2016 Pennsylvania State University Combined Research and Extension Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

Penn State's Agricultural Experiment Station (AES) and Cooperative Extension Service (CES) operate in concert within the College of Agricultural Sciences to address present and future needs in agriculture at local, state, national, and international scales. The College has taken bold, proactive measures to reduce costs, increase operational efficiencies, and maintain the highest possible level of services for our students and stakeholders. We are exploring various methods of increasing financial sustainability of our programs.

Our research efforts, as outlined in the College's 2014-2019 strategic plan, fall into the planned programs below. The planned programs are dynamic and allow for the development and integration of new scientific approaches. Departmental annual reviews and strategic plans, as well as their signature research areas, also inform the planned programs.

Advanced Agricultural and Food Systems-Transforming thinking and practice in agricultural and food systems through research and extension programming focused on productivity, sustainability, and adaptability.

Biologically Based Materials and Products-Discovering novel approaches to using genetic systems and biological materials for value-added commercial and consumer products. Laying the groundwork for biobased energy and industries in Pennsylvania.

Community Resilience and Capacity-Helping communities improve their economic resilience, create sustainable infrastructures, and promote their local economy through value-added opportunities, new business development, and improved efficiency in established operations.

Environmental Resilience-Providing innovative research and extension programming to enhance and protect managed and natural ecosystems, ecosystem services, and human well-being. Exploring potential issues resulting from global climate change, and possible mitigation and adaptation.

Global Engagement-Providing global solutions to challenges in agriculture, health, and sustainability that impact the future of an interconnected world.

Integrated Health Solutions-Advancing and improving the health of animals and communities through research and extension programming into preventive, corrective, diagnostic, and predictive solutions to challenges presented by food safety, lifestyle, diseases, pests, and toxins.

Positive Future for Youth, Families, and Communities-Providing a wide range of evidence-based programming to support healthy families, build positive youth skills, and strengthen intergenerational relationships within rural and urban communities.

We developed the planned programs by analysis of cross-cutting emerging themes across the College. We solicited and received input from broad internal and external stakeholder groups, such as from the

College leadership advisory groups, topical faculty focus groups, college employees, and the Penn State Ag Council.

We are energized by the interdisciplinary and global nature of the new planned programs. Diverse teams of faculty from the College of Agricultural Sciences are addressing complex societal issues that transcend disciplines to impact people on scales ranging from local to global.

Our planned programs capture the systems approach that we have identified as a key element for generating impact, uniting our research efforts with our extension education capacity. Penn State provides an environment that encourages interdisciplinary work and values outreach to stakeholders. The University has built a framework of university-wide consortia and institutes (e.g., Life Sciences; Energy and Environment; Social Sciences--Children, Youth, and Families; Materials; Ethics; Sustainability), and the College of Agricultural Sciences plays an integral role in these organizations. This interdisciplinary philosophy has reinforced the natural tendency of our faculty and extension educators to work cooperatively to solve problems. Coupled with the joint research-extension appointments of many of our college faculty, our work effectively unites fundamental knowledge with practical solutions delivered to stakeholders. The net result is a tangible benefit in economic prosperity and quality of life for Pennsylvania citizens and beyond.

Our programs continue to focus on high profile problems that, in addition to their impact in Pennsylvania, frequently represent regional, national, and international priorities. Below are just a few highlights from our research program this year.

In Advanced Agricultural and Food Systems, our investigators explored the cost to dairy farms of complying with federal occupational safety and health inspections; the cost savings of nematicide not sprayed in Northeast peach and apple orchards by using crop rotation and biofumigation; and the increase in net returns from interseeding a cover crop into cash crops.

Innovations in machinery and technology include investigating harvest efficiency of a prototype apple harvest-assist unit; further refinement of the InterSeeder cover crop planter; and development of a smart-phone app for management of barley yellow dwarf virus in cereals.

In Biologically Based Materials and Products, some highlights include the application for a patent on a natural food colorant from avocado, and the development of a patented biofoam pad composed of potato starch and chitosan from shellfish for wound and trauma care.

In Community Resilience and Capacity, Penn State researchers assessed the value of Cooperative Extension programs nationally in helping farmers stay in business; analyzed opportunities for growth in the Mid-Atlantic wine industry; helped lead a local community engagement and economic development effort that resulted in the development of 12 new businesses; and generated $ 17.1 million in economic impact through their work with the hard cider industry in PA.

In Environmental Resilience, our faculty helped lead research to determine the cost savings due to reduced pesticide use by PA tree fruit growers who supported populations of a beneficial predatory mite. Another team measured the annual expenditure on bottled water in PA shale counties as a measure of concern about drilling's potential effects on drinking water quality.

A Penn State team surveyed thousands of Pennsylvania farmers to inventory their self-financed water quality best management practices benefitting Chesapeake Bay cleanup efforts. The Chesapeake Bay Program's Ag Workgroup approved the survey process, and U.S. EPA approved the process for use in other states.

Other researchers investigated the relative effectiveness of U.S. Federal Emergency Management Agency expenditures on hurricane-induced property losses; the effects of deer browsing preferences on invasive plant spread; and the impacts of climate change on above- versus belowground parts of arctic plants.

A team in the college is collaborating widely to develop the next generation suite of science-driven modeling and analytic capabilities. The community of practice will focus on analysis of the stressors, impacts, adaptations, and vulnerabilities of global and regional change, with emphasis on understanding the energy-water-land nexus.

In Global Engagement, highlights include study of poverty and food insecurity in rural India; pathogenesis in cacao plants; and potential changes in malaria transmission with climate change. Our scientists also led efforts to develop a rapid method for assessing root architecture in service of the quest for more drought-tolerant crop lines, and to develop and implement an international youth engagement curriculum.

In Integrated Health Solutions, project highlights include the study of invasive plants on malaria control, and human dimensions of dairy mastitis management. Our long-running Dining with Diabetes extension program continues to produce statistically significant improvements in health outcomes and large health-care cost savings.

Our food safety team studied the efficacy of cold fill pickling for safe processing of sausage, and microbial contamination of surface water used for crop irrigation in PA. They are also looking into the presence of listeria in fruit processing by exploring routes of transmission and conducting anonymous surveys. The safety of food sold at farmers markets is another focus of the food safety team.

In Positive Future for Youth, Families, and Communities, our agricultural safety and health program continues to produce cost-saving and injury prevention programs, this year in farm equipment and rural transportation accidents and in workplace safety for Hispanic/Latino crop workers.

Penn State researchers also led investigations of national Hispanic health insurance coverage rates in new and established destinations, and the influence of neighborhood food environment factors on obesity status.

PA AES and CES must be responsive to new societal needs, investing our federal funds in a manner that furthers national agricultural goals, but also addressing the local implications of those national priorities. Our renowned pollinator research group found that bumble bees can detect the nutritional quality of pollen, and that this ability helps them selectively forage among plant species to optimize their diets. These studies can help identify plant species and stocks that provide high-quality nutrition for bumble bees and potentially other bee species, which will help in the development of pollinator-friendly plantings. These tactics may help in the face of worldwide decline of bees.

An important initiative within our College is to establish Penn State as a leader in the field of gender issues in agriculture and the environment, both domestically and internationally. Our team is developing a network of scholars and researchers to initiate and respond to new opportunities for research, instruction, and evidence-based outreach that address the intersections of gender with agricultural and environmental sciences. With leveraged funding we have developed Women in Ag Networks (WAgN) in Honduras and Cambodia.

The College continues to focus our program deliverables, align program priorities with budget realities and changing needs, excel in research and education on topics of greatest importance to Pennsylvania citizens and industries, operate as a cohesive organization, and be more efficient in our operations.

A few explanatory notes regarding the report that follows:

In the planned program descriptions, we highlight specific projects with notable results. Many more projects are underway that are not specifically mentioned in the state-defined outcomes. We strive to highlight different projects each year, so as to best portray the breadth of our program. Many of the projects previously reported on, including work with underrepresented groups such as Hispanics, Anabaptists, young growers, and grand-families, continue.

In addition, the variances in contact numbers (both direct/indirect and adult/youth) from previous years are a result of a number of factors as explained below and in the external factors of each section. While the numbers throughout the report may increase/decrease, we feel that the numbers we are providing are accurate to the best of our knowledge. Please note that we are constantly improving the mechanism for collecting this important data. For example:

- Resource loss - decrease in educator positions, less funding, etc. (Nutrition Links, Shale Team, Poultry, Equine, PROSPER participants)
- Increased resources - new hires, new monies, etc. (Livestock, Forage and Field Crops, StrongWomen)
- Refocused programs - due to need or redirection related to emerging issues (i.e. avian influenza, previous one-time events with relatively large audiences, etc.)
- Data Management - new method of recording contacts allowed for more accurate reporting
- Capturing New Programming - new programs that previously were not part of our data collection tool have been included in this year (Youth Workforce Readiness, Vibrant Communities, School-Based Healthy Communities, Business and Dairy Herd Management, Environmental Stewardship, Positive Weed Control, Youth Watershed, Pesticide Education, Farm Safety, and collaborative programming with beef industry partners)
- Inaccurate date reported in previous years (Poultry, Dairy, Livestock, Renewable Natural Resources)

Total Actual Amount of professional FTEs/SYs for this State

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	464.6	0.0	696.5	0.0
Actual	464.2	0.0	615.5	0.0

II. Merit Review Process

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

- Internal University Panel
- External University Panel
- External Non-University Panel
- Combined External and Internal University Panel
- Combined External and Internal University External Non-University Panel
- Expert Peer Review

2. Brief Explanation

Both CES and AES programs undergo comprehensive review utilizing a number of merit review processes.

Internal university panels were used to review AES projects. The Hatch, McIntire-Stennis, Animal Health, and State projects were internally reviewed at initiation by at least two qualified faculty. In addition, external university panels are used for Multistate Research Project (MRP) activities. Both extension and academic faculty are encouraged to participate to meet the jointly agreed objectives. These projects are reviewed multiple times through the five-year duration.

External non-university panels are used as new Penn State extension programmatic issues or AES projects are implemented. Stakeholder and/or program advisory groups provide ongoing review of programs to ensure a focus on priority needs as identified by advisory groups. Reviewers' comments provide mechanisms for improving our educational and research programs.

Combined internal and external university panels are assigned to each of the programmatic issues. These panels are integrated, multidisciplinary State Extension Units made up of field-based extension educators and faculty with split appointments in both extension and research. Unit members broadly represent all parts of the Commonwealth, and faculty members are chosen to represent relevant research and extension perspectives. Extension Assistant Directors of Programs provide overall leadership to the State Extension Units, and programs are reviewed by extension administrators. State administrators and academic unit leaders serve as liaisons to each unit. Each State Extension Unit developed a program plan, based on logic model components, that guide extension programming and applied research efforts.

Combined internal and external university and external non-university panels were used to create advisory committees for each State Extension Unit. These panels assisted in identifying issues where expertise can be applied in program efforts. The work plans were developed and revised with input from the advisory committees.

III. Stakeholder Input

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

- Use of media to announce public meetings and listening sessions
- Targeted invitation to traditional stakeholder groups
- Targeted invitation to non-traditional stakeholder groups
- Targeted invitation to traditional stakeholder individuals
- Targeted invitation to non-traditional stakeholder individuals
- Targeted invitation to selected individuals from general public
- Survey of traditional stakeholder groups
- Survey of traditional stakeholder individuals
- Survey specifically with non-traditional groups
- Other (County Extension Boards)

Brief explanation.

College administration and faculty advisory groups conferred regularly with key stakeholder groups. The Penn State Ag Council (http://agcouncil.cas.psu.edu) provided us with direct contact to nearly 100 member organizations and groups representing the agricultural industry across Pennsylvania. Also part of the Ag Council membership are organizations such as the Chesapeake Bay Foundation

and the County Commissioners Association of Pennsylvania. We sought input for all sectors representing the interests of Pennsylvania citizens. In addition, college leadership met multiple times per year with individual stakeholder groups, such as the Pennsylvania Farm Bureau, PennAg Industries, Pennsylvania Forest Products Association, Pennsylvania Department of Agriculture, State Horticultural Association of Pennsylvania, etc.

Also in our stakeholder base are state and federal partners, with whom we had regularly scheduled meetings, including the Pennsylvania Department of Environmental Protection, Pennsylvania Department of Conservation and Natural Resources, the Pennsylvania Department of Health, the US Department of Agriculture's Agricultural Research Service and Animal and Plant Health Inspection Service, and the US Environmental Protection Agency.

Listening sessions, such as routine meetings with the Penn State Ag Council, were held to seek input from the representative traditional and non-traditional stakeholders.

The Department of Plant Pathology and Environmental Microbiology hosted strategic planning meetings with prominent members of the potato and mushroom industries in Pennsylvania to outline issues facing these industries that would benefit from Penn State research, to evaluate Penn State expertise and resources available, and to document gaps and develop strategies to fill them. Industry stakeholders and faculty attendees agreed that the collaboration was beneficial and similar meetings are being planned for the coming year.

Targeted invitations to traditional and non-traditional stakeholder groups and/or individuals were used heavily in our extension efforts. Invitations were extended to these stakeholders and members of the general public to identify industry representatives and/or individuals that would formulate program advisory committees (e.g., Ag Business/Economic and Community Development Advisory Committee, Intergenerational Initiatives Advisory Group, StrongWomen program leaders, PROSPER program collaborators, etc.).

Surveys and/or focus groups meetings of traditional and non-traditional stakeholder groups and/or individuals were used to collect more detailed information from stakeholders.

Stakeholder input was continually sought to help set the course for CES and AES programs, primarily through Cooperative Extension. More statewide extension programs are using retrospective evaluation to gather information about the number of participants who actually put into practice lessons learned through extension programs. Measuring costs averted or profit increased can show powerful, tangible benefits of our programming. The results of these assessments are available as resources to all extension personnel through the internal Extension Program SharePoint site.

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

1. Method to identify individuals and groups

- Use Advisory Committees
- Use External Focus Groups
- Other (External Consultants)

Brief explanation.

Advisory committees, such as program advisory committees at the county, district, and state extension unit level and the University Industry Advisory Committee, assisted our programs with

identification and selection of stakeholder individuals and groups. Program advisory committee members were selected to represent program areas, emerging issues, geographic areas, and population diversity. These groups helped extension educators with program design and implementation, which may include identifying resources to support the programs, tailoring the content to specific audience needs, and marketing the programs to targeted audiences and communities.

External focus groups, such as the County Extension Boards, were representative of demographics of the county/district in which they serve, and where appropriate, Hispanics, African Americans, Asians, Anabaptists, or other minorities serve on the groups and provide input to extension programs. Our programs met the needs of traditional agricultural information consumers (e.g., farmers, rural residents), as well as homeowners, newer audiences in urban areas, and, increasingly, those historically underserved by extension.

Penn State Ag Council meetings were publicly announced, and broad representation was continually reassessed to ensure the inclusion of new and traditionally underserved audiences.

External consultants (i.e., Aspen Group, Fieldstone Innovations, etc.) were contracted to assist in identifying industry stakeholders that can provide leveraging dollars and research opportunities for faculty, and help establish long-term working relationships.

Maintaining contact with alumni is an important strategy throughout the College. This helps meet our students' needs for career networking, builds direct links to our stakeholder groups and industries, and increases the likelihood of leveraging funds in the future. Alumni and friends banquets and football tailgates were common throughout the College, and enjoyed continuing high attendance.

Our faculty served on dozens of state and federal government and professional association boards and groups. Their selection and election to these roles reflects their stature in their fields. They will continue this service.

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

Brief explanation.

To collect stakeholder input, educators or faculty held regularly scheduled meetings, such as advisory groups and Penn State Ag Council. Meetings and/or surveys occurred with members of traditional or non-traditional groups, but all are viewed as stakeholders.

Phone and email requests for information from county extension offices provided additional measures of clientele needs. If similar information was requested repeatedly, that is a sign that an issue is of concern to the public and we try to develop a resource to meet that need.

Individual meetings resulting from office visits, farm visits, etc., allowed stakeholders to provide feedback. During and after extension educational programs, participants may request additional

programs or updates, or suggest new topics about which an educational program would be helpful. This input may be verbal only or collected in meeting survey instruments. To collect more detailed information from traditional and non-traditional stakeholders, sophisticated survey instruments or focus group meetings were implemented and the data collected were summarized and analyzed.

More extension programs are collecting long-term follow-up data, surveying participants three months or more after an educational event to gather information about actual changes that have been made, and the associated costs and added values. More extension programs are also translating their results into estimated economic impacts.

Our Ag Council delegates assisted us with identifying and prioritizing a small number of specific learning objectives for extension programs. These were used to populate a post-program evaluation and a longer term customized survey to be sent to individuals approximately 9-12 months after they had completed the extension program(s). The post-program evaluation asked participants what they expected to achieve on specific objectives. The longer term survey garnered self-reports of impacts the individuals have achieved. If an individual attended more than one program, their survey included questions addressing the expected impacts from all programs.

All departments and extension unites maintained websites and distributed regular electronic and/or hard-copy communications and/or social media messages to stakeholders. These avenues allowed stakeholders to provide feedback on new developments.

Many programs held regular field tours (e.g., pasture walks) and site tours, which allowed them to see conditions on the ground and hear from stakeholders directly.

Most departments and extension units held at least annual meetings with stakeholders to share updates and gather feedback. The Department of Plant Pathology and Environmental Microbiology hosted strategic planning meetings with prominent members of the potato and mushroom industries in Pennsylvania to outline issues facing these industries that would benefit from Penn State research, to evaluate Penn State expertise and resources available, and to document gaps and develop strategies to fill them.

Some extension offerings meet regulatory requirements, such as the ServSafe course for retail food service and restaurant managers. The fact that companies send employees to participate in these courses year after year indicates a degree of satisfaction with the value of the programs.

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
- Other (how and where programs are offered)

Brief explanation.

Budget Process: Availability of funding from certain extramural funding sources influenced resource allocations.

To Identify Emerging Issues: Stakeholder feedback helped to identify emerging issues that would benefit from extension programming and/or research when multiple stakeholders indicated the same need.

Redirect Extension Programs: Information collected from stakeholders was used to adjust issue areas that determine Cooperative Extension programming. We engaged representatives of the Penn State Ag Council as key team members on our internal implementation teams. This served to inform our programs on the real-world demands for new information and programs.

Redirect Research Programs: Information collected from stakeholder groups, such as industry associations, was used to directly influence applied research activity through local decisions about priorities. We engaged representatives of the Penn State Ag Council as key team members on our internal implementation teams. This informed our programs on the real-world demands for new information and programs.

In the Staff Hiring Process: Information collected from stakeholders influenced hiring decisions for faculty and extension educators to address unmet needs. Stakeholder feedback also indicated where volunteers and donors would be interested in assisting with programs and initiatives.

In the Action Plans: Our mission is to serve our stakeholders, so we analyzed the information gathered from stakeholders and adjusted our action plans as needed to meet their needs.

To Set Priorities: Our stakeholders' priorities must be our priorities, and we adjusted our programs as needed.

Other - How and Where programs are offered: Stakeholder input directly affects how we offer our extension programs. Feedback indicated that additional methods of program delivery were needed as demands for resources and/or time increased. As a result, educational opportunities are being offered via other methods--podcasts, online webinars, synchronous and asynchronous means--migrating away from the traditional classroom setting. In addition, stakeholder input helped determine the locations and times that extension programs are offered. With the restructuring of extension into statewide efforts (previously county-based), stakeholder need was a deciding factor in where programs are held.

Brief Explanation of what you learned from your Stakeholders

Stakeholder input directly affects how we offer our extension programs. Feedback indicated that additional methods of program delivery were needed as demands for resources and/or time increase. As a result, educational opportunities are being offered via other methods, such as home-study courses, pasture walks, podcasts, and online webinars, via synchronous and asynchronous means, besides the traditional classroom setting. In addition, stakeholder input helps determine the locations and times that extension programs are offered.

Globalization of research efforts, outcomes, and extension is increasingly important. As more and more people travel and the Internet and mobile phones break down barriers to information, scientists are realizing that a crop or technique that works in Pennsylvania might be adaptable to places in Africa, for instance.

Research commercialization, engagement with industry, and economic development are important to our stakeholders. As grant funding becomes tighter, there is greater pressure to raise funds by commercializing research innovations. Some of our programs, such as the Biologically Based

Materials and Products team, the Marcellus Education Team, and the Food Science team, are more heavily engaged in this area than others.

The Food Safety Modernization Act and Good Agricultural Practices regulations continue to challenge our stakeholders and drive new and continuing programs. The most recent calls are for training in agricultural water management to meet GAP guidelines.

We are also seeing the tremendous benefits of interdisciplinary teams in solving problems. A group of experts who all bring to the problem a part of the solution can often move beyond the sum of their knowledge. However, this type of collaboration raises new questions as often as it brings about solutions.

We learned that participants need adaptations in programs because many have little money or time available for travel. We have responded with more web-based, home-study, and asynchronous options, and with more programs at the times and in the locations that our audiences prefer.

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
10672929	0	7653472	0

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	10902438	0	7582000	0
Actual Matching	18287059	0	25828637	0
Actual All Other	22299242	0	36437963	0
Total Actual Expended	51488739	0	69848600	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	1958518	0	3984784	0

V. Planned Program Table of Content

V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Advanced Agricultural and Food Systems

☑ 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	5%		10%	
104	Protect Soil from Harmful Effects of Natural Elements	5%		5%	
123	Management and Sustainability of Forest Resources	5%		5%	
133	Pollution Prevention and Mitigation	5%		5%	
205	Plant Management Systems	5%		5%	
211	Insects, Mites, and Other Arthropods Affecting Plants	5%		10%	
212	Diseases and Nematodes Affecting Plants	5%		10%	
215	Biological Control of Pests Affecting Plants	5%		10%	
301	Reproductive Performance of Animals	10%		5%	
311	Animal Diseases	5%		5%	
315	Animal Welfare/Well-Being and Protection	5%		5%	
402	Engineering Systems and Equipment	5%		5%	
404	Instrumentation and Control Systems	5%		5%	
601	Economics of Agricultural Production and Farm Management	10%		5%	
610	Domestic Policy Analysis	10%		5%	
723	Hazards to Human Health and Safety	10%		5%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.0	0.0
Actual Paid	86.9	0.0	165.5	0.0
Actual Volunteer	99.9	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**
3577531	0	3057353	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
5480046	0	9008454	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
3154285	0	6352770	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research and extension program areas employ a systems-based approach to address the complex issues surrounding advanced agricultural and food systems. Research and extension programs focus on the farm-to-fork continuum.

Entomology research in the College is diverse and robust, including exploration of plant defenses against insect herbivory, the relative value of wild populations of pollinators versus rented beehives, and modeling the seasonal migration of fall armyworm moths. Recent exploration of biocontrol methods for fungus gnats in commercial mushroom houses has direct bearing on cost-effective and environmentally sustainable production methods.

As new pests such as the spotted lanternfly take hold, our research and extension teams help illuminate the pests' life cycles and develop effective control strategies.

Efforts are widespread to reduce herbicide and pesticide use by employing cutting-edge technology that provides real-time information about pest presence on the ground. This saves producers money and contributes to environmental health.

Researchers studying crops helped develop a smart-phone app for barley yellow dwarf virus; examined the effects of several types of green manure on cash crop yields, weeds, and economics; and furthered efforts to commercialize and refine the Penn State InterSeeder, which can plant a cover crop between rows of corn, soybean, or other row crops.

Animal science research and extension programs encompass the major livestock classes. Some highlights include an investigation of the effect of a methane inhibitor feed additive on enteric methane emission and microbial profile in lactating dairy cows; the effects of contaminated colostrum on dairy calves; calf growth traits and dairy production; optimizing feed nutritional content and other practices to minimize production costs; and planning for an outbreak of highly pathogenic avian influenza and other biosecurity concerns. Equine research and extension work focuses on parasite management and education to help reduce the unnecessary use of dewormers. Another strain of animal science research attempts to improve the profitability and sustainability of production agriculture by studying, among other things, the economic benefits of precision breeding technology and the costs to dairy farms of preparing for and complying with OSHA safety inspection.

For the wine industry, Penn State researchers and extension personnel investigated freeze protection and assessed growers' challenges and needs. With private leveraged funds, they are attempting to learn more about the viticultural and environmental factors affecting rotundone--black pepper aroma--in Noiret grapes grown in Pennsylvania.

There is a focus on mechanization to increase efficiency. The tree fruit and grape team continues to research and develop precision harvest and pruning technologies.

Another important theme is meeting the needs of traditionally underrepresented audiences, such as female and young farmers, and growers and farm workers whose first language is not English.

2. Brief description of the target audience

Agricultural Producers/Farmers/Landowners
Agriculture Services/Businesses
Nonprofit Associations/Organizations
Business/Industry
Community Groups
Education
General Public
Government Personnel
Human Service Providers
Military

3. How was eXtension used?

At least some members of most extension units answer Ask an Expert questions and use eXtension resources as reference materials to address client questions and acquire personal knowledge when appropriate.

The poultry team delivered "Housing for Small Poultry Flocks," a national eXtension webinar PowerPoint presentation. There were 30 live viewers and 162 views of the recording as of December 31, 2015 (last report received).

Penn State Extension supports faculty and staff use of eXtension and promotes communities of practice as a way of broadening sources of information and outreach. Penn State Extension supports the professional development offered through eXtension.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	181140	485108	73461	20497

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

Patent Applications Submitted

Year: 2016

Actual: 7

Patents listed
Serial No. 15/223,382; Filed 7/29/2016; Title: 3D Laser Ablation Tomography

Serial No. 14/885,140; Filed 10/16/2015; Title: Methods and Compositions for Multiplex RNA Guided Genome Editing and Other RNA Technologies

Serial No. PCT/US2015/0559; Filed 10/16/2016; Title: Methods and Composition for Multiplex RNA Guided Genome Editing and Other RNZ Technologies

Serial No. 15/227,154; Filed 8/3/2016; Title: Benzoxaborole-Containing Coating Resistant to Cellulose-Support Fungus

Serial No.PCT/US2016/0453; Filed 8/3/2016; Title: Benzoxaborole-Containing Coating Resistant to Cellulose-Support Fungus

Serial No. 62/362,382; Filed 7/14/2016; Title: Infective Non-Growing Pathogens for Disease Control in Agriculture and Medicine

Serial No. 62/395,434; Filed 9/16/2016; Title: Targeted Modification of Maize Roots to Enhance Abiotic Stress Tolerance

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	49	169	218

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants in extension education classes and workshops.

Year	Actual
2016	109868

Output #2

Output Measure

- Number of technology disclosures involving college faculty, staff, extension educators, and students.

Year	Actual

2016 4

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	New crop varieties or lines.
2	Improved efficiency of operation for livestock producers.
3	Average cost savings from implementation of program suggestions.
4	Greater understanding of the biology of an invasive pest and/or new strategy for combating.
5	Cost savings from more efficient use of pesticide and/or herbicide.
6	Enhanced knowledge to address the pollinator crisis.
7	Innovation in farm machinery to increase efficiency and reduce labor costs.
8	Improved understanding of agricultural change expected with climate change.
9	Finding that the cost of compliance with Occupational Safety and Health Administration (OSHA) inspection of New York dairy farms was less than 1% of milk production costs.
10	Potential value (in $) of saving even 1% of calves born annually in Pennsylvania by ensuring that colostrum fed to calves contains minimal bacterial contamination, thereby allowing maximum absorption of immune-boosting immunoglobulin G.
11	Percentage increase in harvest efficiency (apples picked/second) using a prototype apple harvest-assist unit compared with conventional apple harvest using ladders for apples in the upper portion of trees.
12	Development of expert decision support system for management of barley yellow dwarf virus in cereal crops.
13	Approximate number of InterSeeder units sold.
14	Increase in net returns (in $/hectare) when red clover was interseeded into winter wheat or rye the year before corn planting, primarily because of red clover forage value.
15	Sex pheromone of fungus gnat (Lycoriella ingenua) identified, with potential for deployment in traps and other control mechanisms important to PA mushroom industry.
16	Minimum accuracy percentage of public reports of invasive spotted lanternfly sightings in Pennsylvania, indicating the effectiveness of extension and outreach efforts.
17	Minimum cost savings (in $) for nematicide not sprayed if the recommendations developed through this research were applied on just 1% of peach and apple acreage in the Northeast.

Outcome #1

1. **Outcome Measures**

   New crop varieties or lines.

   Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

   Improved efficiency of operation for livestock producers.

   Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

   Average cost savings from implementation of program suggestions.

   Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

   Greater understanding of the biology of an invasive pest and/or new strategy for combating.

   Not Reporting on this Outcome Measure

Outcome #5

1. **Outcome Measures**

   Cost savings from more efficient use of pesticide and/or herbicide.

   Not Reporting on this Outcome Measure

Outcome #6

1. **Outcome Measures**

Enhanced knowledge to address the pollinator crisis.

Not Reporting on this Outcome Measure

Outcome #7

1. **Outcome Measures**

Innovation in farm machinery to increase efficiency and reduce labor costs.

Not Reporting on this Outcome Measure

Outcome #8

1. **Outcome Measures**

Improved understanding of agricultural change expected with climate change.

Not Reporting on this Outcome Measure

Outcome #9

1. **Outcome Measures**

Finding that the cost of compliance with Occupational Safety and Health Administration (OSHA) inspection of New York dairy farms was less than 1% of milk production costs.

2. **Associated Institution Types**

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Studies in other sectors show that workers' compensation claims rates and costs can decrease after a worksite is inspected. OSHA inspection of dairy farms began in 2014 in New York. The impact of these inspections is not known in terms of the farmer's ability to comply with regulations. A case study in partnership with the NY Center for Agricultural Medicine and Health addressed how dairy farm managers prepared for inspections and identified farm-level costs of preparing for and being inspected.

What has been done
With leveraged funding from the National Institute for Occupational Safety and Health, four farms that were OSHA inspected and 12 farms that were not were included in the mixed method evaluation using a multimodal (telephone, email, or mail) survey. The study examined the effects of actual or potential inspection, the costs of implementing work safety programs or physical changes, the impact of the threat of inspection on compliance, and attitudes of dairy farm owners/managers about inspections.

Results
Overall, the impact of OSHA inspections was positive, leading to improved safety, physical changes on the farm, and worker trainings, although the farmers' perspectives about OSHA inspection were mixed. The cost of compliance was typically less than 1% of milk production costs. Clarifications and engineering solutions for specific dairy farm hazard exposures are needed to facilitate compliance with OSHA regulations.

The findings of this evaluation could have been different based on at least two factors. While these farms were preparing for potential OSHA inspection, the price of milk was high in NY. That price advantage increased farmers' ability to invest in safety. The farms also had access to many free services and materials through the NY Center for Agricultural Medicine and Health. This type of funding is often targeted for termination, which could increase the expense to farms of compliance and result in higher penalties and more injuries.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
610	Domestic Policy Analysis
723	Hazards to Human Health and Safety

Outcome #10

1. Outcome Measures

Potential value (in $) of saving even 1% of calves born annually in Pennsylvania by ensuring that colostrum fed to calves contains minimal bacterial contamination, thereby allowing maximum absorption of immune-boosting immunoglobulin G.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	364375

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Calves aren't born with antibodies in their blood, and they can't produce them efficiently in their first month, so they must receive antibodies from colostrum. Antibodies recognize pathogens and signal the body to destroy disease-causing organisms. Immunoglobulin G (IgG) is the most common class of antibody in bovine colostrum. The lack of antibodies at birth and a less effective immune system typically make the first month of life the period of highest calf sickness and death.

What has been done
To test the combined effects of colostrum bacteria content and heat treatment on IgG absorption, Penn State researchers studied 104 bull calves to compare IgG absorption among calves fed four different colostrum treatments. Colostrum from individual cows was pooled, divided, either heat treated or unheated, and allowed to incubate for bacterial growth or not. The 4 treatments were unheated, low bacteria; unheated, high bacteria; heat-treated, low bacteria; and heat-treated, high bacteria.

Results
When bacteria entered the gut of a newborn calf with colostrum feeding, the ability to absorb IgG fell significantly. All the calves consumed the same amount of IgG and colostrum, but calves that received colostrum with high bacteria absorbed only about half the IgG of calves receiving clean colostrum. Calves fed heat-treated, low-bacteria colostrum tended to experience fewer scour days.

Any bacteria calves consume can affect their ability to absorb IgG. Therefore, it's important for calves to be born in a clean environment. Colostrum can become contaminated during collection and feeding or bacteria can grow during storage. Colostrum can be pasteurized to reduce the number of live bacteria reaching the gut and enhance IgG absorption.

Improving the health and survival of calves will increase dairy profits. Saving the lives of even 1% of dairy calves born in Pennsylvania each year by feeding uncontaminated colostrum would reduce dairy costs by more than $364,000.

4. Associated Knowledge Areas

KA Code	Knowledge Area

301	Reproductive Performance of Animals
311	Animal Diseases
315	Animal Welfare/Well-Being and Protection

Outcome #11

1. Outcome Measures

Percentage increase in harvest efficiency (apples picked/second) using a prototype apple harvest-assist unit compared with conventional apple harvest using ladders for apples in the upper portion of trees.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	95

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The U.S. apple industry is facing difficulties because apple production costs have been continuously increasing. Three factors contribute to this situation: close dependence on a large seasonal workforce, increasing labor costs, and decreasing availability of agricultural employees. Apple harvest is the most labor-intensive operation during the production season. U.S. apple production increased by 25% from 2012 to 2014.

What has been done
An economical apple harvest-assist unit prototype targeting fresh market apples was designed and field tested, aimed at increasing harvest efficiency, reducing harvest-related injuries, and increasing the potential labor pool by decreasing strength requirements. The unit focused on apples in the upper canopy, which typically require ladders for harvest. The first year of field testing focused on identifying components that caused apple bruising, and the second year focused on unit performance.

Results
After being identified as the major component causing apple bruising, the distributor, which distributes apples evenly in the bin, was improved and then tested in year 2. Bruising tests showed that this unit could provide 100% of apples at the Extra Fancy level.

For the apples in the upper portion of the trees, the harvest-assist unit increased harvest efficiency (apples picked/second) by 95% compared with conventional apple harvest using

ladders.

Use of the harvest-assist unit increased the percent of time pickers spent on harvesting from 76% to 98%, compared to conventional harvest using ladders.

Total costs to develop the prototype harvest-assist unit were less than $35,000, and costs of a production unit could be less. An apple harvest-assist device such as this could improve the efficiency and speed and reduce labor costs of harvest, and also ease concerns about labor availability.

Future work should test the unit on other apple varieties and fruits and in other parts of the country.

4. Associated Knowledge Areas

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

Outcome #12

1. Outcome Measures

Development of expert decision support system for management of barley yellow dwarf virus in cereal crops.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Adoption and accuracy of decision support systems (DSSs) running on mobile devices are increasing, leading to an enhancement of agricultural decision-making. Expert DSSs are based on the problem-solving abilities of human experts. Barley yellow dwarf (BYD) virus is spread by more than 20 species of aphids and affects worldwide grain production was used as a model disease system. Infection results in yield losses up to 70%, and the problem is expected to grow with climate change.

What has been done

With USDA NIFA leveraged funding, a Penn State-led team created an expert DSS for winter wheat growers based on dependency networks. At key points throughout the growing season the networks interpret how field conditions affect management recommendations for BYD. To address nine possible management recommendations, the networks analyze 72,387 combinations of input field conditions. The system was also designed to accept feedback on management techniques used in the field to update recommendations.

Results
The DSS, developed in collaboration with a private-sector partner, ZedX, Inc., was created for use in a mobile device app that will frequently update input field conditions to produce real-time recommendations, emulating disease management experts. Coupling this expert DSS with high resolution weather, pest, and disease forecasts will prove to be a powerful management tool in the future. This method of decision modeling can potentially be used to help enable the efficient management of other crop pests and diseases and enable a more sustainable agroecosystem.

Considerations of sustainability, profit, and yield can be added into the DSS, helping growers to balance environmental regulations and profitability. Growers could explore effects of recommended management tactics on sustainability, profit, and yield to reach their own ideal compromise. The integration of all DSSs related to a commodity should greatly increase productivity while contributing to a more sustainable agroecosystem.

4. Associated Knowledge Areas

KA Code	Knowledge Area
212	Diseases and Nematodes Affecting Plants
404	Instrumentation and Control Systems

Outcome #13

1. Outcome Measures

Approximate number of InterSeeder units sold.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	40

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Grain farmers in the Mid-Atlantic, Northeast, and Midwest have had mixed success with establishing cover crops after grain harvest in the fall. The workload created by harvesting leaves farmers little time to plant a new crop. The weather also might not cooperate. Cover crops can reduce soil erosion, take up excess nutrients, suppress weeds, and provide forage and biofuel feedstock, so researchers sought to improve cover-crop establishment before harvest of the primary crop.

What has been done
Penn State developed the InterSeeder to plant cover crop seeds between rows of standing corn or soybeans in late June and simultaneously spray a post-emergent herbicide and apply fertilizer for the cover crop. This required finding compatible herbicides, optimizing cover crop species, seeding rates, and planting times, and optimizing cash crop varieties. The Penn State team patented and licensed the technology, started a company, and hired a manufacturer to produce the equipment.

Results
The InterSeeder is the only agricultural implement on the market that can plant a cover crop between rows of standing corn, soybean, or other row crops. The Interseeder is beginning to achieve commercial success. After many improvements and field trials, the company experienced double its sales goals in 2015. They now produce four sizes of InterSeeders, with demand for the newest model, a 30-foot-wide unit for the Midwest market, particularly strong. The company will continue to increase the size of the equipment, continue to improve the equipment based on customer feedback, and enlist early adopters in new locations. They are encouraged by the growing number of universities and conservation professionals across North America initiating research projects to help improve success.

Along with multiple environmental benefits from the cover crop, there's also a modest increase in corn/soybean yields when they are planted into what remains of the cover crop from the year before.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
104	Protect Soil from Harmful Effects of Natural Elements
133	Pollution Prevention and Mitigation
402	Engineering Systems and Equipment
601	Economics of Agricultural Production and Farm Management

Outcome #14

1. Outcome Measures

Increase in net returns (in $/hectare) when red clover was interseeded into winter wheat or rye the year before corn planting, primarily because of red clover forage value.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1360

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Red clover (Trifolium pratense L.) and hairy vetch (Vicia villosa Roth) are legumes (green manure) valued for N2-fixing. They also provide weed control in cash crops. In 2014 more land area in PA was managed with no-till or conservation tillage than conventional tilling. This is typically combined with herbicide-resistant (HR) crops. But concerns about impacts of HR weeds, herbicide pollution, and nontarget toxicity of herbicides prompt exploration of alternative weed management strategies.

What has been done
This study compared weed control, crop yields, herbicide use, and economic performance of these green manures in a no-till winter cereal-green manure-corn (Zea mays L.) silage sequence in central PA. Red clover was interseeded into winter wheat (Triticum aestivum L.) or rye (Secale cereale L.); hairy vetch and triticale (X Triticosecale) were planted after winter cereal harvest. The researchers expected that interseeded red clover would reduce herbicide inputs and costs by controlling weeds.

Results
Compared to hairy vetch, red clover provided continuous soil cover between the winter cereal and corn and two herbicide applications could not be applied (one in wheat and one prior to seeding hairy vetch) to the red clover, reducing herbicide active ingredient use by 28%. Weed infestation in wheat and corn did not differ between green manure systems, but corn yield following red clover averaged 3,320 kg/ha more, and 2012 wheat yield was 180 kg/ha greater in the red clover sequence. Corn after hairy vetch-triticale had lower corn plant population in 2012-2013. Yield differences in corn in 2012 probably resulted from population differences. Primarily because of red clover forage value, the red clover system resulted in greater net returns to management by US$1,360/ha, and even without the forage harvest, the red clover system would have been more profitable due to lower production costs.

4. Associated Knowledge Areas

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

Outcome #15

1. Outcome Measures

Sex pheromone of fungus gnat (Lycoriella ingenua) identified, with potential for deployment in traps and other control mechanisms important to PA mushroom industry.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Adult fungus gnats (Lycoriella ingenua) found in mushroom houses can transfer a fungal pathogen that destroys young mushrooms. In addition, each female's eggs result in about 200 larvae that consume compost nutrients, reducing mushrooms' ability to grow and leading to significant crop losses of up to 70%. PA farms produce more than 60% of all U.S. white button mushrooms. Insecticides that were used to control these gnats have been banned, and growers are seeing a resurgence of this pest.

What has been done
Penn State entomologists used gas chromatography and electroantennography to identify a sex pheromone that attracts male L. ingenua to females. The synthetic pheromone could help trap males and disrupt mating, thereby reducing crop damage.

The team also identified fungi in mushroom compost that attract L. ingenua females, and are working to characterize the volatile chemicals from these fungi responsible for the attraction.

Results
The complicated configurations of the sex pheromone have so far precluded attempts to synthesize it. The worldwide distribution of this pest and its impact on mushroom cultivation should make commercialization of this pheromone profitable. Pheromones typically have an "exemption from tolerance" by the EPA. Pheromones have routinely been approved for use in organic production.

The team found that female fungus gnats are strongly attracted to the fungal pathogen Trichoderma aggressivum. They bring this mold into mushroom houses and spread it as they lay eggs. By the time the infestation is noticed, this "green mold" has probably already destroyed

most of the belowground mushroom parts and produced airborne spores. Identifying new female-attractive compounds from this mold could produce novel, effective control measures.

These natural, behavior-modifying chemicals could help increase profitability and sustainability of the $2 billion per year PA mushroom industry.

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
215	Biological Control of Pests Affecting Plants

Outcome #16

1. Outcome Measures

Minimum accuracy percentage of public reports of invasive spotted lanternfly sightings in Pennsylvania, indicating the effectiveness of extension and outreach efforts.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	50

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In September 2014, the Pennsylvania Department of Agriculture (PDA) confirmed the first detection in the U.S. of spotted lanternfly (Lycorma delicatula) (SLF) in Berks County. This Far East native feasts on at least 56 plant species. It threatens PA's $20.5 million grape, nearly $134 million apple, and $24 million stone fruit industries, as well as the $12 billion hardwood industry. Early detection is vital to control of this pest and the protection of PA agriculture and natural resources.

What has been done
In light of the potential impact to Pennsylvania's agricultural and natural resources, PDA issued a quarantine to restrict movement of this pest as Penn State researchers and extension staff and governmental and non-governmental cooperators develop a strategy to eliminate this pest from the Commonwealth.

Results
Leveraged funding for research at Penn State currently focuses on the impact of SLF feeding on grape vine vigor and yield, as well as exploring chemical control options compatible with current viticultural practices. Penn State Extension organized multiple meetings and produced fact sheets with the latest information about SLF. Extension efforts aim to inform the public about what to look for and how to submit specimens for identification. These efforts have led to an extremely high rate of detection in new, unknown areas, allowing for rapid response to smaller populations. The accuracy percentage of public reports is over 50%. The messaging and training provided by extension has helped to keep SLF relatively contained by showing residents and businesses in the infested area how to minimize potential spread. This component of the cooperative response is crucial, as it gives time for the long-term control solutions to be identified, implemented, and evaluated.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
211	Insects, Mites, and Other Arthropods Affecting Plants

Outcome #17

1. Outcome Measures

Minimum cost savings (in $) for nematicide not sprayed if the recommendations developed through this research were applied on just 1% of peach and apple acreage in the Northeast.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1000000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Nematodes are economically important pathogens on fruit crops. They reduce tree vigor and crop yields. They predispose trees to disease, reduce winter hardiness, and transmit viruses.

Two of the most serious nematode problems in the Northeast are peach stem pitting and apple union necrosis and decline. Both diseases are transmitted by dagger nematodes (Xiphinema

spp.). The root-lesion nematode (Pratylenchus penetrans) can be the most widespread nematode pest of fruit trees.

What has been done
Many fruit growers in Pennsylvania are using a new method for renovating old orchard sites before a new planting. They're using crop rotation and biofumigation with rapeseed and sorghum to manage the dagger nematode. Nematode assays conducted before and after 2 years of rotation with biofumigant crops demonstrated that dagger nematodes decreased to the zero tolerance levels recommended for preventing the need for pre-plant nematicides. Root lesion nematodes also decreased significantly.

Results
The reduction in need for pre-plant nematicide applications represents an economic savings of $1,000-$2,000 per acre. The environmental impact quotient (EIQ), a formula created to provide growers with data regarding the environmental and health impacts of their pesticide options, for a nematicide is over 78, which is 2-3 times higher than most pesticides.

Nearly 100,000 acres of apple and peach are grown in the Northeast. Producers replant approximately 3% of their acreage each year. If the recommendations developed through this research were applied on 1% of acreage, the cost savings in nematicide not sprayed would be a minimum of $1,000,000. This does not account for the environmental and health benefits of reducing chemicals sprayed.

Suppression of root lesion nematodes has been shown to increase early tree growth, which results in earlier fruit production and increased economic return on investment.

4. Associated Knowledge Areas

KA Code	Knowledge Area
212	Diseases and Nematodes Affecting Plants
601	Economics of Agricultural Production and Farm Management
723	Hazards to Human Health and Safety

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Public Policy changes
- Competing Public priorities
- Populations changes (immigration, new cultural groupings, etc.)
- Other (Extramural Funding)

Brief Explanation

Natural disasters
-An outbreak in poultry of avian influenza (HPAI) reduced access and redirected efforts to the more immediate task of defending the poultry industry.
-Much of PA suffered from a drought during the summer months. This decreased the amount of available pasture for feeding livestock and increased feed costs for the year. In

addition, the market value of feeder calves dropped significantly and is approximately half of the value from the previous year.
-Unseasonably cold temperatures in the spring created frost challenges for apple growers in several regions of the state.

Economy
-The dairy industry was affected greatly after 2008, and we continue to see farmers and the industry in economic hardship.
-The economy and reduced commodity prices have caused growers to be economically stressed and to look for alternative sources of income.
-The budget stalemate in Pennsylvania took time and attention away from programming.

Public policy changes
-The EPA and Pennsylvania Department of Agriculture have mandated changes to the way we approach the Pesticide Applicator Short Course. Tests are now closed book for the categories we teach, except Cat. 10 and Cat. 23. All pesticide exams will move to closed book as study materials and exams are rewritten.
-Changes to Worker Protection Standards require employers to provide more and different training than in the past, which has increased attendance at programs.

Competing public priorities
-Competing public priorities force us to continually align our programs with budget realities.

Competing programmatic challenges
-Due to new expectations, one team member was not able to hold the Entomology Short Course in September.

Populations changes
-The dairy industry increasingly relies on Hispanic workers, who need training in Spanish.

Extramural funding
-Some of our programs are affected by extramural funding, either by adding resources to promote them or by shaping the content of the product.
-The Field and Forage team's lack of extramural funding hampers our efforts to evaluate some local issues we have identified.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The generation of outcomes from existing programs and the development of new programs require improved evaluation that identifies pre- and post-responses to information and monitoring for long-term behavioral changes that result in improved outcomes. More statewide extension programs are using retrospective evaluation to gather information about the number of participants who actually put into practice lessons learned through extension programs. Measuring costs averted or profit increased can show powerful, tangible benefits of our programming--the type of feedback that keeps people coming back for more information. We are also seeing more extension programs gathering this type of data. Customer satisfaction and needs assessment instruments (Salesforce) are scheduled to be implemented in spring 2017 to provide feedback on the quality and value of our programs.

Key Items of Evaluation

See highlights of state-defined outcomes in this planned program.

V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Biologically Based Materials and Products

☑ 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
403	Waste Disposal, Recycling, and Reuse	30%		30%	
502	New and Improved Food Products	15%		15%	
511	New and Improved Non-Food Products and Processes	30%		30%	
723	Hazards to Human Health and Safety	25%		25%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.0	0.0
Actual Paid	50.8	0.0	27.5	0.0
Actual Volunteer	5.0	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**
1580494	0	448809	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
3019600	0	1296719	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
2030977	0	1023403	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research into biologically based materials and products includes increasing the efficiency of pelletizing bioenergy crops, pellet quality metrics on various bioenergy crops, and use of miscanthus as poultry bedding.

Teams of scientists are investigating and developing sustainable technologies to convert biomass resources into chemicals for medicine, energy, materials, and other value-added products. Examples include anthracite briquettes with agricultural byproducts as an ecofriendly fuel for foundries, production of bioethanol from potato waste in a biofilm reactor, the use of tea waste for production of fermentable sugar, and reverse methanogenesis for liquid biofuel precursors.

Two Penn State College of Agricultural Sciences professors leveraged the Hatch-funded portions of their salaries in the development of inventions that they are in the process of commercializing. One patent-pending discovery is a natural food colorant stemming from avocado pits. The other is a patented biomedical foam for wound and trauma care composed of potato starch and chitosan from shellfish. Both inventions have benefited from leveraged funds from other sources as well.

Extension work in biologically based materials and products includes using leveraged funding from the U.S. Forest Service to develop a state wood energy team that promotes the sustainable use of wood as a statewide, top-tier energy resource; and organizing and hosting on-site field days, demonstration site tours, individual site visits, and other on-site educational opportunities, as well as webinars, newsletters, and other online outreach programs.

2. Brief description of the target audience

Agricultural Producers/Farmers/Landowners
Agriculture Services/Businesses
Nonprofit Associations/Organizations
Business/Industry
Community Groups
Education
General Public
Government Personnel
Human Service Providers
Local, Regional, State, and Federal agencies
Military
Policy Makers

3. How was eXtension used?

Some teams use eXtension as an occasional technical resource.

Penn State Cooperative Extension supports faculty and staff use of eXtension and promotes communities of practice as a way of broadening sources of information and outreach. Penn State Cooperative Extension supports the professional development offered through eXtension.org.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	79252	816286	15250	1323

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

Patent Applications Submitted

Year:	2016
Actual:	3

Patents listed

Serial No. PCT/US2016/033496; Filed 5/20/2016; Title: Multi-Surfactant System

Serial No. 14/894,914; Filed 11/30/2015; Title: Polymer Compositions and Coating

Serial No. 62//382,262; Filed 4/27/2016; Title: Cyanobacterial Soil Amendment

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	25	35	60

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants in extension education classes and workshops.

Year	Actual
2016	25370

Output #2

Output Measure

- Number of technology disclosures involving college faculty, staff, extension educators, and students.

Year	Actual
2016	3

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increased knowledge about a biologically based product or chemical or a novel biologically based product or chemical.
2	New or improved use for agricultural waste product.
3	Demonstration of optimal bioethanol production from potato waste in a biofilm reactor.
4	Patent application filed for natural food colorant from avocado.
5	Finding that anthracite briquettes prepared with elemental Si powder and either rice hull ash or rice hull powder showed sufficient mechanical strength under fire that they could viably serve as fuel in a cupola furnace.
6	Estimated minimum yearly future sales potential (in $) of a patented biofoam pad for wound and trauma care.

Outcome #1

1. Outcome Measures

Increased knowledge about a biologically based product or chemical or a novel biologically based product or chemical.

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

New or improved use for agricultural waste product.

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Demonstration of optimal bioethanol production from potato waste in a biofilm reactor.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Bioethanol production is of great interest to meet the renewable energy demand and reduce the negative environmental impacts of petroleum fuel while providing energy security. In 2014, 54 billion liters of fuel ethanol were produced in the U.S. But ethanol production from crops that also serve as food is a concern. Agricultural wastes can present cost-competitive alternative feedstocks. Novel processing technologies with higher productivities are also needed.

What has been done
A repeated-batch biofilm reactor was used as a novel approach for production of bioethanol from potato waste hydrolysate by yeast (Saccharomyces cerevisiae). To achieve a successful biofillm

formation, various plastic composite supports (PCS) were evaluated. A PCS composed of polypropylene, soybean hull, soybean flour, yeast extract, and salts was selected. Then the response surface method was used to optimize the growth parameters pH, temperature, and agitation.

Results
Optimum conditions for ethanol fermentation were found to be pH 4.2, temperature 34 degrees C, and 100 rpm. These conditions resulted in 37 g/L ethanol with a 2.3 g/L/h productivity and 92% theoretical yield. The results indicate that biofilm reactors with PCS can enhance ethanol fermentation from industrial potato wastes.

Previous research without the biofilm reactor yielded only 24 g/L ethanol from the same amount of potato waste. The biofilm allows greater microbial population in the reactor, which helps to enhance productivity. The use of biofilm with PCS is patented by the research team.

4. Associated Knowledge Areas

KA Code	Knowledge Area
403	Waste Disposal, Recycling, and Reuse
511	New and Improved Non-Food Products and Processes

Outcome #4

1. Outcome Measures

Patent application filed for natural food colorant from avocado.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Many consumers today are interested in natural ingredients. Most current food colorants are made from materials, such as turmeric or saffron, that have inherent value themselves. A food colorant made from the pits of avocados would address several of the shortfalls among current food colorants. In 2012, more than 815,000 metric tons of avocados were consumed in the U.S., and this volume is growing quickly.

What has been done
Leveraging the Hatch-funded portion of his salary, a Penn State food scientist has captured brilliant red and orange colors from an enzyme in avocado pits. Changing the pH and concentration alters the hue. The colorant can withstand heat, light, and oxidation, and is shelf-stable. The colorant is expected to be less expensive than competing natural food colorants because it is made from the waste avocado pit. The global natural food color additive market was worth $1.14 billion in 2014.

Results
Developing a natural colorant can help replace artificial dyes, and finding a use for avocado pits can help reduce waste. Commercializing the colorant has grown into a business, and has already earned funding through the university. The company's product, called AvoColor, has been tested as a water-soluble coloring in soda, ice cream, gummy bears, and cake. The founders recently determined the chemical structure of the new colorant. The next step is to develop a consistent process of extracting the color from avocado pits. Toxicology studies continue, but so far, the colorant seems to be nontoxic. U.S. Food and Drug Administration approval would be required, and corporate partners will be identified. The team will target food color companies, who can then market to the food companies themselves.

4. Associated Knowledge Areas

KA Code	Knowledge Area
502	New and Improved Food Products

Outcome #5

1. Outcome Measures

Finding that anthracite briquettes prepared with elemental Si powder and either rice hull ash or rice hull powder showed sufficient mechanical strength under fire that they could viably serve as fuel in a cupola furnace.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

A cupola furnace is used to melt iron in a foundry. Fuel in a cupola furnace must keep its porous structure for fast burning as it passes through three zones in the furnace. Coke is commonly burned in cupola furnaces because it has high energy, low volatility, and a rigid porous structure, but the production of foundry-grade coke using bituminous coal emits air pollutants and is energy-inefficient. Coke is also no longer cost-effective because the price has recently increased sharply.

What has been done
To overcome these disadvantages, a Penn State-led research team has been developing ecofriendly anthracite briquettes as an alternative fuel to replace coke. Anthracite briquettes were developed using mainly waste anthracite fines; rice hulls and rice hull ash, plant byproducts that have high SiO2 content and are inexpensive relative to silicon metal; and silicon metal powder as an ecofriendly alternative to conventional coke used in a cupola furnace.

Results
Si metal powder reacts with anthracite to form SiC, which provides high mechanical strength to an anthracite briquette when it is exposed to a high temperature in the cupola furnace. The formation of SiC was investigated under different conditions using X-ray diffraction and transmission electron microscopy. In addition, unconfined compressive strength of the briquettes was measured when the rice hull or ash substituted for Si powder partially or completely. When anthracite briquettes prepared with elemental Si powder and either rice hull ash or rice hull powder were pyrolyzed at 1400 degrees C for 2 hours, SiC formed and the briquettes showed high mechanical strength in the range of 2000-4000 kPa, which is enough to keep their structural integrity in a cupola furnace.

4. Associated Knowledge Areas

KA Code	Knowledge Area
403	Waste Disposal, Recycling, and Reuse
511	New and Improved Non-Food Products and Processes

Outcome #6

1. Outcome Measures

Estimated minimum yearly future sales potential (in $) of a patented biofoam pad for wound and trauma care.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
There is a significant clinical need for materials that help stop bleeding and promote rapid clotting for internal and surface wounds or surgery, especially in trauma care. Some of the products currently on the market are effective clotting agents but are very difficult to use and extremely expensive. Others need to be removed if used internally. Gelatin and collagen bioabsorb but can provoke an allergic response. Other materials are soluble and need pressure to help stop bleeding.

What has been done
With Penn State Hershey College of Medicine, an agricultural and biological engineer, leveraging the Hatch-funded portion of his salary, is working to commercialize a patented biofoam pad for wound and trauma care. The nonstick material, made from potato starch and chitosan from shellfish, can be left inside the body, expands to put pressure on a wound, conforms to the wound's shape, and naturally helps stop bleeding. It will be useful in surgical, military, and veterinary settings.

Results
Preliminary testing of the clinical properties of the foam has been performed on cadavers and on swine. Additional animal studies and human clinical trials will follow. The team hopes to produce foam packs in various shapes to instantly treat any number of wounds.

An extremely conservative forecast of potential future sales (in 5 years) totals as much as $45 million per year, with the biofoam taking just 0.5-1% of the current market. This includes sales of traditional wound care products (gauze, pads, nonstick bandages), active wound care products (hydrogels and foams), and advanced products (collagen, biosynthetics). The company is expected to create at least 17 jobs.

4. Associated Knowledge Areas

KA Code	Knowledge Area
511	New and Improved Non-Food Products and Processes
723	Hazards to Human Health and Safety

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Competing Public priorities
- Other (Extramural Funding)

Brief Explanation

Economy
-The economy and reduced commodity prices have caused economic stress for growers, and many are looking for alternative sources of income.

Competing Pubic Priorities
-Competing public priorities force us to continually align our programs with budget realities.

Extramural Funding

-Some of our programs are affected by extramural funding, either by adding resources to promote them or by shaping the content of the product.
-Our lack of extramural funding to address local issues hampers our efforts to evaluate some local issues that we have identified.
-Extramural funding directed much of our efforts (e.g., the US Forest Service-funded State Wood Energy Team).

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The generation of outcomes from existing programs and the development of new programs require improved evaluation that identifies pre- and post-responses to information and monitoring for long-term behavioral changes that result in improved outcomes. More statewide extension programs are using retrospective evaluation to gather information about the number of participants who actually put into practice lessons learned through extension programs. Measuring costs averted or profit increased can show powerful, tangible benefits of our programming--the type of feedback that keeps people coming back for more information. We are also seeing more extension programs gathering this type of data. Customer satisfaction and needs assessment instruments (Salesforce) are scheduled to be implemented in spring 2017 to provide feedback on the quality and value of our programs.

Key Items of Evaluation

See highlights of state-defined outcomes in this planned program.

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Community Resilience and Capacity

☑ 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
511	New and Improved Non-Food Products and Processes	10%		10%	
601	Economics of Agricultural Production and Farm Management	10%		10%	
602	Business Management, Finance, and Taxation	10%		10%	
604	Marketing and Distribution Practices	10%		10%	
609	Economic Theory and Methods	10%		10%	
610	Domestic Policy Analysis	10%		10%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	10%		10%	
805	Community Institutions and Social Services	10%		10%	
901	Program and Project Design, and Statistics	10%		10%	
903	Communication, Education, and Information Delivery	10%		10%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.0	0.0
Actual Paid	11.1	0.0	19.9	0.0
Actual Volunteer	0.8	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**
345680	0	509786	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
641961	0	970559	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
415041	0	840659	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research in this program area included study of impacts of Walmart's local produce sourcing, extension's role in farm retention, mapping unemployment impacts from the Great Recession, consumer preferences and motivations for visiting Mid-Atlantic winery tasting rooms, and development of the hard cider industry. Some of these research projects also had extension components.

Extension programs encouraged agricultural entrepreneurship. The Economic and Community Development (ECD) team collaborated with multipartner teams on developing community gardens in vacant lots in Pittsburgh and on revitalizing a two-block area of downtown New Kensington, PA. The Marcellus shale team continues to be in demand by government officials from other U.S. states and foreign countries for advice in wisely developing the shale gas resources in those areas.

2. Brief description of the target audience

Agricultural Producers/Farmers/Landowners
Agriculture Services/Businesses
Nonprofit Associations/Organizations
Business/Industry
Community Groups
Education
General Public
Government Personnel
Local, Regional, State, and Federal agencies
Policy Makers
Military

3. How was eXtension used?

All team members in Agricultural Business Management completed the eXtension-based online professional development training related to development of impact stories. Additionally, one team member was an eXtension i-Three Corps and design-a-thon member. Team members used eXtension as a tool to address client needs and questions.

Some teams referred new growers to eXtension resources. It also was used for incorporation of materials and worksheets in workshops and webinars.

A Marcellus team member participated in the inaugural i-Three Corps effort. This included participation in

the Design-A-Thon in San Antonio during eXtension's annual conference. The project was related to energy development in a rural context.

Penn State Cooperative Extension supports faculty and staff use of eXtension and promotes communities of practice as a way of broadening sources of information and outreach. Penn State Cooperative Extension supports the professional development offered through eXtension.org.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	3968	41234	938	91

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

Patent Applications Submitted

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	2	22	24

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants in extension education classes and workshops.

Year	Actual
2016	5291

Output #2

Output Measure

- Number of technology disclosures involving college faculty, staff, extension educators, and students.

Year	Actual
2016	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Average cost savings from implementation of program suggestions.
2	Number of new and beginning farmers assisted.
3	Number of farms helped to implement added-value opportunities.
4	Number of farmers who stayed in business since 1985 because of assistance from federal cooperative extension programs.
5	Analysis of wine tourism and Mid-Atlantic wine consumers' interest in tasting-room activities.
6	Number of new businesses started in a 2-block area of New Kensington, PA, as a result of a multi-partner community engagement and economic development effort.
7	Total estimated economic impact (in $) of Penn State Extension programming on the hard cider industry.

Outcome #1

1. **Outcome Measures**

Average cost savings from implementation of program suggestions.

Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

Number of new and beginning farmers assisted.

Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

Number of farms helped to implement added-value opportunities.

Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

Number of farmers who stayed in business since 1985 because of assistance from federal cooperative extension programs.

2. **Associated Institution Types**

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	137000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Food production is vital to national security. Technological advances now allow fewer farmers than ever to grow our food. Since the middle of last century, the number of U.S. farm workers has declined by 78%, while agricultural output has more than doubled. Even so, a critical minimum number of farmers could be needed to maintain viable agriculture. The federal Cooperative Extension program was set up to translate and transmit state-of-the-art research findings from land-grant universities.

What has been done
A study recently published in the journal Applied Economic Perspectives and Policy used annual data (1983-2010) covering all 50 states to examine the impact of Extension on net changes in the number of farmers. The historical transition of farmers out of U.S. agriculture raises the question of whether Cooperative Extension and underlying Hatch-funded research spending keeps farmers in agriculture. The researchers used data from the Bureau of Economic Analysis, and the U.S. Census.

Results
The study showed that investment in Cooperative Extension was directly associated with higher net farm income, which helped farmers stay in business. Public investments in farmers are better made through programs of the land grant universities, rather than through direct subsidies to farmers.

Cooperative Extension effectively creates jobs. Over the study period, this federal spending amounted to $265/farmer/year. Ag research spending added another $140. The average state match of federal extension dollars is now nearly $3.5 in state contributions for every $1 nationally, but in PA it is only $2. This translates into an annual state cost of about $1,000/farm for the extension program nationally, and $500 in PA. The cost of creating a single new job through traditional state industrial recruitment programs usually exceeds $100,000.

Continuing to fund land grant universities and cooperative extension and related research efforts is vital for the future of U.S. farmers and our food supply.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
609	Economic Theory and Methods
610	Domestic Policy Analysis
901	Program and Project Design, and Statistics
903	Communication, Education, and Information Delivery

Outcome #5

1. Outcome Measures

Analysis of wine tourism and Mid-Atlantic wine consumers' interest in tasting-room activities.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In 2011, Pennsylvania wineries hosted 1.2 million visitors to their tasting rooms, for a total economic impact of $979 million. The numbers for New York were about five times these. Researchers at Penn State were part of a team leveraging a USDA Federal-State Marketing Improvement Program grant to document consumer purchasing and consumption of wine in the Mid-Atlantic (NJ, NY, PA) and examine the effects of different promotion and marketing efforts on consumption of Mid-Atlantic wines.

What has been done
A series of questions was asked in one of five Internet surveys conducted between 2012 and 2016 to learn about the importance of various options offered at tasting rooms and in close proximity when deciding whether or not to visit. Another survey assessed with whom visitors went to tasting rooms and which additional activities would appeal to visitors.

Results
Sixty percent of survey participants indicated that it was important for a tasting room to have light snacks available for purchase. This was followed in importance by activities and/or events (46%), restaurant (44%), gift shop (42%), and lodging (25%). Respondents asked to rank the importance of amenities in close proximity to the winery selected restaurants (63%), shopping (47%), lodging (45%), cultural and historical experiences (45%), tour and sightseeing activities (44%), and other winery tasting rooms (41%).

Sixty percent of respondents visited tasting rooms with a romantic partner, while 51% visited with 3 or more family members and/or friends.

These findings are critical to people considering opening new vineyards and tasting rooms or wanting to build their business or a region's reputation as a winery-rich area or a wine trail. The findings were shared on the Wine & Grapes U blog, which reaches nearly every industry member in PA and as far away as South Africa and Australia.

4. Associated Knowledge Areas

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

602 Business Management, Finance, and Taxation
604 Marketing and Distribution Practices

Outcome #6

1. Outcome Measures

Number of new businesses started in a 2-block area of New Kensington, PA, as a result of a multi-partner community engagement and economic development effort.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	12

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In many Pennsylvania communities, there is a shortage of citizens who recognize their communities' assets and their own abilities to improve their communities. This deficit results in a lack of community interest and capacity to undertake steps that could lead to more vibrant economies, improved environmental conditions, and stronger community dynamics. Existing groups often do not work well together.

What has been done
Extension facilitated visioning sessions and planned "Better Block" (betterblock.org) events focusing on a 2-block area of downtown New Kensington, PA, an industrial area that had about 80% building vacancy. The leaders built relationships with and among property owners and community members and offered relevant educational opportunities. New collaborations resulted in improved relationships and nonmotorized access, and the establishment of businesses and amenities to draw people to the area.

Results
The efforts led to:
-12 new businesses, at least 3 minority-owned and/or operated, with a 70% success rate so far, beating national statistics for new business failure rates.

-conceptualization and funding of an economic generator that rehabilitated 2 vacant properties, and created an incubator for new entrepreneurs and businesses. This initiative has leveraged over $300,000 of additional funding.

-the cleaning and repurposing of 15 formerly vacant or underutilized downtown properties in the

targeted blocks.

-the creation of 3 nonprofit community service organizations and strengthening of others with new members and volunteers.

Partners include Penn State-New Kensington, other local universities and branch campuses, Westmoreland County, Habitat for Humanity, the city of New Kensington, and local businesses.

This effort demonstrates what's possible when stakeholders work toward a common vision. The team is now organizing to implement a similar process in other southwest PA communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
805	Community Institutions and Social Services
903	Communication, Education, and Information Delivery

Outcome #7

1. Outcome Measures

Total estimated economic impact (in $) of Penn State Extension programming on the hard cider industry.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	17100000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Currently hard cider sales in Pennsylvania cities rank 3rd, 6th, and 7th as the highest selling cider markets in the nation when compared to percent of beer market sales. This burgeoning market, which saw sales skyrocket 71% in 2014, is continuing a steady and sustainable growth trend compared with other food and beverage categories. With market trends following the craft beer market and the UK cider market, the U.S. cider industry is well poised to become a big player in the beverage arena.

What has been done

To address this growing industry Penn State Extension offers a wide variety of workshops and educational products to support the needs of beginning and expanding hard cider operations and their support industries and consumers. Resources include a step-by-step hard cider guidebook; domestic and international producer tours to keep PA producers on par with this globally developing industry; business development workshops; and many other resources available at the Penn State Hard Cider webpage.

Results

Penn State Extension programming has produced an estimated direct economic gain of $9.6 million in the hard cider industry, plus $7.4 million in indirect economic gain in the broader economy. This includes the creation of 32 cider jobs in the first quarter of 2016, with an average annual salary (nationally) of $44,000, plus another 42 jobs created in the broader economy. These numbers are based on expected jobs created as a result of information gained at PSU Extension hard cider workshops and tours in 2016 and analysis based on PA Implan economic data.

Participation in the cider industry could increase farm revenue by 166% compared to process apple sales/bushel for an average PA orchard. Extra-fancy grade apples bring $4-5/bushel. U.S. grade 1 apples allow the average producer to break even. An orchard that presses its own sweet cider earns about $2/bushel, and selling those apples to a cider mill brings about $5/bushel. But hard cider produced by the orchard brings $3-8/bushel.

4. Associated Knowledge Areas

KA Code	Knowledge Area
511	New and Improved Non-Food Products and Processes
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

Natural disasters

-Drought and excessive heat added a layer of complexity for producers this past summer. The multiple days above 90 degrees affected not only crop quality and quantity, but also

worker performance and decision-making capabilities. Some farm managers responded by installing shade structures, misters, and irrigation systems, adding to the costs to production.

Economy
-Apple growers expressed a need to diversify their income stream through the production of value-added hard cider.
-Lack of jobs providing living wages and benefits necessitates entrepreneurship for some.
-Funding cuts, budget reallocations, and limited resources have affected some organizations' abilities to attend training or conduct planning efforts. These issues, however, increased a need for grant writing training.
-Because Pennsylvania's shale energy production is an important driver for both public and private economic development and revenue generation, it is important for extension to be participating in the public dialogue.

Appropriation changes
-The state appropriation did not come until we were 75% of the way through the year, so professional development travel was strongly affected.

Public policy changes
-Policies related to food safety standards (FSMA) are driving some programming.
-Increased interest in environmental, tax, and land planning policy in PA at the local and state levels has motivated residents affected by shale drilling to seek out our programs.

Governmental regulations
-Government regulations play an important part in ECD programming for multiple subject areas, including land use and agricultural preservation.
-Federal and state regulations surrounding the production, tax, and sale of some crops drive the need for education.
-Interest in PA's comprehensive regulatory environment is strong for residents in the Commonwealth affected by the development of shale energy. This interest extends to the many international delegations we have hosted in immersive shale trainings this program year.

Competing pubic priorities
-Competing public priorities force us to continually align our programs with budget realities.

Competing programmatic challenges
-Most staff members are stretched very thin due to multiple needs from various producer or industry groups. The small staff is working to prioritize issues.

Population changes
-Immigration, new cultural groupings, millennials, and retirees all present challenges in that they prefer to be reached in different ways.

Extramural funding
-Some of our programs are affected by extramural funding, either by adding resources to promote them or by shaping the content of the product.
-The power and influence of family foundations funding food systems competes with some of our programs.

-The Marcellus shale team secured several modest grants related to pipeline development, outreach education, risk management and energy for agricultural producers, and best management practices for rights-of-way. We also were awarded a grant from the U.S. State Department allowing the team to convey its research-based outreach on policy to the government of Argentina, which is the largest emerging shale gas region in the world outside of North America.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The generation of outcomes from existing programs and the development of new programs require improved evaluation that identifies pre- and post-responses to information and monitoring for long-term behavioral changes that result in improved outcomes. More statewide extension programs are using retrospective evaluation to gather information about the number of participants who actually put into practice lessons learned through extension programs. Measuring costs averted or profit increased can show powerful, tangible benefits of our programming--the type of feedback that keeps people coming back for more information. We are also seeing more extension programs gathering this type of data. Customer satisfaction and needs assessment instruments (Salesforce) are scheduled to be implemented in spring 2017 to provide feedback on the quality and value of our programs.

Key Items of Evaluation

See highlights of state-defined outcomes in this planned program.

V(A). Planned Program (Summary)

Program # 4

1. Name of the Planned Program

Environmental Resilience

☑ 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	0%		5%	
112	Watershed Protection and Management	0%		5%	
123	Management and Sustainability of Forest Resources	10%		5%	
132	Weather and Climate	5%		5%	
133	Pollution Prevention and Mitigation	5%		5%	
135	Aquatic and Terrestrial Wildlife	0%		5%	
136	Conservation of Biological Diversity	0%		5%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	5%		10%	
206	Basic Plant Biology	0%		5%	
211	Insects, Mites, and Other Arthropods Affecting Plants	5%		5%	
215	Biological Control of Pests Affecting Plants	5%		5%	
306	Environmental Stress in Animals	10%		5%	
401	Structures, Facilities, and General Purpose Farm Supplies	0%		5%	
405	Drainage and Irrigation Systems and Facilities	5%		5%	
605	Natural Resource and Environmental Economics	10%		5%	
607	Consumer Economics	10%		5%	
610	Domestic Policy Analysis	10%		5%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources	10%		5%	
901	Program and Project Design, and Statistics	10%		5%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.0	0.0
Actual Paid	47.6	0.0	185.5	0.0
Actual Volunteer	3.6	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**
1530152	0	1643909	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2651596	0	6335426	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
1615643	0	8760054	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

An important aspect of research into environmental resilience in our College focuses on interactions between and among insects and plants. Our researchers are investigating the interactions of plants' defense mechanisms and insect foraging, the beneficial impacts of integrated pest management for brown marmorated stink bugs, and bumblebee pollen preferences.

Penn State geneticists are working to preserve important tree species in the Mid-Atlantic region. They are analyzing the transcriptome for green ash in hopes of stopping the devastating emerald ash borer, and working on interspecific hybridization of American chestnut, which had almost disappeared from the region's forests.

Highlights from our active wildlife research program include the discovery of a virus infecting the fungus that causes white-nose syndrome in bats, evaluation of pH preference and avoidance responses in brook trout and brown trout, the effects of Marcellus shale development on forest bird populations, and the impacts of deer browsing on invasive and nonnative plants.

Environmental economics and socioeconomic and policy analysis are strengths of the College. Penn State researchers analyzed hurricane-induced property losses to identify the most effective investment of Federal Emergency Management Agency funding; the purchase of bottled water in areas affected by Marcellus shale development activity as an indicator of citizens' concern about real or perceived water pollution threats; and climate change adaptation tools and their limits.

A team in the College is collaborating nationally and internationally to develop the next generation suite of science-driven modeling and analytic capabilities. The community of practice will focus on analysis of the stressors, impacts, adaptations, and vulnerabilities of global and regional change, with emphasis on understanding the energy-water-land nexus.

A critical research/extension activity is educational and technical support for the implementation of the Chesapeake Bay TMDL to government agencies and NGOs. Research included a survey of thousands of Pennsylvania farmers to inventory their self-financed water quality best management practices. Survey results were field verified, and this method was accepted for use in other states to aid bay cleanup assessment.

Penn State hosted a conference in March 2016 of agricultural and environmental leaders collaborating to identify new solutions to help ensure that the state maintains a vibrant agriculture industry, while meeting water-quality goals for PA waterways and the Chesapeake Bay.

In a related effort, the 2015 North American Manure Expo, co-hosted by Penn State's College of Agricultural Sciences, was recognized with the Governor's Award for Environmental Excellence, the state's highest honor for environmental performance and innovation. The expo drew a record 2,000 attendees from 23 states and four Canadian provinces. Professionals were exposed to information and equipment that allow simultaneous and practical progress for animal agriculture, crop production, and environmental stewardship.

2. Brief description of the target audience

Agricultural Producers/Farmers/Landowners
Agriculture Services/Businesses
Business/Industry
Community Groups
Education
General Public
Government Personnel
Human Service Providers
Military
Nonprofit Associations/Organizations

3. How was eXtension used?

Some members of most teams serve as topic experts and answer questions submitted to eXtension's Ask an Expert system. Team members also use eXtension resources for further information for themselves and/or clientele. Some teams publish articles and/or conduct webinars through eXtension.

Members of a few teams completed the impact statement training through eXtension.

A member of the equine environmental stewardship team serves on the federal eXtension Horse Quest Community of Practice National Equine Resource Team. In addition, members of the PSU equine team are members of the eXtension HorseQuest Community of Practice. One team member served as the national chair for the pasture management section of the Equine Community of Practice.

A Marcellus team member participated in the inaugural i-Three Corps effort in FY15/16. This included participation in the Design-A-Thon in San Antonio during eXtension's annual conference.

Penn State Extension supports faculty and staff use of eXtension and promotes communities of practice as a way of broadening sources of information and outreach. Penn State Extension supports the professional development offered through eXtension.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	69912	570175	11580	1121

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

Patent Applications Submitted

Year: 2016

Actual: 2

Patents listed

Serial No. 62/287,693; Filed 1/27/2016; Title: Capacitive Plant Tissue Sensor

Serial No. 62,287,709; Filed 1/27/2016; Title: Plant Tissue Thickness Sensor

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	31	171	202

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants in extension education classes and workshops.

Year	Actual
2016	19937

Output #2

Output Measure

- Number of technology disclosures involving college faculty, staff, extension educators, and students.

Year	Actual
2016	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increased knowledge of ecosystem change expected with climate change.
2	Improved strategy for addressing nutrient pollution in Chesapeake Bay.
3	Improve urban environments through green infrastructure research and extension.
4	Cost savings (in $) to Pennsylvania tree fruit growers in reduced pesticide costs by growing and supporting populations of a beneficial predatory mite.
5	Linear feet of streambank fencing that Pennsylvania farmers in the Chesapeake Bay watershed voluntarily erected with their own money to help improve local and bay water quality.
6	Evaluation of the relative effectiveness of U.S. Federal Emergency Management Agency expenditures on hurricane-induced property losses.
7	Finding that deer selectivity likely plays an important role in the process of plant invasion.
8	Finding that climate change is affecting arctic plants above ground more than belowground.
9	Finding that shale gas development in core forest can have negative consequences for forest songbirds.
10	Minimum estimated annual averting expenditures (in $) for bottled water in Pennsylvania shale counties.
11	Potential yearly savings nationally (in $) of fumagillin treatment not applied to 5% of currently treated honeybee colonies in the U.S. in light of finding no impact of fumagillin use on colony survival.

Outcome #1

1. **Outcome Measures**

Increased knowledge of ecosystem change expected with climate change.

Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

Improved strategy for addressing nutrient pollution in Chesapeake Bay.

Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

Improve urban environments through green infrastructure research and extension.

Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

Cost savings (in $) to Pennsylvania tree fruit growers in reduced pesticide costs by growing and supporting populations of a beneficial predatory mite.

2. **Associated Institution Types**

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1000000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Tree fruit is a $69 million a year industry in PA. The introduction of synthetic insecticides in the mid-20th century to control some orchard pests wiped out populations of some predatory mites that kept herbivorous pest mites detrimental to fruit production in check. But implementation of the Food Quality Protection Act in 1996 removed some of the more toxic, broad-spectrum insecticides from use. Now more selective pesticides are allowing a new beneficial predatory mite to flourish in orchards.

What has been done
With leveraged funding, a Penn State researcher found high numbers of the predatory mite, Typhlodromus pyri, in several Penn State and commercial apple orchards. The mite could be detected in about 75% of the Pennsylvania orchards surveyed, but often at levels too low to be effective. Despite several earlier surveys, this predatory mite had never been found in PA or the Mid-Atlantic. Experimentation has since refined insecticide recommendations to conserve and augment T. pyri populations.

Results
Through a PA Department of Agriculture grant, the researcher is transferring T. pyri to other orchards and developing pest management recommendations for the 1-2 years it takes to build up sufficient populations of T. pyri to prevent plant-feeding pest mites from becoming a problem. He is testing all new pesticides to see how they affect T. pyri and is looking to expand the program to other parts of PA and other Mid-Atlantic states.

Growers who properly use T. pyri benefit from a 90% reduction in miticide costs (up to $150/acre previously) and leaf injury, eliminate the widespread miticide resistance problems seen previously, and could be eligible to receive USDA incentive payments from conservation programs that support environmentally sustainable pest management and pesticide use reductions. Biological mite control by T. pyri has reduced miticide applications by about 1 ton of active ingredient and is saving fruit growers over $1 million each season.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
136	Conservation of Biological Diversity
211	Insects, Mites, and Other Arthropods Affecting Plants
215	Biological Control of Pests Affecting Plants
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources

Outcome #5

1. Outcome Measures

Linear feet of streambank fencing that Pennsylvania farmers in the Chesapeake Bay watershed voluntarily erected with their own money to help improve local and bay water quality.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1300000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Pennsylvania must install agricultural best management practices (BMPs) to comply with the Chesapeake Bay total maximum daily load (TMDL). The PA Department of Environmental Protection (DEP) tracks BMPs implemented with public financial assistance funds. However, many PA farmers install BMPs without state or federal assistance. Accurate compliance monitoring requires that these investments are credited by the Chesapeake Bay Program.

What has been done
DEP funded a Penn State-led survey, to which nearly 7,000 farmers responded, that was the first comprehensive inventory of farmers' self-financed BMPs to reduce nitrogen, phosphorus, and sediment entering PA streams. To verify response accuracy, researchers randomly selected more than 700 of the respondents for farm visits by dozens of trained Penn State Extension staff.

Results
Respondents reported implementing and covering the cost of these water-quality best management practices:
-475,800 acres of nutrient/manure management
-97,562 acres of enhanced nutrient management
-2,164 animal-waste storage units
-2,106 barnyard runoff-control systems
-55,073 acres of ag erosion/sedimentation control plans
-228,264 acres of conservation plans
-More than 1.3 million linear feet of streambank fencing
-1,757 acres of grass riparian buffers
-5,808 acres of forested riparian buffers

On-site verification confirmed that farmers' responses were highly accurate. This survey reports self-financed practices that, to date, have not been adequately captured and reported for PA's credit.

The Chesapeake Bay Program's Ag Workgroup approved the survey process and U.S. EPA approved the process for use in other states.

Penn State has been helping to facilitate efforts to improve PA's TMDL performance and to develop strategies for optimal placement of nutrient best management practices.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
401	Structures, Facilities, and General Purpose Farm Supplies
405	Drainage and Irrigation Systems and Facilities
901	Program and Project Design, and Statistics

Outcome #6

1. Outcome Measures

Evaluation of the relative effectiveness of U.S. Federal Emergency Management Agency expenditures on hurricane-induced property losses.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Increased population and the accumulation of wealth in coastal areas have contributed to rising property losses to hurricanes in the U.S. Given projected increases in hurricane intensities due to climate change, damage figures will likely increase substantially unless coastal development is curbed and building standards are improved. Since 1989, the U.S. Federal Emergency Management Agency (FEMA) has spent more than $13 billion to help communities implement long-term hazard mitigation projects.

What has been done
With leveraged funding from the U.S. Department of Energy, this study evaluated the relative effectiveness of FEMA expenditures on hurricane-induced property losses implemented by federal and local governments. The model includes two FEMA categories: (1) cumulative spending in ex-ante mitigation and planning programs, as well as improvement of structural projects; and (2) ex-post recovery and clean-up spending from prior incidents.

Results

Analysis showed that a 1% increase in annual spending on ex-ante risk reduction and warning projects reduces damages by 0.21%, while a 1% increase in ex-post recovery and clean-up spending reduces damages by 0.12%. Although both types of spending are effective, the marginal return from spending on programs that target long-term mitigation and risk management was almost twice that of spending on ex-post recovery programs. Given that current FEMA spending on mitigation programs is smaller by an order of magnitude relative to spending on disaster response and clean-up programs, the results suggest that we would expect a significantly larger return on investment if more FEMA spending was directed to ex-ante mitigation measures at the margin.

4. Associated Knowledge Areas

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

Outcome #7

1. Outcome Measures

Finding that deer selectivity likely plays an important role in the process of plant invasion.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Many invasive plant species lack natural controls, have aggressive growth patterns, and reproduce rapidly and prolifically. Combined with their lack of nutritional and habitat quality for native wildlife, they can be disruptive in the forest and watershed ecosystems on which we all depend. Not much is known about animal preferences for invasive and/or non-native plants.

What has been done
A Penn State team conducted a study of deer dietary choices during which eight captive mature does without fawns were simultaneously offered in containers a selection of eight non-native invasive and seven native plants to determine the animals' preferences. Feeding preferences

were documented from spring to early fall. An automated camera allowed the researchers to observe and record deer behaviors. The amount of each plant consumed was measured.

Results
Although deer consumed more native than introduced plant biomass overall, their food preference varied strongly by plant species. Results show consistent deer avoidance of several invasive, introduced plants--garlic mustard, Japanese barberry and Japanese stiltgrass. Deer also avoided one native plant, hay-scented fern. But deer highly preferred other invasive, introduced plants--Oriental bittersweet, European privet, and Morrow's honeysuckle, and a native plant--red maple.

This study provides evidence that deer impacts on plant invaders depend on plant species' palatability. Consequently, deer selectivity likely plays an important role in the invasion process. To the extent that herbivory affects plant communities, these results suggest that deer promote the spread of some plant invaders by avoiding them. These findings contribute to the conservation of northeastern U.S. forest understories and natural areas.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants

Outcome #8

1. Outcome Measures

Finding that climate change is affecting arctic plants above ground more than belowground.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Shifts in phenology (plant development) have been widely reported in response to global warming and have strong effects on ecosystem processes and greenhouse gas emissions. It is well

documented that warming generally advances aboveground plant growth, but warming's influence on root phenology is unclear. Most terrestrial biosphere models assume that root and shoot growth occur simultaneously and are influenced by warming in the same manner, but recent studies suggest that this might not be so.

What has been done
With leveraged funding, a Penn State team in 2013 and 2014 examined the timing of root growth in Greenland shrub-graminoid tundra communities in a fully factorial design of plots that were warmed or ambient and excluded or permitted access by large herbivores. Testing the assumption of co-occurring root and shoot growth is particularly important in the Arctic, where more than 70 percent of plant biomass can be belowground and warming is happening faster than in other ecosystems.

Results
Peak root growth occurred 2.5 weeks before leaf growth, suggesting that spring root phenology is not controlled by carbon produced during spring photosynthesis.

Spring leaf growth was advanced by warming and delayed by herbivory, but neither influence significantly affected root phenology. Root growth occurred in near-freezing soil temperatures. Summer root production appeared to be linked to soil moisture.

The plant community studied is important to caribou and musk ox for grazing. This research shows that as a result of climate change, leaves are growing earlier in the year. But caribou migrate at the same time every spring, and they prefer and need the young, tender leaves, without which, previous research shows, the animals have fewer young.

The implications of uncoupling of aboveground and belowground plant growth could be substantial for the accuracy of climate change carbon-uptake models, which don't currently account for uncoupling of root and shoot phenology.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
206	Basic Plant Biology

Outcome #9

1. Outcome Measures

Finding that shale gas development in core forest can have negative consequences for forest songbirds.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The Appalachian shale play, which includes the Marcellus shale formation, is an important source of natural gas and underlies much of the remaining large areas of extensive contiguous forest within the eastern United States, areas that are important breeding sites for forest songbirds. Shale gas development in contiguous forest creates large disturbances and causes habitat fragmentation; the landscape matrix remains characterized by stands of mature forest.

What has been done
Researchers assessed the effects of shale gas development on counts of passerines and near-passerine birds in extensive forest. They surveyed birds within northern hardwoods and mixed oaks at increasing distances from 49 shale gas pads established within contiguous forest. They compared counts of individual species and 3 vegetation-association groups (forest interior, synanthropic, and early successional) versus distance from pad edge, and community composition versus distance from pad edge.

Results
Counts of individuals and species within the forest interior group increased with distance from pad edge. Counts of synanthropic (human-associated) individuals and species were greatest at the pad edge and declined with distance to pad edge. Counts of individuals and species within early successional habitat were greater in oak than northern hardwoods. In northern hardwoods, counts were greatest near the pad edge, whereas counts in oak showed no trend with distance to pad edge. The results suggest that synanthropic species--rare in core forest--can rapidly exploit new development-associated habitat. Counts of forest interior specialists declined, suggesting the habitat is becoming less suitable for them. The results are an early indication that shale gas development in core forest can have negative consequences for forest songbirds. Long-term effects will depend on the scale and extent of shale gas development, emphasizing the need for proactive planning to minimize negative effects.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
135	Aquatic and Terrestrial Wildlife
306	Environmental Stress in Animals

Outcome #10

1. Outcome Measures

Minimum estimated annual averting expenditures (in $) for bottled water in Pennsylvania shale counties.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	19000000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Although unconventional shale gas development is seen as an economic benefit, concerns have been raised about the environmental and health risks associated with the extraction process. Even the perception of risk can affect human well-being because it affects the choices people make to reduce these threats. Averting behavior is likely as households attempt to protect themselves when faced with both real and perceived environmental or health risks.

What has been done
This study combined GIS data on unconventional shale gas development in Pennsylvania and Ohio with household data on bottled water purchases to assess the impact that perceived risks to drinking water from unconventional shale development have had on household well-being using a treatment effects design.

Results
In the preferred triple difference models with time-varying treatment effects, results showed per-household averting expenditure in 2010 ranging from $10.74 in the full sample to $15.64 when omitting urban counties more likely to contain public water supplies. Converting the sample-average averting expenditure of $10.74 to an annual expenditure for the entire impacted population implies an averting expenditure in Pennsylvania shale counties exceeding $19 million for 2010. The results reveal a large, robust increase in averting expenditure associated with shale gas activity that has been overlooked in much of the existing research on environmental impacts of shale development and is not addressed in existing policy. This suggests that substantial welfare improvements could be made through education, water quality testing, and other assurances of public drinking water safety to reduce averting expenditure where water contamination is absent.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
607	Consumer Economics
610	Domestic Policy Analysis

Outcome #11

1. Outcome Measures

Potential yearly savings nationally (in $) of fumagillin treatment not applied to 5% of currently treated honeybee colonies in the U.S. in light of finding no impact of fumagillin use on colony survival.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	310800

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Nosema apis and N. ceranae are common intestinal parasites in honey bee (Apis mellifera L.) colonies. Basic and applied studies are urgently needed to help beekeepers effectively manage Nosema spp. Beekeepers need practical, affordable technologies that facilitate disease diagnosis and science-backed guidelines that recommend when, if at all, to treat infections. Some Nosema infections don't cause colony collapse, and they don't all require treatment.

What has been done
Nosema apis and N. ceranae are common intestinal parasites in honey bee (Apis mellifera L.) colonies. Basic and applied studies are urgently needed to help beekeepers effectively manage Nosema spp. Beekeepers need practical, affordable technologies that facilitate disease diagnosis and science-backed guidelines that recommend when, if at all, to treat infections. Some Nosema infections don't cause colony collapse, and they don't all require treatment.

Results
Fumagillin is the only widely used treatment for Nosema. A beekeeping supplier recommends at least two treatments per year, which cost about $6 per colony per year. In 2016 there were at least 2.59 million honey bee colonies in the U.S. If we assume that this review convinces the keepers of just 5% of treating colonies to stop treating prophylactically, the potential cost savings

in treatments could be > $310,000 nationally.
Nosema infections typically clear up by themselves and, according to the literature review, are not the major factor associated with colony loss. But fumagillin could still be helpful for very severe infections.
Given variation in Nosema virulence, development of regional management guidelines, rather than universal guidelines, may provide optimal and cost-effective Nosema management.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
135	Aquatic and Terrestrial Wildlife

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

Natural disasters
-Weather conditions can drive clients' requests for programs and advice.
-Weather conditions can necessitate changes in field research plans and workshops.

Economy
-The economy influences clientele's interest in and ability to implement tactics suggested. Some clients lack the equipment necessary to implement suggestions.
-Limited budgets for travel do not allow educators to meet all requests for programs. Budget limitations also hinder the development and delivery of programs.
-The budget stalemate in Pennsylvania took time and attention away from programming.
-As the demand for energy grows and evolves to a new paradigm that includes much more natural gas and increased reliance on renewables, PA's national role as the number one producer of shale gas gives PSU a strong rationale for both research and outreach in this space.

Public policy changes
-Increased interest in environmental, tax, and land planning policy in PA at the local and state levels has motivated residents affected by shale to seek out the unbiased educational outreach and research capacities of the Marcellus extension unit.

Government regulations
-Revised regulations can drive the need for new or revised programs.
-Helping farmers comply with federal and state nutrient management regulations continues

to be an important driver for extension programs.
-A critical activity has been educational support for the implementation of the Chesapeake Bay TMDL by USEPA and technical support to government agencies and NGOs for this effort.
-Interest in PA's comprehensive shale gas regulatory environment is high among affected residents in the Commonwealth. This interest extends to the many delegations we have hosted in the immersive shale trainings conducted in FY15/16 for international governments looking to mimic PA's successes and avoid related downsides.

Competing public priorities
-Redirection of time and effort was necessary when PA announced the Chesapeake Reboot Strategy.
- Competing public priorities force us to continually align our programs with budget realities.

Competing programmatic challenges
-Competing priorities often mean that it's not possible to complete all desired work in one area.

Extramural funding
-Some of our programs are affected by extramural funding, either by adding resources to promote them or by shaping the content of the product.
-Extramural funding has allowed some teams to conduct practical applied research projects that include integrated extension/educational components.
-Much of the work occurring to support woodland owner education in Pennsylvania is supported by a USDA Forest Service grant passed through by the DCNR Bureau of Forestry. With declining federal funding, as well as changes in Penn State's expectations of capturing indirect costs on these funds, our ability to do the full scope of work is threatened.
-Extramural funding has declined in recent years. This has had negative effects on productivity, particularly in the wildlife area, where outside funding has been a primary source of revenue for developing publications and other program material.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The generation of outcomes from existing programs and the development of new programs require improved evaluation that identifies pre- and post-responses to information and monitoring for long-term behavioral changes that result in improved outcomes. More statewide extension programs are using retrospective evaluation to gather information about the number of participants who actually put into practice lessons learned through extension programs. Measuring costs averted or profit increased can show powerful, tangible benefits of our programming--the type of feedback that keeps people coming back for more information. We are also seeing more extension programs gathering this type of data. Customer satisfaction and needs assessment instruments (Salesforce) are scheduled to be implemented in spring 2017 to provide feedback on the quality and value of our programs.

Key Items of Evaluation

See highlights of state-defined outcomes in this planned program.

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Global Engagement

☑ 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	5%		10%	
111	Conservation and Efficient Use of Water	10%		10%	
201	Plant Genome, Genetics, and Genetic Mechanisms	5%		10%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	5%		10%	
212	Diseases and Nematodes Affecting Plants	5%		10%	
721	Insects and Other Pests Affecting Humans	10%		10%	
723	Hazards to Human Health and Safety	10%		10%	
802	Human Development and Family Well-Being	10%		5%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	10%		10%	
805	Community Institutions and Social Services	10%		5%	
806	Youth Development	10%		5%	
903	Communication, Education, and Information Delivery	10%		5%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.0	0.0
Actual Paid	4.5	0.0	3.9	0.0
Actual Volunteer	0.3	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**
181930	0	71130	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
300412	0	135551	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
162326	0	337691	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research activity in global engagement often centers on the developing world. Projects address the empowerment of women in agriculture in Honduras and Cambodia (Hatch salary funds leverage other funding sources), pro-poor value chains in potato markets, how youth become radicalized, and a program to foster youth community engagement and problem solving.

Additional leveraged efforts are aimed at malaria transmission potential with climate change and among internally displaced people.

Other researchers are studying diseases of the economically important cacao crop and other aspects of cacao production. Still others strive to increase drought hardiness in crops aided by a new high-throughput method of root architecture analysis; model agricultural production in Uruguay; analyze the sustainability of irrigation with groundwater in India and resultant food insecurity; and help develop the economic potential of shale gas in some foreign countries.

2. Brief description of the target audience

Agricultural Producers/Farmers/Landowners
Agriculture Services/Businesses
Nonprofit Associations/Organizations
Business/Industry
Community Groups
Education
General Public
Government Personnel
Human Service Providers
Non-Governmental Organizations
Nonprofit Associations/Organizations
Policy Makers
Special Populations (at-risk and underserved audiences)
Students/Youth
Volunteers/Extension Leaders

3. How was eXtension used?

Some team members answered questions through the eXtension program.

Penn State Extension supports faculty and staff use of eXtension and promotes communities of practice as a way of broadening sources of information and outreach. Penn State Extension supports the professional development offered through eXtension.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	2065	14522	374	52

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

Patent Applications Submitted

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	0	7	7

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants in extension education classes and workshops.

Year	Actual
2016	2422

Output #2

Output Measure

- Number of technology disclosures involving college faculty, staff, extension educators, and students.

Year	Actual

2016	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Enhanced knowledge of drought tolerance in plants.
2	Improved understanding of globally important disease, such as malaria.
3	Successful strategy for engaging youth, women, or minorities in social action or leadership.
4	Finding that without intervention, poverty and food insecurity in rural India is likely to worsen due to overexploitation of groundwater and climate change.
5	Number of classes of highly divergent pathogenesis-related gene families in cacao that were identified and annotated.
6	Development of shovelomics method of high throughput phenotyping of common bean and cowpea root architecture in the field.
7	Number of international youth trained in a new curriculum aimed at engaging youth worldwide as researchers into social issues.
8	Finding that malaria transmission potential could be reduced with current and future climate change.

Outcome #1

1. **Outcome Measures**

   Enhanced knowledge of drought tolerance in plants.

   Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

   Improved understanding of globally important disease, such as malaria.

   Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

   Successful strategy for engaging youth, women, or minorities in social action or leadership.

   Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

   Finding that without intervention, poverty and food insecurity in rural India is likely to worsen due to overexploitation of groundwater and climate change.

2. **Associated Institution Types**

   - 1862 Research

3a. **Outcome Type:**

   Change in Knowledge Outcome Measure

3b. **Quantitative Outcome**

Year	Actual
2016	1

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

Issue (Who cares and Why)

India is one of the world's largest food producers, making the sustainability of its agricultural system globally significant. Groundwater irrigation underpins India's agriculture, currently boosting crop production by enough to feed 170 million people. Overuse has led to drastic declines in groundwater levels, threatening to push this resource out of reach for millions of small-scale farmers. Historically, losing access to groundwater has decreased agricultural production and increased poverty.

What has been done
A research team assessed climate change challenges facing India's agricultural system and assessed the effectiveness of large-scale water infrastructure projects designed to meet these challenges. They used detailed crop-wise agriculture and weather data from 1970 to 2005 for all the districts in the main agricultural states of India, and a panel data regression to estimate the relationship between inter-annual variation in monsoon climate variables and district-level irrigation decisions.

Results
This study provides the first multidisciplinary assessment of the extent of unsustainable groundwater use in India through midcentury. The results show that that even in areas that experience climate change-induced precipitation increases, expansion of irrigated agriculture will require increasing amounts of unsustainable groundwater. The large national river-linking project, through which the government of India proposes to move 178 billion cubic meters per year of water across river basin boundaries, has limited capacity to alleviate groundwater stress. Thus, without intervention, poverty and food insecurity in rural India is likely to worsen.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water

Outcome #5

1. Outcome Measures

Number of classes of highly divergent pathogenesis-related gene families in cacao that were identified and annotated.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	17

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Plant pathogens present the major challenge to sustainable cacao farming around the world. Pests and diseases reduce the potential crop by an estimated 810,000 tons annually (30% of world production). Individual farm losses can approach 100%. For example, witches' broom disease resulted in a decrease of production in eastern Brazil from 300,000 tons in 1989 to 130,000 tons 10 years later, for an estimated loss of $220 million per year. This caused small-holder growers to lose land and homes.

What has been done
A team led by Penn State researchers published a paper characterizing most of the genes in the pathogenesis-related (PR) families affecting cacao. Concentrations of the PR proteins increase in plant tissues upon contact with a pathogen. To date, 17 classes of proteins have been described that act through multiple mechanisms of pathogen resistance. Characterizing these families in cacao and comparing them to those in other species helps in understanding cacao's immune response.

Results
Candidate genes likely to be involved in cacao's defense against Phytophthora and Colletotrichum infection could be useful for marker-assisted selection for breeding of disease-resistant cacao varieties.

The researchers have also recently contributed to sequencing the entire cacao genome; characterized many genes involved in quality traits, and developed and published innovative methods for the study of functional genomics in cacao.

A method they developed--somatic embryogenesis--enables the rapid propagation of disease-free plants. More than 100 million cacao plants produced by somatic embryogenesis are now in farmers' fields in Indonesia.

In 2016, the research team held an international symposium to mark the 30th anniversary of the Endowed Program in the Molecular Biology of Cocoa at Penn State. About 160 scientists, industry representatives, and government officials from 25 countries attended.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
212	Diseases and Nematodes Affecting Plants

Outcome #6

1. Outcome Measures

Development of shovelomics method of high throughput phenotyping of common bean and cowpea root architecture in the field.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Drought is expected to worsen in some areas with climate change. In some developing countries drought has become so severe that it has disrupted societies, spawned or worsened civil strife, and led to the forced migration of millions of people no longer able to find water or grow food in their homelands. There are about 850 million chronically hungry people on Earth. Chronic malnutrition is the leading cause of childhood deaths in the Third World.

What has been done
A research team published a paper documenting their new "shovelomics" method in Field Crops Research. Shovelomics is an accuracy-validated system for quickly assessing the number and length of roots and their angle of growth on bean and cowpea plants, and image analysis to rapidly compare thousands of previously analyzed plants.

Results
The shovelomics system, which other research groups have extended to other crops, integrates with computer software that models how root architecture and anatomy affect a plant's ability to take up water and nutrients. This knowledge is essential in making crop plants better able to grow in dry, low-nutrient soils, as a way to fight chronic food shortages, and in developing more climate-resilient crops.

Over the past several years, this team has identified the genetic basis for traits that allow key crop plants to produce good yields under stressful conditions. They are helping plant breeders develop crop strains that combine a desired root architecture with the ability to make roots with low "biological cost" to the plant, and testing them in Africa, Asia, Europe, Latin America, Arizona, and Pennsylvania. This work has led to new common bean and soybean lines with greater yield and stress tolerance in Africa, Asia, and Latin America, and benefits corn breeding in Africa and the US.

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

Outcome #7

1. Outcome Measures

Number of international youth trained in a new curriculum aimed at engaging youth worldwide as researchers into social issues.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	200

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
About half of the world's population is currently under 25 years old, and more than one-third of the world's population is under 15 years old. About 90% of this youth population is in the developing world. The United Nations has recognized this group of about 3.5 billion people as a tremendous asset. However, the rise of violent extremism and lack of community engagement can present challenges.

What has been done
The research team studied factors affecting extremism and found that youth engaged with the community are much less likely to radicalize, even with exposure to extremist material online. The team documented the importance of youth as researchers into social issues. They developed a curriculum on basic social research methods for youth and pilot-tested it in 5 locations in Ireland, 1 in Britain, and 1 in Africa, and will pilot it in Pennsylvania this spring.

Results
The curriculum gives youth a voice in their communities by allowing them to identify pressing issues, training them in scientifically valid sampling and data collection, and helping them convey their findings to relevant policy makers. The training is offered in conjunction with local social services agencies. Youth as researchers can access different populations than adults can. Youth spread the word about their research findings through YouTube videos, infographics on social media, and in-person meetings with policy makers. In turn, they are being asked to help make new policies in response to the problems they've studied by serving on advisory boards, etc. Their studies have addressed deep-rooted issues such as mental health, depression and suicide, and LGBTQ rights and awareness. Because youth have framed and analyzed the issues, they are better positioned to help develop solutions that will be more appealing and successful with other youth.

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 and Social Services
806	Youth Development
903	Communication, Education, and Information Delivery

Outcome #8

1. Outcome Measures

Finding that malaria transmission potential could be reduced with current and future climate change.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The distribution of human malaria strongly depends on the interplay among the parasite, the mosquito vectors, and the environment. Small changes in environmental temperature can lead to large changes in transmission risk. Several studies suggest the potential for climate change to increase malaria incidence in cooler, marginal transmission environments. However, the effect of increasing temperature in warmer regions where malaria is endemic has received less attention.

What has been done
Researchers investigated how increases in temperature from optimal conditions (27-30 degrees C and 33 degrees C) interact with realistic diurnal temperature ranges (DTR: ± 0 degrees C, 3 degrees C, and 4.5 degrees C) to affect the ability of key vector species from Africa and Asia (Anopheles gambiae and An. stephensi) to transmit the human malaria parasite, Plasmodium falciparum.

Results
The effects of increasing temperature and DTR on parasite prevalence, parasite intensity, and mosquito mortality decreased overall vectorial capacity for both mosquito species. Increases of 3

degrees C from 27 degrees C reduced vectorial capacity by 51-89%, depending on species and DTR, with increases in DTR alone potentially halving transmission. At 33 degrees C, transmission potential was further reduced for An. stephensi and blocked completely in An. gambiae. These results suggest that small shifts in temperature could play a substantial role in malaria transmission dynamics, yet few empirical or modeling studies consider such effects. The results further suggest that rather than increase risk, current and future warming could reduce transmission potential in existing high transmission settings.

4. Associated Knowledge Areas

KA Code	Knowledge Area
721	Insects and Other Pests Affecting Humans
723	Hazards to Human Health and Safety

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

Natural disasters
-Natural disasters allow the rapid spread of diseases and can damage equipment, such as drinking water treatment systems, that is essential for public health.

Economy
-The global economy influences political instability, and lack of opportunity can incite radical groups, disempower women and minorities, and discourage peace-building activities.

Appropriation changes, public policy changes, competing public priorities, and competing programmatic challenges
-Changes in appropriations, public policy changes, competing public priorities, and competing programmatic challenges can influence the amount of foreign aid available.

Government regulations
-U.S. and foreign government regulations can influence the feasibility and necessity of various projects.

Competing public priorities
-Competing public priorities force us to continually align our programs with budget realities.

Extramural funding

-Some of our programs are affected by extramural funding, either by adding resources to promote them or by shaping the content of the product.

-Extramural funding has allowed some teams to conduct practical applied research projects that include integrated extension/educational components.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The generation of outcomes from existing programs and the development of new programs require improved evaluation that identifies pre- and post-responses to information and monitoring for long-term behavioral changes that result in improved outcomes. More statewide extension programs are using retrospective evaluation to gather information about the number of participants who actually put into practice lessons learned through extension programs. Measuring costs averted or profit increased can show powerful, tangible benefits of our programming--the type of feedback that keeps people coming back for more information. We are also seeing more extension programs gathering this type of data. Customer satisfaction and needs assessment instruments (Salesforce) are scheduled to be implemented in spring 2017 to provide feedback on the quality and value of our programs.

Key Items of Evaluation

See highlights of state-defined outcomes in this planned program.

V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Integrated Health Solutions

☑ 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
112	Watershed Protection and Management	0%		5%	
133	Pollution Prevention and Mitigation	5%		5%	
204	Plant Product Quality and Utility (Preharvest)	0%		5%	
216	Integrated Pest Management Systems	8%		7%	
311	Animal Diseases	5%		5%	
313	Internal Parasites in Animals	5%		5%	
315	Animal Welfare/Well-Being and Protection	5%		5%	
402	Engineering Systems and Equipment	5%		5%	
403	Waste Disposal, Recycling, and Reuse	5%		5%	
405	Drainage and Irrigation Systems and Facilities	5%		5%	
501	New and Improved Food Processing Technologies	8%		8%	
701	Nutrient Composition of Food	5%		5%	
702	Requirements and Function of Nutrients and Other Food Components	5%		5%	
703	Nutrition Education and Behavior	8%		5%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	5%		5%	
721	Insects and Other Pests Affecting Humans	5%		5%	
722	Zoonotic Diseases and Parasites Affecting Humans	5%		5%	
723	Hazards to Human Health and Safety	8%		5%	
724	Healthy Lifestyle	8%		5%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.0	0.0
Actual Paid	85.6	0.0	208.7	0.0
Actual Volunteer	1.1	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**
1535026	0	1720323	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2494036	0	7875893	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
4792198	0	18767210	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

The food processing industry is an important economic driver in Pennsylvania, and much of the research in this planned program contributes to improved and safer food processing. Research includes investigation of Listeria in fresh mushroom processing facilities, mushroom slicer sanitation, and reduction of pathogenic bacteria and spoilage microorganisms in cold fill pickling of sausages.

Food safety relates directly to the quality of the water used in irrigation. Our researchers completed a microbial survey of Pennsylvania surface water irrigation sources. Another team examined the effectiveness of disinfection of municipal wastewater using pulsed ultraviolet light.

Research into one health, toxicology, and immunology in the College covers vitamin D and inflammatory bowel disease, redox modulation of inflammatory pathways by micronutrient selenium, the microbiome's effects on how food is processed, and the effects of consumption of Bifidobacterium on upper respiratory tract infection. Animal-related research explored Bordetella-host interactions, pathogenesis of paramyxoviruses, Johne's disease in dairies, human dimensions of mastitis management in dairies (includes Extension education offerings), and education about whole-farm management and fecal egg counts to reduce resistance development in equine dewormers.

Other research in integrated health solutions includes the effects of a nonnative weed on malaria control, metabolites as biomarkers for obesity in Mexican-American children, the association between ethanol perception and alcohol intake, and preference for fat content in milk.

The requirements of the Food Safety Modernization Act are driving much of our extension programming in this planned program. Trainings in Hazard Analysis Critical Control Point (HAACP) continue. The ServSafe curriculum is frequently presented to meet regulatory requirements for commercial food service operations. We offer specialized food safety trainings for specific industries, such as the wine industry.

Extension work in consumer food safety includes frequent offerings of Cooking for Crowds, for volunteer organizations that prepare and serve food to the public; and workshops by Master Food Preserver volunteers, who teach home food preservation.

We are offering more extension food safety trainings in Spanish to meet the growing need, and we are translating more materials into additional languages as well.

2. Brief description of the target audience

Agricultural Producers/Farmers/Landowners
Agriculture Services/Businesses
Nonprofit Associations/Organizations
Business/Industry
Community Groups
Education
General Public
Government Personnel
Human Service Providers
Military
Nonprofit Associations/Organizations

3. How was eXtension used?

One extension food safety team member answered nearly 170 questions asked via eXtension's Ask an Expert system. Some team members use eXtension as a resource for information and/or articles to use in their programs.

Penn State Extension supports faculty and staff use of eXtension and promotes communities of practice as a way of broadening sources of information and outreach. Penn State Extension supports the professional development offered through eXtension. Members of most teams answered questions submitted to eXtension's Ask an Expert system.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	222702	1136665	5216	871

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

Patent Applications Submitted

Year:	2016
Actual:	7

Patents listed
Serial No. 15/185,296; Filed 6/17/2016; Title: Foaming and Emulsifying Properties of High Pressure Jet Processing Pasteurized Milk

Serial No. 62/250,684; Filed 11/4/2015; Title: Characterization of a Natural Orang Pigment Found in Hass Avocado (Persea Americana) Seed for Use as a Natural Food Colorant

Serial No. 15/054,403; Filed 2/26/2016; Title: Compositions, Methods and Kits for Treating Cancer

Serial No. 14/909,263; Filed 2/1/2016; Title: Inhibitors of the Farnesoid X Receptor and Use Thereof in the Prevention of Weight Gain

Serial No. 15/213,128; Filed 7/18/2016; Title: A Size Tunable Enrichment Platform for Capturing Nano Particles in a Fluid

Serial No. PCT/US2016/0428; Filed 7/18/2016; Title: A Size Tunable Enrichment Platform for Capturing Nano Particles in a Fluid

Serial No. 62/268,921; Filed 12/17/2015; Title: Paramyxovirus Virus-Like Particles as Protein Delivery Vehicles

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	4	195	199

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants in extension education classes and workshops.

Year	Actual
2016	84461

Output #2

Output Measure

- Number of technology disclosures involving college faculty, staff, extension educators, and students.

Year	Actual
2016	5

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of people trained in safe food handling techniques.
2	Change in knowledge related to humane or efficient livestock housing and handling.
3	Change in knowledge related to our understanding of a disease mechanism, diagnostic testing, prevention strategy, or treatment for a livestock and/or human disease.
4	Increased knowledge of livestock genomics to potentially enhance performance and increase efficiency.
5	Finding that the invasive American weed Parthenium hysterophorus can negatively affect malaria control in Africa.
6	Finding of a need for a comprehensive approach to managing dairy herd mastitis that includes human dimensions such as perception of mastitis problems and threshold of concern.
7	Demonstration that cold fill pickling effectively reduces and inhibits bacterial pathogens and spoilage microorganisms in sausages.
8	Study of the occurrence of microbial indicators and pathogens in surface water used for irrigating produce crops grown on Pennsylvania farms.
9	Number of farms enrolled in the equine parasite control project that reduced their use of dewormer based on regular fecal egg counts and education about whole farm management to avoid parasite resistance to various dewormers.
10	Finding that pulsed UV light successfully disinfects wastewater effluent and reduces its organic load and is therefore an alternative to chlorine or conventional UV light for treatment of municipal wastewater effluent.
11	Potential annual benefit (in $) to Pennsylvania if the Dining with Diabetes program was extended to just 50% of all Pennsylvanians with diabetes (both diagnosed and undiagnosed), assuming that they experience a similar reduction in diabetes to those in the sample analyzed, and assuming a 15% decrease in indirect medical costs when diabetic status improves.

Outcome #1

1. **Outcome Measures**

   Number of people trained in safe food handling techniques.

   Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

   Change in knowledge related to humane or efficient livestock housing and handling.

   Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

   Change in knowledge related to our understanding of a disease mechanism, diagnostic testing, prevention strategy, or treatment for a livestock and/or human disease.

   Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

   Increased knowledge of livestock genomics to potentially enhance performance and increase efficiency.

   Not Reporting on this Outcome Measure

Outcome #5

1. **Outcome Measures**

   Finding that the invasive American weed Parthenium hysterophorus can negatively affect malaria control in Africa.

2. **Associated Institution Types**

   - 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Changing climatic conditions have negatively affected human health through emergence and resurgence of infectious diseases, spread of vector-borne diseases to new areas, and spread of invasive plant species. The spread of invasive plant species is of particular interest because they often cause widespread replacement of indigenous flora. The indirect effects of invasive plant species on human health, and particularly their interactions with disease-transmitting vectors, remain poorly explored.

What has been done
With leveraged USDA-ARS and NIH funds, a study sought to investigate the impact of the invasive neotropical weed Parthenium hysterophorus and its toxins on the survival and energy reserves of the malaria vector Anopheles gambiae. Scientists compared the fitness of A. gambiae fed on three differentially attractive mosquito host plants and their major toxins--the aggressive invasive weed Parthenium hysterophorus in East Africa and two other adapted weeds, Ricinus communis and Bidens pilosa.

Results
Results showed that female A. gambiae fitness varied with host plants as females survived better and accumulated substantial energy reserves when fed on P. hysterophorus and R. communis compared to B. pilosa. Females tolerated parthenin and 1-phenylhepta-1, 3, 5-triyne, the toxins produced by P. hysterophorus and B. pilosa, respectively, but not ricinine produced by R. communis. Given that invasive plants such as P. hysterophorus can suppress or even replace less competitive species that might be less suitable host plants for arthropod disease vectors, the spread of invasive plants could lead to higher disease transmission. P. hysterophorus represents a possible indirect effect of invasive plants on human health. This international study, which was led by a team in Kenya, highlights the need to include an additional health dimension in risk-analysis modelling for invasive plants.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems
721	Insects and Other Pests Affecting Humans
723	Hazards to Human Health and Safety

Outcome #6

1. Outcome Measures

Finding of a need for a comprehensive approach to managing dairy herd mastitis that includes human dimensions such as perception of mastitis problems and threshold of concern.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The ability to improve udder health and milk quality and to reduce antibiotic use relies on effective and consistent application of mastitis control practices. The US dairy industry is increasingly relying on nonfamily labor to perform critical tasks to maintain milk quality. Thus, it is important to understand dairy producer attitudes and beliefs relative to management practices, as well as employee performance, to advance milk quality within the changing dynamic of the dairy industry.

What has been done
To assess the adoption rate of mastitis control practices in US dairy herds, and to assess social variables, including attitudes toward employees relative to mastitis control, 1,700 dairy farms in Michigan, Pennsylvania, and Florida were surveyed. The survey included questions related to sociodemographics and farm characteristics, milking proficiency, milking systems, cow environment, infected cow monitoring and treatment, farm labor, and attitudes toward mastitis and related antimicrobial use.

Results
Reported 3-month bulk tank somatic cell count (BTSCC) for all herds was 194,000 cells/mL. Multivariate analysis determined that udder health practices, such as use of internal teat sealant, blanket dry cow therapy, and not using water during pre-milking udder preparation, were associated with lower BTSCC. Owner and manager beliefs and attitudes, including perception of mastitis problems and concern if BTSCC exceeds 300,000, were associated with herd BTSCC. Ensuring milking protocol compliance, giving employees a financial or other penalty if BTSCC increased, and perceived importance of reducing labor costs were negatively associated with BTSCC in farms using nonfamily labor. These findings highlight the need for a comprehensive approach to udder health that includes human dimensions.

The Vet Extension Unit offers milking equipment training and mastitis troubleshooting, and the Dairy Extension Unit offers custom training to help Hispanic employees improve their knowledge and skills.

4. Associated Knowledge Areas

KA Code	Knowledge Area
311	Animal Diseases
315	Animal Welfare/Well-Being and Protection
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
722	Zoonotic Diseases and Parasites Affecting Humans

Outcome #7

1. Outcome Measures

Demonstration that cold fill pickling effectively reduces and inhibits bacterial pathogens and spoilage microorganisms in sausages.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Pickling is a means of preserving a variety of foods, including meat products. Cooked sausages have traditionally been pickled using a heated solution of vinegar, salt, and spices in a process known as hot filling. However, hot fill pickling can result in quality defects unappealing to consumers. Alternatively, room temperature brine does not cause these quality defects.

What has been done
Little information exists on the safety of the cold fill pickling process to inhibit growth of pathogenic bacteria and spoilage microorganisms on acidified meat products. Researchers conducted two studies using brine solution to pickle precooked, ready-to-eat sausages inoculated with a pathogen cocktail consisting of Listeria monocytogenes, Staphylococcus aureus, and 3 types of Salmonella (study 1) or with select lactic acid bacteria (LAB), yeasts, and molds (study 2) over 28 days of pickling.

Results
In study 1, all Salmonella, L. monocytogenes, and S. aureus pathogens were reduced ~6.80 log CFU/g in 72 h when enumerated on nonselective media. On selective media, Salmonella and L. monocytogenes decreased 6.33 and 6.35 log CFU/g in 12 h, respectively, whereas S. aureus was reduced 6.80 log CFU/g in 24 h. Sausages experienced significant decreases in pH over the 28 days of storage, whereas no significant differences were observed in water activity or salt concentration of the sausages or brine. The results of study 1 demonstrate that cold fill pickling can effectively reduce and inhibit bacterial pathogens.

Study 2 revealed reductions of 5.51 log CFU/g in 24 h for LAB counts, 3.89 log CFU/g in 48 h for yeast counts, and 4.09 log CFU/g in 24 h for mold counts. This experiment is the first to demonstrate that cold fill pickling effectively reduces and inhibits spoilage microorganisms.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #8

1. Outcome Measures

Study of the occurrence of microbial indicators and pathogens in surface water used for irrigating produce crops grown on Pennsylvania farms.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Recent produce-associated foodborne illness outbreaks have been attributed to contaminated irrigation water. Food safety best practices (good agricultural practices) include control measures for the potential for irrigation water to become a source of pathogens. In PA surface water sources used for irrigation, possible relationships were studied between microbial indicator organisms and water physicochemical characteristics, and the potential for predicting the presence of human pathogens.

What has been done
Samples (153) were collected from irrigation sources on 39 farms in southeast PA 3 times in the growing season over 2 years. Samples were analyzed for 6 microbial indicator organisms (aerobic plate count, Enterobacteriaceae, coliform, fecal coliforms, E. coli, and enterococci), two human pathogens (Salmonella and E. coli O157), and 7 physical and environmental characteristics (pH, conductivity, turbidity, air and water temperature, and sampling day and 3-day-accumulated precipitation).

Results
Indicator populations were highly variable and not predicted by water and environmental characteristics. Only five samples were confirmed positive for Salmonella, and no E. coli O157 was detected. Predictive relationships between microbial indicators and the occurrence of pathogens could therefore not be determined.

Sampling frequencies outlined in USDA good agricultural practice and good handling practice audit guidelines could be too low to capture extreme population values over a growing season.

In this study an insufficient number of samples may have been collected to accurately represent sporadic changes in pathogen occurrence.

Microbial levels are likely influenced by factors not included in this study.

This study is in agreement with many others that showed overall poor correlations between microbial indicators and pathogens in surface waters. This underscores the need for more research before establishing a single nationwide metric for irrigation water safety.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
204	Plant Product Quality and Utility (Preharvest)
405	Drainage and Irrigation Systems and Facilities
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #9

1. Outcome Measures

Number of farms enrolled in the equine parasite control project that reduced their use of dewormer based on regular fecal egg counts and education about whole farm management to avoid parasite resistance to various dewormers.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	65

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Taking a whole-farm approach to managing parasites in horses can decrease the frequency of deworming, eliminate the use of products that are no longer effective on a farm, help owners learn which horses have natural resistance and which ones are "shedders," and help decrease the development of resistance to dewormers. No new products are on the immediate horizon, so if resistance continues to progress at the present rate, the equine industry could face a major crisis.

What has been done
Workshops are offered on parasites, pastures and manure management, and data collection to document parasite resistance to various dewormers. Eighty-one farms representing 681 horses in 19 PA counties are enrolled in the parasite control project. They monitor strongyle worm egg production following established protocol and evaluate product efficacy by conducting pre- and post-deworming egg counts every 8 weeks. Participants modify their parasite management plan based on the data collected.

Results
Sixty-eight percent of participants improved pastures to reduce grazing near manured areas, 45% removed manure from pastures, and 79% stopped harrowing pastures or restricted it to late fall. All participants (100%) identified their horses that are high shedders of parasites, as well as their horses that had good immunity against small strongyle. Nearly all participants (95%) determined the effectiveness of the dewormers they used, and 81% reduced their use. All participants reported increased confidence in surveillance-based deworming practices.

Whole-farm fecal monitoring revealed that most horses maintained low to moderate strongyle egg count levels throughout the study and had consistent immunity to small strongyles. High shedders tend to remain high and must be strategically dewormed. There is significant resistance to pyrantel and fenbendazole on PA farms. Horse owners must use a comprehensive approach to manage parasites to reduce the rate of resistance development.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
313	Internal Parasites in Animals

Outcome #10

1. Outcome Measures

Finding that pulsed UV light successfully disinfects wastewater effluent and reduces its organic load and is therefore an alternative to chlorine or conventional UV light for treatment of municipal wastewater effluent.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Ultraviolet (UV) irradiation is an attractive alternative to chemical disinfection for water and wastewater, and its use has increased. However, the use of conventional UV light has several shortcomings, including poor penetration depth, low emission power, potentially longer treatment times, and reduced efficacy with high suspended solids. An emerging technology, pulsed UV light, appears to have potential to overcome these shortcomings and increase the effectiveness of UV disinfection.

What has been done
A study was undertaken to characterize the efficacy of flow-through pulsed UV light for inactivation of Escherichia coli and Bacillus subtilis spores in synthetic (SMWE) and real municipal wastewater effluent (RMWE). Pulsed UV light uses short pulses (100-400 microseconds) at wavelength 100-1100 nm, with more than 50% of the light below 400 nm. The killing effects of pulsed light are caused in a short time duration by the broad-spectrum light content and the high peak power of the pulsed light.

Results
Complete inactivation was observed with a 10 L/min flow rate for E. coli and 6 L/min flow rate for B. subtilis using one-pass pulsed UV treatment and SMWE. For two-pass treatment, complete inactivation was observed in SMWE with a 16 L/min flow rate for E. coli and 10 L/min flow rate for B. subtilis. Complete inactivation was observed with 10 L/min flow rate treatments for E. coli in RMWE, whereas 4.15 Log reduction was observed at 6 L/min for B. subtilis in RMWE for one pass. The raw wastewater was also treated under flow-through pulsed UV light at 10 L/min flow rate and complete inactivation was observed. The treatment resulted in significant chemical oxygen demand (COD) and total organic carbon (TOC) reductions. These results indicate that pulsed UV not only successfully disinfects wastewater effluent, but also reduces the organic load

of municipal wastewater effluent. Therefore, pulsed UV technology can be an alternative for chlorine and conventional UV light for municipal wastewater effluent.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse
723	Hazards to Human Health and Safety

Outcome #11

1. Outcome Measures

Potential annual benefit (in $) to Pennsylvania if the Dining with Diabetes program was extended to just 50% of all Pennsylvanians with diabetes (both diagnosed and undiagnosed), assuming that they experience a similar reduction in diabetes to those in the sample analyzed, and assuming a 15% decrease in indirect medical costs when diabetic status improves.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	195000000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In 2013 the Pennsylvania Department of Health identified diabetes as the sixth leading cause of death in the state. An estimated 12 percent of Pennsylvanians have diagnosed diabetes, and another 25 percent (total=1,348,305) are undiagnosed.

What has been done
Penn State Extension's Dining with Diabetes (DWD) program helps people with type 2 diabetes or prediabetes manage and prevent this disease. Registered dietitians or certified diabetes educators lead discussions addressing important numbers in understanding diabetes, planning healthy meals, healthy food preparation, and physical activity. Each class offers food demonstrations and tastings, physical activity and ideas to take home, and discussions that help people manage their diabetes.

Results
After completing DWD, a significant number of participants experience a reduction in A1C, a measure of long-term blood glucose control, and blood pressure and increase their diabetes self-management knowledge and skills.

If the DWD program was extended to just 50% of the 1,348,305 people with diabetes in Pennsylvania (both diagnosed and undiagnosed), and if they experience a similar reduction in diabetes to those in the sample analyzed, the one-year benefit to the state would be approximately $195 million, assuming a 15% decrease in indirect medical costs when diabetic status improves. In addition, given a 3% interest rate, the five- and ten-year benefits would be about $920 million and $1.71 billion.

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Other (Extramural Funding)

Brief Explanation

Economy
-The food industry is a major economic driver for the state. Issues that impact a company or an industry will have a ripple effect throughout the state, from sales to jobs.

Public policy changes
-Oversight of food and farm businesses at all levels of government affects our program efforts, and we must stay current.

Government regulations
-The Food Safety Modernization Act is having an enormous impact on the food supply chain. Foodborne illness cases and food recalls continue to grab news headlines, which has a dramatic impact on the entire food chain. Food producers and processors need improved practices under increased scrutiny from the public, law makers, and regulators.

Competing public priorities

-Competing public priorities force us to continually align our program priorities with budget realities.

Competing programmatic challenges

-The Cooking for Crowds workshop is provided on an as requested basis because educators have other program obligations. As a result the number of workshops provided is based on perceived need by nonprofit organizations. With the current increase in number of educators the workshop could potentially be provided more routinely because there is better coverage throughout the state at this time.
-Training for newly hired extension educators on home food preservation was a team priority. Program funds allowed the team to hold a 2-day Master Food Preserver training workshop that included newly hired educators and selected individuals in geographic areas where home food preservation support was needed and an extension educator mentor was available.

Extramural Funding

-Some of our programs are affected by extramural funding, either by adding resources to promote them or by shaping the content of the product.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The generation of outcomes from existing programs and the development of new programs require improved evaluation that identifies pre- and post-responses to information and monitoring for long-term behavioral changes that result in improved outcomes. More statewide extension programs are using retrospective evaluation to gather information about the number of participants who actually put into practice lessons learned through extension programs. Measuring costs averted or profit increased can show powerful, tangible benefits of our programming--the type of feedback that keeps people coming back for more information. We are also seeing more extension programs gathering this type of data. Customer satisfaction and needs assessment instruments (Salesforce) are scheduled to be implemented in spring 2017 to provide feedback on the quality and value of our programs.

Key Items of Evaluation

See highlights of state-defined outcomes in this planned program.

V(A). Planned Program (Summary)

Program # 7

1. Name of the Planned Program

Positive Future for Youth, Families, and Communities

☑ 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	10%		5%	
704	Nutrition and Hunger in the Population	10%		10%	
723	Hazards to Human Health and Safety	5%		10%	
724	Healthy Lifestyle	10%		10%	
801	Individual and Family Resource Management	5%		5%	
802	Human Development and Family Well-Being	5%		10%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	10%		10%	
805	Community Institutions and Social Services	5%		5%	
806	Youth Development	15%		7%	
901	Program and Project Design, and Statistics	10%		10%	
902	Administration of Projects and Programs	5%		8%	
903	Communication, Education, and Information Delivery	10%		10%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.0	0.0
Actual Paid	177.8	0.0	4.5	0.0
Actual Volunteer	1.7	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**
2151625	0	130690	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
3699408	0	206035	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
10128772	0	356176	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Penn State researchers assisted with expanding the PROSPER program, a community-wide effort to reduce alcohol, tobacco and other drug use among youth, to Vermont; and studied the differences in Hispanic health insurance coverage rates across the country.

Rural health and safety efforts include development of an online design aid for evaluating manure pit ventilation systems to reduce entry risk; analysis of farm equipment/vehicle and horse and buggy/vehicle traffic accidents to determine optimal points for education; and development of an intervention designed to increase protective equipment use among Mexican immigrant and Mexican-American farmworkers.

4-H offers programs that help young people increase their knowledge, improve eating and physical activity habits, develop leadership and decision-making skills, and perform community service. 4-H volunteers develop their leadership, time management, and organization skills while earning the personal fulfillment attained through giving back. A research/extension tie-in involved a study of the effects of age, gender, and participation in 4-H on development of life skills in youth.

Other extension activities include a focus on grand-families and diabetes education. The Better Kid Care program improves preschool childcare via extensive online professional development training. The Bringing the Protective Factors Framework to Life in Your Work curriculum increases the ability of preschool educators to approach at-risk families by focusing on their strengths and applying the attributes of healthy families.

2. Brief description of the target audience

Agricultural Producers/Farmers/Landowners
Agriculture Services/Businesses
Nonprofit Associations/Organizations
Business/Industry
Community Groups
Education
General Public
Government Personnel
Human Service Providers
Military
Non-Governmental Organizations
Nonprofit Associations/Organizations

Policy Makers
Special Populations (at-risk and underserved audiences)
Students/Youth
Volunteers/Extension Leaders

3. How was eXtension used?

The PA 4-H Science Group uses eXtension as a reference resource. This ensures that the scientific information included in curriculum components is accurate and up-to-date. eXtension has also been a source of potential curriculum ideas for program development. Some 4-H science extension educators are engaged in Communities of Practice within eXtension.

Team members in 4-H Volunteer Management and Development completed the Impact training module.

Better Kid Care provides a link to eXtension on its website and eXtension provides a link on their site to Better Kid Care. Educators share this resource at their events. Members of the BKC program team serve as experts for eXtension questions.

Penn State is the lead institution for the Farm & Ranch in eXtension for Safety and Health (FReSH) Community of Practice (CoP). The CoP consists of over 100 members who are actively involved in developing and reviewing content for the site. The FReSH site is the official ag safety and health website for the Agricultural Safety and Health Council of America (ASHCA), which is linked to industry. eXtension is used for information dissemination, webinars (Learn), mobile app promotion, and online courses (Moodle). Grant funding was obtained this fiscal year that will continue to enhance and expand the FReSH CoP. The team's role with eXtension has enabled the Ag Safety and Health Program to generate close to $2 million in an 8-year period for program development and expansion. During this reporting period, there were over 64,000 visits to the FReSH site, compared to 56,000 visitors the previous year. USDA-NIFA emphasized the use of eXtension in the grant application for the SAY Project, and because Penn State has a primary role in FReSH, the team was able to write a successfully funded grant application that integrated Penn State Ag Safety and Health, multiple land-grants, and a for-profit organization that used eXtension as the primary mechanism for hosting and promoting SAY Project information. During this year, Penn State Ag Safety and Health partnered with University of Nebraska Medical Center to complete an i-Three Corp project that used wearable technology to test the usability and ergonomic designs of pitch forks for women. eXtension provided funding for two people to attend the annual conference, which provided resources for project design. Even though the i-Three Corp project has been completed, the Penn State team is still involved with the development of educational material with an additional partner, the University of Missouri.

At least some members of most extension units answer Ask an Expert questions and use eXtension resources as reference materials to address client questions and acquire personal knowledge when appropriate. Some programs include a link to the appropriate eXtension community articles on their site.

Penn State Extension supports faculty and staff use of eXtension and promotes communities of practice as a way of broadening sources of information and outreach. Penn State Extension supports the professional development offered through eXtension.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	317707	370423	7276	987

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

Patent Applications Submitted

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	5	14	19

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants in extension education classes and workshops.

Year	Actual
2016	118831

Output #2

Output Measure

- Number of technology disclosures involving college faculty, staff, extension educators, and students.

Year	Actual
2016	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Additional way to educate about farm safety.
2	Improvement in key health metrics for program participants.
3	Participants will show measurable changes in life skills.
4	Youth and families will illustrate skills in healthy lifestyles.
5	Potential savings (in $) to society if even one fatal farm equipment and one fatal horse and buggy traffic accident were prevented by following the recommendations of this study.
6	Analysis of disparities in Hispanic health insurance coverage rates in metropolitan and nonmetropolitan new and established destinations.
7	Finding that females ages 8-18 in studied 4-H programs had higher levels of competencies in life skills at the start of the program and were more likely to improve in these areas over the course of a year than their male counterparts.
8	Finding that neighborhood food environment factors, such as food desert status, were associated with obesity status even after controlling for home food environment factors.
9	Potential savings (in $) of eliminating even 10% of medically consulted injuries in the nation's population of crop field workers via just 5% adoption of protective clothing suggested in a newly created Spanish language farm safety app.

Outcome #1

1. **Outcome Measures**

   Additional way to educate about farm safety.

   Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

   Improvement in key health metrics for program participants.

   Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

   Participants will show measurable changes in life skills.

   Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

   Youth and families will illustrate skills in healthy lifestyles.

   Not Reporting on this Outcome Measure

Outcome #5

1. **Outcome Measures**

   Potential savings (in $) to society if even one fatal farm equipment and one fatal horse and buggy traffic accident were prevented by following the recommendations of this study.

2. **Associated Institution Types**

   - 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	3100000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Farm equipment (FE) and horse and buggy (HAB) crashes on public roads are relatively rare occurrences in the context of total vehicular crashes in Pennsylvania, but the effects of these crashes can be severe for the occupants involved and deserve the attention of injury prevention professionals.

What has been done
A Penn State team investigated characteristics associated with farm equipment and horse and buggy roadway crashes in relation to person, incident, and injury characteristics to identify appropriate points for prevention. They analyzed Pennsylvania Department of Transportation information on crashes occurring on public roads from 2010 through 2013.

Results
The average crash rate for FE was 198 crashes per 100,000 farm population, and for HAB it was 89 crashes per 100,000 Amish population per year. Crash severity analysis showed that 4.1% of FE and 2.6% of HAB crashes resulted in a fatality. This is much higher than the fatality rate for all other motor vehicles (almost 1%).

The National Safety Council's Injury Facts: 2017 estimates that the 2015 average cost of a death involving motor vehicles was $1,550,000. There were 13 fatalities from FE crashes and 7 fatalities involving HAB in the study period. If even only one fatality of each type (FE, HAB) was averted by following the recommendations in this report, the savings to society would be $3,100,000.

This study suggests that road safety and public health programs should focus not only on farm equipment operators and horse and buggy drivers but also on the other motorists sharing the roadway.

4. Associated Knowledge Areas

KA Code	Knowledge Area
723	Hazards to Human Health and Safety

Outcome #6

1. Outcome Measures

Analysis of disparities in Hispanic health insurance coverage rates in metropolitan and nonmetropolitan new and established destinations.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Hispanics have the lowest health insurance rates of any racial or ethnic group, but rates vary significantly across the U.S. One-third of non-elderly U.S. Hispanics are uninsured--twice the rate for whites. The unprecedented growth of the Hispanic population since 1990 in rural areas raises questions about disparities in access to health insurance coverage. Hispanics' access to health insurance is important due to the increasing Hispanic population and their geographic dispersion across the U.S.

What has been done
This study leveraged funding to identify spatial disparities in Hispanic health insurance rates to illuminate the contexts within which Hispanics are least likely to have health care access, and to inform policy approaches for increasing coverage.

1990, 2000, and 2010 census data were used to group counties into 4 mutually exclusive categories based on Hispanic population size/growth: established destinations, 1990s (early) new destinations, 2000s (recent) new destinations, and nondestinations.

Results
Early new destinations (those that experienced rapid Hispanic population growth during the 1990s) have the lowest Hispanic adult health insurance coverage rates, with little variation by metropolitan status. Conversely, among the most recent new destinations that experienced significant Hispanic population growth during the first decade of the 2000s, metropolitan counties have Hispanic health insurance rates similar to established destinations, but rural counties have Hispanic health insurance rates that are significantly lower than those in established destinations. Findings demonstrate that the new destination disadvantage is driven entirely by higher concentrations of immigrant noncitizen Hispanics in these counties, but labor market conditions

were salient drivers of the spatially uneven distribution of foreign-born noncitizen Hispanics to new destinations, particularly in rural areas.

4. Associated Knowledge Areas

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

Outcome #7

1. Outcome Measures

Finding that females ages 8-18 in studied 4-H programs had higher levels of competencies in life skills at the start of the program and were more likely to improve in these areas over the course of a year than their male counterparts.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
According to the 2012 National 4-H Enrollment Report, almost 6 million youth participated in 4-H Youth Development. Most 4-H programming and curricula are based on sound research and provide hands-on activities. If designed appropriately, 4-H programs offer a safe environment that provides opportunities for youth to explore their world, develop life skills, and gain a sense of belonging with peers and adults, as well as within themselves.

What has been done
This study examined the effects of age, gender, and 4-H involvement in clubs on life-skill development of youth ages 8-18 over a 12-month period. 4-H must provide outcome data that assist in garnering future support and funding. This study helps meet the current push for empirical evidence related to programs that work, the need to better understand factors that can

also affect life skills, and the need to better understand how to assess life skills.

Results
Age, gender, and 4-H involvement significantly influenced life-skill development. Females had higher levels of competencies in life skills at the start of the program and were more likely than their male counterparts to change in these areas during the year. International/diversity and science/technology projects can influence life skill development more than others.

The findings suggest that STEM programming needs to be strengthened to continue to attract boys into 4-H while also targeting this programming to girls who are less represented in that area. In addition, it seems gender-specific projects/clubs can have more effect on life skill development than mixed-gender projects.

Presurvey assessments can be helpful in understanding the youths' level of competencies at the start of the program and the changes in life skills during the year. New strategies should be tested for keeping youth engaged, including use of new technologies for traditional projects.

4. Associated Knowledge Areas

KA Code	Knowledge Area
805	Community Institutions and Social Services
806	Youth Development
901	Program and Project Design, and Statistics
902	Administration of Projects and Programs
903	Communication, Education, and Information Delivery

Outcome #8

1. Outcome Measures

Finding that neighborhood food environment factors, such as food desert status, were associated with obesity status even after controlling for home food environment factors.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Although some recent studies have uncovered significant associations between the neighborhood food environment and health outcomes, particularly obesity status, other studies have not. With leveraged funding from the USDA Economic Research Service, this study examined household-level health information and food-purchase data to investigate how obesity and overweight status were influenced by the local food environment after controlling for diet quality.

What has been done
This study examined associations between obesity and the food environment, measured both at the household and census-tract level. The at-home food environment was proxied by the USDAScore, which evaluates the adherence of a household's observed monthly expenditure shares of 24 aggregated food categories to USDA recommended values. Food environment data came from the US Census Bureau, food purchase information came from the IRI Consumer Panel, and health data came from IRI's MedProfiler.

Results
After controlling for a number of confounders at the individual, household, and neighborhood levels, the USDAScore, which indicates the healthfulness of the household's at-home food environment, was negatively linked with obesity status. Conversely, a census tract-level indicator of food-desert status was positively linked with obesity status. This study was the first to find this food desert-obesity link after controlling for the healthfulness of households' food purchases.

The food-desert status was positively associated with obesity status even after controlling for a wide number of household and individual characteristics.

Overall, food-desert status and other neighborhood-level indicators of the food environment generally had less significant impact on overweight status and obesity than individual- or household-level characteristics.

Higher densities of club stores and supercenters were associated with higher odds of overweight or obesity status in a nonmetropolitan subsample.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population
724	Healthy Lifestyle
805	Community Institutions and Social Services

Outcome #9

1. Outcome Measures

Potential savings (in $) of eliminating even 10% of medically consulted injuries in the nation's population of crop field workers via just 5% adoption of protective clothing suggested in a newly created Spanish language farm safety app.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	67270000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Farmworkers' exposures to pesticides are reduced when they wear personal protective equipment (PPE). Mobile health (mHealth) platforms can potentially deliver information to farmworkers to help promote PPE use. However, little is known about the feasibility of using mHealth platforms to promote farmworkers' use of PPE. A Penn State team conducted a study to describe the development and feasibility-testing of Protect Yourself! (¡Protéjase!), an intervention designed to increase PPE use.

What has been done
¡Protéjase! was developed in several steps. First, ethnographic observations were performed to understand what prevents PPE use. Next, researchers developed program components to meet these challenges. Feasibility was assessed using surveys and focus groups in both Spanish and English. Finally, both the PPE provided to each worker and the delivery of a smart-phone app that promoted use of PPE through daily individualized messaging were pilot-tested.

Results
All study participants self-identified as Mexican or Mexican-American. Overall, the PPE provided to workers, as well as the mHealth platform, were both perceived as useful for promoting PPE use.

The National Safety Council's Injury Facts: 2017 estimates the average cost of a medically consulted injury to be $31,000 per injured worker. The USDA Economic Research Service estimates that 434,000 people work in crop agriculture nationwide. If we assume just 5% adoption (21,700) of ¡Protéjase-suggested protective clothing, and assume that it is 100% effective in reducing medically consulted injuries, then the potential value of eliminating even 10% of medically consulted injuries in this population is > $67 million.

¡Protéjase! is an innovative way to engage farmworkers for pesticide protection. It might serve as a model program that could be altered to address other health issues in farmworker populations by tailoring messages to their daily needs.

4. Associated Knowledge Areas

KA Code	Knowledge Area

723	Hazards to Human Health and Safety
901	Program and Project Design, and Statistics
903	Communication, Education, and Information Delivery

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Public Policy changes
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)
- Other (Extramural Funding)

Brief Explanation

Economy
-Funding is limited to conduct agricultural safety and health trainings.
-Some clientele could not participate in statewide programming because of costs.
-Our inability to recruit high quality staff to deliver 4H science programs decreases the reach of our programmatic efforts.
-Cutbacks in funding for extension have resulted in the loss of educator positions.
-With less money available to support the 4-H organization as a whole, more money needs to be raised above and beyond the typical fundraising goals.
-Instability of state funding and the delay in passing a state budget threw staff, volunteers, and 4-H families into several months of uncertainty. 4-H families and volunteers drew attention to the budget crisis and possible loss of Extension programs throughout the state. After many months of uncertainty, the budget was approved with an increase in funding support for Extension. This experience brought a new sense of importance to the need to communicate clearly and frequently the impact that Extension has on the citizens of Pennsylvania.

Public policy changes
-Recent federal legislation (reauthorization of the Child Care Development Fund) mandates minimum health and safety training for all child care professionals. Better Kid Care responded to this need with an online course that has already reached more than 12,000 Pennsylvania child care professionals since July 2016. The capacity to rapidly respond to emerging issues related to children's health and wellness through research-based programming is a strength of the Better Kid Care program.
-This year, the Office of Child Development and Early Learning changed the amount of training required for early childhood educators around topics like health and safety. The allotted hours for professional development were spent on the mandated training with few hours left for non-required programs.

Competing public priorities
-Competing public priorities force us to continually align our programs with budget realities.

Competing programmatic challenges
-Engaging participants in the Bringing the Protective Factors Framework to Life in Your

Work professional development series has been difficult because the entire course takes 14 hours. Therefore, stand-alone sessions rather than the entire series were the most frequent delivery format.

Population changes
-The number of native Spanish speakers is on the rise. Our programs must adapt to be relevant to that audience.

Extramural funding
-Some of our programs are affected by extramural funding, either by adding resources to promote them or by shaping the content of the product.
-The PA 4-H Science Team obtained funding to support new curriculum initiatives and staff development totaling $321,412.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The generation of outcomes from existing programs and the development of new programs require improved evaluation that identifies pre- and post-responses to information and monitoring for long-term behavioral changes that result in improved outcomes. More statewide extension programs are using retrospective evaluation to gather information about the number of participants who actually put into practice lessons learned through extension programs. Measuring costs averted or profit increased can show powerful, tangible benefits of our programming--the type of feedback that keeps people coming back for more information. We are also seeing more extension programs gathering this type of data. Customer satisfaction and needs assessment instruments (Salesforce) are scheduled to be implemented in spring 2017 to provide feedback on the quality and value of our programs.

Key Items of Evaluation

See highlights of state-defined outcomes in this planned program.

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

Childhood Obesity (Outcome 1, Indicator 1.c)	
0	Number of children and youth who reported eating more of healthy foods.
Climate Change (Outcome 1, Indicator 4)	
0	Number of new crop varieties, animal breeds, and genotypes whit climate adaptive traits.
Global Food Security and Hunger (Outcome 1, Indicator 4.a)	
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)	
0	Number of new or improved innovations developed for food enterprises.
Food Safety (Outcome 1, Indicator 1)	
0	Number of viable technologies developed or modified for the detection and
Sustainable Energy (Outcome 3, Indicator 2)	
0	Number of farmers who adopted a dedicated bioenergy crop
Sustainable Energy (Outcome 3, Indicator 4)	
0	Tons of feedstocks delivered.