to the hunger/food insecurity challenge facing their communities. In the spirit of getting the food to the people who need it, where they need it, **mobile markets** were organized to fill the gap in food deserts. In 2018, 370 volunteers devoted 5640 hours to benefit 4,740 individuals with mobile food markets in Illinois. The **Illinois 4-H Feeding and Growing our Committees** program held meal packaging events throughout the state and celebrated the threshold of packaging and distributing over one million meals since 2014.

New this year, Master Gardeners at sixteen sites partnered with food pantries and SNAP-Ed educators as part of the **Growing Illinois Food Access Allocation [GIFAA]** project to increase fresh produce at local pantries and promote selection of fresh produce among pantry patrons. Master Gardeners established a new garden or rejuvenated an existing garden in areas of high need. At the same time, SNAP-Ed worked with the partnering pantries to provide direct education and to make changes to the policies, systems, and environment of the pantry. In total, 270 volunteers committed 9,070 hours to the projects through assistance with planning the garden, planting, weeding, harvesting, and transportation of produce to pantries. More than 8,000 pounds of produce were donated to local pantries in GIFAA communities. Direct education in both the garden and pantry setting was provided to community members. Master Gardeners provided 107 garden-based lessons to 2,980 adult and youth participants and SNAP-Ed provided 119 lessons to 1,800 participants in the pantry setting.

2. Brief description of the target audience

Members of the target audience included health professionals, school administrators, health policy researchers/scientists, the agricultural and applied economics and food and nutrition academic communities, policymakers, food manufacturers, restaurants, students in the field of food engineering, researchers in academia, industry, and government, public health professionals and public policy groups,

school nutrition staff in the state of Illinois, limited-resource families in Champaign County, food science professionals who work in the area of sensory science [especially those focused on consumer test protocols], product developers who are interested in improving microencapsulation technology, the cheese industry, researchers in the fields of economics, public health, and nutrition, policymakers charged with improving the well-being of low-income Americans, program administrators overseeing food assistance programs, U.S. food producers, ingredient manufacturers, those in the healthcare and government sectors, and those in the general public who have an interest in biosensors, diagnostics, undernutrition, and fortification of foods.

Extension targeted volunteers who serve food to the public, certified food handlers, individuals interested in home canning and home preparation for farmers markets, producers of food distributed through local systems, producers of commercial fruit and vegetable crops, 4-H youth, producers of feedstuffs for livestock, certified crop advisors, and limited resource youth and families that are food stamp eligible.

3. How was eXtension used?

Ten members of the Family and Consumer Science or Local Foods/Small Farms Team are members of one or more Communities of Practice with eXtension.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	8590	1883826	11230	261995

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

Patent Applications Submitted

Year:	2018
Actual:	1

Patents listed

[2016-009-02 [US]] - Recombinant Microorganisms For Conversion Of Oligosaccharides Into Functional Sweeteners.

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	22	22

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number Of Completed Hatch Research Projects

Year	Actual
2018	1

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number Increasing Knowledge Of New Corn And Soybean Crop Management Techniques
2	Number Of Pounds Of Food Produced Or Donated For Consumption By Vulnerable Populations
3	Number Of Food Preparers Reporting Using Proper Time And Temperature Controls
4	Number Of Growers, Producers, And Employees Completing GAPS, GMPs, HACCP, Food Safety Certification, And Onfarm BMP Programs To Increase Food Safety
5	Development Of Fortification Technologies For Developing Countries
6	Enhancement Of Microbial Safety In Fresh Produce
7	Development Of Effective Methods For The Investigation Of Potent Odorants In Foods
8	Incorporating Protein Into Extruded Or Puffed Snack Foods
9	Developing New Varieties Attractive To U-Pick Produce Consumers
10	Increased Knowledge Of Fresh Fruit And Vegetable Production Practices
11	Increased Knowledge Of Small Farm Production Options
12	Improved Understanding Of Zein Self-Assembly Mechanisms And Development Of Novel Materials And Applications
13	Developing Sodium Chloride-Loaded Microcapsules To Reduce Sodium Content In Foods
14	Improving The End-Use Functionality Of Whole Wheat Flour

Outcome #1

1. Outcome Measures

Number Increasing Knowledge Of New Corn And Soybean Crop Management Techniques

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	162

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Crop producers and advisers are seeking ways to improve their efficiency of production leading to enhanced profitability of their enterprise. Emerging pathogens can represent a significant threat to yield and revenue. One example is an epidemic of tar spot occurring in the Midwest, where the disease was detected in 172 counties across the affected states in 2018. Fields in the most severely affected regions reached 100% disease incidence and over 50% severity on the ear leaf before dent. Yield losses from the affected states was estimated at 184,903,465 bushels. Assuming a conservative estimate of $3.50 per bushel, this is equivalent to $647,162,125 in lost revenue.

What has been done
Crop Management Conferences held at four Illinois locations provided information to support field crop producers and related professionals in making research-based decisions for the crops they produce or advise on. Specific topics among the four 2018 settings addressed managing pests, crop economics, nitrate loss solutions, maximizing efficiency and production, and updates on Dicamba. A total of 364 participants included those primarily employed in agri-business [73%], as certified crop advisers [61%], and crop producers [45%]. They collectively farm an estimated 43,700 acres and manage or advise on an estimated 8.2 million acres.

In response to the tar spot epidemic, a series of education and outreach events were delivered by an Extension faculty specialist. These events included eleven face to face meetings presented to approximately 1,100 individuals including certified crop advisors, agronomists, Extension specialists, industry researchers, and producers. At these sessions, information on tar spot and what is currently known was presented. Electronic articles posted to a field crop disease website pertaining to tar spot resulted in 6,747 page views. Twitter mentions released pertaining to tar spot from June through December of 2018 resulted in 355,903 impressions. Two webinars were offered on tar spot management and research updates. These webinars were delivered to 262

individuals, representing approximately 71,877,642 corn acres in 21 states and Canada. A publication on tar spot was produced and published on the Crop Protection Network and is available at no charge.

Results

Nearly all [89] of the 96 Crop Management Conference evaluation respondents reported that attending the conference increased their knowledge of new crop management techniques and [63%] planned on implementing something that they learned during the next growing season. Of the return attendees [those who attended the 2017 Crop Management Conference], 97% reported they had taken action as a result of what they had learned. Specific actions taken as a result of last year's conference include the use of herbicide mixing where allowed to prevent herbicide resistance [82%], adoption of revised phosphorus and potassium crop removal fertility recommendations [55%], and use of soybean Sudden Death Syndrome resistance ratings while selecting soybean varieties [42%]. In addition, the value of the information from this year's conferences reported by producers was estimated at $261,618. This estimate is based on values reported by survey respondents [26% of attendees]. Extrapolated to all attendees, there is a potential total estimated value exceeding $1 million.

A detailed survey was given to 78 individuals, representing 1,154,041 corn acres across five states, who attended the educational events and meetings addressing the epidemic of tar spot of corn. Results from the survey indicated that 86% of respondents were concerned about tar spot, 94% [73 out of 78 surveyed] learned something that will benefit their operation, and learning increase measured via pre-post assessments indicated a 50.7% increase in knowledge on tar spot. Participants of this session placed a total value, based on an estimated dollar value per acre, at $6,120,420.

4. Associated Knowledge Areas

KA Code	Knowledge Area
704	Nutrition and Hunger in the Population

Outcome #2

1. Outcome Measures

Number Of Pounds Of Food Produced Or Donated For Consumption By Vulnerable Populations

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	88022

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
According to Feeding Illinois [the association of Illinois food banks], over 1.8 million Illinois residents [14.2%] are food insecure and households with 662,000 children [21.6%] under age 18 are considered food insecure, which means they do not have regular access to nutritious food. Thirty-eight percent of food insecure households and 34 percent of children in Illinois exceed federal poverty guidelines that would qualify them for food assistance. Hungry children are more likely to have trouble concentrating, get headaches and infections, be hospitalized, and are less likely to perform well on athletic fields and in classrooms.

What has been done
Illinois 4-H responded to the hunger/food insecurity challenge facing their communities. In the spirit of getting the food to the people who need it, where they need it, mobile markets were organized to fill the gap in food deserts. In 2018, 370 volunteers devoted 5,640 hours to benefit 4,740 individuals with mobile food markets in Illinois.

New this year, Master Gardeners at sixteen sites partnered with food pantries and SNAP-Ed educators as part of the Growing Illinois Food Access Allocation [GIFAA] project to increase fresh produce at local pantries and promote selection of fresh produce among pantry patrons. Master Gardeners established a new garden or rejuvenated an existing garden in areas of high need. At the same time, SNAP-Ed worked with the partnering pantries to provide direct education and to make changes to the policy, systems, and environment of the pantry. In total, 270 volunteers committed 9,070 hours to the projects through assistance with planning the garden, planting, weeding, harvesting, and transportation of produce to pantries. Direct education in both the garden and pantry setting was provided to community members. Master Gardeners provided 107 garden-based lessons to 2,980 adult and youth participants and SNAP-Ed provided 119 lessons to 1,800 participants in the pantry setting.

Results
The 4-H efforts to bring the food to the people resulted in 88,000 pounds of food distributed [including produce and other healthy shelf stable products]. More importantly, these 4-H members taught other youth in their community how to garden and partnered with developmental centers to engage developmentally-disabled youth in gardening activities with their resulting harvest being donated.

The GIFAA project lasted from May 2018 to October 2018. Eight thousand twenty-two [8,022] pounds of produce were donated to eighteen food pantries in fifteen communities throughout Illinois. Among pantry personnel educated through technical assistance, 73% reported an increase in their ability to nudge fresh produce items in the pantry, thereby creating more access and appeal of these items with pantry patrons. Direct education with pantry patrons revealed that 61% of those who had not performed a targeted healthy behavior in the past week intended to do so following the pantry lesson.

4. Associated Knowledge Areas

KA Code	Knowledge Area
701	Nutrient Composition of Food
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population

Outcome #3

1. Outcome Measures

Number Of Food Preparers Reporting Using Proper Time And Temperature Controls

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Number Of Growers, Producers, And Employees Completing GAPS, GMPs, HACCP, Food Safety Certification, And Onfarm BMP Programs To Increase Food Safety

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	396

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Illinois regulations require food establishments to have at least one Certified Food Protection Manager [CFPM]. Federal regulations outlined in the Food Safety Modernization Act articulate standards of practice and training requirements for producers to improve both animal and human food safety and prevent food-borne illness at the supply source.

What has been done
Extension educators on the nutrition and wellness team offered seventeen CFPM programs to 317 participants. The eight-hour course is designed to prepare food managers with the knowledge needed to pass the state-mandated certification. Five [5] Extension educators on the local foods/small farms team trained 96 participants in four locations throughout Illinois on the requirements of the FSMA, using the Produce Safety Alliance Grower Training Course.

Results
Utilizing the National Registry of Food Safety Professionals examination, 93% of participants [N=300 of 217 participants] successfully passed the CFPM certification exam in 2018, with an average passing score of 88 out of 100. Completion of the Grower Training Course signifies a threshold level of knowledge in adherence with the FSMA regulations for all 96 participants who

completed the training. The impact of these programs extends far beyond the individuals who demonstrate knowledge of food safety given the many acres and thousands of individuals who will benefit from a safer food supply and service.

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 #5

1. Outcome Measures

Development Of Fortification Technologies For Developing Countries

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Enhancement Of Microbial Safety In Fresh Produce

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Surface roughness, hydrophobicity and epicuticular composition have received considerable attention in studies into the mechanism of human pathogen adhesion to various surfaces. However, the results reported in the literature are not consistent. Furthermore, few studies have taken into consideration all the above-mentioned factors when evaluating attachment/removal of human pathogens to/from various surfaces.

What has been done
In this work, silicone-base artificial leaf surfaces of Romaine lettuce and Carmel spinach were developed to study the attachment of gram-positive and gram-negative bacteria to fresh produce leaves. Polydimethylsiloxane [PDMS] was used as a substrate to create artificial leaves using a "double-casting" method. To achieve different hydrophobicity levels, PDMS was mixed with a non-ionic surfactant at two concentrations [1%, 10%]. A mixture of alkanes, fatty alcohols, and fatty acids was developed and sprayed on the PDMS leaves to recreate the epicuticular wax of the leaves. E. coli O157:H7 and L. innocua were spot inoculated on the artificial and fresh leaves of lettuce and spinach. Samples were incubated for two hours to promote attachment of bacteria followed by a rinse with deionized water at ratios of 1:10 to remove loosely attached bacteria. Samples were transferred to a sampling bag containing a saline buffered solution and pummeled for two minutes. The solutions were then tenfold-diluted and spread in selective media.

Results
Higher attachment was observed in spinach and lettuce samples when E. coli O157:H7 was inoculated on fresh leaves [5.0 ± 0.2 Log CFU/ml; 5.2 ± 0.06 Log CFU/ml, respectively], and lower attachment was observed in hydrophobic artificial leaves [4.6 ± 0.4 Log CFU/ml; 4.3 ± 0.1 Log CFU/ml]. Similarly, higher attachment was observed for L. innocua inoculated on fresh lettuce samples and hydrophilic artificial leaves [5.8 ± 0.1 Log CFU/ml; 6.2 ± 0.07 Log CFU/ml, respectively] and a 1-Log decrease in attachment was observed in hydrophobic artificial leaves [4.8 ± 0.3 Log CFU/ml]. We conclude that hydrophobicity and epicuticular composition play a significant role in the attachment of pathogenic bacteria to fresh produce. The artificial leaves can be used to study bacterial attachment, screen sanitizers, and provide recommendation to the food industry based on different produce surface characteristics.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
503	Quality Maintenance in Storing and Marketing Food Products
704	Nutrition and Hunger in the Population
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #7

1. Outcome Measures

Development Of Effective Methods For The Investigation Of Potent Odorants In Foods

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The project will develop and employ effective methods for the identification and measurement of potent odorants [aroma-active compounds] in foods, food ingredients, and various other complex materials. Key to the success of the project is the development of efficient procedures for the isolation, separation, and identification of trace level volatile constituents [specifically potent odorants] from complex [non-volatile] matrices. The project will make use of modern analytical techniques including gas chromatography-olfactometry [GCO] and GC-mass spectrometry [GC-MS]. The project will involve the development of accurate and precise GC-MS quantification methods based on the use of stable isotopes as internal standards, so called stable isotope dilution assays [SIDA], and use of GCO dilution techniques to quantitate ultra-trace level odorants that are present below limits of detection of GC-MS.

What has been done

The pleasant popcorn-like smelling compound 2-acetyl-1-pyrroline [2AP] occurs naturally in many foods but is scarcely used as a flavoring agent due to its great instability. In this work, we evaluate the potential of high amylose corn starch to complex and stabilize 2AP. The methodology was first optimized using model compounds, 2-acetylpyridine and 2-acetyl-2-thiazoline, and then applied to 2AP. Complexes were successfully prepared and characterized using X-ray diffraction, gas chromatography, and differential scanning calorimetry. Loadings of up to 0.504 [±0.071] % 2AP were achieved and storage studies showed that over half of the flavor was retained after two weeks at 0% relative humidity. To our knowledge, this is the first demonstration that 2AP can form amylose inclusion complexes and may lead to a method to effectively stabilize this labile aroma compound.

Results

A moisture-sensitive 2-acetyl-1-pyrroline zinc chloride complex [2AP-ZnCl2] was successfully encapsulated by spray chilling using a hydrophobic moisture barrier as a practical way to protect the complex and to help facilitate its general use in food applications. Use of octacosane as wall material provided a flavor retention of 65.3%. The results from scanning electron microscopy and X-ray micro-computed tomography indicated desirable morphological characteristics of the matrix type microcapsules. Gas chromatography and absorbance spectroscopy were used for chemical quantitation of 2AP and ZnCl2, respectively, in the microcapsules. Results revealed no degradation of 2AP occurred as a result of the encapsulation process. This study is the first to demonstrate the feasibility of producing high quality microcapsules from labile flavor complexes by spray-chilling. The use of generally recognized safe substances including 2AP, ZnCl2, and paraffin wax may allow for widespread commercial use of 2AP as a flavor ingredient.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies

502	New and Improved Food Products
503	Quality Maintenance in Storing and Marketing Food Products
702	Requirements and Function of Nutrients and Other Food Components

Outcome #8

1. **Outcome Measures**

Incorporating Protein Into Extruded Or Puffed Snack Foods

Not Reporting on this Outcome Measure

Outcome #9

1. **Outcome Measures**

Developing New Varieties Attractive To U-Pick Produce Consumers

Not Reporting on this Outcome Measure

Outcome #10

1. **Outcome Measures**

Increased Knowledge Of Fresh Fruit And Vegetable Production Practices

Not Reporting on this Outcome Measure

Outcome #11

1. **Outcome Measures**

Increased Knowledge Of Small Farm Production Options

2. **Associated Institution Types**

- 1862 Extension

3a. **Outcome Type:**

Change in Knowledge Outcome Measure

3b. **Quantitative Outcome**

Year	Actual
2018	164

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
According to the United States Department of Agriculture National Agricultural Statistics Service [USDA-NASS], as of February 2017, Illinois had 72,200 farms. Illinois farmland covers nearly 27 million acres [about 75 percent of the state's total land area]. Producers and potential producers need trusted, unbiased information to ground data-driven decisions.

What has been done
Extension educators from the local foods/small farms team conducted two programs to promote best practices for those who are invested or are considering investing in small farming operations. In 2018, the Small Farms Winter Webinar Series reached 861 attendees via eleven live webinars, which were subsequently recorded and posted to the Extension website along with all prior series since 2015. The series provided online lunch-hour presentations, filled with practical strategies relevant to small farm enterprises. Several Extension field offices hosted a webinar site for potential audiences without access to broadband internet access for streaming.

In its second year, the Master Urban Farmer Training Program [MUFTP] trained sixteen participants through twelve onsite educational sessions during 2018. The MUFTP, operating out of Cook County which includes the City of Chicago, is designed to provide new urban farmers with the introductory knowledge and skills to start an urban farm. At the end of the program it is expected that participants will be able to write a viable business plan and have the information necessary to move forward with their urban farming goals.

Results
At the conclusion of each webinar, Small Farms Winter Webinar Series attendees were asked to rate their knowledge level before and after participating in the session. Across the webinar series, 80% [N=198] of respondents rated their knowledge level associated with covered topics AFTER the session as a 4 or 5 [on scale where 1 = "no knowledge" and 5 = "extensive knowledge"]. Only 20% [N=50] of respondents rated their knowledge at that level BEFORE the session. As a result of participation, 148 survey respondents reported a higher level of mastery of the topical areas covered, compared with their level of mastery prior to attendance. All respondents [N=23] who attended the Native Pollinators on Your Farm session reported they were "likely" or "very likely" to implement new practices based on their participation in the session.

At the conclusion of the Master Urban Farmer Training Program, participants were asked to comment on their knowledge gain and changes adopted over the course of the twelve-week program. All surveyed participants [N=16] reported gaining "a lot" to "advanced" levels of knowledge in at least 1 of the 20 topical area covered during the training and over one-half of respondents reported they gained "a lot" of knowledge in 9 of the 20 topics. Additionally, 50% of respondents [8 out of 16] reported that they had already adopted practices recommended related to Food Safety, Tools and Equipment, and Vegetable Production Systems.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
503	Quality Maintenance in Storing and Marketing Food Products

Outcome #12

1. Outcome Measures

Improved Understanding Of Zein Self-Assembly Mechanisms And Development Of Novel Materials And Applications

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Proteins often self-assemble into supramolecular structures to accomplish their function in biological systems. But protein self assembly may be associated with the onset of diseases including Alzheimer's, Parkinson's, and Type II diabetes. From an industrial point of view, protein self-assembly is used in developing well-ordered vesicles for drug delivery.

What has been done
The self-assembly of zein in ethanol-water containing oleic acid was investigated by ultra-small angle x-ray scattering, rheological parameters, and Raman spectroscopy. USAX scattering profiles were taken on fresh solutions and after aging the samples for four months.

Results
The scattering intensity plot indicated the formation of hierarchical structures at three distinct levels. Aging significantly increased the size of primary units, suggesting an increased level of organization of oleic acid around zein. Viscoelasticiy parameters of fresh and aged samples confirmed that samples turned into gels during storage. Raman spectroscopy suggested that zein conformational changes took place during aging. Transitions in the secondary structure from alpha-helix to beta-sheets played an important role in promoting aggregation. Data presented is expected to advance the understanding of zein self-assembly mechanisms and thus contribute to the development of novel materials and applications.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
502	New and Improved Food Products

Outcome #13

1. Outcome Measures

Developing Sodium Chloride-Loaded Microcapsules To Reduce Sodium Content In Foods

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
During this period, sodium was encapsulated in two types of matrices using a spray drying with two- or three-fluid nozzles. Controlling release of sodium during oral processing of food is a promising way to achieve sodium reduction in food products. Microencapsulation is a potential technique to control the sodium release. The objective of this study was to develop sodium chloride-loaded microcapsules and to characterize the sodium release of those microcapsules.

What has been done
Maltodextrin [DE10] and octenyl succinic anhydride [OSA] modified starch were evaluated as carriers to create microcapsules using spray drying with a 2-fluid and 3-fluid nozzle. For the 2-fluid nozzle, the carrier solution [5 or 10% w/w] and NaCl solution [25% w/w] were mixed before spray drying. For the 3-fluid nozzle, the carrier solution and NaCl solution flowed separately through two different channels without mixing for the spray drying. The morphology of microcapsules was observed by scanning electron microscope [SEM]. The SEM images showed most sodium was encapsulated into the carriers successfully.

Results
Microcapsules made with OSA modified starch had more smooth, round, and uniform spherical shape than with the maltodextrin samples. The sodium release was measured in the form of total dissolved solids using a conductivity probe. Increasing the concentration of OSA modified starch significantly decreased Rmax [maximum sodium release rate], C50 [sodium concentration at 50s] and C150 [sodium concentration at 150s] and the same trend was observed for the maltodextrin.

Generally, the samples spray dried with a 2-fluid nozzle released sodium faster than the samples with a 3-fluid nozzle. This study indicated the delivery of sodium could be altered by using various type and concentration of carriers as well as the type of spray dry nozzles, which may provide strategies to reduce sodium content in foods, especially salty snack foods.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
502	New and Improved Food Products

Outcome #14

1. Outcome Measures

Improving The End-Use Functionality Of Whole Wheat Flour

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Biofortification is the endogenous fortification of nutrients in foods by biological manipulation of the crop. There are three forms of biofortification: agronomic interventions, conventional breeding, and genetic modification, each with its advantages and disadvantages. New strategies using physical and/or chemical treatments to enhance the endogenous nutritional values of food crops have gained increasing interest in recent years. These new methods have shown promise as alternative biofortification strategies that overcome the problems associated with the conventional biofortification methods, such as limited natural genetic variation and special germplasm, the time and costs of introducing a new trait into commercial cultivars, and public concerns about the safety of genetically modified foods.

What has been done
Treatment of food crops with power ultrasound, sound waves in frequencies ranging from 2-20 MHz with sound intensities of 0.1-1 W/cm squared, is a low acoustic power density process that aims to trigger defensive responses in food crops to produce compounds that enhance their nutritional value. Ultrasound is a non-thermal and energy-efficient process, having a "clean" image due to its popular applications in medical imaging. However, there are few studies on the use of power ultrasound as a biofortification method. This work will explore the use of ultrasound as a new biofortification strategy to enhance the nutritional value of fresh produce and sprouted grains.

Results

The findings of this study demonstrated that controlled germination for 5-15 hours produced whole wheat flour with improved flour functionality [increased glucose content, less starch retrogradation during gelatinizing, improved gluten quality with less weakening, and longer mixing stability time during dough mixing]. The severely sprouted soft white flour for 72 hours enhanced health-promoting bioactive compounds, including gamma aminobutyric acid and antioxidants, which could be used as natural nutrient enhancer in foods. The controlled germination process could be an alternative natural approach to produce whole wheat flour to improve its end-use functionality or enhance health benefits as a food ingredient.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
701	Nutrient Composition of Food
702	Requirements and Function of Nutrients and Other Food Components

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Small Farms Winter Webinar Series

At the conclusion of each webinar in the **Small Farms Winter Webinar Series**, attendees were asked to rate their knowledge level before and after participating in the session. Across the webinar series, 80% [N=198] of respondents rated their knowledge level associated with covered topics AFTER the session as a 4 or 5 [on scale where 1 = "no knowledge" and 5 = "extensive knowledge"]. Only 20% [N=50] of respondents rated their knowledge at that level BEFORE the session. As a result of participation, 148 survey respondents reported a higher level of mastery of the topical areas covered, compared with their level of mastery prior to attendance. Participants also reported a high degree of intent to take action, with all respondents reporting they will "likely" or "very likely" take action related to **Native Pollinators on Your Farm**. Participants were least likely to take action related to **Modifying and Building Sprayers for Specialty Crops**.

Key Items of Evaluation

Small Farms Winter Webinar Series

Primarily motivated by the desire to seek information about options for small farm operations, the majority [80%] of Small Farms Winter Webinar Series attendees reported high levels of topic knowledge following participation in one or more of the eleven webinars offered in 2018. In addition, 100% reported they were "likely" or "very likely" to take action based on what they learned during the **Native Pollinators on Your Farm** session.

V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Human Health And Human Development

☑ 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
703	Nutrition Education and Behavior	20%		15%	
704	Nutrition and Hunger in the Population	0%		15%	
724	Healthy Lifestyle	20%		15%	
801	Individual and Family Resource Management	10%		10%	
802	Human Development and Family Well-Being	10%		15%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	0%		10%	
805	Community Institutions, Health, and Social Services	20%		10%	
806	Youth Development	20%		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	0.2	0.0	10.0	0.0
Actual Paid	38.3	0.0	52.1	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**
1816573	0	1705873	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1816573	0	1705873	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
7397710	0	6161036	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Activities in FFY 2018 included research into the extraction of hydroxycinnamic acids from maize for use as a food additive in processed food products as a way to make the health benefits of hydroxycinnamic acids available to all people regardless of socioeconomic class, improvement of an animal model [especially cognitive assessment and neuroimaging procedures] and data analysis pipeline used to test effects of early-life nutrition on cognitive development, work to determine the effect of instrumental color and extractable lipid on sensory ratings of pork chops, an investigation into how nutrients interact with the gastrointestinal tract to change overall physiology and behavior as measured by alterations in absorption, hormonal, and neural signaling, completion of a clinical study on how gut microbes may help reduce stress and anxiety in adults, and work that will help inform the field of youth and emerging adult leadership education not only by illustrating how this population understands the concept of leadership in general and their own practices in particular, but also by providing a structural bridge to inform the practices of educators in helping support the leadership development of these students who participate in formal organizations.

Activities also included an effort to improve our understanding of the influence of interpersonal relationships on the mental health outcomes of African-American adolescents who have experienced racial discrimination, a project that seeks to characterize different botanical estrogens and identify botanical estrogens with beneficial effects in non-reproductive metabolic tissues vs. risks to reproductive tissues, further evaluation of the mechanisms for interactions of botanical estrogens with the development of metabolic syndrome and obesity associated with menopause and high fat diets, the identification of culturally responsive leader practices that can be used to enhance professional training of youth program leaders, the finding that fathers' use of paternity leave is positively associated with their life satisfaction and that this is mediated by an increase in a father's job satisfaction [and that fathers' life satisfaction mediates the relationship between the use of paternity leave and mothers' family relationship satisfaction], and research that seeks to integrate theory and findings across multiple disciplines - including neuroscience, linguistics, psychophysiology, and developmental psychology - to better understand the mechanisms underlying associations between early parent-child relationship quality and children's subsequent social and emotional functioning.

Activities also included the development of results that suggest that parents are generally more likely to racially socialize black girls, except in predominantly low-income, racially segregated neighborhoods [in these kinds of neighborhoods, parents are more likely to socialize black boys; this highlights the important role these practices play in explaining differences among African-American children's educational outcomes as well as a student's gender and neighborhood context], a project that seeks to identify determinants of weight gain prevention as guided by Social Cognitive Theory, the finding that irritable

bowel syndrome is underdiagnosed and ineffectively treated within an endurance athlete population consisting of marathon, ultra-marathon, half-distance triathlon, or full-distance triathlon athletes, work to determine the intention and actual use of diabetes-related apps by diabetes clinicians and health care administrators, and research to evaluate the efficacy of non-pharmacological approaches for reducing cardiovascular disease risk and improving quality of life in hemodialysis patients [the primary purpose of this project is to examine the impact of dietary sodium restriction on tissue sodium levels].

Activities also included an effort to develop and implement theoretically-based dietary intervention programming that can be incorporated into the standard of care for head and neck cancer and breast cancer survivors, a project that will explore the short-term and long-term individual and family health benefits of nature-based activities using Attention Restoration Theory [which shows how certain types of behavioral settings have different effects on restored attention] and Routines and Rituals Framework [which predicts greater developmental benefits of certain types of ritualized experiences over one-time experiences], ongoing development of the Child Development Research Database Project [this project has been designed to facilitate an interdisciplinary, longitudinal, and programmatic research agenda at the Child Development Laboratory in the areas of child development and family studies], a study that will advance our understanding of how young people in local and rural communities engage in activities to combat climate change and support environmental justice [this study will also advance significant theoretical and programmatic knowledge about contemporary youth political practices both globally and locally], and a study that seeks to examine patterns of educational attainment and aspirations for career and geographic residency for rural students at four-year, public institutions in the state of Illinois.

Activities also included an evaluation of the effects of dietary botanical estrogens on breast cancer growth and progression using preclinical animal models, work building upon an existing cohort study to examine the potential for family mealtime practices to moderate biological risk for childhood obesity in the first year of life, an examination of the health, well-being, and economic opportunity of LGBT persons in rural Illinois, a study that seeks to explore the extent to which different types of intimate partner violence are associated with different patterns of judicial involvement, interventions, and legal outcomes over time and how these patterns relate to ongoing threats to mothers' safety and adjustment, work to improve the quality of youth development programs by gaining knowledge of the strategies-in-context used by effective program leaders, and efforts to identify successful programs that promote positive parenting and child care provider behavior around healthy nutrition and physical activity during childhood [the results of this workgroup will be distributed nationwide across Extension communities to provide accessible programming for parents and child care providers to promote positive nutrition and physical activity habits from an early age].

Conference presentations in 2018 included the Reciprocal Meats Conference, Midwest Animal Science Meetings, International Swine Industry Symposium, Society for Experimental Biology and Medicine, Academy of Nutrition and Dietetics Food and Nutrition Conference and Expo, New Jersey Academy of Nutrition and Dietetics, American Association for Cancer Research, Endocrine Society, Society for Research on Adolescence, American Sociological Association, Work and Family Researchers Network Conference, FLUX Satellite Conference, Eastern Psychological Association, International Society for Research in Human Milk, the Lactation Conference, Association for Chemoreception Sciences, Research Society of Alcoholism, Obesity Society, American Society of Nephrology, International Association of Color Manufacturers Global Color Conference, American Chemical Society, American Society for Nutrition, Society for the Study of Emerging Adulthood, Society for Research in Child Development, International Association of Cross-Cultural Psychology, National Council for Family Relations, LGBTQ Research Symposium, International Family Violence and Child Victimization Research Conference, American Camp Association, and Nutrition 2018.

Extension activities targeted human development across the life span and many aspects of physical, emotional, and social health. In many cases, these programs blend multiple focus areas to create learning

opportunities for Illinois residents to prevent and manage challenges that threaten health and wellbeing.

Extension programming to promote brain health remains a major focus of Extension family life educators. The brain health series includes: [1] **Hold That Thought**; [2] **FITWITS: Fostering Improved Thinking While Incorporating Training Strategies**; [3] **Wits Fitness**; [4] **Head Strong: Exercise Strategies to Enhance Memory and Thinking**; and [5] **Two Heads are Better than One**. Each program in the series explores the science of memory and outlines strategies to promote brain health among aging adults. To highlight the role nutrition plays in supporting brain health across the life span, popular programs including **Eating Right for Cognitive Health** to provide brain nourishing nutritional strategies for adults, **Building Healthy Brains**, and **Better Brains for Babies** that focus on the important nutritional needs of infants and children for parents and caregivers.

Wellness programs offered in 2018, appealed to a broad age range of adults. Examples include: [1] **Being Mindful in a Busy World**; focused on defining and identifying the benefits of mindfulness and purposeful attention; [2] **Simplify Your Life: Clear the Clutter and Your Stress** [workshops were conducted for multiple groups throughout Illinois]; and [3] **Someday is Today - Live Your Bucket List** [a program that teaches participants to be intentional and live life to the fullest]. A program gaining popularity in 2018 was **Life Story Writing**, using personal narratives to help participants explore and celebrate their experiences as a way to improve quality of life. Resiliency programs encouraged participants to develop skills to cope with life challenges through **Looking for the Funny Side**, **How High Do You Bounce**, **Color Me Happy**, and **I'm Positive I'm Aging**.

Nutrition programs offered in 2018 spanned a diverse array of issues including weight management, mindful eating, healthy shopping on a budget, food and drug interactions, practical strategies to integrate organic foods, food label literacy, ways to use new and unusual foods, and seasonal favorites targeting healthy holiday meals. Hands-on cooking experiences were used to augment research-based information with participants and promote nutritional health among Illinois residents of all ages.

Two foundational Extension programs that address healthy food choices to prevent childhood obesity with limited resource populations include the **Expanded Food and Nutrition Education Program [EFNEP]** and **Supplemental Nutrition Assistance Program - Education [SNAP-Ed]**. Extension staff working within these programs conducted hands-on activities with children and their parents to promote healthy choices and environments that support access to and use of healthy foods. In 2018 SNAP-Ed Extension staff members delivered more than 597,000 direct educational contacts. EFNEP Extension staff members reached 3,295 adults and 5,211 youth [ultimately benefiting 11,369 family members]. In addition to direct education, SNAP-Ed staff focused on policy, systems, and environmental [PSE] interventions with schools, food pantries and other organizations. PSE interventions focus on organizational collaboration and helping community partners leverage their funding and resources to optimize services provided to their target audiences.

The **ABC's of School Nutrition** is a grant partnership with the Illinois State Board of Education awarded in FY 2016. In 2018, Extension educators provided training and technical assistance to 1,734 school nutrition professionals through 175 on-site trainings and completed 185 Smarter Lunchrooms Assessments in schools. School nutrition staff were trained on menu planning, school wellness, offering smart snacks and beverages, nutrition, food production and serving food, federal meal pattern guidance, food safety, and communications and marketing. The program hosts an active website that features 23 mini-courses that were completed by 1,472 learners and received 77,127 page views in 2018.

Extension offers several programs to build the capacity of youth to engage in healthy nutrition behaviors and to learn the benefits of healthy choices. Two signature programs include the **4-H Food Challenge** and **Illinois Junior Chefs**. The 4-H Food Challenge encourages youth to experiment by creating meals that are healthy and inexpensive, without a recipe, using a mystery ingredient. A total of 727 middle

school and high school level youth participated in 2018. Across the state, 4-H staff delivered 209 hours of programming through 117 educational sessions to implement this program. Illinois Junior Chefs, through a partnership with SNAP-Ed, targets 8 to 13 year olds with ands-on culinary cooking and nutrition activities. The goals are to increase preferences for healthy foods, cooking confidence and skills, and cooking behaviors. A total of 4,789 youth participated in Illinois Junior Chefs programming at 197 different sites.

Additional programming related to youth health and development included **Breaking the Code**, a research-based prevention simulation and guided discussion for junior high and senior high youth supported by statistical research on bullying among teens. **4-H Health Rocks!**, a national healthy living program aimed at 8-16 year olds with the goal of bringing youth, families, and communities together to reduce tobacco, alcohol, and drug use was conducted with 2,041 youth in 2018 [see evaluation section for further details]. Extension educators in Cook County implemented **Off to a Good Start**, a youth program focused on sexual health and decision-making, and **Anxious to Awesome**, a youth program targeting social and emotional health. Cook County teachers participated in workshops related to trauma, compassion and resiliency which provided strategies for creating safe and nurturing classroom environments. Through professional development activities, Extension has the capacity to extend impacts into the lives of the students the teachers reach.

Because so many chronic diseases are best managed and prevented through diet and exercise, Extension offered a variety of programs in 2018 that targeted risk factors associated with heart disease and diabetes. More than 100 educational sessions equipped those living with diabetes to reduce their risks, combining lecture, food demonstrations, activities, and samples of healthy foods. The **Meals for a Healthy Heart** program is a two-part series focused on increasing participant awareness of the risk factors of coronary heart disease, hypertension, high blood cholesterol, and other warning signs. Activity levels and weight management information, as well as food demonstrations, taste testing, and recipes were provided at each session.

2. Brief description of the target audience

Members of the target audience included segments of the U.S. population at risk for mild-to-moderate deficiencies of specific micronutrients, gestating women and those breastfeeding newborns, basic and applied students and researchers in the areas of human obesity and animal production, registered dietitians, health care professionals, scientists, researchers and practitioners in leadership development and leadership education, researchers, clinicians, and interventionists working with African-American families, scientists in the field of metabolic regulation and breast cancer, the academic fields of human development and family studies, education, and psychology, federal and state policymakers, nutrition and dietetics professionals, patients with renal failure undergoing chronic hemodialysis therapy, head and neck, breast, and other cancer survivors, maize producers, LGBT individuals and their families who reside in rural communities across the U.S. and community leaders and providers who work with or serve those families, mothers who co-parent after separation [including those who do and do not experience intimate partner violence], professionals working with mothers in the process of divorce, including family court judges, family law attorneys, custody evaluators, and parent educators, youth program administrators and front line practitioners such as 4-H staff, and individuals living with diabetes and primary care professionals that will be able to offer resources to help individuals living with diabetes to make sound nutritional choices.

Extension target audiences included individuals at-risk for or coping with diabetes, obesity, or heart disease as well as families living in low-income and high-risk neighborhoods. Other target audiences included school nutrition professionals, retirees, aging adults and their caregivers, childcare providers, grandparents responsible for young children, and youth.

3. How was eXtension used?

Thirteen members of the Family and Consumer Sciences team are members of one or more Communities of Practices in eXtension.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	16845	3083416	54346	201389

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

Patent Applications Submitted

Year: 2018

Actual: 2

Patents listed

[2017-229-01 [PRO]] - Engineered Microorganisms For Production Of 2 Flucosyllactose And L-Fucose; [TF12192-03 [CON]] - Biosynthesis Of Oligosaccharides.

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	77	77

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number Of Completed Hatch Projects

Year	Actual
2018	10

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number Of Research Projects Utilizing The Child Development Laboratory Research Database
2	Increased Knowledge Of Children's Behavior At A Given Stage Of Development And Parenting And Childcare Providers Practices To Foster That Behavior
3	Numbers Of Individuals Taking Recommended Actions To Manage Heart Disease And Diabetes
4	Number Of Children/Youth Who Reported Eating Healthier Foods [Those Low In Fat And High In Fiber]
5	Number Of Families/Caregivers That Gained Knowledge About Eating Healthier Foods [Those Low In Fat And High In Fiber]
6	Number Of Adults That Apply Skills As They Age In Maintaining Brain Fitness And Cognitive Health
7	Extension Of A Successful, Evidence-Based Approach For Strengthening Prosocial Sibling Relationships
8	Evaluating The Effect Of Dietary Botanical Estrogens On Breast Cancer Growth And Progression
9	Identifying The Determinants Of Weight Gain Prevention As Guided By Social Cognitive Theory
10	Translating Scientific Energy Balance Evidence And Parenting Styles Into Practical Recommendations For Training Extension Educators
11	Investigating The Ability Of Dietary Tomato Powder To Reduce The Progression Of Prostate Cancer
12	Determining How Prenatal Choline Alters Neurodevelopment
13	Improving Our Understanding Of The Strategies Used By Effective Program Leaders
14	Reducing Obesity Through Improved Utilization Of Nutrition Information
15	Improving Our Understanding Of Social-Emotional Development Among Children From Rural And Suburban Communities
16	Number Of Youth That Increased Knowledge Of Bullying And Actions To Take In Dealing With A Bullying Situation
17	Determining If Parents Underuse Parental Leave Because They Are Penalized By Employers

18	Examining The Potential Neurobiological And Physiological Mechanisms Linking Parent-Child Relationship Quality To Children's Socioemotional Well-Being
19	Measuring Cytokines, Chemokines, And Growth Factors In Mature Human Milk And Assessing Differences In Composition Between Exclusively Breastfeeding And Mixed-Feeding Mothers
20	Understanding How Young Children Experienced The Effects Of The Recession Within Their Families, Schools, And Communities
21	Determining The Intention And Actual Use Of Diabetes-Related Apps By Diabetes Clinicians
22	Advancing Our Understanding Of How Young People Engage In Activities To Combat Climate Change And Support Environmental Justice
23	Exploring The Potential Health Benefits Of Anthocyanin Rich Foods
24	Examining How Experienced Pathways Program Leaders Help Young People Overcome Anxiety
25	Increased Knowledge Among School Nutrition Professionals To Improve School Lunchroom Environments
26	Increased Knowledge Of Consequences Of Risky Behavior On Youth Health And Wellbeing

Outcome #1

1. Outcome Measures

Number Of Research Projects Utilizing The Child Development Laboratory Research Database

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	18

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Infrastructure supports have been identified as a key element in the ability of laboratory schools to facilitate and support teaching, research, and outreach/engagement activities. Through the years

the CDL has established an infrastructure for facilitating research projects while at the same time providing services for enrolled children and their families. Although the CDL has consistently served as a supportive arena for conducting faculty and graduate student research, it wasn't until the development and implementation of the CDL Research Database Project that such efforts moved beyond one-time data collection efforts. These one-time projects were completed on a semester or yearly basis with little or no cross-communication between investigators or systematic compilation of data. Such an approach failed to capitalize on the shared research interests and expertise of faculty within the Human Development and Family Studies Department and the College of ACES, and limited the ability of the CDL to facilitate a programmatic research agenda designed to address important developmental issues facing children and their families.

Since its inception, the development and implementation of the CDL Research Database Project has played a significant role in influencing and shaping the nature of the research being conducted at the program. As a result of the resources provided through the database project, many of the studies being implemented at the CDL now take an applied developmental science approach to data collection, and capitalize on the reciprocal exchange of data that is made available to investigators implementing projects. This has allowed researchers to develop a more comprehensive approach to generating data on the topics which they are investigating while expanding the types of data available for use in their projects, thus enhancing the types of questions they are able to address in their studies.

What has been done

There are four beneficiaries of this project during the current reporting period. First, the systematic procedures used to create this unique database of information on children's behavior across multiple developmental domains allows researchers and instructors to use this data for both historical and projective analyses that focus on child development and outcomes resulting from interactions in high quality early childhood environments. Second, the continuation of the CDL Research Database Project facilitates long-term, interdepartmental and cross-departmental faculty and student collaborations that provides opportunities for creative investigations of children's development. Third, UIUC undergraduate and graduate students have opportunities for enhanced learning experiences as they draw on information contained in the CDL Research Database to support class activities designed to demonstrate the connections between theory, research, and practice. Finally, children and families throughout Illinois and the U.S. have benefited from the knowledge being generated through research projects being conducted as part of this project.

Results

A total of 18 research projects were conducted at the CDL during the current reporting period. These 18 projects represent a diverse array of disciplines [including Human Development and Family Studies, Advertising, Anthropology, Landscape Architecture, Art and Design, Nutritional Sciences, Communications, Community Health, and Music Education] and all focused on various aspects of children's growth and development [social/emotional development, cognitive functioning, physical growth and health]. Four of the projects were investigations conducted by graduate students working under the direction of a faculty advisor, while 14 of the projects were faculty-led investigations.

In addition to the research supported, the CDL Research Database also played an integral role in facilitating teaching activities taking place within the program. During the current reporting period a total of 3,562 student observations in support of 33 different courses, 1,835 student class projects in support of 23 different courses, and 54 student internship placements took place at the CDL. Instructors for these different course experiences accessed information from the CDL Research Database to provide background and demographic information on enrolled children that

informed and guided the experiences of UIUC students.

4. Associated Knowledge Areas

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

Outcome #2

1. Outcome Measures

Increased Knowledge Of Children's Behavior At A Given Stage Of Development And Parenting And Childcare Providers Practices To Foster That Behavior

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Numbers Of Individuals Taking Recommended Actions To Manage Heart Disease And Diabetes

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Number Of Children/Youth Who Reported Eating Healthier Foods [Those Low In Fat And High In Fiber]

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	481

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
As of 2017, the obesity rate among 10-17 year olds in Illinois is 16.2%, which ranks 17th highest in the nation. According to the 2018 Illinois Youth Survey, one out of every ten 12th graders reported they did not eat any vegetables in the past week. Because at least 80% of premature heart disease, stroke, and type 2 diabetes diagnoses could be prevented through healthy lifestyle choices, it is imperative for young people to learn the skills they need to make positive dietary choices early in life.

What has been done
Extension offers several programs to build the capacity of youth to engage in healthy nutrition behaviors and to learn the benefits of healthy choices. Two signature programs include:

4-H Food Challenge encourages youth to experiment by creating meals that are healthy and inexpensive, without a recipe, using a mystery ingredient. A total of 727 middle school and high school level youth participated in 2018. Across the state, 4-H staff delivered 209 hours of programming through 117 educational sessions to implement this program.

Illinois Junior Chefs, through a partnership with SNAP-Ed, targets 8 to 13 year olds with hands on culinary cooking and nutrition activities. The goals are to increase preferences for healthy foods, cooking confidence and skills, and cooking behaviors. A total of 4,789 youth participated in Illinois Junior Chefs programming at 197 different sites.

Results
Program evaluations were conducted with a subset of youth participants in each of Extension's signature healthy nutrition programs. Collectively, 87 Food Challenge participants and 394 participants improved their nutritional habits.

4-H Food Challenge

A total of 80 high school participants and 40 middle school participants completed a program evaluation to determine if youth were more likely to make healthier food choices after participating in the program. Among the high school youth, 71% [N=57] reported that they made healthier food choices due to their experience and 75% [N=30] of the middle school youth reported they eat more fruits and vegetables.

Illinois Junior Chefs

A total of 563 Illinois Junior Chef program participants were surveyed to determine if the program was effective. Overall, the majority of children improved their cooking self-efficacy [77%], cooking attitudes [82%], fruit and vegetables preferences [74%], self-efficacy for eating healthy foods [77%], and their healthy eating and cooking behaviors [70%]. A hands-on cooking assessment showed that 94% of children who participated in Illinois Jr. Chefs improved their cooking skills after participating in the program. Results indicate that a short, five-lesson cooking program shows significant, positive changes in youth cooking behaviors, food preferences, and skills and confidence related to cooking.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population
724	Healthy Lifestyle
801	Individual and Family Resource Management
802	Human Development and Family Well-Being
805	Community Institutions, Health, and Social Services
806	Youth Development

Outcome #5

1. Outcome Measures

Number Of Families/Caregivers That Gained Knowledge About Eating Healthier Foods [Those Low In Fat And High In Fiber]

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	3064

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Illinois has the 27th highest adult obesity rate in the nation, and the 17th highest obesity rate for youth ages 10 to 17. As of 2017, Illinois's adult obesity rate was 31.1%, up from 20.4% in 2000 and from 12.1% in 1990. Parents, guardians, and adult family members can play a key role in promoting healthy nutrition choices. Research has demonstrated that healthy food selection, preparation, and consumption can contribute to a lower prevalence of chronic diseases that disproportionately affect limited-resource populations.

What has been done
The Expanded Food and Nutrition Education Program [EFNEP] is designed to assist limited-resource audiences in gaining knowledge and skills needed to eat a nutritious diet and to live a healthy lifestyle. Programs are research based, hands on, and taught by trained peer educators. EFNEP is located in six counties in Illinois - Cook, Peoria, Champaign, Vermilion, Madison, and St. Clair. In 2018, EFNEP provided 8,506 educational contacts with 3,295 adults and 5,211 youth. Overall, 11,369 family members were reached with skill building opportunities to improve their nutrition and physical activity behavioral practices.

Results
In 2018, EFNEP in Illinois has reported high levels of impact with limited resource families. Self-report data based on entry and exit measures of behavior documented that 93% of adult participants [N=3,064] improved their nutrition practices as a result of their participation in EFNEP educational programs. This impact is particularly powerful in that nearly half [45%] of program participants identified as minority and over one-fourth [28%] identify as Hispanic or Latino, reaching the underserved audiences in Illinois counties at risk for food insecurity with ways to maximize their choices. As adults have a significant influence over the food options available to their families, the potential impact for healthier choices could be estimated to 93% of 11,369 family members [N=10,573] served by Illinois EFNEP in 2018.

4. Associated Knowledge Areas

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

Outcome #6

1. Outcome Measures

Number Of Adults That Apply Skills As They Age In Maintaining Brain Fitness And Cognitive Health

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	174

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
One in ten Illinoisans experience subjective cognitive decline. With continuing growth in this country's aging population, concerns about maintaining one's memory as well as recognizing and managing brain disease are issues of great interest to the aging and their families in maintaining their quality of life.

What has been done
Continuing to draw on research conducted at the University of Illinois and other research institutions, University of Illinois Extension Family Life Educators implemented a total of 117 brain

health workshops with 2,506 participants across Illinois. The brain health series includes programs called FIT WITS, Hold that Thought, Wits Fitness, Two Heads are Better than One, and Head Strong. Workshops are designed to increase knowledge and self-efficacy to take actions that actively address brain health. In many locations, participants have the option to attend multiple workshops.

Results
Participants reported high levels of impact as a result of the workshop content and activities. Of the 245 participants responding to an end-of-program evaluation, 87% [N=214] reported an increase in knowledge of how lifestyle choices can contribute to brain health OR increase in awareness of the strategies and techniques to improve memory. Additionally, 78% indicated they felt more confident in their ability to use recommended techniques to promote brain health. Participants were asked to share any actions they intended to take as a result of what they learned. The majority [174 of 245] of respondents reported at least one recommended action they intended to take.

4. Associated Knowledge Areas

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

Outcome #7

1. Outcome Measures

Extension Of A Successful, Evidence-Based Approach For Strengthening Prosocial Sibling Relationships

Not Reporting on this Outcome Measure

Outcome #8

1. Outcome Measures

Evaluating The Effect Of Dietary Botanical Estrogens On Breast Cancer Growth And Progression

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Our preliminary data suggest that thermally abused frying oil [TAFO] may influence breast cancer [BC] recurrence and could promote metastasis. Diets high in fat can increase BC metastasis, and the type of fat is an important factor. There is only limited research conducted on TAFO. However it is estimated that Americans consume approximately 8% of their total calories from the lipid present in fried foods. It is likely that the lipid in these fried foods may be thermally oxidized and cause significant harm to these BC survivors. Thus, the influence that TAFOs might be having on breaking residual disease dormancy in breast cancer survivors nominally "cured" of disease becomes a vital issue of health concern.

What has been done
Understanding how TAFO promotes BC progression requires a comprehensive and innovative approach. Our evaluation will be of the effect of TAFO on tumor growth and metastasis; yet, TAFO might also alter several whole animal systems. It is possible that TAFO may alter the microenvironment in visceral tissues and allow for aggressive mammary tumor cells to grow at sites distant from the original BC. We will provide quantitative measures of BC progression using state of the art technologies such as bioluminescence imaging [BLI]. Additionally, we will produce sufficient amounts of well-characterized TAFO to further characterize the undesirable components in TAFO and characterize the production process so that follow-up studies can be done to evaluate the potential of TAFO to enhance BC progression.

Results
In the past year we have begun to evaluate potential mechanisms as to why TAFO increase breast cancer metastasis. In our early investigations we have observed that TAFO increase the number of tumors that metastasize from the bone to the lung. The likely mechanism involves the ability of the tumor cells to create their own blood supply - suggesting there is angiogenesis associated with the breast cancer cells. This study used a late-stage breast cancer murine model and we continue to evaluate various genes associated with alteration in angiogenesis. Further, in animals consuming the TAFO treatment diet, metastatic tumors in the lung displayed an increase in cellular proliferation. In summary, these tumors are more aggressive, proliferate, and invade surrounding tissues to a greater extent than the raw soy oil used as a control oil.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population
724	Healthy Lifestyle

Outcome #9

1. Outcome Measures

Identifying The Determinants Of Weight Gain Prevention As Guided By Social Cognitive Theory

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The overarching aim of this research program is to prevent the burden of adult obesity among women. The specific purpose of this research project is to identify determinants of weight gain prevention as guided by Social Cognitive Theory. It is hypothesized that compared to a wait-list control group, women who undergo a weight gain prevention intervention designed to increase self efficacy, self regulation, outcome expectations, and family and social support regarding weight gain prevention will maintain current body weight over 12 months. Further, it is expected that women in an intervention group led by a registered dietitian will have lesser weight gain over 12 months compared to women in an intervention group led by a counselor.

What has been done
This research program aimed to prevent the burden of adult obesity among women. Rather than waiting until overweight or obesity develops, this study identified determinants of weight gain prevention and applied principles of weight gain prevention strategies to food-based dietary guidance. In total, 95 women completed this randomized controlled trial regarding weight gain prevention. A total of 48 women completed all components of the full study. Data collection has been completed.

Results
Major activities completed and experiments conducted include the enrollment of women in the randomized controlled trial, completion of the food-based intervention, and completion of the 12-month food-based intervention. Women completed the weekly and monthly nutrition education sessions that focused on nutrition education, intake of fruits and vegetables, and practical weight management skills.

Data have been collected at baseline, month 3, month 6, month 9, and month 12. Variables included dietary intake, physical activity, anthropometric and blood pressure measurements, biochemical markers of health, eating behaviors and health perceptions, and mediators of behavior change. Sixty-two percent of women were able to maintain body weight after one year of intervention; this did not differ by registered dietitian or counselor education group. Comparison of the registered dietitian nutrition education group to the counselor nutrition education group indicated that women in the registered dietitian group were estimated to have consumed more fruits at months 3, 6, 9, and 12 [all $P<0.01$] and non-meat protein sources at month 3 [$P<0.001$]. Women have learned about vegetable consumption, planning ahead for food intake and portion control, and general nutrition information based on Dietary Guidelines for Americans, 2010-2015 [current version at the time the study was initiated]. A group of young adult women and women in

midlife have successfully prevented body weight gain over one year of the study.

Food and nutrition professionals have been made aware of this intervention and initial findings related to the feasibility and ability for a group of young adult women and women in midlife to prevent body weight gain. Moreover, characteristics of young adult women and women in midlife who do not continue with a weight gain prevention intervention have been described so that dropout risk may be monitored and evaluated to tailor intervention strategies to maximize continued participation and compliance with Dietary Guidelines for Americans as related to body weight regulation and weight gain prevention. Finally, there was a negative association between scores on the grit [or perseverance] scale and body weight among women, suggesting that women who have the characteristics of resiliency have lower body weight at a given point in time.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population
724	Healthy Lifestyle

Outcome #10

1. Outcome Measures

Translating Scientific Energy Balance Evidence And Parenting Styles Into Practical Recommendations For Training Extension Educators

Not Reporting on this Outcome Measure

Outcome #11

1. Outcome Measures

Investigating The Ability Of Dietary Tomato Powder To Reduce The Progression Of Prostate Cancer

Not Reporting on this Outcome Measure

Outcome #12

1. Outcome Measures

Determining How Prenatal Choline Alters Neurodevelopment

Not Reporting on this Outcome Measure

Outcome #13

1. Outcome Measures

Improving Our Understanding Of The Strategies Used By Effective Program Leaders

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In the decade ending in 2010, the total Latino population in the U.S. grew by 43% - over four times more than the general population. Several trends combine to shape the current situation of Latino families. First, growth in the Latino population shifted from being primarily the result of migration to being the result of natural increase [excess of births relative to deaths]. Second, the Latino population has shifted from being primarily urban to being dispersed across the U.S. and increasingly settling in "new destinations" in the Midwest and South. As a result of these trends, an increasing number of immigrant Latino parents are raising U.S.-born children in rural communities. Reflecting these larger shifts, scholars have increasingly focused on the unique situation of Latino families in rural contexts. Our previous work has documented that rural communities are often not well prepared to support immigrants and that immigrant parents actively work to balance old and new ways of parenting as they raise children in the U.S. This project examines how contextual factors affect the experiences of immigrant Latino families. This project builds directly on past work by exploring socialization practices, autonomy issues, and how cultural issues play out with respect to youth's participation in mainstream institutions [afterschool programs]. There is a clear need for this work. Much current research with Spanish-speaking families in Illinois addresses primarily physical health aspects.

Furthermore, few studies have involved families in rural Illinois; for example, the USDA-funded Rural Family Speaks project involved data collection in 17 states [including several in the Midwest] but Illinois was not part of that study and parenting was not a major focus.

What has been done
This project uses data from the Pathways Project to examine parenting in immigrant Latino families. Research focuses on two key areas: [1] Cultural-contextual dimensions of adolescents' program participation; and [2] Socialization practices and interactions within diverse families.

During the reporting year, the team worked on data analyses, conference dissemination, and manuscript preparation focused on both of these areas.

Results
Two papers relating to the first area [cultural-contextual dimensions of adolescents' program participation] have yielded findings that can inform program design and staff training. For example, we found that immigrant Latino/a parents are largely unfamiliar with youth programs, yet many saw programs as spaces where their adolescent children could learn skills to bridge the heritage and mainstream cultures. Most importantly, although the programs we studied did not focus primarily on cultural issues, two-thirds of the caregivers discussed cultural elements relating to their child's program participation and described how youth programs supported multiple domains of cultural socialization. The in-progress case study of a rural program serving Latino/a youth complements these findings by examining leaders' perspectives. We have identified culturally-responsive leader practices that can be used to enhance professional training of youth program leaders.

Analyses relating to the second area are providing insights into how socialization practices and family interactions differ according to contextual and individual factors. For example, we conducted a quantitative dyadic analysis to examine how parents' and adolescents' reports of autonomy and relatedness are configured. Three clusters were identified that validate proposed theoretical models in a U.S. sample and provide empirical support for the view that families characterized by relatively high levels of both autonomy and relatedness are optimal developmental contexts. Of note, immigrant and Latino/a families were distinct from the rest of the sample in terms of both autonomy and relatedness. These findings have implications for practitioners who work with immigrant families.

4. Associated Knowledge Areas

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

Outcome #14

1. Outcome Measures

Reducing Obesity Through Improved Utilization Of Nutrition Information

Not Reporting on this Outcome Measure

Outcome #15

1. Outcome Measures

Improving Our Understanding Of Social-Emotional Development Among Children From Rural And Suburban Communities

Not Reporting on this Outcome Measure

Outcome #16

1. Outcome Measures

Number Of Youth That Increased Knowledge Of Bullying And Actions To Take In Dealing With A Bullying Situation

Not Reporting on this Outcome Measure

Outcome #17

1. Outcome Measures

Determining If Parents Underuse Parental Leave Because They Are Penalized By Employers

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The United States and Korea both offer parents parental leave. From a public policy perspective, parental leave benefits the society as a whole because it is related to many positive child and family outcomes. However, many men do not use any parental leave when having a child and many women do not use parental leave to its full extent. This project will test if parents underuse parental leave because they are penalized by employers [suffer a lower wage growth] and whether the penalties differ by gender, professional states, and country. We will use American and Korean nationally representative data to explore these questions.

What has been done
Paternity leave policies are gaining increased recognition from researchers and policymakers for being an instrumental tool that can have a positive impact on individuals, families, and societies. In this study, we estimate the effect of Korean fathers' paternity leave use on mothers' family relationship satisfaction using dyadic longitudinal data. Applying a spillover-crossover theoretical framework, we predict that fathers who use paternity leave experience a positive spillover manifested in increased life satisfaction and that this process will be mediated by an increase in their job satisfaction. In turn, this will "cross over" to positively affect mothers' family relationship satisfaction. We further propose that gender role agreement will moderate this relationship.

Results
Using nationally representative longitudinal panel data from the Korean Labor and Income Panel Study, which follows individuals and families on an annual basis, we find that fathers' use of paternity leave is positively associated with their life satisfaction and that this is mediated by an increase in father's job satisfaction. Further, fathers' life satisfaction mediates the relationship between the use of paternity leave and mothers' family relationship satisfaction. We also find support for the moderating role of gender role agreement. We do not find any support for a direct link between paternity leave use and mothers' family relationship satisfaction. We conclude that taking paternity leave has a positive association with beneficial outcomes for fathers, mothers, and families as a whole.

4. Associated Knowledge Areas

KA Code	Knowledge Area
724	Healthy Lifestyle
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 #18

1. Outcome Measures

Examining The Potential Neurobiological And Physiological Mechanisms Linking Parent-Child Relationship Quality To Children's Socioemotional Well-Being

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Parental support during emotional challenges predicts an array of positive outcomes, including secure attachment, emotional understanding, empathy toward others, and harmonious peer relationships. Despite clear evidence indicating that early parent-child relationships, especially with respect to child-mother attachment security, yields psychological, emotional, and social benefits, we know little about the potential neurobiological and physiological mechanisms linking parent-child relationship quality to children's socioemotional well-being. In the studies proposed here, we will assess children's stress regulation at multiple levels of analysis - brain, body, and behavior - as potential mechanisms linking qualities of the parent-child relationship to children's subsequent social and emotional functioning. Importantly, the ability to effectively regulate stress is related to emotional and physical health across the lifespan. Although individual differences in stress regulation are multi-determined, evidence is accumulating across animal studies that suggests early caregiving plays a critical role in shaping the structure and function of the organism's emerging neurological, physiological, and behavioral stress-response systems. Given the unique types of stressors that children and families in more rural communities may face [geographic isolation, fewer support services and economic opportunities] and given that much of the research on children's regulation of stress to date has focused on children and families in urban settings, addressing these key aims among children and families from rural and suburban communities is needed.

What has been done
During this past reporting period we have completed cleaning of the electocardiogram/interbeat interval [ECG/IBI] data for both mother and child participants. We have also begun data analyses to address our specific research aims. Specifically, a series of multilevel models revealed contemporaneous associations between maternal prosody [captured via a composite of acoustic measurements: fundamental frequency mean, max, range, and standard deviation] and maternal behavior: Higher prosody in a given 15-second interval [relative to one's own mean] predicted mothers' higher-than-average emotional support and positive affect and lower-than average cognitive assistance in the same interval. Controlling for maternal behavior and affect, within-person increases in maternal prosody contemporaneously predicted children's vagal augmentation [high barrier only; B = .09, SE = .036, p = .014], as well as decreased task attention/persistence, increased frustration/withdrawal [low barrier only], and increased positive affect.

Results
These initial findings suggest that momentary increases in maternal speech prosody are associated with related changes in emotionally salient parenting [comforting], whereas decreases in prosody are associated with increases in cognitively relevant behaviors [teaching]. Likewise, above and beyond observed maternal behavior, momentary increases in maternal prosody were associated with contemporaneous increases in cardiac vagal tone [vagal augmentation] and positive and negative dimensions of child affect, but decreases in child task-related attention. Maternal emotional prosody may serve a unique function to socially orient the child toward the mother and may also be a central component of the maternal response to a child's affective cues.

Such moment-to-moment coupling between maternal prosody, on the one hand, and child affect and physiology, on the other, may underlie dyadic co-regulatory processes. We will follow up these preliminary model tests with examination of lagged effects as well as comparisons of within-person associations across interactive tasks assessed in this study [play, low-barrier puzzle, and high-barrier puzzle].

4. Associated Knowledge Areas

KA Code	Knowledge Area
802	Human Development and Family Well-Being
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
806	Youth Development

Outcome #19

1. Outcome Measures

Measuring Cytokines, Chemokines, And Growth Factors In Mature Human Milk And Assessing Differences In Composition Between Exclusively Breastfeeding And Mixed-Feeding Mothers

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Human milk [HM] is composed of a diverse profile of immune components which are believed to influence infant innate and adaptive immunity. Factors such as maternal age, geography, gestational age, and lactation stage influence immune composition. However, the breadth of cytokines, chemokines, and growth factors [CCGFs] present in HM is not well characterized, and whether breastfeeding exclusivity affects CCGF composition is unknown. The objective was to measure CCGFs in mature HM and assess differences in composition between exclusively breastfeeding [EBF] and mixed-feeding [MF] mothers.

What has been done
Milk samples [EBF = 44; MF = 25] collected at six weeks postpartum from healthy mothers enrolled in the STRONG Kids 2 birth cohort study were utilized for analysis. All mothers vaginally-delivered their infants at term. Samples were analyzed for 41 CCGFs using a human cytokine/chemokine multiplex magnetic bead panel.

Results
Forty components were detectable in the milk samples. Twelve CCGFs [EGF, TGF-alpha, GRO, MDC, PDGF-AA, IL-15, IL-4, IL-7, IL-8, IP-10, MCP-1, and VEGF] were identified in more than 94% of samples. TNF-alpha, Fractalkine, and IL-1alpha were detected in more than 78% of samples. Among this subset of 15 analytes, IL-8 was the only CCGF within limits of detection [LOD] which differed between groups, with greater concentrations in the milk of MF relative to EBF mothers [p=0.002]. EGF and GRO were above the LOD [10,000 pg/ml] in most samples. Fisher exact tests were used to determine differences in frequency of detection for all CCGFs between EBF and MF mothers. The probability of detecting Fractalkine was greater among EBF compared to MF mothers [p=0.04]. The probability of detecting IL-3 [p=0.009], IL-6 [p=0.02], IL-9 [p=0.02], and MIP-1beta [p=0.006] was greater among MF compared to EBF mothers.

While levels of many CCGFs have been shown to be higher in early lactation, results demonstrate that a wide range of immune components are present at detectable levels in mature HM. The high frequency of detection of a subset of CCGFs may point to a core immune composition in mature HM. Differences in CCGF components in HM of EBF and MF mothers suggests that breastfeeding exclusivity impacts the immune profile of HM, which may be related to differences in oral microbiota of EBF and MF infants.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population
724	Healthy Lifestyle
806	Youth Development

Outcome #20

1. Outcome Measures

Understanding How Young Children Experienced The Effects Of The Recession Within Their Families, Schools, And Communities

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The Great Recession, which began with the collapse of the housing market in December of 2007, resulted in the largest contraction of the U.S. labor market since the Great Depression, with devastating consequences for American families and communities. While the recession officially ended in 2009, the impact of the reduced economic activity, job loss, falling wages, foreclosure, and diminished wealth had lasting effects for many American workers and their families. The Great Recession and subsequent slow recovery provide a unique opportunity to examine how exposure to adverse social and economic circumstances affects children's development and learning. Further, the recession occurred on the heels of rising income inequality and persistent disparities in educational achievement and attainment between racial and socioeconomic groups. Therefore, the overall goal of this research project is to understand how young children experienced the effects of the recession within their families, schools, and communities and how these experiences shaped their development and impacted educational inequality during elementary school.

What has been done

The impact of the recession and the later recovery was not experienced equally by individuals or across regions, states, and communities. For example, less educated workers and workers employed in manufacturing, construction, and low-end service jobs were more likely to experience job loss and prolonged unemployment. Neighborhoods with higher concentrations of poverty and African-Americans also fared much worse during the recession and have been slower to recover. Rural areas, in general, were less impacted by job loss during the recession compared to urban and suburban areas, though rural counties with high concentrations of African-Americans were the exception. States also experienced the recession differently. High unemployment and persistent financial uncertainty resulted in the tightening of state budgets which directly impacted many school budgets leading to reduced teaching staff and larger class sizes. Given the geographic and individual variation in both the employment effects of the recession and the speed with which workers and their communities have recovered, it is essential to examine how the recession has impacted children at multiple levels and across different contexts. Utilizing data collected from a national, longitudinal sample of kindergarten children beginning in 2010-2011, we examined how the recent recession affected children's cognitive, socioemotional, behavioral, and physical health over time within the context of their families, schools, and communities.

Results

During the past year, we continued to conduct analyses and develop measures of family socioeconomic status including changes in income, work status, number of hours worked, and marital status. In addition, we extracted data from the 2010 U.S. Census and created detailed measures characterizing neighborhood disadvantage using Principal Components Analysis. We began conducting analysis using this measure to predict student changes in academic achievement over time.

Our results suggest that parents are generally more likely to racially socialize black girls, except in predominantly low-income, racially segregated neighborhoods. In these kinds of neighborhoods, parents are more likely to socialize black boys. This work highlighted the important role these practices play in explaining differences among African-American children's educational outcomes as well as student's gender and neighborhood context. We also examined how parental practices in the home, including racial socialization, affect short and long term changes in African-American students behavior and achievement. The results from this paper were presented at the annual meeting of the National Council on Family Relations.

4. Associated Knowledge Areas

KA Code	Knowledge Area
801	Individual and Family Resource Management
802	Human Development and Family Well-Being
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
805	Community Institutions, Health, and Social Services
806	Youth Development

Outcome #21

1. Outcome Measures

Determining The Intention And Actual Use Of Diabetes-Related Apps By Diabetes Clinicians

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The objective of this work is to determine the intention and actual use of diabetes-related apps by diabetes clinicians and health care administrators, which are influenced by various individual and organizational factors depicted by technology acceptance model [TAM] and Unified Theory of Acceptance and Use of Technology [UTAUT]. Our working hypothesis is that health care personnel will have high personal app use and low professional app use, based upon preliminary data we have collected from dietitians. These results will be mediated by variables in TAM and UTAUT. We will test our working hypothesis by conducting focus groups and interviews to determine use and psychosocial and environmental influences. Both data collection methods complement each other in that focus groups can foster consensus while interview solicits individuals' opinions. Our expectations are that these results will form the basis of a real world intervention by assuring technology integration feasibility and minimizing barriers. These objectives are in line with NIFA's support of research and educational efforts that encourage Americans to make more informed food choices and become more physically active.

What has been done
Most clinicians and administrators were enthusiastic both about apps and future research. Performance expectancy, effort expectancy, and social influence were the primary constructs of

UTAUT2 that related to a future app intervention for both administrators and clinicians. The primary motivators by the administrators and clinicians to using health apps in the patient care setting were accessibility, availability, ease of use, convenience, and access to nutrition information. The primary deterrents to using health apps were the age of clients [administrators and clinicians perceive that clients older than 65 would not use health apps], cost of the apps, education about apps by both clinicians and patients, and security of the apps.

Results
While client age and app cost are issues that are unlikely to change, app education is an area that can be addressed by nutrition educators and researchers. App security is an issue that nutrition educators and researchers may encourage developers to address. This research provides important qualitative evidence that administrators and clinicians overall feel positively disposed towards using health apps and new mobile technologies and that a future feasibility study examining health app use in patients with type 2 diabetes at the Riverside Diabetes Wellness Center is appropriate and would be supported in this health care system.

4. Associated Knowledge Areas

KA Code	Knowledge Area
724	Healthy Lifestyle
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
805	Community Institutions, Health, and Social Services

Outcome #22

1. Outcome Measures

Advancing Our Understanding Of How Young People Engage In Activities To Combat Climate Change And Support Environmental Justice

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
This study will advance our understanding of how young people in local and rural communities engage in activities to combat climate change and support environmental justice. This study will also advance significant theoretical and programmatic knowledge about contemporary youth

political practices both globally and locally.

What has been done
Our work expands academic studies of youth by examining their political practices in both spaces of power [the United Nations] and at the grassroots community level. Findings and implications from this research will better inform national and international programs and policies for young people at local, national, regional, and international levels.

Results
The major impact of this project was a change in knowledge. Some major changes in knowledge include: [1] The young people invited to partake in youth empowerment projects are a select group of global elites in their twenties, who are educated, English-speaking, savvy world travelers who live and work in a country other than the one they hold citizenship, and who are knowledgeable about the international policy norms and protocols that inform UN-related meetings; [2] These efforts to include youth enact the current norm in global governance to incorporate the participation of multiple stakeholders in the agenda-setting of international policies; and [3] This research found that while these global youth initiatives may enable more equitable representation and democratic participation, they also work to normalize youth agency within the well-defined terrain of international protocols found in international politics.

4. Associated Knowledge Areas

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

Outcome #23

1. Outcome Measures

Exploring The Potential Health Benefits Of Anthocyanin Rich Foods

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Obesity and diabetes are becoming more and more prevalent in modern America. Obesity affects one in three adults in the United States, and 9.3% of the population has diabetes. Obese individuals have far more adipose tissue than a healthy individual. Adipose cells, or adipocytes, release chemical signaling factors known as adipokines. Adipokines are involved in the regulation of appetite, blood pressure, inflammatory responses, and metabolism. Antioxidant compounds such as anthocyanins can eliminate reactive oxygen species and reduce obesity, inflammation, and insulin resistance. Highly colored fruits and vegetables contain flavonoid compounds such as anthocyanins. The chemical nature of these compounds is complex. Anthocyanin rich foods clearly illustrate the potential health benefits they contain through their impact in obesity and insulin-resistance diseases.

Recent studies have shown that a blue maize extract improved blood pressure, lipid profiles, and adipose tissue in high-sucrose diet-induced metabolic syndrome in animals. It is known that purified anthocyanins might exert different biological activities due to their specific chemical structures. Therefore, it is important to characterize and test individual anthocyanins from dietary extracts to elucidate their biological potential. The combination of different anthocyanins can exert synergistic or antagonistic effects. Therefore, there is a need to understand the mechanism of action of individual anthocyanins as well as complex mixtures of anthocyanins from different foods.

What has been done

In this study, we provide a comprehensive evaluation using pure anthocyanins, and an anthocyanin-rich extract with a unique chemical profile from pericarp purple maize, under basal and inflammatory conditions related to obesity. Therefore, the aim is to compare the effect of an anthocyanin-rich extract from purple maize pericarp, and pure anthocyanins, on adipogenesis, inflammation, and insulin resistance in adipocytes on basal and inflammatory conditions. Our hypothesis is that anthocyanins from a water extract from pericarp purple maize would ameliorate the inflammatory status of treated adipocytes through different mechanisms of action involving decreased levels of reactive oxygen species, adipokine secretion, and modulation of the insulin pathway. For the first time, the protective effect of anthocyanins from purple maize pericarp on inflammation-associated events induced in adipocytes in comparison to basal conditions through mechanistic analysis will be elucidated. The knowledge gained will benefit farmers and at the end the consumer that will have available bioactive pigments that may substitute synthetic colorants. Natural pigments such as anthocyanins with known bioactivity are an alternative to synthetic colorants.

Results

This study aimed to investigate the associations between phenolic composition of selected purple maize genotypes and their anti-inflammatory, anti-adipogenic, and anti-diabetic properties in vitro. Anthocyanin-rich water extracts [PMWs] from 20 purple maize genotypes were evaluated in RAW 264.7 macrophages and 3T3-L1 adipocytes under different conditions. Cyanidin-3-O-glucoside [C3G], pelargonidin-3-O-glucoside [Pr3G], peonidin-3-O-glucoside [P3G], and corresponding acylated forms were major anthocyanins in PMW, accompanied by ten tentatively identified non-anthocyanin phenolics. Correlation studies showed that C3G, P3G and derivatives, but not Pr3G and its acylated form, contributed to the biological properties of PMW. Besides anthocyanins, quercetin, luteolin, and rutin were the dominant anti-inflammatory and anti-diabetic components in terms of down-regulating pro-inflammatory mediator production in inflamed macrophages and adipocytes, modulating diabetes-related key enzymes and improving insulin sensitivity in insulin-resistant adipocytes. Quercetin and phenolic acids, especially vanillic acid and protocatechuic acid, were closely associated with anti-adipogenic properties of PMW via inhibition of the

preadipocyte-adipocyte transition.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
724	Healthy Lifestyle

Outcome #24

1. Outcome Measures

Examining How Experienced Pathways Program Leaders Help Young People Overcome Anxiety

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Overwhelming challenges in youth program projects [arts, leadership, STEM] can create intense anxiety for adolescents that disrupts engagement in their work. This study examines how 27 experienced Pathways program leaders respond to these episodes to help youth overcome anxiety. Leaders' most frequently response was reframing - providing youth new cognitive frames to understand anxiety-eliciting situations, reduce anxiety, and restore motivation. We identified three types of reframing strategies. First, reframing youth's understanding of their abilities entailed providing youth new perspectives for enhancing their conceptions of their competencies in the work. Second, reframing youth's understanding of challenge involved suggesting new frameworks for youth to assess and control work challenges. Third, reframing emotion involved helping youth understand anxiety as normal and as a tool for problem-solving.

What has been done
In educational scholarship, bargaining with students has often been seen as inappropriate because it undercuts a teacher's authority. However, now completed analyses of interview data from fifty Pathways leaders on bargaining shows they that use it in intentional ways that contributes to youth's motivation and ownership of learning activities. Leaders of younger youth have limits on when they used bargaining, while leaders of older youth often use bargaining as a way to empower youth.

Results
During the year we analyzed data from our pilot interviews with twenty instructors. In these data we identified 18 examples of situations when youth became stressed to the point that they experienced an emotional meltdown. These were cases in which the challenges youth were dealing with were no longer just having a heavy backpack, but a debilitating spiral of emotion leading to extreme helplessness, loss of control, and breakdown in motivation. Our analyses identified how instructors successfully helped youth overcome meltdowns and learn to avoid the spiral of distress.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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 #25

1. Outcome Measures

Increased Knowledge Among School Nutrition Professionals To Improve School Lunchroom Environments

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	545

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Health and wellness are influenced by the places in which people live, learn, work and play. School food-service professionals can benefit from training that helps them understand ways to make the cafeteria environment more appealing to encourage healthy eating and reduce waste. The Illinois State Board of Education requires ongoing professional development for school food service personnel, creating the need for trusted and low-cost options for professionals to meet these standards.

What has been done

The ABC's of School Nutrition is a grant partnership with the Illinois State Board of Education, awarded in FY 2016. In 2018, Extension educators provided training and technical assistance to 1,734 school nutrition professionals through 175 on-site trainings and completed 185 Smarter Lunchrooms Assessments in schools. School nutrition staff were trained on menu planning, school wellness, offering smart snacks and beverages, nutrition, food production and serving food, federal meal pattern guidance, food safety, and communications and marketing. The program hosts an active website that features 23 mini-courses that were completed by 1,472 learners and received 77,127 page views in 2018.

Results
Online training participants are asked to complete a short [five question] feedback survey to assess their self-reported knowledge changes associated with the content of the module. Results of these online module evaluations have been collected since the grant started in FY 2016, representing 69.8% of course completers. The respondents were asked to rate their knowledge of the topics discussed both before and after the program. Using 6-part scale [1 = "Very Low", 2 = "Low", 3 = "Somewhat Low", 4 = "Somewhat High", 5 = "High", and 6= "Very High"], a total of 1,733 participants provided a before program rating and 1,651 participants provided an after program rating. Level of knowledge about the session's topic PRIOR to the program was rated as a 4 or above for 1,019 respondents whereas knowledge ratings about the session's topic AFTER the program was rated 4 or above for 1,564 respondents. This represents an increase in knowledge for 545 participants.

In addition, 65% of respondents reported that they "Agree" or "Strongly Agree" with the statement "Because of the training today, I intend to make a change directly related to what I learned". Generalized to the 1,755 participants who completed the post-training assessment, an estimated 1,140 participants intend to make a change in their school lunchrooms.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
805	Community Institutions, Health, and Social Services

Outcome #26

1. Outcome Measures

Increased Knowledge Of Consequences Of Risky Behavior On Youth Health And Wellbeing

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	559

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Recent statistics confirm what parents, teachers, and other concerned adults suspect that children and teens continue to use tobacco, alcohol, and drugs in significant numbers. According to the 2018 Illinois Youth Survey, 27% of 8th graders and 40% of 10th graders have used alcohol in the past year and 20% of 10th graders have used some form of tobacco or vaping product. Early drug education is essential for addressing risky beliefs and attitudes that research has shown to be important contributing factors to youth substance abuse.

What has been done
University of Illinois Extension 4-H Youth Development staff implemented 4-H Health Rocks!, a national healthy living program aimed at 8-16 year olds, with the goal of bringing youth, families, and communities together to reduce tobacco, alcohol, and drug use. Trained teens and staff provided ten or more hours of educational hands-on activities in school classrooms, summer youth programs, and after school programs. In addition to learning the facts about drugs and the consequences of taking them, the youth engaged in educational activities that encompassed building life skills such as showing concern for others, making healthy lifestyle choices, managing stress, and developing refusal skills. A total of 2,041 youth participants completed the full 10 hours of required training.

Results
Six hundred and seventy-six [676] participants completed a retrospective post-pre evaluation of the program. Respondents rated their agreement with statements about beliefs about drugs and their own life skills. A total of 87% [559 out of 676 respondents] reported a favorable change in one or more drug or life skills related beliefs. On average, six of the thirteen beliefs addressed in the program changed for participants in a favorable direction. In addition to these impacts on health-positive beliefs, satisfaction ratings were extremely high as 96% agreed that "the program was interesting" and 97% agreed that they "learned a lot." Health Rocks! was successful in changing beliefs and attitudes that are research-based contributing factors to substance abuse among youth.

4. Associated Knowledge Areas

KA Code	Knowledge Area
724	Healthy Lifestyle
806	Youth Development

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Competing Public priorities
- Competing Programmatic Challenges

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Brain Health Series

University of Illinois Extension Family Life Educators implemented 117 workshops in 2018 to empower adults to take actions that maximize brain health and memory. In 2018, 2,506 participants attended at least one of the research-based brain health workshops including **FIT WITS**, **Hold that Thought**, **Wits Fitness**, **Two Heads are Better than One**, and **Head Strong**. At the end of the program, participants were asked to complete a one-page evaluation that asked them to report their knowledge, attitudes, and self-efficacy to take actions that intentionally address memory and cognitive function. In addition, open-ended questions sought examples of actions participants intended to take, the most important thing they learned, and what additional topics or emphasis on topics they would be interested to learn more about. Evaluations were completed by a sample of 245 participants across the workshops offered.

Using a five-part scale [with 1 = "Very Low", 2 = "Low", 3 = "Average", 4 = "High", and 5 = "Very High"], participants were asked to rate their knowledge before and after their experience at the workshop[s] they attended.

Knowledge Gain

N=197 of 239 [82%] Improved knowledge or awareness about how lifestyle choices can contribute to brain health and function.

N=177 of 199 [89%] Improved knowledge about a variety of strategies and activities that help give the brain a workout or awareness about memory strategies and techniques.

N= 214 of 245 [87%] Improved knowledge in one or both of the workshop topics.

Change in Efficacy and Intention to Implement Recommended Techniques

N=48 of 62 [79%] Improved ability to choose and use intellectual challenges/lifestyle choices/self-identified techniques that contribute to brain health.

When participants were asked to "List one action you intend to take as a result of this

program", 174 [70%] of the 245 respondents listed at least one action. This participant feedback suggests that the series successfully addressed ways to alleviate concerns about aging and maintaining one's quality of life.

Expanded Food and Nutrition Education Program

The Expanded Food and Nutrition Education Program [EFNEP] collects data on all adults who participate in the program. Demographic characteristics, food, and physical activity questionnaires and 24-hour dietary recalls are administered at entry and at exit to measure behavior change. In 2018, 3,295 adult participants completed assessments.

Adult Impact

- 93% of adult participants improved nutrition practices
- 73% of adult participants improved physical activity behaviors
- 77% of adult participants improved food resource management
- 78% of adult participants improved food safety practices

Overall Youth Impact

- 83% of youth improved knowledge and ability to choose healthier foods
- 48% of youth improved physical activity knowledge or practices
- 48% of youth improved food safety knowledge or practices
- 54% of youth improved knowledge or ability to prepare simple, nutritious, affordable food

Illinois Jr. Chefs Curriculum

Illinois Jr. Chefs is a curriculum targeting 8-13 year olds through a hands-on culinary and nutrition education program. The goals are to increase preference for healthy foods, cooking confidence and skills, and cooking behaviors. A total of 4,789 students participated in Illinois Jr. Chefs programming at 197 different sites. Over the course of the year, 1,458 sessions were offered. Each group received an Illinois Jr. lesson an average of 4.8 times. A sample of youth [n=563] participating in the Illinois Jr. Chefs program completed a pre- and post-assessment that asked about changes in children's cooking self-efficacy, cooking attitudes, fruit and vegetable preferences, self-efficacy for eating healthy foods, and healthy eating and cooking behaviors.

There was a significant difference between pre-intervention scores [M = 3.40, SD = .48] and post-intervention scores [M = 3.72, SD = .35] for Cooking Self-Efficacy [t [563] = 21.77, p < .001], pre- [M = 3.27, SD = .49] and post-intervention scores [M = 3.35, SD = .52] for Fruit and Vegetable Preferences [t [563] = 14.77, p < .001], pre- [M = 3.69, SD = .38] and post-intervention scores [M = 3.79, SD = .37] for Cooking Attitudes [t [563] = 34.09, p < .001], and pre- [M = 2.34, SD = .81] and post-intervention scores [M = 2.45, SD = .85] for Cooking Behaviors [t [563] = 15.10, p < .001].

Overall, the majority of children improved their cooking self-efficacy [77%], cooking attitudes [82%], fruit and vegetables preferences [74%], self-efficacy for eating healthy foods [77%], and their healthy eating and cooking behaviors [70%]. A hands-on cooking assessment showed that 94% of children who participated in Illinois Jr. Chefs improved their

cooking skills after participating in the program. Results indicate that a short, five-lesson cooking program shows significant, positive changes in youth cooking behaviors, food preferences, and skills and confidence related to cooking.

4-H Health Rocks!

4-H Health Rocks! is a national healthy living program aimed at 8-16 year olds with the goal of bringing youth, families, and communities together to reduce tobacco, alcohol, and drug use. In addition to learning the facts about drugs and the consequences of use, the educational activities encompassed building life skills such as showing concern for others, making healthy lifestyle choices, managing stress, and developing refusal skills.

Over 80% of participants were in the 9 to 13 year old age range, 17% identified as Hispanic/Latino ethnicity, and 75% identified as a minority race. The majority [63%] were living in an urban or suburban setting. Six hundred seventy-six [676] of the 2,041 youth participants in **4-H Health Rocks!** completed a retrospective pre-post evaluation tool. The program evaluation survey included statements about risky drug use beliefs and positive life skills, where respondents rated their agreement with each statement on a scale from 1 to 4 [with 1 = "Strongly Disagree" and 4 = "Strongly Agree"]. The youth were instructed to provide a rating that reflected their agreement with the statements after the program and then provide a rating of their agreement with the statements before the program. The ratings for each statement were compared within subject to calculate a change score. The change scores were then analyzed to determine the proportion of respondents that favorably changed from before to after the program. In addition, the number of favorable changes were summarized to determine how many beliefs and attitudes changed.

A total of 87% [559 out of 676 respondents] reported a favorable change in one or more drug or life skills related beliefs. On average, 6 of the 13 beliefs addressed in the program changed in a favorable direction.

In response to the final set of four questions regarding program satisfaction and experience, 96% felt "the program was interesting", 98% agreed that the "staff members were friendly", and 97% agreed that "they learned a lot".

Key Items of Evaluation

Brain Health Series

In 2018, 2,506 participants attended one of the 117 research-based brain health workshops offered throughout Illinois. Improvements were observed from pre-program to post-program for all measures of knowledge and awareness. Participant feedback suggests that the series successfully addressed ways to improve awareness and knowledge of how memory can be maximized to maintain quality of life throughout the aging process.

Expanded Food and Nutrition Education Program

Nutrition education programs in Illinois, serving 11,369 limited resource family members, documented that 93% of adults improved their nutrition practices and 83% of youth improved their knowledge and ability to choose healthier foods.

4-H Health Rocks!

As a result of participation in a ten-hour health education program, 87% [559] of youth increased agreement with at least one of the evaluation statements regarding drug facts, consequences of use, and building life skills such as showing concern for others, making healthy life styles choices, managing stress, and developing refusal skills. On average, youth ratings improved for six out of the thirteen statements. Feedback from participants was very positive and youth participants were highly satisfied with the program activities and staff. **Health Rocks!** was successful at changing beliefs and attitudes that are contributing factors to drug use among youth.

V(A). Planned Program (Summary)

Program # 7

1. Name of the Planned Program

Natural Resources And The 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
102	Soil, Plant, Water, Nutrient Relationships	20%		10%	
111	Conservation and Efficient Use of Water	0%		5%	
112	Watershed Protection and Management	20%		10%	
123	Management and Sustainability of Forest Resources	5%		10%	
132	Weather and Climate	10%		10%	
133	Pollution Prevention and Mitigation	20%		10%	
134	Outdoor Recreation	0%		10%	
135	Aquatic and Terrestrial Wildlife	0%		10%	
211	Insects, Mites, and Other Arthropods Affecting Plants	15%		5%	
405	Drainage and Irrigation Systems and Facilities	0%		10%	
605	Natural Resource and Environmental Economics	0%		10%	
806	Youth Development	10%		0%	
	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	0.0	0.0	7.0	0.0
Actual Paid	15.3	0.0	29.2	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
726629	0	855828	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
726629	0	855828	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
2959084	0	4963101	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Activities in FFY 2018 included a project that studied the implications of climate change for agricultural policies and projects with a focus on regions affected by civil conflict [civil conflict has been identified as one of the main obstacles to economic growth and poverty reduction and it has well documented negative effects on many indicators of human well-being and development including nutrition, health, and education], a study attempting to quantify the changes in streamflow, sediment load, nutrient concentration, and fish population in the Fort Cobb Reservoir Experimental Watershed due to changes in climate, land use, and different land management activities [the results of this study will help facilitate timely implementation of focused adaptation and mitigation practices or policies for sustainable agro-ecosystems], a project that seeks to generate tools, datasets, and guidelines for use by managers to detect, predict, and mitigate the individual and interactive ecological effects of climate change, land use practices, stakeholder use, and invasive species on fish communities and aquatic ecosystems, and efforts to identify the factors that push restorations along ideal trajectories toward target states or constrain restorations, instead, to trajectories leading toward novel or undesired states [upon completion of this project, it is our expectation that we will make specific management recommendations for avoiding undesirable wetland restoration outcomes].

Activities also included a recent study looking at the history of the Missouri River, damages and changes from the 2011 flood, and its current post-flood condition, an effort to better understand the influence of environmental conditions and time since invasion on forest ecosystem structure and function, a study with the goal of assessing media performance in the reporting of crop genetic engineering and the use of antibiotics in animals and to test journalistic techniques practicing reporters can adopt to help counter assaults on the best scientific evidence about these two contentious agricultural issues, measurement of how psychological, institutional, and ecological conditions shape human behavior to determine the pivotal role of anglers in the spread of aquatic invasive species across Great Lakes ecosystems [this study will also advance theoretical understanding of human behavior by helping to close the knowledge-action gap that plagues efforts to reduce human contributions to the spread of invasive species in freshwater environments], research with the goal of determining the effects of contrasting management practices involving rotation [continuous corn vs. continuous soybean vs. corn-soybean], tillage [chisel tilled vs. no-tilled], cover cropping [cover crop vs. bare fallows], and residue removal [full removal vs. no removal] on soil biological properties of ongoing long term experiments in Illinois, and an effort to document the relationship between forests and on-farm trees and socio-economic well-being and increase understanding of the effectiveness of different types of forestry and agroforestry interventions in enhancing such well-being over the long term.

Activities also included work that will contribute to gaining a better understanding of plant-soil relations as influenced by farming management practices [gained knowledge will ultimately contribute to improved efficiency, productivity, and quality of grain produced to satisfy needs of local food markets], efforts to improve our understanding of how the use of habitats change over time and why species use different habitats to improve conservation strategies, a project that seeks to build our knowledge of the factors that govern the formation of methylmercury - the most toxic form of Hg - in agricultural watersheds so that efforts aimed at mitigating other water quality problems, such as excess nutrients, will not inadvertently worsen the problem of Hg pollution, and ongoing support of the **Program in Ecology, Evolution and Conservation Biology** [many of the students in PEEC conduct research on the conservation of natural resources in the agricultural and urban landscapes of Illinois and the Midwest and PEEC also serves to unite faculty around common objectives and provide true interdisciplinary training that spans a wide range of specific talents and backgrounds].

Conference presentations in 2018 included the Southeast Biodiversity Conservation Forum, Turtle Survival Alliance Annual Symposium, Society for Freshwater Science, American Society of Agricultural and Biological Engineers, National Great Rivers Research and Education Center Symposium, International Symposium on Society and Resource Management, Kaskaskia River Watershed Summit, 55th Annual Conference of the Animal Behavior Society, Illinois Symposium for Reproductive Sciences, 78th Annual Midwest Fish and Wildlife Conference, Ecological Society of America, Soil Health Institute, International Symposium for Society and Natural Resources, Illinois Chapter of the American Fisheries Society, Lower Lake Committees Meeting for the Great Lakes Fishery Commission, Argentinian Congress of Environmental and Agricultural Microbiology, Agronomy Society of America-Crop Science Society of America, Green Lands, Blue Waters Conference, Forests and Livelihoods: Assessment, Research, and Engagement [FLARE] Network Conference, International Conference on Global Food Security, 6th Annual Agroforestry Academy, Bloomberg Data for Good Exchange Conference, International Mycological Congress, 17th International Behavioral Ecology Congress, Midwest Ecology and Evolution Conference, Computation Genomics for Reproductive Health, and the Illinois Farm Bureau.

The **Illinois Master Naturalist [ILMN]** program serves as an important Extension outreach and engagement activity around natural resources and the environment. In 2018, 887 Illinois Master Naturalists were actively engaged in a wide variety of projects as environmental stewards and educators; 122 of these volunteers were new to the program. These Master Naturalists invested 83,574 volunteer hours to educational program delivery and natural resource stewardship activities. Based on the value of a volunteer hour of $26.02 from the Independent Sector, Master Naturalists' volunteer service reflects an estimated value of more than $2 million in 2018.

Hands-on activities were offered through **Youth Conservation Days** held in many locations throughout the state that included outreach through classrooms, summer education programs, and special events. The **I Think Green** curriculum was implemented with 2,059 youth to investigate how living things interact with each other and with their environment [see evaluation section for additional details]. **Monarchs on the Move** engaged an additional 1,350 youth to increase knowledge about the impact of the declining butterfly population as an important pollinator. In order to independently explore their own environmental interests, more than 62,000 4-H enrollments were in projects related to natural resources and the environment.

Local Extension units promoted environmental awareness through celebration of an annual **Stewardship Week** and several units offered programs to recognize **Earth Day**. A partnership of Forest Preserves of Cook County and Extension, **Conservation@Home Cook County** recognizes and certifies properties that demonstrate environmentally sound landscape practices. Springboarding off the success of the **Conservation@Home** program, Cook County Extension educators piloted **Conservation@School**, a similar program to certify that a school meets the criteria for employing sustainable landscaping practices.

The **Illinois-Indiana Sea Grant** program staff maintained focus on expanding medicine collection programs to keep pharmaceutical and personal care product disposal from impacting water quality. The number of permanent collection programs has reached a total of 52.

The **Gateway Green Industry Conference** drew 474 participants in southern Illinois this year. Participants working in settings related to lawn care, landscaping, nurseries, garden centers, golf courses, and other grounds-related industries learned new ideas and research-based information about diverse topics such as shade perennial, native trees, and pollinators. Distance delivery learning opportunities included the **2018 Soil and Water Management Seminar** which provided university research-based information on issues related to soil erosion, nutrient transport, cover crop selection, soil microbes, and soil health tests.

The Extension forestry team conducted 15 forestry-related field days, 35 forestry-related training sessions, and 32 forest landowner on-site visits in addition to employing social media to release information to followers.

At the nexus of agricultural production and environmental protection, Extension educators and water quality specialists delivered educational sessions as part of conferences and free-standing workshops to advance knowledge around the best management practices to mitigate nitrogen runoff in support of **Illinois' Nitrogen Loss Reduction Strategy**. Practices such as cover crops were covered in educational programs and online resources such as podcasts, posted on the Illinois Nutrient Loss Reduction Podcast website [https://will.illinois.edu/agriculture/note/illinois-nutrient-loss-reduction-podcast].

2. Brief description of the target audience

Members of the target audience included the Alabama Natural Heritage Program, U.S. Fish and Wildlife Service, California Department of Fish and Wildlife, Idaho Department of Fish and Game, Illinois Department of Natural Resources, non-profits such as the Nature Conservancy, Corn Belt soybean and corn producers, commercial entomology and crop protection/pest management professionals, Extension personnel, agricultural biotechnology company representatives, college students in agricultural sciences, Illinois homeowners, United States Army Corps of Engineers [Carlyle Lake and Lake Shelbyville], Illinois Farm Bureau, Heartlands Conservancy, Montgomery County Soil and Water Conservation District, Kaskaskia Watershed Association, ecologists, land managers, restoration practitioners, government agency personnel involved in planning, implementing, and regulating wetland restoration programs, journalists and reporters who cover the science and food beats, communication officers of agribusiness enterprises, stakeholders in the Great Lakes basin [particularly anglers, scientists, and fishery managers], farmers that are already established or are interested in pursuing organic certification, plant breeders, professional scientists conducting research into bioaccumulation of toxic trace elements in aquatic food webs, and natural resource managers managing aquatic ecosystems.

Extension activities targeted pesticide applicators, forest landowners, crop producers, public officials, representatives from land management agencies, residents interested in natural resource stewardship, homeowners, youth, and Extension Master Gardener and Master Naturalist volunteers.

3. How was eXtension used?

Four members of the Agriculture and Natural Resources program area are members of one or more Communities of Practice in eXtension.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	4631	1326545	56035	7080776

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

Patent Applications Submitted

Year: 2018

Actual: 1

Patents listed

[2017-197-01 [PRO]] - A System And Method To Fuse Multiple Sources Of Optimal Data To Generate A High-Resolution Frequent Cloud/Gap Free Surface Reflectance Product.

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	64	64

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number Of Completed Hatch Projects

Year	Actual
2018	3

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number Of Individuals That Increased Knowledge Of Human Actions That Negatively Affect The Environment
2	Dissemination Of Air Quality And Atmospheric Data Through Web Hits On The National Atmospheric Deposition Program Website
3	Improved Development Of Conservation Strategies Through An Improved Understanding Of How The Presence Of Social Cues Affects The Occupancy And Density Of Grassland Birds
4	Estimating The Value Of Natural Resources And Environmental Amenities To Guide Resource Management Decisions
5	Number Of Pesticide Applicators Making A Decision To Avoid Harming The Environment
6	Actions Taken By Program Participants To Protect The Environment [Water Quality, Air Quality, Soil Loss, Wildlife, Natural Vegetation]
7	The Design And Evaluation Of Resource Management Policies That Are Cost-Effective And Maintain Or Improve Environmental Conditions
8	Exploring The Mechanisms Through Which Climate Change Affects Agriculture
9	Evaluating Habitat Quality Restoration And Success
10	Monitoring Seasonal And Year-To-Year Patterns Of Pest Abundance
11	Definining The Impact Of Food Deprivation On The Behavior Of Fishes
12	Developing A Comprehensive Plan To Address Flooding Impacts Of The Missouri River
13	Developing Interpretive Frameworks For Soil Quality Indicators
14	The Development Of Nano-Fertilizers To Improve Agricultural Production

Outcome #1

1. Outcome Measures

Number Of Individuals That Increased Knowledge Of Human Actions That Negatively Affect The Environment

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	387

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Increasing concern over degradation of the environment addresses a critical issue related to sustaining life for future generations.

What has been done
The I Think Green curriculum was developed by 4-H and horticulture Extension specialists to engage elementary-age youth in investigating how living things interact with each other and with their environment. This program included four tracks in 2018: [1] Worms; [2] Butterflies; [3] Insects; and [4] Birds. All four tracks follow a sequence of four 40-60 minute investigations in which youth practice observation skills, conduct hands-on investigations with living things, explore different life cycles, identify how living things function, adapt, and change, and compare how living things interact with each other and with their environment. The objectives of the program include: [1] to develop youth skills in scientific observation; [2] to increase youth knowledge of concepts that explain how living things function, adapt, change, and interact within the environment; and [3] to increase youth knowledge of things they can personally do to help protect the environment. The program was delivered by 4-H and Master Gardener trained volunteers and involved 2,059 youth this past year.

Results
Of the 2,059 youth who attended one or more of the I Think Green program tracks, 464 completed an end of program evaluation. The ten question evaluation tool included statements about the environment and about the program and asked respondents to mark "yes", "no", or "not sure" to signify their agreement with each statement. Across all tracks, 464 respondents [85%] agreed with the statement "I am more excited about helping to care for the environment", 385 respondents [83%] agreed with the statement "I would like to get involved in food composting, recycling, or other activities to help take care of the environment in my community", and 387 respondents [83%] agreed with the statement "I have more ideas about ways that I can help care

about the environment" as a result of participating in I Think Green.

4. Associated Knowledge Areas

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

Outcome #2

1. Outcome Measures

Dissemination Of Air Quality And Atmospheric Data Through Web Hits On The National Atmospheric Deposition Program Website

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Improved Development Of Conservation Strategies Through An Improved Understanding Of How The Presence Of Social Cues Affects The Occupancy And Density Of Grassland Birds

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Estimating The Value Of Natural Resources And Environmental Amenities To Guide Resource Management Decisions

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The focus has been on collating and mapping the evidence on the socio-economic contribution of forests and trees on farms [agroforestry]. The major impact of this work is that we now have comprehensive maps of relevant evidence on the impacts of forest conservation and management on poverty and broader prosperity as well as the impacts of agroforestry on human well-being, agricultural productivity, and ecosystem services. Based on the maps we have prepared, researchers, policymakers, and practitioners will have at their fingertips all the evidence on these relationships that is currently available, which they can use to inform future investments, research, and actions. Our maps save an enormous amount of time for those interested in these topics by presenting the evidence in one easy-to-access place [www.natureandpeopleevidence.org].

What has been done
We identified 242 articles for inclusion in the systematic map. The evidence base on forest-based productive activities and poverty alleviation is increasingly rapidly, but displays a number of biases in the distribution of articles on key linkages. For example, few studies looked at poverty-specific linkages in wealthier countries like the United States. The majority of the evidence base [72%] examined links between productivity-enhancement strategies [e.g. forest management] and monetary income and/or social capital outcomes. Non-monetary aspects of poverty have been largely overlooked in the literature.

Results
For the evidence base on agroforestry, we have completed the evidence map for developing countries with 394 studies included. Research in this area has grown steadily, from less than ten relevant studies in 2000 to nearly fifty in 2016. There are hundreds of observational studies on agroforestry practices, but the evidence base on the impacts of agroforestry interventions on farmers' land remains very thin. We know quite a bit about the effect of specific practices farmers may undertake [such as intercropping and silvopastoralism], but very little about the impacts of specific interventions [such as provision of seedlings and technical support] to promote such practices. Finally, we also found that the human well-being outcome most commonly studied related to income and household expenditure.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
134	Outdoor Recreation
605	Natural Resource and Environmental Economics

Outcome #5

1. Outcome Measures

Number Of Pesticide Applicators Making A Decision To Avoid Harming The Environment

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Actions Taken By Program Participants To Protect The Environment [Water Quality, Air Quality, Soil Loss, Wildlife, Natural Vegetation]

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	22370

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
How we choose to use and dispose of pharmaceuticals and personal care products impacts the quality of the water we drink, bathe in, and use for recreation. Most of us do not use all of the medications that we buy. Using the toilet or trash to dispose of medicine can put people, animals, and the environment at risk.

What has been done
With grant funding from University of Illinois Extension, the Illinois-Indiana Sea Grant program provided technical assistance this year to one additional Illinois community on how to start a permanent medicine collection "take-back" program and purchased the collection boxes.

Results
This brings the number of permanent collection programs assisted by Illinois-Indiana Sea Grant to a total of 52. Altogether this year, these programs collected and properly disposed of 22,370 pounds of unwanted medication, protecting water quality, wildlife, and human health. Additionally, since the inception of the program in 2008, over 200,000 pounds of unwanted medicine [translating into over 100 tons of incinerated medicines] have been diverted from our water supply.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources

133	Pollution Prevention and Mitigation
806	Youth Development

Outcome #7

1. Outcome Measures

The Design And Evaluation Of Resource Management Policies That Are Cost-Effective And Maintain Or Improve Environmental Conditions

Not Reporting on this Outcome Measure

Outcome #8

1. Outcome Measures

Exploring The Mechanisms Through Which Climate Change Affects Agriculture

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
This project will study the implications of climate change for agricultural policies and projects, with a focus on regions affected by civil conflict. Civil conflict has been identified as one of the main obstacles to economic growth and poverty reduction. It has well documented negative effects on many indicators of human well-being and development, including nutrition, health, and education. Perhaps as a result of these negative effects, fragile and conflict-affected countries have made much slower progress toward eradicating poverty than peaceful and stable developing countries. Not a single fragile or conflict-affected country has achieved the Millennium Development Goals.

What has been done
Many of the world's poorest people live in the rural regions of conflict-affected countries. These people are often trapped in a vicious cycle in which poverty leads to violent conflict, which leads to insufficient investment in agriculture, which in turn leads to poverty. Climate change poses challenges for agriculture as well as for conflict resolution and therefore has the potential to severely exacerbate this vicious cycle. This project will explore the mechanisms through which climate change affects agriculture and civil conflict. Understanding these mechanisms is important

for the design of adaptive policies that can limit the detrimental effect of climate change on agriculture and conflict.

Results
The project has generated evidence that changes in the seasonal pattern of precipitation [a move towards wetter wet seasons and drier dry seasons] is harmful for agriculture and exacerbates civil conflict in the Philippines. Our analysis shows that this effect cannot be explained by psychological or infrastructure-related mechanisms, which suggests that agriculture is an important mechanism that mediates the effect of climate change on civil conflict. The results of this study were published in a leading journal in environmental economics during the reporting period.

In addition, we have generated new evidence that an increase in the value of export crops - such as bananas and sugar - can lead to an increase in conflict violence and territorial control by non-government armed groups. This suggests that a move towards export-oriented agriculture can have unintended adverse effects for fragile and conflict-affected states. The results of this study were written up as an academic article and submitted to a leading journal in economics, where it received a request to revise and resubmit. We are currently working on the revisions.

Finally, we began work on a project that studies whether irrigation dam infrastructure can mitigate the link between precipitation, agricultural production, and civil conflict. We collected evidence for such a mitigating effect in a case study in Indonesia. We are currently in the process of writing up the results of this study as an academic article.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
132	Weather and Climate
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

Outcome #9

1. Outcome Measures

Evaluating Habitat Quality Restoration And Success

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Mitigation and biodiversity offset programs have been established worldwide to balance development and conservation goals. These policies, including wetland mitigation in the U.S., require restoration as compensation for the destruction of critical ecosystems or endangered species habitat, but their effectiveness relies on predictably successful restoration. If restoration trajectories converge on one or a few ecosystem states with similar structure and function, then the replacement of diverse natural ecosystems with homogenized restorations could result in the loss of specialized species and functions at regional and watershed scales. In addition to mitigation polices, many U.S. state and federal programs provide funds to support voluntary restoration efforts on agricultural land [such as the Conservation Reserve Program, Wetlands Reserve Program, and Illinois Acres for Wildlife], providing valuable ecosystem services to rural landowners including timber production, floodwater management, water quality improvement, and hunting opportunities.

The goal of most ecological restoration programs is to restore a particular community or ecosystem type or enhance biodiversity and ecosystem services. There exists, therefore, a critical need to identify the factors that push restorations along ideal trajectories toward target states or constrain restorations, instead, to trajectories leading toward novel or undesired states. Upon completion of this project, it is our expectation that we will make specific management recommendations, based on our research, for avoiding undesirable wetland restoration outcomes.

What has been done
Due to the small sample size for restored wetlands, we have decided to address the goal of investigating convergence and divergence among wetlands using a much larger [n = 59] 15-year data set of naturally occurring wetlands in Illinois. Long-term plant community trajectories were analyzed using ordination techniques and Monte Carlo permutation methods. Results indicate that the plant communities of herbaceous emergent wetlands have significantly converged due to the increased presence and abundance of Phalaris arundinacea and the decline of several other species. The canopy layer of floodplain forests has also homogenized as Celtis occidentalis has increased in importance.

Results
We used multiyear tree census and hydrologic data from 19 compensatory mitigation wetlands that were restored by the Illinois Department of Transportation to relate planted and volunteer tree establishment to flood frequency, depth, and duration. Annual survival of planted trees decreased with greater annual maximum flood depth and duration. By the end of official compliance monitoring, sites with greater flood exposure had greater planted tree mortality. Across all sites, compliance with tree survival standards was poor, but influenced by hydrologic conditions. We conclude that current compensatory mitigation performance standards for tree survival may be unrealistic in restored wetlands that are exposed to long-duration floods. A manuscript based on this research was submitted to Wetlands in 2018.

During summer 2014 and 2015, we established standardized permanent plots in 38 restored wetlands in Illinois. In restored forested wetlands, vascular plants were sampled within 30 0.25 square meter quadrants distributed along three 50 meter transects. Additionally, a 0.1-ha plot surrounding one transect was surveyed for additional species. In restored herbaceous wetlands, vascular plants were sampled in 20 0.25 square meter plots located along a single transect, and a larger 0.2-ha plot was searched for additional species. In addition, along with a collaborator at the Illinois Natural History Survey, we compiled previously collected vegetation data from 146 natural reference wetlands surveyed as part of the INHS Critical Trends Assessment Program. The set of reference wetlands includes both forested and herbaceous wetlands that were randomly selected throughout Illinois and surveyed by INHS botanists between 1998 and 2013. Pairwise occurrence- and abundance-based dissimilarity metrics were calculated for the 146 natural wetlands and 38 compensation wetlands to investigate whether compensation wetlands were more homogenous than natural wetlands. Contrary to our expectations, results indicated that compensation wetlands were not more homogenous than natural wetlands.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
132	Weather and Climate
133	Pollution Prevention and Mitigation
134	Outdoor Recreation
135	Aquatic and Terrestrial Wildlife
405	Drainage and Irrigation Systems and Facilities
605	Natural Resource and Environmental Economics

Outcome #10

1. Outcome Measures

Monitoring Seasonal And Year-To-Year Patterns Of Pest Abundance

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual

2018 0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Monitoring seasonal and year-to-year patterns of pest abundance provides valuable records of pest occurrence. Regular insect collections from soybean and adjacent crop fields [primarily cornfields] not only provide material to monitor established pest abundance and ecology, but can also be used to detect the local arrival of invasive species and to document significant changes in secondary pest abundance. Expanding pest monitoring to sample insects flying at high elevations provides added context to the interpretation of canopy level insect abundance data. Insect flight high above the plant canopy may indicate when pest species are leaving the canopy to engage in short and/or long distance movement or migration. Empirical data on local or migratory flight by pests are lacking for most species.

Systematic sampling for flying insects provides data useful to understanding when [or whether] a species engages in migration and how weather conditions, crop phenology and changes in farming practices influence these movements [such as increasing the use of insecticide-fungicide mixes for midseason pest control in row crops]. Documenting how canopy abundance and potential dispersal/migration events are related in time will yield data that are lacking for all but a few key species. This work builds on an existing record of pest abundance [primarily beetle abundance] in soybean and cornfields going back to 1998. It is through the lens of history that we are able to interpret, understand, and ideally anticipate how pest abundance today may impact tomorrow's economic bottom line. Monitoring pests is a fundamental pillar of integrated pest management for all pests.

What has been done

During the project 2013-2018, soybean pest abundance monitoring was the primary focus. Annual sweep net sampling generated patterns of soybean insect abundance that contribute to a 21-year long-term dataset. The most significant soybean insect in this monitoring is the rotation-resistant western corn rootworm [WCR], a pest that lays eggs in soybeans fields to circumvent annual crop rotation as a WCR management tactic. Documenting changing WCR abundance relative to weather, adoption of various rootworm Bt corn hybrids, and WCR resistance to Bt provided the agricultural community with a long-term perspective on pest rootworms.

Results

Parallel collections of soybean pests allowed abundance patterns of those "other" insects to be recorded with similar perspective. The value of documenting pest abundance at one location over many years is to establish a contextual record against which management successes/failures can be viewed. Documenting pest abundance changes and communicating those patterns have been the main accomplishment of this work. Helping to justify management recommendations was one role of these data; however, highly risk adverse producers seem to adopt a high-input, "insurance-based approach" and protect their acres to the fullest, despite an absence of economic pest populations.

The monitoring site has facilitated other projects, including collaboration with an OSU graduate student, to sample ladybird beetles for genetic diversity comparisons and by Integrated Pest Management classes to sample insects for student collections. It has also been a collection site for WCR populations analyzed to discern differential gene expression patterns among rotation susceptible and resistant WCR populations.

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants

Outcome #11

1. Outcome Measures

Definining The Impact Of Food Deprivation On The Behavior Of Fishes

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Stressors such as invasive species, climate change, and land use change can all influence food availability for fishes. Thus, the goal of this study was to define the impact of food deprivation on the behavior of fishes, and how that could translate to stakeholder interactions through angling.

What has been done
To accomplish this goal, largemouth bass were assayed in a laboratory to determine behavioral phenotype [essentially a bold-shy continuum as well as an exploratory-stationary continuum]. Fish were then stocked into one of two ponds, with one pond having an ample food supply, and the other having no food [resulting in fasting/food deprivation]. Fish were then subject to traditional angling practices to quantify how food levels impacted catch and if behavioral types responded differently to food/angling stressors.

Results
Results showed that behavioral phenotypes were equally likely to be captured across both pond treatments, but reductions in food availability resulted in higher angler catch [regardless of behavioral type]. This study generated a number of new findings related to how food related stressors impact the behavior of fishes, and how changes in behavior can translate to interactions with fisheries resources. These findings also resulted in a change in actions for aquatic managers as, should food resources become depleted [such as through climate change or invasive species], fish may be more susceptible to harvest. Managers can therefore either manipulate harvest or prey availability to ensure successful management. Together, data from this experiment will result in a number of changes to condition that include a maintenance of quality of

life through sustained fisheries populations.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
134	Outdoor Recreation
135	Aquatic and Terrestrial Wildlife
605	Natural Resource and Environmental Economics

Outcome #12

1. Outcome Measures

Developing A Comprehensive Plan To Address Flooding Impacts Of The Missouri River

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
As the Missouri River flows across the Great Plains to where it meets the Mississippi River at St. Louis, it accumulates such a large sediment load that it has earned the nickname "Big Muddy". A recent University of Illinois study looked at the history of the river, damages and changes from the 2011 flood, and its current post-flood condition. Flooding, particularly near infrastructures, residences, and cropland can be extremely destructive. We observed the damaging effects to the river and surrounding landscape from the 2011 flood - erosion and sedimentation. We studied the seasonal Mississippi River and tributary flooding for over a decade and observed much of the damage firsthand. The study concludes that the river needs a comprehensive plan with multi-state cooperation.

What has been done
The Missouri River and its tributaries are dynamic and continually changing, moving coarse stones, gravels, sands, and silts. Its power caves in streambanks and erodes river islands, and redeposits them further downstream. When the river overflows its banks, it carries the soils from the floodplain and eroded upland agricultural soils down-stream creating sand dunes, mud flats,

and deltas. Human activity was a contributing factor to the changes in the river. Dams on Missouri River tributaries have changed rural livelihoods and the economics of the basin by reducing downstream flooding, generating hydro-electric power, and irrigating agricultural crops. These river structures and levees have increased the stream velocity that keeps sediments suspended but also during flooding increase peak flows in downstream areas. Balancing economic and environmental aspects of the river is a challenge continuing into the future.

Results
Six dams, built in the 1940's and 1960's on the main stem of the Missouri River, couldn't control flooding in 2011. There is a need for the Mississippi River Commission and the U.S. Army Corps of Engineers to develop a Missouri River and upper Mississippi River plan similar to their lower Mississippi River and tributary plan to address both the upper Mississippi and Missouri river flooding and navigation issues. Such a plan is possible if the northern states adjacent to the Missouri and Mississippi rivers are willing to contribute and participate in the development of the management plan. This plan is essential to address the current waterway infrastructure restoration issues.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
132	Weather and Climate
133	Pollution Prevention and Mitigation
134	Outdoor Recreation
135	Aquatic and Terrestrial Wildlife
405	Drainage and Irrigation Systems and Facilities

Outcome #13

1. Outcome Measures

Developing Interpretive Frameworks For Soil Quality Indicators

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Efforts to develop interpretive frameworks for soil quality indicators [SQIs] tied to soil's biological activity have been a longstanding priority for soil health efforts. We summarize peer reviewed literature reporting results for three 'Tier 2' indicators [beta-glucosidase [BG], fluorescein diacetate [FDA] hydrolysis, and permanganate oxidizable carbon [POXC]] to contribute to the development of useful scoring functions for the Soil Management Assessment Framework [SMAF] or other interpretive algorithms. While all three SQIs are measures of biologically active carbon that are known to respond to management, they differ in their rates of change, the degree to which methods are standardized, and the level of agreement about their functional relevance. Results published between 1990 and 2017 reporting indicator response to use of soil health promoting practices were tabulated using a format to support ongoing development of mathematical functions relating results to influential factors and outcomes.

What has been done
Records from studies reporting relationships between SQIs and crop productivity or greenhouse gas [GHG] emissions were compiled to explore potential for specific scoring function development. The BG indicator is the best developed in terms of shared understanding of its link to soil organic matter [SOM] decomposition, established analytical methods, and the existence of a SMAF curve. Soil FDA, which is the most dynamic of the three SQIs considered, is the least developed and has the greatest variability in analysis methods. It is also the most complex, with known ties to SOM decomposition, nutrient cycling, and disease suppression and so may provide the most unique information. The POXC indicator, which is defined by an analytical method and produced the most records, is associated with changes in SOM stocks but it is the least dynamic indicator and thus most duplicative of total SOM. The abundance of all SQIs considered was increased by use of soil health promoting practices in more than 80% of the cases and changes in abundance were statistically significant [$p < 0.1$] in the majority [BG: 63.6%, FDA: 69.7%, and POXC: 63.8%] of the comparisons. Both POXC and FDA were generally more responsive to use of conservation or no-tillage or grass cover than the use of practices increasing organic matter return [cover crops, organic fertilizers, or residue return]; the reverse was true for BG.

Results
Use of only statistically significant contrasts identifies FDA most responsive to carbon adding practices and BG and POXC as more responsive to grass cover or reduced tillage. This shows how variable use of results will alter perceptions of indicator utility. Even though positive correlation [$R > 0.6$] between SQIs were observed with crop yields [65.9% of the cases] and GHG emissions [73.3% of the cases], dynamic environmental factors hinder the development of interpretive frameworks. Standardization of sample timing and analysis will facilitate development of these SQIs.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
132	Weather and Climate
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

Outcome #14

1. Outcome Measures

The Development Of Nano-Fertilizers To Improve Agricultural Production

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In recent years, development of nano-fertilizers has been considered to improve agricultural production. The possibility for slow-release micronutrients resulting from the nano-sized solid state of these products is appealing for some agricultural systems. In particular, hydrological regimes impacted by climate change could alter the mobility of micronutrients [such as Cu and Zn], influencing the plant growth and microbially mediated biochemical cycles of nutrients. The advent of nanotechnology could increase the feasibility of the long-desired agricultural goal of slow-release fertilizers, which are both more cost-efficient and environmentally sound.

What has been done
Ceria has received much attention in the global nanotechnology market due to its useful industrial applications. Because of its release to the environment, the chemical fate of ceria becomes important in protecting the agricultural and food systems. Using experimental biogeochemistry and synchrotron-based X-ray techniques, the fate of ceria NPs [30 and 78 nm] in an agricultural soil [mildly acidic Taccoa entisols] was investigated as a function of exchangeable Ce[III] concentration [0.3 and 1.56 mM/kg in small and large NPs, respectively] under anoxic and oxic conditions. Both ceria NPs strongly adsorbed [>98%] in soils. Under the anoxic condition, the reduction of Ce[IV] was more pronounced in small NPs, whereas the greater concentration of exchangeable Ce[III] in large NPs facilitated the formation of Ce[III] phosphate/oxalate surface precipitates that suppressed the electron transfer reaction. The study shows the importance of redox-ligand complexation controlled chemical fate of ceria NPs in an agricultural soil.

Results
The potential agricultural use of metal NPs for slow-release micronutrient fertilizers is beginning to be investigated by both industry and regulatory agencies. However, the impact of such NPs on soil biogeochemical cycles is not clearly understood. In this study, the impact of commercially-available copper NPs on soil nitrification kinetics was investigated via batch experiments. The X-

ray absorption near edge structure spectroscopy analysis showed that the NPs readily oxidized to Cu[II] and were strongly retained in soils with minimum dissolution [<1% of total mass]. The Cu2+ [aq] at 1 mg/L showed a beneficial effect on the nitrification similar to the control: an approximately 9% increase in the average rate of nitrification kinetics [Vmax]. However, Vmax was negatively impacted by ionic Cu at 10 to 100 mg/L and CuNP at 1 to 100 mg/L. The copper toxicity of soil nitrifiers seems to be critical in the soil nitrification processes. In the CuNP treatment, the suppressed nitrification kinetics was observed at 1 to 100 mg/kg and the effect was concentration dependent at greater than or equal to 10 mg/L. The reaction products as the results of surface oxidation such as the release of ionic Cu seem to play an important role in suppressing the nitrification process. Considering the potential use of copper NPs as a slow-release micronutrient fertilizer, further studies are needed in heterogeneous soil systems.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
132	Weather and Climate
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Programmatic Challenges

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

I Think Green Program

In 2018, a total of 2,059 youth participated in the I Think Green program. A ten-question evaluation was completed by 6 Worm track participants, by 390 Butterfly track participants, by 9 Insect track participant, and by 59 Bird track participants. The ten question evaluation tool included statements about the environment and about the program and asked respondents to mark "yes", "no", or "not sure" to signify their agreement with each statement. There was a common set of survey items across all tracks and also a set of items unique to each track. Responses from all tracks are reported for Environment Related Questions and Participation Related Questions. Track-specific responses are not reported for the Worm track, Insect track or Bird track due to low numbers of respondents.

Environment Related Questions - I Think Green [N=464]

- 83% reported having more ideas about ways they could help care for the environment
- 85% reported being more excited about helping to care for the environment
- 83% reported wanting to get involved in food composting, recycling, or other activities

Participation Related Questions

- 95% reported that the I Think Green activities were fun to do
- 91% reported that they would like to do more activities like the ones in I Think Green
- 80% reported that they would like to help with a community garden project

Butterfly Track Specific Questions [N=390]

- 91% reported that they were encouraged to ask questions about butterflies and the environment
- 97% reported that the activities helped them learn about butterflies and how they grow
- 93% reported that the activities help them to learn how butterflies interact with other living things
- 95% reported that the activities help them learn how butterflies contribute to the environment

Key Items of Evaluation

I Think Green Program

The majority of the youth participants [over 80%] reported that the **I Think Green** activities helped them learn about ways to help care for the environment. Even more youth [88%] agreed that they would like to get involved in stewardship activities to help take care of their community.

V(A). Planned Program (Summary)

Program # 8

1. Name of the Planned Program

Plant Health, Systems And Production

☑ 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	50%		10%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%		15%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	0%		10%	
206	Basic Plant Biology	0%		10%	
211	Insects, Mites, and Other Arthropods Affecting Plants	10%		10%	
212	Pathogens and Nematodes Affecting Plants	10%		15%	
213	Weeds Affecting Plants	10%		10%	
214	Vertebrates, Mollusks, and Other Pests Affecting Plants	0%		10%	
216	Integrated Pest Management Systems	20%		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	0.0	0.0	10.0	0.0
Actual Paid	9.6	0.0	43.3	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**
454143	0	1632220	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
454143	0	1632220	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
1849428	0	9063424	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Activities in FFY 2018 included an exploration of Lysobacter sp. as a model to understand the molecular mechanisms of beneficial microorganism-fungi interactions and antibiotic resistance [we will identify genes responsible for antagonism and antibiotic resistance in Lysobacter sp. and determine the underlying molecular mechanisms; we believe that a better understanding of beneficial microorganism-fungi interactions and antibiotic resistance in Lysobacter sp. will provide increasing insight into antibiotic resistance reservoirs, offer predictive capacity for the emergence and epidemiology of antibiotic resistance, and improve biocontrol efficacy], a project examining a subset of topics that are closely related to resistance in corn rootworms including the genetics of Northern Corn Rootworm and Western Corn Rootworm resistance, the biology of moving and dispersing rootworm adults, and the geography of resistance and the efficacy of Integrated Pest Management/Insect Resistance Management strategies and tactics, the development of additional methods for control of H. glycines to supplement existing control strategies, and a project using a combination of microscopy and molecular biology to determine how plant-parasitic nematodes are able to complete their life-cycles in diverse environments and devise economically-practical and environmentally-sound strategies for their control with the ultimate goal of reducing yield loss caused by plant-parasitic nematodes on economically important crops in the U.S.

Activities also included research that will contribute information for a better understanding of the origin and evolution of adaptive traits in agronomic weed species, a series of field experiments and observational studies conducted to improve the efficiency and predictive value of sampling methods for western corn rootworm and western bean cutworm, ongoing implementation of genomic selection to Illinois breeding programs [the advantages of genomic selection in maize breeding programs have been demonstrated, and it is expected that similar advantages will come into fruition for dedicated soybean genomic selection breeding programs], work that will study the potential for agroforestry systems to contribute to food production while also providing additional ecosystem services [our central hypothesis is that agroforestry systems incorporating nut- and fruit-bearing trees and shrubs could make a substantial contribution to food security when established on lands that are marginal for annual row crops], the identification of leaf traits, and the genes that control these traits, in maize and related grasses that alter photosynthesis and transpiration [these findings will be incorporated into elite germplasm and tested under agronomically relevant conditions], a wheat breeding program that seeks to evaluate experimental genotypes for agronomic performance and disease resistance, the identification of pathogenesis proteins from major diseases of corn, soybean, and wheat [allowing us to make informed recommendations for the deployment of disease resistant varieties and chemical controls], and the development of strategies to effectively manage X. cucurbitae in pumpkins.

Activities also included research focused on the determination of photosynthetic productivity of different

commercial corn and soybean varieties on a whole-plant basis in response to differing levels of management inputs [multiple genotypes of both corn and soybean will be grown in several environments with various populations, nutritional availabilities, and plant health additives to allow characterization into "offensive-racehorse" or "defensive-workhorse" classifications depending upon their efficiency of capturing sunlight, interacting with agronomic management, and powering yield], the development of a new satellite-based algorithm for measuring crop productivity using sun-induced fluorescence from the NASA OCO-2 satellite, ongoing work to quantify and document the occurrence and distribution of herbicide-resistant weed populations in Illinois, a project that seeks to attract more customers to the farm by helping growers identify rootstocks that will reduce tree height without compromising fruit quality and yield [and also to provide direct market customers more selection of fruits that are tree ripened and of superior quality], and continuing work under a soybean breeding program focused on developing knowledge, technology, germplasm, and varieties that will increase the productivity, profitability, and sustainability of soybean production in Illinois and throughout the U.S.

Activities also included a project that seeks to acquire information about genes and their expression for traits important to both economic and environmental sustainability in crop systems, the use of next-generation DNA sequencing to measure changes in a diverse set of field soybean cyst nematode populations that have shown increasing and decreasing tendencies on both resistant and susceptible soybean plants, the development of practical and easy-to-implement strategies that help address N leaching and N2O emission concerns in Illinois, work to reveal and identify new and important genes and proteins that confer safener-induced tolerance in grain sorghum using a diverse array of methods, research with a a long-term objective of improving domesticated Asian rice with unique and beneficial genes from its wild African relative, O. longistaminata [providing rice farmers with improved cultivars that increase food security while requiring fewer inputs], and a project that seeks to characterize how bacterial species in the Xanthomonas genus affecting tomato and pumpkin plants may be adapting to evade the host recognition machinery.

Conference presentations in 2018 included the International Congress of Plant Pathology, American Phytopathological Society, Entomological Society of America, Evolution - Genetic Novelty/Genomic Variations by RNA Networks and Viruses Conference, Soil Health Partnership Cover Crop Field Day, Soil and Water Conservation Society, 60th Annual Maize Meeting, Sustainable Agriculture Research and Education Conference, Illinois Farm Bureau Local-Regional Food Conference, International Congress of Plant Pathology, International Conference of Nitrogen Cycling and its Environmental Impacts in East Asia, American Society of Agronomy-Crop Science Society of America-Soil Science Society of America, American Geophysical Union, 3rd Annual Crops in Silico Symposium, North Central Weed Science Society, U.S. Wheat and Barley Scab Initiative, Soybean Breeders' Workshop, the Biennial Conference on the Molecular and Cellular Biology of the Soybean, UIUC-Illinois Maize Breeding Conference, International Plant & Animal Genome XXVI Conference, and the 5th International Rice Congress.

Extension activities in this planned program focused largely on non-commercial plant health and systems, including both food and non-food horticulture crops and pest management. The **Ask Extension - Hort Corner** [https://web.extension.illinois.edu/askextension/?AskSiteID=34] comprised of multiple topics, many of which are in Spanish, received more than 6.6 million views during the past year. The site allows visitors to find answers about plant care, through an online compilation of questions and answers, with the ability to ask additional questions of an Extension educator via an online web form. A series of twelve horticulture programs, the **Four Seasons Gardening Webinar Series,** was again offered by Extension horticulture educators in 2018. The webinar series drew over 600 participants, accessible remotely through personal computers and also hosted by several Extension offices throughout the state. Following the live broadcast, the webinars were archived on YouTube and made available through links posted on the Extension website.

Extension's Master Gardener Program is an essential and foundational outreach activity to provide

horticulture information and education to the public. This past year, there were 2,622 active Master Gardeners in Illinois, who contributed more than 219,000 volunteer hours. Based on the value of a volunteer hour of $26.02 from the Independent Sector valuation for Illinois, this reflects an overall economic value of their contributions estimated to be over $5.7 million. Master Gardeners conducted presentations through the **Master Gardener Speakers Bureau** and provided assistance to individuals and facilities, and creating opportunities for residents to learn how to grow food and other plants. In 2018, Master Gardeners delivered 411 Speakers Bureau presentations. Because initial and ongoing volunteer training is central to the success of this program, Extension staff devote significant time and attention to training opportunities. In 2018, Extension released an interactive online option for Master Gardeners to complete initial training. Of the 402 new Master Gardeners trained in 2018, 78 new volunteers elected to use this mode of training.

Extension staff and Extension-trained volunteers support hundreds of community gardens throughout Illinois. These gardens serve many functions, including; [1] education and demonstration at schools and in communities, [2] development of therapeutic settings for hospitals and assisted living facilities, [3] locations for environmental stewardship supporting pollinators and other beneficial insects, [4] development of life and work skills at correctional facilities, and [5] expansion of food access through produce donations. Extension educators and volunteers also partner to organize **Saturday Gardening Days**, annual events held in 25 communities around the state to provide education on a variety of home and community garden topics. These events reached an estimated 3,120 people this year.

Pollinator support remained a popular initiative through outreach targeting a wide span of ages. Using hands-on activities, 2,718 youth participated in the **Honey Bee Challenge**. 4-H teen members taught youth about honey bee habitats, showed the important role of pollinators in agriculture and food production, showed the current threat to honey bee habitats, and explored ways to preserve these bee habitats. Educational programs addressing the protection of pollinators were also delivered via Master Gardener training and through community presentations.

The **University of Illinois Plant Clinic** provides service to the citizens of Illinois as a source of unbiased diagnosis of routine, unusual, and exotic plant problems and provides educational support to manage those pest issues. The **Plant Clinic** Facebook page is one of the top ten most viewed for the University of Illinois. In 2018, the Plant Clinic provided 2,645 diagnoses for 1,557 plant samples submitted for disease diagnosis, phytosanitary certification, or plant or insect identification in 2018. An additional 1,228 soil and plant samples were submitted for nematode analysis and 336 field and seed samples were analyzed for herbicide resistance and/or molecular identification. Commercial and home fruits and vegetable samples accounted for 74 and 25 samples respectively, with additional other household insect, aquatic plant, and other samples accounting for the remainder. Additionally, information was provided via approximately 2,000 telephone, e-mail, and app requests and through 250 walk-in consultations. This is a total of and additional 2,250 diagnostic service interactions at the Plant Clinic in 2018.

Digitally delivered information to support plant health and production is distributed through Extension's **Gardener's Corner** website which posts a quarterly publication with contributions from Extension horticulture educators and posted online [https://extension.illinois.edu/gardenerscorner/index.cfm]. Articles in this publication focus on research-based practices for home gardening and landscape management. The website also features podcasts and YouTube videos with demonstrations for home gardeners to view. Another popular resource for digitally delivered information is **Green Side Up** [https://web.extension.illinois.edu/podcasts/greensideup/], a weekly podcast series covering a wide variety of timely topics produced by an Extension horticulture educator.

2. Brief description of the target audience

Members of the target audience included scientists in the disease control research community and related areas of general microbiology, bacteriology, and antibiotic resistance, plant pathologists, educators, Illinois [and Corn Belt] corn producers, Illinois crop consultants, seed technology/biotechnology professionals, scientists, students, nematologists, plant pathologists, members of the general public, Extension personnel, breeders, agronomists, quantitative geneticists, researchers that investigate crop improvement and the enhancement of photosynthesis, wheat producers in Illinois and other Midwest states, wheat breeding colleagues, the seed industry, farmers of field crops, researchers working on reducing the impact of plant pathogens, cucurbit growers, home gardeners, corn and soybean farmers, scientists investigating crop yield estimation at large scales and the applications of novel satellite products in agriculture domains, the weed science community and practitioners of weed management, agrichemical retail applicators, certified crop advisors, agronomic commodity organizations, professional weed science societies, agricultural media organizations, industry and government laboratories, farmers who are interested in alternative methods to control plant-parasitic nematodes, and breeders and growers of rice [especially those interested in cultivars with new genes for abiotic and biotic stress-tolerances].

Extension audiences included homeowners and other residents, Master Gardeners, green industry owners and employees [landscapers, nursery stock growers, lawn and garden business owners and employees, insurance adjusters, and arborists], and crop producers.

3. How was eXtension used?

Three members of the Horticulture team are members of one or more Communities of Practice in eXtension.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	57064	7982154	62366	7833039

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

Patent Applications Submitted

Year:	2018
Actual:	1

Patents listed

[TF10105-06 [DIV]] - RHG1 Mediated Resistance To Soybean Cyst Nematode.

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	57	57

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number Of Completed Hatch Research Projects

Year	Actual
2018	5

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	More Informed User Of Pesticides
2	Improved Control Of Waterhemp
3	Development Of New Soybean Breeding Lines
4	Evaluating The Effectiveness Of Cover Crops In Reducing Disease Severity
5	Improved Resistance To Western Corn Rootworm
6	Development Of Improved Winter Wheat Varieties Adapted To Illinois
7	Documenting The Occurrence And Distribution Of Herbicide-Resistant Weed Populations In Illinois
8	Development Of Alternative Soybean Disease Management Strategies
9	Identification Of New Microbial Pathogens Of Plant Parasitic Nematodes Important In Illinois
10	Number Of Individuals Increasing Knowledge Related To Detecting And Managing Invasive Pests and Plants
11	Number Of Individuals Implementing Practices Related To Lawn And Garden Plant Systems
12	Improved Understanding Of The Beneficial Microorganism-Fungi Interactions And Antibiotic Resistance In Lysobacter Sp.
13	Understanding Plant Resistance To Cold Stress And The Metabolic Processes Underlying Its Molecular Mechanisms
14	Specification Of The Evolution And Definition Of Giant Viruses
15	Improving Our Understanding Of The Origin And Evolution Of Adaptive Traits In Agronomic Weed Species
16	Identifying The Potential Of Hazelnuts In Illinois
17	Development Of Practical Strategies That Address Nitrogen Leaching And N2O Emission Concerns In Illinois

18	Identifying New And Important Genes And Proteins That Confer Safener-Induced Tolerance In Grain Sorghum
19	The Development Of Biomass Crop Species That Can Be Grown In Specific And Challenging Environments

Outcome #1

1. Outcome Measures

More Informed User Of Pesticides

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Improved Control Of Waterhemp

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Group 15 herbicides, although discovered in the 1950's, remain an important resource for preemergence [PRE] control of annual grasses and small-seeded broadleaves. Previous and ongoing research with a five-way resistant population of waterhemp [Amaranthus tuberculatus] from Champaign County, Illinois [designated CHR] demonstrates that Group 15 herbicides alone are not effective for PRE control of the population.

What has been done
Acetochlor, alachlor, and pyroxasulfone provide the greatest PRE control of CHR under field conditions, while S-metolachlor and dimethenamid-P provided significantly less control. A similar observation had been previously reported for another multiple herbicide-resistant [MHR] waterhemp population from Mclean County, Illinois [designated MCR]. Since both CHR and MCR are resistant to s-triazine, HPPD-, and ALS-inhibiting herbicides, the objectives of this research

were to compare CHR and MCR to other waterhemp populations in a controlled growth environment and investigate a possible association among the various known resistances and Group 15 efficacy. Progeny generated from each MHR population [CHR-M6 and MCR-NH40] were compared to another MHR waterhemp population from Illinois [ACR; s-triazine, ALS- and PPO-inhibitor resistant] and a known herbicide-sensitive population [WUS] under greenhouse conditions for their responses to four Group 15 active ingredients.

Results
Based on biomass reduction [GR50] values, calculated resistant-to-sensitive ratios [R/S] between CHR-M6 and WUS were 7.5, 6.1, 5.5, and 2.9 for S-metolachlor, acetochlor, dimethenamid-P, and pyroxasulfone, respectively. R/S ratios between CHR-M6 and WUS were larger when calculated using seedling survival [LD50] and values were greater for MCR-NH40 than CHR-M6. ACR was the most sensitive to all Group 15 herbicides tested. Results from these greenhouse studies complement and corroborate previous findings from the field. Future research is planned to further investigate the CHR and MCR populations and determine whether an edaphic factor or a physiological factor, such as rapid metabolism, is responsible for the differences in activity among the Group 15 active ingredients tested under both environments.

4. Associated Knowledge Areas

KA Code	Knowledge Area
206	Basic Plant Biology
213	Weeds Affecting Plants

Outcome #3

1. Outcome Measures

Development Of New Soybean Breeding Lines

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Evaluating The Effectiveness Of Cover Crops In Reducing Disease Severity

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Improved Resistance To Western Corn Rootworm

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Western corn rootworm [WCR] resistance to Cry3Bb1, mCry3A, and Cry34/35Ab1 Bt toxins were assessed for Champaign County, Illinois field populations. Cry toxin efficacy was measured by comparing adult beetle emergence, corn root injury, and larval survival in single plant Bt-resistance bioassays.

What has been done
Adult insects were also collected from screenhouses erected over a variety of Bt and non-Bt corn plantings to obtain adults that were used to generate eggs to be used in 2019 bioassays. Due to variability in adult emergence and NIS among individual Bt corn treatments, these data were pooled into non-Bt controls, Cry34/35Ab1-expressing CRW Bt corn hybrids, and non-Cry34/35Ab1 expressing CRW Bt corn hybrids. Resistance to Cry3Bb1 and mCry3A [collectively "Cry3"] traits expressed in Bt corn has been previously documented in this area; the Cry34/35Ab1 trait still provides significant protection from WCR larvae. Not surprisingly, corn hybrids that expressed Cry34/35Ab1 had significantly less adult WCR emergence than controls and non-Cry34/35Ab1 expressing CRW Bt hybrids.

The Cry34/35Ab1 hybrids also suffered significantly less node injury than controls and non-Cry34/35Ab1 expressing CRW Bt hybrids. However, NIS for non-Cry34/35Ab1 expressing CRW Bt hybrids were also significantly less than those of the non-Bt controls. In spite of 2017 bioassays suggesting little local Cry3 efficacy, expression of only the Cry3 trait[s] can still reduce root injury compared to an unprotected non-Bt corn root, albeit at a level that would constitute significant economic injury.

Results
Single plant Bt resistance bioassays using the offspring of 2017-collected WCR populations suggest that there may be little, if any, susceptibility remaining to the Cry3Bb1 and mCry3A toxins expressed in Bt corn hybrids. Survival data clearly show that Champaign County WCR populations are resistant to Cry3 toxins. While the proportions of surviving WCR larvae are unaffected by Cry3 toxins, the distribution of larval head capsule widths indicates that not all of the surviving larvae are performing like larvae on non-Bt isoline hybrids. A portion of the "resistant" larvae surviving from suspected Bt-resistant populations develop slower than their siblings on non-Bt isoline corn roots. Slower development on Bt root results in a slight, but statistically smaller, mean head capsule sizes. Evidence for a small [but significant] difference in larval size between populations on Bt vs. non-Bt hybrids suggests that Cry3-resistance in WCR may not be fixed, especially with respect to the developmental fitness of larvae. Bioassay survival

and head capsule width data for larvae tested on Cry34/35Ab1-expressing corn hybrids indicates that open field-collected populations retain full susceptibility to Cry34/35Ab1-expressing corn hybrids. Notably, when the parental WCR populations were collected from circumstances where all of the beetles had survived larval development on Bt corn hybrids, there was evidence of reduced susceptibility to the Cry34/35Ab1 trait. These data indicate that there Cry34/35Ab1 resistance alleles are present in Champaign County populations, but at low levels.

Growers can expect Cry34/35Ab1-expressing corn hybrids to provide significant root protection against WCR in 2019. Evidence of resistance alleles in the populations should motivate adoption of IPM-based approaches to WCR management - including use of economic thresholds in corn.

4. Associated Knowledge Areas

KA Code	Knowledge Area
206	Basic Plant Biology
211	Insects, Mites, and Other Arthropods Affecting Plants
216	Integrated Pest Management Systems

Outcome #6

1. Outcome Measures

Development Of Improved Winter Wheat Varieties Adapted To Illinois

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Documenting The Occurrence And Distribution Of Herbicide-Resistant Weed Populations In Illinois

Not Reporting on this Outcome Measure

Outcome #8

1. Outcome Measures

Development Of Alternative Soybean Disease Management Strategies

Not Reporting on this Outcome Measure

Outcome #9

1. Outcome Measures

Identification Of New Microbial Pathogens Of Plant Parasitic Nematodes Important In Illinois

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Previous work on identifying nematode pathogens relied on the culture of disease causing microorganisms. With the rise of new DNA sequencing technologies [Next-generation DNA sequencing], the ability to acquire vast amounts of DNA sequence has become cost effective. The exponential increase of DNA sequence data output has made it possible to sequence the DNA of all organisms associated with soil-borne plant parasitic nematodes. Such analysis of the nematode phytobiome is referred to as metagenomics since it aims to sequence the DNA of all organisms in a given sample or environment. Since metagenomics has the potential to discover organisms in a culture-independent manner, it has the ability to identify multi-trophic interactions that may be lowering nematode reproduction and thus may be useful for nematode control. In this project we proposed to conduct a metagenomic survey of natural plant parasitic nematode communities that suppress nematode reproduction. The use of metagenomic analysis of nematode phytobiomes could identify nematode pathogenic viruses, and bacterial and fungal organisms. These microorganisms may be of use in controlling plant parasitic nematodes.

What has been done
In this phase of the project, we analyzed several microorganisms that might cause disease in the soybean cyst nematode [SCN]. One organism was a suspected fungus that was parasitizing the nematodes' eggs/cysts. DNA from the infected SCN was extracted and then sequenced. A number of putative fungal sequences were identified, but the most common was from an unknown species of Fusarium. Since this sequence did not exactly match any known species of this fungus and Fusarium is known to be associated with SCN, we conclude this may be a new nematode parasitic fungus. We were able to culture it on PDA media and are currently testing it for its effectiveness at parasitizing SCN. If successful this approach may add a new tool for sustainable plant-parasitic nematode management in Illinois and throughout the world.

Results

We also analyzed a new nematode virus that has been shown to infect both SCN and the beet cyst nematode [BCN]. This new virus is a positive-strand RNA virus, thus it has great potential to be used as a viral vector. Preliminary data suggests this virus can be introduced into uninfected SCN and replicate. This exciting discovery suggests it may be possible to use the virus as a biological control agent. It is also possible that the virus could be genetically modified to increase its pathogenicity to SCN and other closely related nematodes. The SCN virus project has the potential to provide new and novel tools for managing SCN and other problematic nematodes.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
206	Basic Plant Biology
212	Pathogens and Nematodes Affecting Plants
216	Integrated Pest Management Systems

Outcome #10

1. Outcome Measures

Number Of Individuals Increasing Knowledge Related To Detecting And Managing Invasive Pests and Plants

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	2250

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Emerging pathogens and insects can cause serious damage and loss to Illinois trees, native plants, and crops if not detected early resulting in economic and environmental consequences related to treatment or replacement.

What has been done
A primary objective of the University of Illinois Plant Clinic is to provide unbiased plant pest diagnosis and management recommendations. There were 1,557 plant samples submitted for disease diagnosis, phytosanitary certification, or plant or insect identification in 2018. The majority of samples were agronomic [671 standard plant and phytosanitary samples, 1,228 soil and plant nematology samples, and 336 field and seed samples tested for herbicide resistance and/or

Palmer amaranth identification].

Results
The University of Illinois Plant Clinic provided 2,645 diagnoses for 1,557 plant samples submitted for disease diagnosis, phytosanitary certification, or plant or insect identification in 2018.

Additionally, information was provided via approximately 2,000 telephone, e-mail and app requests, and 250 through walk-in consultations. This is a total of an additional 2,250 diagnostic service interactions at the Plant Clinic in 2018, resulting in new knowledge for those submitting samples and requesting expert assistance.

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants

Outcome #11

1. Outcome Measures

Number Of Individuals Implementing Practices Related To Lawn And Garden Plant Systems

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	218

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Over 90% of Illinois residents live in metropolitan areas, putting them in close proximity to residential and urban landscapes. The characteristics of green spaces in these areas impact air quality, water quality, and local and global climate as well as having documented wellness and economic impacts.

What has been done

The Master Gardener program continues its core mission of developing a team of volunteers who build and enhance their communities through gardening outreach activities. Extension trained 402 new Master Gardeners in 2018, bringing the total number of active Illinois Master Gardeners to 2,622. These dedicated volunteers collectively contributed 219,272 hours of volunteer time this year alone. In 2018, Extension launched an online core volunteer training program to expand availability, with 78 participants enrolling in the extensive, self-supporting training program through the digital platform.

The Master Gardeners Speakers Bureau program combines digital and high-touch methods to enhance Extension's cost-effective delivery of research-based education. Extension educators prepare educational presentations that Master Gardeners deliver with audiences in their communities. Videos of the webinars are posted so that Master Gardeners can refresh their knowledge and address questions during their presentations. In 2018, eight new topics were developed and presented. Master Gardeners delivered 411 Speakers Bureau presentations in their communities.

Results

The core training curriculum, both via classroom and online methods, demonstrated effectiveness in equipping Master Gardeners with the knowledge and confidence they need to assist residents in their communities engage with their garden and landscapes. A course evaluation was conducted with 159 new Master Gardeners in 2018. Based on self-reported ratings of their knowledge levels before and after their core training, 100% of surveyed trainees reported an increase in knowledge on one or more topics related to plant and landscape cultivation, including 90% with an increase in knowledge required to grow fruits and vegetables. When asked to rate their ability to carry out the responsibilities of their role as community impactors, 86% [N=137] rated their ability to identify and use accurate, research-based sources for garden and landscape information as high or very high based on what they gained through the core training. Overall, 81% of trainees were very satisfied with their experience in the core training program.

In 2018, 94 Master Gardeners who attended one or more Speakers Bureau webinars completed a post webinar evaluation. Across all webinars, 84% of trainees [N=79] reported an increase in ability to present on the topic covered. The share reporting they had a "high" or "very high" ability to present on the topic increased from 16% to 72% as a result of the webinars.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants

Outcome #12

1. Outcome Measures

Improved Understanding Of The Beneficial Microorganism-Fungi Interactions And Antibiotic Resistance In Lysobacter Sp.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
We propose to explore Lysobacter sp. as a model to understand the molecular mechanisms of beneficial microorganism-fungi interactions and antibiotic resistance. We expect that, by performing basic research experiments, including a genome search and screening libraries for antifungal activities and antibiotic susceptibility, we will identify genes responsible for antagonism and antibiotic resistance in Lysobacter sp. and determine the underlying molecular mechanisms. We believe that a better understanding of beneficial microorganism-fungi interactions and antibiotic resistance in Lysobacter sp. will provide increasing insight into antibiotic resistance reservoirs, offer predictive capacity for the emergence and epidemiology of antibiotic resistance, and improve biocontrol efficacy.

Molecular information of antibiotic resistance will further facilitate our understanding of the evaluation, spread, and mechanisms of antibiotic resistance in human and animal pathogens. Increased understanding of resistance will also provide new targets for discovery of novel therapeutics. The advantage of using Lysobacter spp. to study antibiotic resistance instead of clinical isolates is that the two Lysobacter isolates can grow at extremely high levels of antibiotics [at 8,000 mg/ml ampicillin] and they can inhibit clinically important gram positive bacteria and fungi. Completion of this project will be beneficial to soybean growers, the general public, and researchers in plant pathology and microbiology, as well as companies in the antibiotics industry.

What has been done
We have generated two mutant library of LeC3, one contained about 3,000 clones and the other 7,000 clones, and screened using soybean white mold pathogen [Sclerotinia sclerotiorum] to identify genes associated with LeC3 antagonism against fungal pathogens. We identified 141 mutants that exhibited significant decrease in inhibiting hyphae growth of S. sclerotiorum. Among them, 74 mutants no longer inhibited S. sclerotiorum hyphae growth and nine mutants were selected for further characterization.

Results
These nine mutants were partially recovered in their abilities in inhibiting hyphae growth of S. sclerotiorum. In addition, all nine mutants decreased significantly in their abilities in suppressing spore germination of the sudden death syndrome pathogen [Fusarium virguliforme] and in producing four extracellular enzymes. Furthermore, secretion of the heat stable antifungal factor [HSAF], a fungal specific antibiotic of LeC3, was significantly decreased in all nine mutants.

Collectively, our findings suggest that the nine genes of LeC3 play important roles in antagonism against fungal pathogens probably by affecting both extracellular enzymes and HSAF.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
201	Plant Genome, Genetics, and Genetic Mechanisms
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
206	Basic Plant Biology
212	Pathogens and Nematodes Affecting Plants

Outcome #13

1. Outcome Measures

Understanding Plant Resistance To Cold Stress And The Metabolic Processes Underlying Its Molecular Mechanisms

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The study of plant resistance to cold stress and the metabolic processes underlying its molecular mechanisms benefit crop improvement programs. Scientists have described biochemical changes that protect plant cells from damage and some of the genes controlling them. However, it is not clear how all the cellular processes involved in plant protection work together. Lacking this global view, plant breeders have struggled to engineer cold-tolerant crops.

What has been done
We investigated the effects of cold stress on the metabolic pathways of Arabidopsis thaliana, a small plant commonly studied to understand genetic and physiological processes. These effects were directly inferred at the system level from transcriptome data. The strategy goes beyond the traditional approach of examining a single gene, protein, or biochemical pathway at a time. Instead, it simultaneously examines the entire collection of genes, metabolites, pathways, and reactions involved in the cold stress response. First, we coupled transciptome data and a database that annotates genes and gene products to identify significantly changed gene

expression at four time points of cold treatment. Second, a metabolite-centric reporter pathway analysis approach that we developed enabled the computation of metabolites significantly associated with transcripts. Third, tripartite networks of gene-metabolite-pathway connectivity outlined the response of metabolites and pathways to cold stress.

Results
Our metabolome-independent analysis revealed stress-associated metabolites in pathway routes of the cold stress response, including amino acid, carbohydrate, lipid, hormone, energy, photosynthesis, and signaling pathways. Cold stress first triggered the mobilization of energy from glycolysis and ethanol degradation to enhance TCA cycle activity via acetyl-CoA. Interestingly, tripartite networks lacked power law behavior and scale free connectivity, favoring modularity. Network rewiring explicitly involved energetics, signal, carbon, and redox metabolisms and membrane remodeling. Our study contributes a possible route forward for plant breeders and biological engineers, though more research is required to determine if the pathways involved can be modified simultaneously. Specifically, the methodology will allow scientists to use systems biology tools to study metabolic reactions that populate important pathways, and collectively engineer enzymes to improve how plants respond to environmental insults. The use of complex networks that systematically link the activities of genes to relevant biological functions now open remarkable opportunities for genetic engineering and synthetic biology.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
206	Basic Plant Biology

Outcome #14

1. Outcome Measures

Specification Of The Evolution And Definition Of Giant Viruses

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Giant viruses of amoebae were discovered in 2003. Since then, their diversity has greatly expanded. They were suggested to form a fourth branch of life alongside Bacteria, Archaea, and Eukarya. Their origin and ancestrality remain controversial. Here, we specify the evolution and definition of giant viruses.

What has been done
Phylogenetic and phenetic analyses of informational gene repertoires of giant viruses and selected bacteria, archaea and eukaryota, were performed including structural phylogenomics based on protein structural domains grouped into 289 universal fold superfamilies [FSFs]. Hierarchical clustering analysis was performed based on a binary presence/absence matrix constructed using 727 informational Clusters of Orthologous Groups [COGs] from cellular organisms. The presence/absence of "universal" FSF domains was used to generate an unrooted maximum parsimony phylogenomic tree. Comparison of the gene content of a giant virus with those of a bacterium, an archaeon, and a eukaryote with small genomes was also performed.

Overall, both cladistic analyses based on gene sequences of very central and ancient proteins and on highly conserved protein fold structures as well as phenetic analyses were congruent regarding the delineation of a fourth branch of microbes comprised by giant viruses. Giant viruses appeared as a basal group in the tree of all proteomes. A pangenome and core genome determined for Rickettsia bellii [bacteria], Methanomassiliicoccus luminyensis [archaeon], Encephalitozoon intestinalis [eukaryote], and Tupanvirus [giant virus] showed a substantial proportion of Tupanvirus genes that overlap with those of the cellular microbes. In addition, a substantial genome mosaicism was observed, with 51, 11, 8, and 0.2% of Tupanvirus genes best matching with viruses, Eukarya, Bacteria, and Archaea, respectively. Finally, we found that genes themselves may be subject to lateral sequence transfers.

Results
In summary, our data highlight the quantum leap between classical and giant viruses. Phylogenetic and phyletic analyses and the study of protein fold superfamilies confirm previous evidence of the existence of a fourth supergroup of life that includes giant viruses, and highlight its ancestrality and mosaicism. They also point out that best evolutionary representations for giant viruses and cellular microorganisms are rhizomes, and that sequence transfers rather than gene transfers have to be considered.

4. Associated Knowledge Areas

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

Outcome #15

1. Outcome Measures

Improving Our Understanding Of The Origin And Evolution Of Adaptive Traits In Agronomic Weed Species

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The overall aim of this research is to contribute information for a better understanding of the origin and evolution of adaptive traits in agronomic weed species. As a step towards meeting this long-term goal, shorter-term studies will focus on three major weed species in the genus Amaranthus [waterhemp, Palmer amaranth, and smooth pigweed] since these are among the weeds that pose the greatest threat to row crop production in the Midwestern United States. Moreover, these species are chosen to take full advantage of the genomic resources currently available from our previous work and the work of our colleagues.

What has been done
Source material for assessing genetic variation in adaptive traits in three weedy amaranth species [waterhemp, Palmer amaranth, and smooth pigweed] was obtained from natural field locations [non-agricultural], agricultural fields, and curated germplasm collections at the University of Illinois. During the 2017 and 2018 growing seasons, new collections of amaranth weeds [including tissue and seed] were obtained from diverse populations throughout native and introduced or newly-invasive ranges in the Midwest and Southwestern U.S. as well as several localities in central California.

Twenty eight new populations of Palmer amaranth were sampled from different geographic localities in California, Arizona, New Mexico, Texas, Illinois, and Minnesota. These samples, plus new collections of waterhemp and smooth pigweed, were added as new accessions to our germplasm inventory. Subsets of individuals from each sampled population are currently being genotyped with molecular markers to provide data on genetic diversity within and among populations and allelic diversity for specific herbicide-resistance genes [ALS, PPO, and EPSPS genes]. Our ongoing screening of allelic variation in specific herbicide target-site genes continues to provide data on the presence and frequency of specific resistance mechanisms. Screening for target-site-based resistance mechanisms also contributes data on the occurrence of non-target-site-based [or metababolic] resistance mechanisms [NTSR] in some plants. As suggested from our prior investigations, NTSR mechanisms may be linked to certain other adaptive traits contributing to improved stress tolerance. We are continuing to study these links in greater depth via a combination of molecular/genomic approaches and greenhouse trials. During the course of our greenhouse trials, observations related to seed dormancy, germination, and other phenotypic characteristics were recorded.

Results

Controlled-crossing experiments in the greenhouse between Palmer amaranth [Amaranthus palmeri] and smooth pigweed [A. hybridus] were initiated to investigate possible gene flow and interspecies transfer of herbicide resistance traits. Eleven Palmer amaranth [a dioecious species] females were placed in separate pollination tents with multiple smooth pigweed plants as the pollen donors. All smooth pigweed individuals used in the crosses were ALS-inhibitor resistant, whereas all Palmer amaranth female plants were herbicide-susceptible [previously confirmed through herbicide screening and molecular assays]. This approach was chosen to facilitate the identification of hybrid progeny among those that might otherwise be derived from apomixis or accidental contamination. Plants were crossed and allowed to mature over a period of five to six months. Palmer female plants were harvested and processed to estimate seed number and viability of offspring.

Studies are underway to verify putative hybrids using molecular markers and herbicide treatment. Allied experiments were also initiated to specifically address facultative apomixis in Palmer amaranth. A first-round of trials with four isolated female plants from one population were completed. These plants produced low seed sets [ca. few hundred seeds] that were harvested. A second trial with additional Palmer females, and including females from different geographic populations, is underway to investigate asexual seed production in greater detail. Results from these experiments will contribute to a better understanding of the potential for interspecies transfer of herbicide resistance among species and the influence of apomixes on resistance evolution and management.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
206	Basic Plant Biology
213	Weeds Affecting Plants

Outcome #16

1. Outcome Measures

Identifying The Potential Of Hazelnuts In Illinois

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
To build an understanding for the potential of hazelnut performance in Illinois, a geospatial mapping study was implemented to determine baseline data on where commercial hazelnut performance is likely to be high in Illinois. This study utilized eight soil parameters [such as depth, pH, drainage, and percent clay] with known classes of respective suitability levels for commercial hazelnut production.

What has been done
These parameters were geospatially mapped individually across Illinois. An index was created from these individual maps to display the parameters collectively and represent the comprehensive distribution of hazelnut soil suitability throughout Illinois.

Results
This map is immensely informative to guide subsequent research, development, and outreach work as no previous information was available of this kind. The GIS mapping work was in part presented at this year's European Agroforestry Congress, where it was well received and published in the conference proceedings. An invited manuscript including the mapping work has been developed for the journal Sustainability as a part of a special issue entitled Sustainable Agroforestry Systems.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships

Outcome #17

1. Outcome Measures

Development Of Practical Strategies That Address Nitrogen Leaching And N2O Emission Concerns In Illinois

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

In this study maize yield response and potential nitrogen leaching losses were simultaneously quantified to test the hypothesis that N rates which produced maximum yields would result in minimum yield-scaled N leaching potential. Field experiments were conducted at two sites in 2015 and 2016 to determine the effect of N rate [0, 79, 179, 269, kg N ha-1] on yield, crop N uptake, potential N leaching losses, and post-harvest soil N concentrations. Results show that a significant yield response [up to 179 kg N ha-1] occurred in all years compared to the control. Nitrogen leaching potential increased at 269 kg N ha-1 compared to the control in 2015 but not 2016.

Yield-scaled N leaching potential was not statistically different among treatments in three of four site-years. There was no improvement in crop N uptake or N recovery efficiency for 269 kg N ha-1 compared to 179 kg N ha-1 in three of four site years, which coincided with a trend of increasing post-harvest soil N concentrations, further escalating the risk of environmental N losses. These results did not support our hypothesis that yield-scaled N leaching potential is minimized at N rates that optimize yields [on a normalized basis yield-scaled N leaching potential increased by 28% compared to the control]. However, normalized data indicate that 179 kg N ha-1, the N rate most closely aligned with current recommendations in this region, resulted in 96% of maximum yield while preventing a 25% increase in yield-scaled N leaching potential compared to 269 kg N ha-1, underscoring the potential for achieving high yields while avoiding increased N leaching potential on an environmental efficiency basis.

What has been done

In the U.S. Midwest, corn [Zea mays L.] stover removal combined with no-till practices may increase or decrease soil N2O emissions by influencing soil moisture, temperature, and nutrient dynamics, yet empirical evidence from long-term field experiments is inconsistent. We investigated the effects of residue management [residue retained or removed] and tillage [chisel-till or no-till] on cumulative soil nitrous oxide [N2O] emissions, grain yield, and yield-scaled N2O emissions in a three-year study initiated ten years after treatment implementation in a long-term, continuous corn experiment in Illinois. Crop yields were affected by treatment in only one of three study years, with the combination of residue removal and no-till reducing yields compared to both chisel-till treatments. Cumulative N2O emissions, soil inorganic N concentrations, and yield-scaled N2O emissions differed over the three-year period and were significantly affected by tillage, with no response to residue management.

In two years, no-till decreased cumulative N2O emissions and yield-scaled N2O emissions by an average of 64% and 60%, respectively. While more research across a range of sites and management practices is needed, our findings support previous studies which have challenged Intergovernmental Panel on Climate Change [IPCC] methodology assumptions regarding the effects of residue removal on N2O emissions. We conclude there is inherent difficulty in predicting the impacts of residue removal due to the complexity of soil processes underlying N2O emissions coupled with inter-annual weather variability in this rainfed continuous corn system. Future efforts to evaluate the net greenhouse gas emissions of cellulosic biofuel production may benefit from accounting for this uncertainty.

Results

The objectives of this study were to assess N2O emissions, soil inorganic nitrogen concentrations, grain yield, and grain N content for three enhanced-efficiency nitrogen fertilizers [EENFs] compared with anhydrous ammonia in a rainfed corn system in Illinois over three years [2015-2017]. Treatments included a control [check] and four N sources applied at 202 kg N ha-1: injected anhydrous ammonia, stabilized urea containing urease and nitrification inhibitors

[SuperU, Agrotain International], polymer-coated urea [ESN, Agrium Advanced Technologies], and injected urea-ammonium nitrate [UAN] + nitrapyrin.

Significant reductions in N2O emissions were observed for several EENFs compared with anhydrous ammonia, but results were not consistent across treatments and years. SuperU reduced area- and yield-scaled N2O emissions in two of three study years compared with anhydrous ammonia, while ESN had no N2O mitigation benefit. Injected UAN + nitrapyrin had the highest emissions in the first year but significantly decreased emissions in the second year. No treatment significantly improved yield or grain N content compared with anhydrous ammonia. In light of efforts to broadly promote EENFs in the U.S. Midwest, these results demonstrate there is some promise for N2O mitigation, but the lack of clear crop productivity benefits combined with inconsistent N2O mitigation effects do not support the conclusion that EENFs inherently improve agronomic and environmental outcomes.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants

Outcome #18

1. Outcome Measures

Identifying New And Important Genes And Proteins That Confer Safener-Induced Tolerance In Grain Sorghum

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Herbicide safeners are non-phytotoxic compounds that confer protection to cereal crops by inducing detoxification and defense systems, including massive increases in the expression and activity of glutathione S-transferases [GSTs] and cytochrome P450 enzymes, although the precise mechanisms for crop protection via induction of defense gene expression remain largely unknown. Safeners are frequently used with herbicides that normally cause injury in unsafened cultivated grain sorghum [Sorghum bicolor L. Moench], and are typically applied as seed

treatments to avoid safening weedy sorghum relatives such as johnsongrass [Sorghum halepense]. The overall goal of our project is to reveal and identify new and important genes and proteins that confer safener-induced tolerance in grain sorghum using a diverse array of methods.

What has been done

Using a genome-wide association study [GWAS], 800 diverse sorghum lines were evaluated for phenotypic differences in herbicide tolerance, and the expression of two candidate SbGST genes identified via GWAS were investigated further via gene-specific RT-pPCR. Greenhouse studies were conducted with preemergence pyroxasulfone and S-metolachlor, plus or minus the safener fluxofenim applied as a seed treatment or soil drench, to determine phenotypes for natural herbicide tolerance and safener-induced responses. Data analysis revealed that the molecular marker most significantly associated with safener-induced response was located on sorghum chromosome 9, where a single-nucleotide polymorphism was detected in a phi-class SbGST gene [as well as about 15 kb from a different phi-class SbGST gene]. Transcript levels of these two candidate SbGSTs were quantified in etiolated shoot tissues by utilizing RT-qPCR and gene-specific primers. Constitutive and safener-induced expression of each SbGST in three sorghum genotypes at 4, 8, or 12 HAT [normalized to three stably expressed reference genes] indicated that expression of each gene increased significantly within the 12-hour period following safener treatment. However, expression levels and kinetics of induction by safener differed by specific gene and genotype, suggesting that these SbGST enzymes may play a functional role in the herbicide-safening response. Transcript profiling studies identified numerous safener-induced GSTs, P450s, glucosyl transferases, and vacuolar transporters that are likely involved with cellular herbicide detoxification pathways, but interestingly several new and novel defense-signaling related genes were also induced such as 12-oxo-phytodienoic acid reductases [SbOPRs] and genes related to synthesis and catabolism of the sorghum chemical defense compound dhurrin.

Results

Future experiments will aim to functionally characterize these signaling genes and/or other genes encoding metabolic detoxification enzymes that may also play a role in safener-regulated herbicide tolerance in grain sorghum. The possible connection between safener-regulated detoxification responses and dhurrin synthesis/catabolism in sorghum seedlings is a new and intriguing link that warrants further investigation, and metabolite profiling experiments will help to comprehensively understand how safeners may coordinately regulate and reprogram the transcriptome and metabolome towards enhanced chemical-defense mechanisms. Identifying effective herbicide x safener combinations is an ongoing challenge that limits grain sorghum production in the U.S., but understanding the biochemical and molecular basis of safener-induced detoxification responses via this research will facilitate the discovery of new crop protection chemicals for enhancing herbicide tolerance in cereal crops as well as assist in developing rapid and high-throughput marker-based screening assays to identify sorghum lines with an increased safener response or abiotic stress tolerance.

4. Associated Knowledge Areas

KA Code	Knowledge Area
206	Basic Plant Biology

Outcome #19

1. Outcome Measures

The Development Of Biomass Crop Species That Can Be Grown In Specific And Challenging Environments

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The overall goal of the proposed research is to develop biomass crop species that can be grown in specific and challenging environments. Rather than being a villain with respect to environmental concerns, agricultural producers are stewards of the land. If global warming continues at the predicted pace every citizen of earth will be greatly effected. Agriculture may provide a key to solving global warming. By reducing greenhouse gases, agriculture could alleviate the impact of global warming all over the world. In addition, agricultural producers will also be assisting themselves in preventing the predicted disruption of climate due to global warming such as drought that could result in devastating crop losses that would limit the individual farmer's ability to make a living and seriously jeopardize agriculture's ability to feed the world.

What has been done
Shortly after the initiation of this research, it was expanded to include additional species and other factors that affect telomeres and how plant hybridization would affect adaptation and telomere function. By comparing natural polyploids with induced polyploids in Prairie cordgrass, comparisons of mitotic and meiotic stability between the two different polyploids indicated that the recently induced polyploids have meiotic instability which is indirect evidence for telomeric instability. In addition, a natural neoploid population of Prairie cordgrass was observed to be outcompeting its parental population, indicating that natural selection can increase meiotic stability [and possibly telomeric stability].

Results
Induced polyploids in conjunction with natural selection may play a major role in adaptation to climate change as polyploidy has been hypothesized to increase stress tolerance such as what occurs during climate change. This information may allow plant breeders to produce food and energy crops that will continue to show increasing yields in changing climates. The last data has

been collected from the neopolypoids of Prairie cordgrass and is now being analyzed to show the full potential of this research.

4. Associated Knowledge Areas

KA Code	Knowledge Area
206	Basic Plant Biology

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Master Gardener Program

The **Master Gardener** program continues its core mission of developing a team of volunteers who build and enhance their communities through gardening outreach activities. Extension trained 402 new Master Gardeners in 2018, bringing the total number of active Illinois Master Gardeners to 2,622. These dedicated volunteers contributed 219,272 hours of volunteer time this year. In 2018, Extension launched an online core volunteer training program to expand availability, with 78 participants enrolling in the extensive, self-supporting training program through the digital platform.

The **Master Gardeners Speakers Bureau** program combines digital and high-touch methods to enhance Extension's cost-effective delivery of research-based education. Extension educators prepare educational presentations that Master Gardeners deliver with audiences in their communities. Videos of the webinars are posted so that Master Gardeners can refresh their knowledge and address questions during their presentations. In 2018, eight new topics were developed and presented. Master Gardeners delivered 411 Speakers Bureau presentations in their communities.

The core training curriculum, both via classroom and online methods, demonstrated effectiveness in equipping Master Gardeners with the knowledge and confidence they need to assist residents in their communities engage with their garden and landscapes. A course evaluation was conducted with 159 new Master Gardeners in 2018. Based on self-reported ratings of their knowledge levels before and after their core training, 100% of surveyed trainees reported an increase in knowledge on one or more topics related to plant and landscape cultivation, including 90% with an increase in knowledge required to grow fruits and vegetables. When asked to rate their ability to carry out the responsibilities of their role as community impactors, 86% [N=137] rated their ability to identify and use accurate, research-based sources for garden and landscape information as "high" or "very high"

based on what they gained through the core training.

In 2018, 94 Master Gardeners who attended one or more Speakers Bureau webinars completed a post webinar evaluation. Across all webinars, 84% of trainees [N=79] reported an increase in ability to present on the topic covered. The share reporting they had a "high" or "very high" ability to present on the topic increased from 16% to 72% as a result of the webinars.

The quantitative outcome [N=218] reported for this impact is based on 86% [N=137] of new Master Gardeners reporting an increase in their ability to assist others with lawn and garden activities and the 84% [N=79] of Speakers Bureau webinar participants who reported an increased ability to present on one or more topics covered by the webinar series.

Key Items of Evaluation

Master Gardeners feel well prepared to deliver education and technical assistance as a result of the training and support they receive from Extension staff.

V(A). Planned Program (Summary)

Program # 9

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
133	Pollution Prevention and Mitigation	0%		15%	
136	Conservation of Biological Diversity	0%		10%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%		15%	
206	Basic Plant Biology	0%		15%	
402	Engineering Systems and Equipment	40%		15%	
601	Economics of Agricultural Production and Farm Management	0%		10%	
605	Natural Resource and Environmental Economics	10%		0%	
801	Individual and Family Resource Management	0%		10%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	40%		10%	
806	Youth Development	10%		0%	
	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	0.0	0.0	3.0	0.0
Actual Paid	1.9	0.0	8.3	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**
90829	0	258829	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
90829	0	258829	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
369886	0	1633929	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Activities under this Planned Program in FFY 2018 included several studies for improving biofuels production from corn and biomass feedstocks [developing a process to improve biofuels production by reducing product inhibition, using corn with high amino acid content for ethanol production and for improving the nutritional content of DDGS, producing xylo-oligomer as high value coproduct in biomass to biofuels process, reducing operating costs of dry grind ethanol processes by eliminating the use of exogenous enzymes, and developing a low severity hot water and mechanical refining process of biomass to achieve high sugar yields], a project that will help develop new efficient bioprocesses that are capable of efficiently delivering multiple products [biofuels, foods, and industrial products from a wide range of conventional and transgenic feedstocks], and the development of strategies to recover value added products and characterize components of corn, other cereal grains, and biomass.

Activities also included an investigation into the technical and economic potential for sugarcane ethanol production in Brazil and its land use implications, an examination of optimal biofuel policy in the presence of learning by doing in cellulosic biofuel production and the effectiveness of alternative policies in promoting cost reducing innovations in the biofuel sector under alternative assumptions about market and technological conditions in the oil sector, an examination of the effects of riskiness of energy crops compared to conventional crops and its implications for crop, contract, and location choices for refineries, the development of higher value coproduct solids in process streams to retain bioprocessor competitiveness through new process designs, improved efficiency, reduced environmental impact, and incorporation of new technology, research to establish an integrated computational and experimental pipeline for analyzing both metabolites and metabolic fluxes from various model systems [the primary target model systems are Saccharomyces cerevisiae], and efforts to obtain, plant, cultivate, and evaluate new woody plant germplasm for landscape and bioenergy purposes.

Conference presentations in 2018 included the Advanced Bioenergy Leadership Conference, Workshop on A Decade of Biofuel Policies - Lesson Learned, Coalition on Agricultural Greenhouse Gases, International Consortium of Applied Bioeconomy Research, Advanced Bioeconomy Leadership Conference on Next-Gen of Technology, Coordinating Research Council Workshop on Life Cycle Analysis of Transportation Fuels, and the Agricultural and Applied Economics Workshop.

Extension highlights include the **Smart Grid/Smart Meter** grant that rolled out in 2018 to provide educational workshops about Smart Meters and energy efficiency. The primary target population was rural areas with limited resource populations. During the first year of the grant, 41 workshops were delivered by Extension, serving over 700 residents. Other activities in this planned program included a focus on energy-efficient landscaping and two wind/solar seminars.

2. Brief description of the target audience

Members of the target audience included dry grind, cellulosic ethanol, and bioprocessing companies, seed, enzyme, and equipment manufacturers, bioprocessors that produce biofuels, food, and bioproducts, academics, farmers, policy makers, industry groups, fuel ethanol production facilities, researchers working on improving efficiency of fuel ethanol production, scientists and graduate students in the field of industrial microbiology and biotechnology, producers of energy crops, local conservation groups, crop consultants, farm input suppliers, regional and national agriculture industries, state and national governmental agencies, and members of the nursery industry who work with production of landscape plants. Extension targeted crop producers, landowners [including forestry owners and managers], public officials, agency employees, individuals and families who wish to reduce energy consumption and expenses, and 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	569	58597	246	0

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

Patent Applications Submitted

Year:	2018
Actual:	4

Patents listed

[2016-38-02 [US]] - Recombinant Microorganisms With Mixed Sugar Utilization; [2016-237-02 [US]] - Methods And Compositions For Ethanol Production; [2017-073-01 [PRO]] - Enzyme-Free Bioconversion Of Sucrose And Fructose Into Allulose By Engineered Microorganisms; [TF10122-12 [DIV]] - Thermostable C. Bescil Enzymes.

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	10	10

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number Of Completed Hatch Projects

Year	Actual
2018	5

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

Outcome #1

1. Outcome Measures

Understanding The Causes Of Evaporator Fouling In Maize And Ethanol Production Systems

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Economic Analysis Of The Implications Of Cellulosic Biofuel Production

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
We published the Handbook of Bioenergy Economics and Policy, Volume II. The chapters in this book are grouped into three sections. The first section describes the market forces and policy incentives that have contributed to the development of the biofuel industry in the U.S. and Brazil. Biofuels emerged as an infant industry whose high costs of production required high market prices or policy incentives that level the playing field with their functionally equivalent fossil fuels. These chapters describe the type of biofuel policies pursued in U.S. and Brazil, differences in the structure of the fossil fuel industry and the fossil fuel pricing policies, and the differing role of the government in providing demand side incentives for biofuel production in the two countries. It analyzes the implications of these different approaches for the outcomes over time in the two countries.

The second section describes the methodological and conceptual issues involved in assessing the direct and indirect lifecycle GHG emissions and land use changes associated with biofuel production. Chapters in this section describe the life-cycle approach to GHG accounting, the rationale for including GHG emissions due to direct and indirect land use change, and the role of life-cycle analysis in assessing compliance with biofuel policies in the U.S. and the European Union. It also discusses issues that arise in modeling land use change. Approaches ranging from

stylized models to partial domestic models to global general equilibrium models were presented. These chapters describe the conceptual considerations that should be incorporated and empirical strategies utilized by modelers to represent the determinants of land use change due to biofuels, the mix of biofuels and feedstocks likely to be produced under alternative policy scenarios, and their global impacts on food and fuel prices. These chapters also assess the extent to which biofuel policies in the U.S. and Brazil lead to land use change, the type of land use change likely to occur, and its economic and environmental consequences. The last section includes chapters that discuss the issues related to developing a supply chain for cellulosic biofuel feedstocks, including the contractual arrangements needed to induce biomass production. It includes chapters that review the existing literature on contact design and incentives for technology adoption and discusses the factors likely to influence farmer willingness to produce bioenergy crops and the policies needed to overcome the barriers to do so.

What has been done

We also published a paper that describes future directions for research on sustainable agricultural production taking into account growing demands for food, fuel, and environmental quality. This paper suggests directions for future research in nine key dimensions that can fill important gaps in the existing literature and build on new research methods and policy needs and inform strategies for sustainable growth of agriculture.

Results

We also examined the effect of the increase in corn ethanol production on indirect impacts on the expansion of cropland and its implications for the environment. In particular, land enrolled in the Conservation Reserve Program [CRP] declined by 7.2 million acres between 2007 and 2012 while corn ethanol production more than doubled. However, the extent to which this decline in CRP acres can be causally attributed to increased ethanol production has yet to be determined. Using a dynamic, partial equilibrium economic model for the U.S. agricultural sector we find that doubling of corn ethanol production over the 2007-2012 period [holding all else constant] led to the conversion of 3.2 million acres of unused cropland, including one million acres in CRP, to crop production. While substantial in magnitude, we find that these land use changes due to biofuel production accounted for only 16% and 13% of the total reduction in unused cropland and in CRP acres, respectively, that occurred over the 2007-2012 period. We also found that the land use change per million gallons of corn ethanol has declined non-linearly over time from 453 acres to 112 acres over the 2007-2012 period.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
601	Economics of Agricultural Production and Farm Management
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #3

1. **Outcome Measures**

Toward An Improved Understanding Of How Biofuel Crops Will Impact Habitat Connectivity

Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

Breeding Miscanthus Cultivars With High Yield Potential In The Midwest

Not Reporting on this Outcome Measure

Outcome #5

1. **Outcome Measures**

Increased Knowledge Of Biomass Energy Production And Use

2. **Associated Institution Types**

- 1862 Research

3a. **Outcome Type:**

Change in Knowledge Outcome Measure

3b. **Quantitative Outcome**

Year	Actual
2018	0

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

Issue (Who cares and Why)
Dry grind ethanol production in the U.S. has grown more than 600% in the last ten years due to demand for ethanol as a fuel oxygenate. As of January 2013, there are 193 plants producing 13.85 billion gallons of corn ethanol per year. This is 38.6% of the total biofuels capacity mandated by the year 2022 by the Renewable Fuels Standard within the U.S. Energy Independence and Security Act. Lately, due to high corn and low ethanol prices, profit margins in dry grind ethanol production are shrinking. Further improvements in feedstock, fermentation technology, biocatalysis, and process design are required to increase ethanol productivity, recover new coproducts, and improve plant profitability.

What has been done
Cellulosic biomass can be used for ethanol production due to the abundance of hexose and pentose sugars present. While the basic technology for converting biomass into ethanol has been developed, processing biomass still remains relatively expensive, despite lower feedstock costs. High costs stem primarily from the recalcitrant nature of the harvested biomass and costly pretreatment technologies to deconstruct cell wall structures. Expensive cellulose and hemicellulose hydrolyzing enzymes are required for breakdown of carbohydrates. Finally, low productivity of hexose and pentose cofermenting microbes, and low ethanol titers [final ethanol concentration], also contributes to higher production costs. Recent advances have been made to overcome some of these challenges separately in pretreatment, enzymology, and microbial development. However, a systems approach is missing. As a consequence, there remains a critical need to apply systems thinking and combine these technologies [deconstruction, hydrolysis, and microbiology] and develop an efficient, cost effective system for converting biomass into biofuels.

Results
Under this project several studies were conducted for improving biofuels production from corn and biomass feedstocks: [1] Developed a process to improve biofuels production by reducing product inhibition; [2] Using corn with high amino acid content for ethanol production and for improving the nutritional content of DDGS; [3] Producing xylo-oligomer as high value coproduct in biomass to biofuels process; [4] Reducing operating costs of dry grind ethanol process by eliminating use of exogenous enzymes; and [5] Developed a low severity hot water and mechanical refining [pretreatment] process of biomass to achieve high sugar yields.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
206	Basic Plant Biology
402	Engineering Systems and Equipment
601	Economics of Agricultural Production and Farm Management

Outcome #6

1. Outcome Measures

Generating Biomass Feedstock From Crop Residues And Dedicated Perennial Energy Crops Such As Switchgrass

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The role of production agriculture is very important for the future of sustainable food and biorenewable energy production. With challenges of raising world-wide energy consumption, global climate change, and a deteriorating U.S. rural economy, biofuels produced from bio-renewable resources are drawing attention. A biobased industry has the potential to reduce reliance on fossil fuels, decrease greenhouse gas emissions, and strengthen rural economies.

The U.S. agro-ecosystem is still largely focused on providing raw materials for the food and feed industry rather than chemicals and fuels. Therefore, the future demand for liquid fuels can only be met by increased plant productivity and much improved biomass-to-fuel conversion efficiency. Biobased renewable resources can be obtained from a wide range of agricultural crops, forestry products, and processing industries. The 2007 Energy Independent and Security Act mandates 36 billion gallons of biofuel production, with 21 billion gallons coming from advanced biofuels such as ethanol from cellulosic biomass feedstock, by the year 2022. Twenty one billion gallons of biofuel will require over 350 million tons of dry cellulosic feedstock annually. To meet the U.S. federal goal, a significant portion of biomass feedstock will come from production agriculture including crop residues and dedicated perennial energy crops such as switchgrass [Panicum virgatum] and other native grasses.

Switchgrass and other native grasses growing on marginal and less productive soils as a renewable bioenergy crop have many obvious environmental and economic benefits including improved soil conservation, enhanced energy gain, and reduction of greenhouse gas emissions. Over the past fifteen or so years, switchgrass has been extensively evaluated for potential as a bioenergy crop across the nation and in many parts of the world. As a result, a considerable amount of information is currently available on switchgrass biomass production. However, most of these studies were conducted with conventional varieties, which were developed for forage production rather than high biomass production. In addition, recent studies revealed that feedstock diversity is one of most important considerations for sustainable production. Obviously, identifying and developing high yielding dedicated energy crops for various land types are the necessary steps to meet the national goal for sustainable bioenergy production using perennial grasses.

What has been done

The U.S. has access to significant amounts of biobased resources, including those of the highly productive corn/soybean cropping system in the central U.S. [arguably the largest man-made ecosystem on the planet]. Corn stover represents the largest quantity of biomass residue in the U.S. with over 250 million dry tons produced annually, and as a consequence, it is a formidable renewable biomass resource which can be used to produce chemicals and biofuels. However, our efforts on corn production systems are currently limited to grain yield and other traits related to nutrient use efficiency and stress tolerances. Since we are now looking for total biomass increase and stover composition as well as grain yield, it is important to add our effort on total biomass production.

Results
All biomass harvests were completed, and during this reporting period we focused on feedstock chemical composition analysis, data analysis, and manuscript writing. We published two manuscripts related to this research. The first manuscript, "Warm-Season Grass Monocultures and Mixtures for Sustainable Bioenergy Feedstock Production in the Midwest, USA" provided valuable information on the selection of bioenergy crop species, cultivars, and mixtures to the scientific community and local producers and revealed the importance of early season [April-June] precipitation, no more than the region's 30 year average, for sustainable biomass production. The second manuscript, "Cellulosic Ethanol Potential of Feedstocks Grown on Marginal Land" demonstrated that switchgrass and prairie cordgrass could be a good option for ethanol production on wet and salt affected marginal lands. Also, this manuscript revealed that high ash concentration caused by soil salinity does not interfere with ethanol fermentation. A third manuscript is nearing completion. This manuscript will provide best management practices information for warm-season energy crop production on marginal land.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
201	Plant Genome, Genetics, and Genetic Mechanisms
206	Basic Plant Biology

Outcome #7

1. Outcome Measures

Improving The Bioconversion Of Xylose

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The bioconversion of xylose into high-value fuels and chemicals by engineered Saccharomyces cerevisiae has been a long-term goal of the metabolic engineering community. Although most efforts have heavily focused on the production of ethanol, yield and productivy of ethanol produced from xylose has remained inferior as compared to ethanol produced from glucose.

However, this narrow-sighted focus on ethanol has concealed the fact that many aspects of xylose metabolism favor the production of non-ethanol products.

What has been done

Through reduced overall metabolic flux, a more respiratory nature of consumption, and evading glucose signaling pathways, the bioconversion of xylose can be more amenable to redirecting flux away from ethanol towards a desired target product. We show that coupling xylose consumption with a mitochondrially-targeted isobutanol biosynthesis pathway leads to enhanced product yields and titers as compared to cultures utilizing glucose or galactose as a carbon source. Through optimization of culture conditions, we achieved production of 2.56 g/L and 2.6g/L isobutanol in fed-batch flask and bioreactor fermentations, respectively.

Results

In order to gain some insight into why xylose assimilation leads to a nearly six-fold improvement in production of isobutanol, we performed metabolite profiling to obtain a systems-level analysis of the strains cultured in different carbon sources. Principle component analysis showed a clear separation between the metabolite profiles obtained from glucose and xylose cultures. Additionally, there were clear differences in the quantity of valine and isoleucine, key metabolites related to the isobutanol production pathway. While isoleucine contents were higher in glucose cultures, xylose cultures led to increased accumulation of valine.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
402	Engineering Systems and Equipment
601	Economics of Agricultural Production and Farm Management

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Programmatic Challenges

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

There were no evaluations conducted for this planned program.

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 10

1. Name of the Planned Program

4-H Youth Development

☑ 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
806	Youth Development	100%		0%	
	Total	100%		0%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.0	0.0
Actual Paid	68.9	0.0	0.0	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**
3269832	0	0	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
3269832	0	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
13315879	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

4-H Club enrollment in Illinois totaled 24,408 in 2018. Recruitment efforts resulted in 8,563 new first year members in 2018. Nearly 200,000 youth were involved in some type of 4-H program such as clubs or programs offered at the community level to address a special interest, during school, at a partner site, or at

a military installation. Youth also had opportunities to experience 4-H through conferences and camps. The **4-H Memorial Camp** is used 190 days per year with 8,500 unique guests this year. A total of 1,280 youth participated in the five-week experience while developing new skills, new friendships, and independence.

Efforts continued to focus on expanding these 4-H opportunities to underserved youth including those in metro areas of 100,000 or more to meet the needs of urban youth. Extension youth development educators and Extension program coordinators continued to focus efforts to create opportunities for inclusion of youth of Hispanic ethnicity and in expanding opportunities for teens to assume leadership roles as advocates for change, planning activities, promoting 4-H impact, advising partnering councils, mentoring peers, or teaching others. Gains have been made to engage minority youth, and specifically youth of Hispanic ethnicity. Over the past six years, 4-H minority club membership is up 59% and 4-H Hispanic club membership is up 176%.

Adult 4-H volunteers are the lifeblood of program, serving as caring adults who create an environment that is a critical element of positive youth development. This past year over 11,000 adult volunteers gave their time and talents to the 4-H Youth Development program in Illinois with approximately 3,506 unique adults serving as club leaders. Leaders had instant access to seven online courses to help them carry out their role. In addition to a basic course orienting new volunteers, other course topics included an overnight chaperone orientation, child protection, parliamentary procedure, working with committees, club program planning, and public presentations. Extension program coordinators provide both group-based continuing education and individualized technical assistance to support 4-H adult volunteers.

Educational priorities for all 4-H delivery systems remain focused on: [1] College and career readiness; [2] Food access; [3] Environmental stewardship; [4] Leadership; and [5] Health.

Activities and programs focused on youth career exploration and workforce preparation included the **Illinois Summer Academies** conferences held on the University of Illinois campus. High school teens [280] spent three days exploring the college campus and engaging in hands-on workshops conducted by professors and graduate students in career fields of their choice. For many teens, it was their first time on the University of Illinois campus and their first time to consider potential college majors and future careers. With 40% who reported a minority affiliation and 10% who identified as Hispanic, this pipeline to college experience promotes inclusion of youth audiences who benefited from exposure to over seventeen academic areas of study offered at the conference in 2018.

Welcome to the Real World, a multi-disciplinary curriculum and simulation that allows youth to explore careers and money management [balancing income and expenses] in adult life, was delivered to 3,385 youth in 2018 [this activity is further discussed in the Agricultural and Consumer Economics planned program].

To promote college and career readiness, Illinois has continued to place strong emphasis on engaging youth in science, technology, engineering, math and agriculture. Across Illinois, 4-H participants enrolled in over 37,000 STEM-related projects in 2018. Reaching 5,492 youth in 121 schools, the **4-H Incubation and Embryology** program was implemented by Extension-trained teachers to apply STEM in the classroom. Robotics remains a strong way to provide youth with hands-on learning to building STEM-related skills. Statewide, there were 9,100 individual and group enrollments in Robotics and Computer Science projects in 2018. Regional events provided 1,394 youth [76% minority] in nine Illinois counties with more than twenty hours of STEM training. The State Robotics Competition drew 420 youth from 22 counties where participants reported gains in STEM-related skills and in the ability to work in teams.

Illinois 4-H responded in amazing ways to the hunger/food insecurity challenge facing their communities. In 2018, youth and adult volunteers contributed to solutions including community gardens, meals for food

pantry patrons, a weekend backpack program, canned food drives, meal packaging events, and creating mobile pantries. In 2018, 88,000 pounds of food were distributed through mobile markets alone, benefiting over 4,700 individuals. Through the individual and collective efforts of the **Illinois 4-H Feeding and Growing Our Communities** outreach program over 10,000 volunteers have spent over 43,000 hours packaging and distributing over one million meals to 7,500 families to address food insecurity in tangible and responsive ways, since the program's inception in 2014.

The **I Think Green** curriculum was developed by 4-H and horticulture Extension specialists to engage Kindergarten through 8th grade youth in investigating how living things interact with each other and with their environment [also discussed in the Natural Resources and the Environment planned program]. Through individual and group exploration, over 62,000 4-H project enrollments focused on the environment and natural resources. This includes popular programs such as **Monarchs on the Move**, **4-H Honey Bee Challenge**, **Citizen Scientist**, and **4-H Healthy Soils CSI**.

A hallmark of the Illinois 4-H Youth Development program is to build leaders for both today's and tomorrow's world. In 2018, the **4-H Junior Leadership Conference** was attended by 98 middle school youth who represented 39 counties in Illinois. The **Speaking for Illinois 4-H** program trained 252 youth to tell their 4-H story about the impact of the 4-H program with legislators in 2018. In the spirit of positive youth development, nearly 1,000 youth demonstrated their leadership through serving as **Teen Teacher** volunteers and **Illinois 4-H Feeding and Growing Our Communities** volunteers this past year.

The 4-H Food Smart Families partnership with the Illinois Supplemental Nutrition Assistance Program - Education [SNAP-Ed] continued to expand in 2018. The **Illinois Junior Chefs** program engaged over 4,700 youth ages 8 to 13 in 2018. **Health Jam**, a popular program supported by Teen Teachers, provided 1,109 youth [85% minority and 71% Hispanic] with a nine-week healthy living program that focuses on both health careers and healthy behaviors. Other healthy living programs offered in 2018 include the **4-H Food Challenge**, where youth experiment in healthy cooking using a mystery ingredient, and **Health Rocks!**, a ten-hour program focusing on empowering young people to build their knowledge and skills to resist peer pressure and avoid using alcohol, tobacco and other drugs.

2. Brief description of the target audience

4-H youth development has broadened its target audiences to include urban, Hispanic, and military family youth between the ages of 8 and 19, youth leaders [paid and volunteer], teen teachers, adult leaders of 4-H clubs and other youth-serving organizations, parents, and community members.

3. How was eXtension used?

Four members of the 4-H Youth Development Team are members of one or more Communities of Practice in eXtension.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	67157	105247	417430	957517

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	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number Of Completed Hatch Projects

Year	Actual
2018	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Youth Will Demonstrate Leadership Efficacy [Citizenship Common Measure Indicator]
2	Cumulative Effect Of 4-H Participation Through The Development Of Skills And Competencies In Making Choices, Forming Connections, Effectively Communicating, And Applying Content Results In Citizens Who Contribute To Their Community And To The World [Universal Common Measure Indicator]
3	Youth Will Demonstrate The Ability To Communicate Through Multiple Methods And Media [Universal Common Measure Indicator]
4	Youth Will Express Interest And Be Engaged In Science Related Activities [Science Common Measure Indicator]
5	Youth Participate In Community Service And Volunteer [Civic Engagement Common Measure Indicator]

Outcome #1

1. Outcome Measures

Youth Will Demonstrate Leadership Efficacy [Citizenship Common Measure Indicator]

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	83

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Research shows that youth who engage in their communities become adults who are actively engaged. It is important to provide opportunities to enable youth to affect and influence others through their actions and ideas.

What has been done
The Illinois State 4-H Youth Leadership Team plans and leads the annual Illinois Junior Leadership Conference for 7th and 8th grade 4-H members. All activities and workshops are developed by the 4-H Youth Leadership Team teens in partnership with adult volunteers. This overnight conference offers a chance to explore new 4-H project areas, learn activities and games they can take home to their 4-H clubs, and learn and practice new leadership skills and interact with other 4-H members from around the state. Participants leave with a better understanding of the opportunities available in the Illinois 4-H program and learn how to make a difference in their own communities. In 2018, 98 youth attended from 39 counties.

Results
Participants were asked to complete an end-of-conference evaluation to determine what they learned and what they will do as a result of new knowledge and skills. All Illinois Junior Leadership Conference participants completed the end-of-conference survey in 2018. Using the a 4-part scale [1 = "Strongly Agree", 2 = "Agree", 3 = "Disagree", and 4 = "Strongly Disagree"], youth were asked to respond to a series of statements about self-efficacy to demonstrated leadership skills, what they learned during the conference, and to what extent they plan to translate that knowledge into action. A majority [83 out of 98 respondents] agreed that they learned skills they can use with their 4-H projects or take back to their 4-H clubs. Through application of what they learned, these youth leaders have the potential to influence hundreds of 4-Hers across 39 counties in Illinois.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #2

1. Outcome Measures

Cumulative Effect Of 4-H Participation Through The Development Of Skills And Competencies In Making Choices, Forming Connections, Effectively Communicating, And Applying Content Results In Citizens Who Contribute To Their Community And To The World [Universal Common Measure Indicator]

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Youth Will Demonstrate The Ability To Communicate Through Multiple Methods And Media [Universal Common Measure Indicator]

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Youth Will Express Interest And Be Engaged In Science Related Activities [Science Common Measure Indicator]

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	2746

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
According to the Department of Labor's Bureau of Labor Statistics, STEM fields have the greatest

potential for job growth in the 21st century. Engaging youth early in scientific discovery is important for skills and interest to grow over time.

What has been done
The 4-H Incubation and Embryology Project has been implemented in elementary school classrooms for over two decades using hands-on science concepts in caring for and observing the growth process of chicken embryos from the inception of the eggs through hatching of chicks. Curriculum development and training was provided to teachers by an Extension poultry faculty member and by local educators. Teachers were trained to conduct classroom incubation and embryonic development projects. Detailed information on the stages of embryonic development and the preservation of embryos is included. Instructional methods include lectures, discussions, demonstrations, and visual aids. Teachers are provided hands-on suggestions for how to use classroom incubation and embryonic development projects to enhance programs in science, language arts, mathematics, social studies, and art.

Results
Evaluations were collected from 121 teachers who implemented the program across 19 counties in 2018. Collectively, respondents reported reaching a student population of over 5,492 students with the program. About 75% of teachers reported teaching Kindergarten - 2nd grade and 25% reported teaching 3rd - 11th grade. The goal of the evaluation was to use teacher observations to detect student changes in science abilities and life skills as a result of participating in the program. Using a 4-part scale [1 = "Not at All", 2 = "Sometimes", 3 = "Usually", and 4 = "Always"], teachers were asked to rate their students [as a group] with respect to science abilities and life skills before and after the program. Teacher ratings of students' pre-program science competencies were compared with ratings of students' post-program competencies. For every science skill rated and for every life skill rated, a higher proportion of teachers reported that their students "Usually" or "Always" demonstrated the skill after the program compared to before the program.

Teachers were also asked to query their students, through a show of hands, to gauge how their students felt about the program, about science, and about their interest in a future job related to science. Nearly all [95%] of teachers reported that the majority of students raised their hands when asked if they want to learn more about science. With a conservative estimate of 50% of the students [majority] expressing an interest in learning more about science, an estimated 2,746 youth expressed an interest in science as a result of their participation in the 4-H Incubation and Embryology Program. Additionally, 65% of teachers reported that the majority of students raised their hands when asked if they would like to have a job related to science.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #5

1. Outcome Measures

Youth Participate In Community Service And Volunteer [Civic Engagement Common Measure Indicator]

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	948

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Research shows that youth who engage in their communities become adults who are actively engaged. It is important to provide opportunities to enable youth to affect and influence others through their actions and ideas. In addition to the benefits to the community and to the personal development and growth of the youth volunteer, there are also tangible benefits for building a track record of experience for job and college applications. It's a win-win situation in which youth learn how to impact the lives of people in the world around them and the experience, in turn, forever changes the life of the young volunteer.

What has been done
The 4-H Youth Development Program offers countless local opportunities for young people to become engaged in service to their community, whether through a local community donation garden or assisting with other community programs. Two of the larger, more structured, service opportunities are participation in the Illinois 4-H Feeding and Growing Our Communities project and training to serve as a Teen Teacher. In 2018, 386 youth participated in the Illinois 4-H Feeding and Growing our Communities Program while learning ways they can take action to fight hunger in their communities. The Teen Teacher training was offered to 562 high-school age youth throughout the state, who attended one or more of the 147 educational sessions offered. Examples of programs Teen Teachers volunteered to facilitate include Illinois Junior Chefs, Health Jam, and Health Rocks where the "near peer" social influence resonates with their younger peers when learning about how to make healthy choices and avoid risky choices.

Results
Across these two programs alone, the Illinois 4-H Youth Development Program trained, supported, and inspired 948 youth to give back to their community in order to make a difference in the lives of others. Both programs conducted surveys of the volunteer participants to understand how they felt about their volunteer experience. Of the 191 youth surveyed as part the Feeding and Growing Our Communities food access program, 97% said that 4-H has inspired them to volunteer in their community. A subset of Teen Teachers [N=67] completed a survey in 2018 to better understand how the experience of being a Teen Teacher impacted them. A strong majority [95%] reported that they "Agree" or "Strongly Agree" that they had an opportunity to help with a project that made a difference.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

4-H Incubation and Embryology Program

Using materials developed by a University of Illinois poultry specialist in conjunction with state and local 4-H staff, 121 teachers responded to a survey asking them to share their perceptions of the impact of the multi-week 4-H Incubation and Embryology Program. A reported 5,492 students in Kindergarten-11th grade classrooms participated in the program in 2018.

Based on a 4-part scale [1 = "Not at All", 2 = "Sometimes", 3 = "Usually", and 4 = "Always"], teachers were asked to rate their students [as a group] with respect to demonstration of specific **science skills** before and after the program. For every life skill rated, a higher proportion of teachers reported that their students either "Usually" or "Always" demonstrate the skill after the program compared to before the program.

Student science skills rated by teachers included the ability to collect data, evaluate, problem solve, summarize, interpret/analyze/reason, communicate/demonstrate, hypothesize, question, observe, and predict. There was a statistically significant improvement in teacher ratings of each science skill, comparing ratings before the program to after the program.

Using a 4-part scale [1 = "Not at All", 2 = "Sometimes", 3 = "Usually", and 4 = "Always"], teachers were asked to rate their students [as a group] with respect to demonstration of specific **life skills** before and after the program. For every life skill rated, a higher proportion of teachers reported that their students "Usually" or "Always" demonstrate the skill after the program compared to before the program.

Student life skills rated by teachers included critical thinking, communication, planning/organizing, accepting differences, self-responsibility, teamwork, sharing, concern for others, cooperation, and keeping records. There was a statistically significant

improvement in teacher ratings of each life skill, comparing ratings before the program to after the program.

Teachers were also asked to query their students, through a show of hands, to gauge how their students felt about the program, about science, and about their interest in a future job related to science. Nearly all [95%] teachers reported that the majority of students raised their hands when asked if they want to learn more about science and 65% of teachers reported that the majority of students raised their hands when asked if they would like to have a job related to science.

Teacher ratings of student life skills and science competencies suggest that the program was successful in supporting enhancement of science skills that are crucial building blocks for STEM-related careers. Students responded positively to the program and to interest in science-related careers.

Key Items of Evaluation

4-H Incubation and Embryology Program

Using materials developed by a University of Illinois poultry specialist in conjunction with state and local 4-H staff, 121 teachers responded to a survey asking them to share their perception of the impact of the multi-week 4-H Incubation and Embryology Program. A reported 5,492 students in their Kindergarten to 11th grade classrooms participated in the program.

Teachers were more likely to report that their students "Usually" or "Always" demonstrated every targeted science skill after the program compared to before the program. Teachers were also more likely to report that their students "Usually" or "Always" demonstrated every targeted life skill after the program compared to before the program.

Teacher ratings of improvements in student life skills and science competencies suggest that the program was successful in supporting enhancement of science skills that are crucial building blocks for STEM-related careers.

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)	
4	Number of new crop varieties, animal breeds, and genotypes whit climate adaptive traits.
Global Food Security and Hunger (Outcome 1, Indicator 4.a)	
0	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)	
22	Number of new or improved innovations developed for food enterprises.
Food Safety (Outcome 1, Indicator 1)	
3	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.