

2017 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.

This year we implemented a major reorganization of our Extension programs to better serve clients. The changes are intended to better align programs and products with stakeholder needs, deliver programs in ways that best meet customer preferences, and maximize operational efficiency statewide. The reorganization is presented in greater detail below.

Our faculty strive to conduct research that will provide solutions to the most pressing challenges to growers, producers, industry, and other stakeholders, and to team with extension personnel to transfer new knowledge and innovations into the field where they can make a measurable difference in the bottom line.

Planned 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 strategies.

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

Integrated Health Solutions-Advancing and improving the health of people, 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 emerging themes that engage expertise 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 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 over 200 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.

New Penn State Research Centers in which the College Participates. The university received a \$4.92 million gift from CSL Behring, a global specialty biotherapeutics leader, to create the multidisciplinary Center of Excellence in Biotechnology, and to revitalize the Shared Fermentation Facility, an engine for collaboration and innovation in biological training and research on the University Park campus. This will be important to some of our Biobased Materials and Products researchers.

Penn State's new Center for Security Research and Education will be a focal point to which some of our College faculty will contribute research about agricultural biosecurity. The center reflects Penn State's commitment to bringing together interdisciplinary groups in a multifaceted approach to this complex and pressing issue.

The interdisciplinary Microbiome Center continues to grow and thrive. The center hosted an intercollege, inter-campus day-long symposium identifying important intersections between fields where impactful questions lie. An outcome of the symposium was the formation of focused research groups that may seek funding to find answers at these crossroads.

This Year's Program Highlights. Our programs continue to focus on high profile problems that, in addition to their impact in Pennsylvania, frequently represent regional, national, and international priorities. These include meeting requirements of the Food Safety Modernization Act; studying and controlling the emerging threat of *Listeria monocytogenes* in fruit packing houses; regulatory issues in the Chesapeake Bay watershed; endocrine disruptors in the environment; organic biocontrols for fruit growers; developing best management practices for pollinator and honey bee health; and farm biosecurity training for natural gas contractors. Some programs are also cultivating stronger relationships with elected officials to better

understand their evolving needs and take advantage of their knowledge and networks related, for example, to issues and business opportunities stemming from the construction of an ethane cracker plant in western Pennsylvania. Below are some highlights from our programs this year.

In Advanced Agricultural and Food Systems, our projects included the release for commercialization of a new variety of high lycopene, high-yielding tomato; corn hybrid evaluation and advanced forage testing; determination of seasonal occurrence of spotted wing drosophila in various fruits and berries in Pennsylvania and Maryland and recommendation of a reduced schedule of pesticide spraying; development of ways to combat weeds while reducing reliance on herbicide; a method for predicting the storage potential of Honeycrisp apples that are prone to bitter pit disorder; and help for grape growers in meeting the climatic challenges of the Northeast. Other projects identified an indigenous predator of brown marmorated stink bugs and assessed consumer preference for fresh apples in the Mid-Atlantic.

In Biologically Based Materials and Products, some highlights include assessment and development of the croton nut value chain in East Africa; development of a new biomaterial that could replace plastic laminates and eliminate millions of tons of petroleum-based plastics each year; analysis of drivers and barriers to adoption of sustainable jet fuel; biorefinery site selection; and economic and life cycle analyses of biomass utilization for bioenergy products.

In Community Resilience and Capacity, Penn State researchers recalculated the economic impact of development of Marcellus shale natural gas resources in Pennsylvania and found that initial figures were overestimated by about half. Accurate initial estimates of resource potential are important because elected officials and voters form opinions about whether to support initiatives based on these figures. The Shale Energy Extension team conducted workshops for farmers receiving shale energy royalties to improve royalty management and increase earnings.

In Environmental Resilience, our faculty helped lead research to determine that neonicotinoids in seed coats are riskier than thought to predatory insects. They also studied the development of radio-frequency treatment to phytosanitize wood packing materials for international shipping; integrated pest management in the context of broad interest in soil health; and methods to save ash trees from the invasive emerald ash borer. Penn State researchers found that a common crop chemical leaves bees susceptible to deadly viruses and monitored for DNA of Asian carp in the Ohio River valley.

In Global Engagement, highlights include food safety management classes in Armenia, with similar programs planned for Ukraine and several countries in Africa; assessment of the potential for building the croton tree nut value chain; supporting efforts to replace illicit coca plants with cacao plants in post-conflict Colombia and to support the growth of the cacao industry in that country; and the development of new common bean varieties that yield about 79% more than standard varieties.

Project highlights in Integrated Health Solutions include the determinations that flavonoid intake is inversely associated with obesity in U.S. adults and that a whole food diet may help prevent colon cancer and other chronic diseases. Veterinary science researchers found that supplementation of transition dairy cows to fight disease during this critical period supports milk production and reduces clinical mastitis. Food scientists examined the prevalence and phylogenetic characterization of *Escherichia coli* and hygiene indicator bacteria isolated from leafy green produce, beef, and pork obtained from farmers' markets in Pennsylvania. The state has seen decreasing incidences of pesticide exposure in conjunction with the Pest Management extension team's long-term education efforts. Popular Extension offerings include preventive food safety controls for both human and animal food to help meet requirements of the Food Safety Modernization Act.

In Positive Future for Youth, Families, and Communities, our agricultural safety and health program helped solve two problems in the Amish community. After the Commonwealth's Amish Safety Committee asked

for help with children getting run over by farm equipment, Penn State personnel partnered on a grant to buy and distribute back-up cameras for Amish farm equipment. The committee also brought to the team the issue of children suffering head injuries by falling through hay holes in barns. The extension team worked with medical personnel and others to design, order, and distribute hay hole covers to reduce the threat of this injury.

Penn State researchers also led an investigation of the effectiveness of a new partnership with a church in creating a community health outreach event. The multipartner PROMoting School-community-university Partnerships to Enhance Resilience (PROSPER) program was found to be effective in reducing young adults' abuse of prescription and other drugs even after high school graduation.

Extension Reorganized to Better Serve Clients. Changes in operational structure and programming that occurred in spring 2017 will enhance the value of Penn State Extension to the Pennsylvania communities and clients it serves. Penn State Extension is evolving to better serve its stakeholders with enhanced customer service and relevant products and programs, delivered online and through its statewide network of county-based educators.

The goals of this restructuring are to better align programs and products with stakeholder needs, to deliver those programs in ways that best meet customer preferences, and to maximize statewide operational efficiency. To ensure that legacy continues, we are continuing to evolve in a digital era to capitalize on the technologies that allow us to get science-based educational resources to more Pennsylvanians.

Local relationships always have been a core value of Penn State Extension, and we have taken the next step by formally building client relations into top-level administration. We have added an associate director of client relations position. This person works closely with the associate director of programs and the associate director of operations. Together with the director of extension, these four positions comprise the executive leadership team.

The spotlight on customer relations permeates the organization statewide. Instead of 20 districts managed by district directors, Extension is now organized into 10 multicounty areas (<http://news.psu.edu/story/480705/2017/09/05/impact/client-relationship-business-operations-managers-named-penn-state>), each of which is overseen by a customer relations manager and a business operations manager. By dividing the duties of the former district directors, the individuals who fill these new positions can concentrate solely on building client relationships and providing program operational support, respectively.

Client relations managers are tasked with working with county stakeholders, raising awareness of the breadth of extension products and services available to them, defining local issues and needs, and working to bring the full resources of extension to bear on these issues.

Business operations managers now manage the operation of county extension offices, providing a network for program delivery. They are working to standardize systems and procedures across the organization, to increase efficiency and effectiveness of our operations.

All extension educators, no matter where they are located, are now part of an extension unit. The seven units, each overseen by an assistant director of programs, are 4-H Youth Development; Agronomy and Natural Resources; Animal Systems; Energy, Entrepreneurship, and Community Development; Food Safety and Quality; Food, Families, and Health; and Horticulture.

Educators in these units are organized around state program teams that draw expertise from across the College's nine academic departments and from the seven newly designated extension units. These teams focus on specific areas such as dairy, poultry, and crops, or on priority issues such as the Food Safety

Moving forward, online, digital education will dramatically expand the reach and distribution of extension products and services, making them available when, how, and where customers want them. These digital products--including videos, articles, publications, online courses, webinars, and other resources--will complement current face-to-face programming and allow educators to use their in-the-field time more strategically by putting routine educational materials online.

All program teams are participating in a strategic program-development process that will result in a diverse mix of products and services to address Pennsylvania priorities. As part of this process, teams will gather customer and stakeholder input to ensure relevancy.

Products and services will be focused on improving customer access and usability, will be marketed to customers based on their self-selected interest areas, and will include blended online and face-to-face delivery methods.

These steps are designed to dramatically improve the relevancy, usability, and reach of our programs and services. The goals are to listen and learn, to match customer needs and priorities with a robust portfolio of science-based information and education, and ultimately to help keep businesses competitive and growing and families and communities thriving.

The Penn State Extension offices in Philadelphia and Delaware counties in southeastern Pennsylvania and in Allegheny County in southwestern Pennsylvania are not part of the 10 multicounty-area structure. They are administered through the Penn State Center Philadelphia and the Penn State Center Pittsburgh, respectively. They broaden the reach of our programs to traditionally under-served urban audiences.

Diversity Efforts. Our programs address diversity in the U.S., including Plain Sect farm and food safety; bilingual integrated pest management training and livestock care training; increased social media presence in Spanish; the Pennsylvania Woodland Owner Women and Their Woods class; programs that strengthen relationships between employers and their Hispanic and Latino workers; and many others. We constantly seek to diversify the College's student body and enact more opportunities for global competency and global and transformative learning.

Some 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 here. We strive to highlight different projects each year, so as to best portray the breadth of our programs. Many of the projects previously reported on, including work with underrepresented groups such as Hispanics, Plain Sect, young growers, and grand-families, continue.

PA CES captures data on contacts (direct and indirect) and participants. We consider participants to be the number of individuals who attend the educational programs that we offer. Our contact numbers are derived from the number of people each of our extension educators and/or faculty have contacted. Direct contact numbers are only those from face-to-face meetings; indirect contacts are through Zoom or Adobe Connect sessions, website views, etc.

With the changes in operational structure and programming within our Extension enterprise, we re-evaluated and realigned our extension efforts among the Planned Program topical areas in this report. This has resulted in potential variances in Extension FTEs (paid and volunteer), expenditures, contacts, publications, and participants reported in the Planned Programs.

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 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.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	460.9	0.0	705.2	0.0
Actual	491.7	0.0	604.7	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 merit review using a number of processes.

Internal university panels review AES projects. At least two qualified faculty internally review Hatch, McIntire-Stennis, Animal Health, and State projects at initiation for the following metrics: 1) Relevance to priorities and mission of the units; 2) Probability of practical benefits; 3) Probability of contribution to basic knowledge; 4) Personnel available and qualified to do proposed work; 5) Provision for cooperative efforts; 6) Adequacy of equipment and facilities available; 7) Probability that objectives will be reached in proposed duration; 8) Proposal complete and format conforms to AES guidelines; and 9) Overall scientific and technical quality.

In addition, external university panels are used for Multistate Hatch activities. These projects are reviewed multiple times during the five-year duration. At initiation, multistate activities are evaluated for sound scientific approach, achievable goals/objectives, appropriate scope of activity to accomplish objectives, potential for significant outputs (products), outcomes, and/or impacts; and overall technical merit. Midterm evaluations rate progress reports and accomplishment of stated objectives, linkages among project participants and with other projects/agencies, funding sought or obtained, and success or plans for information and technology transfer. Both extension and academic faculty are encouraged to actively participate to meet the jointly agreed objectives.

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 external panels. 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 representative of integrated, multidisciplinary State Program Teams made up of field-based extension educators and faculty with split extension/research appointments. Program Team 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 Program Teams, and extension administrators review programs. State administrators and academic unit leaders serve as liaisons to each unit. Each State Program Team developed a program plan, based on formal needs assessment processes, that guides 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 Program Team. 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 panel members.

III. Stakeholder Input

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

- Targeted invitation to traditional stakeholder groups
- Targeted invitation to non-traditional stakeholder groups
- Targeted invitation to traditional stakeholder individuals
- Targeted invitation to non-traditional stakeholder individuals
- Survey of traditional stakeholder groups
- Survey of traditional stakeholder individuals
- Survey of the general public
- Survey specifically with non-traditional groups
- Survey specifically with non-traditional individuals
- Other (County Extension Boards)

Brief explanation.

College administration and faculty advisory groups confer regularly with key stakeholder groups. The Penn State Ag Council (<http://agsci.psu.edu/business/agcouncil>) provides us with direct contact to nearly 100 member organizations and groups representing the agricultural industry across the Commonwealth. Also part of the Ag Council membership are organizations such as the Chesapeake Bay Foundation and the County Commissioners Association of Pennsylvania. We seek input from all sectors representing the interests of Pennsylvania citizens. In addition, college leadership meet multiple times per year with individual stakeholder groups, such as the Pennsylvania Farm Bureau, PennAg Industries, Pennsylvania Forest Products Association, and State Horticultural Association of Pennsylvania.

Also in our stakeholder base are state and federal partners, with whom we have regular meetings, including the Pennsylvania Departments of Environmental Protection, Conservation and Natural Resources, and Health, the U.S. Department of Agriculture, and the U.S. Environmental Protection Agency.

Targeted invitations to traditional and non-traditional stakeholder groups and/or individuals are used heavily in our extension efforts. Invitations are extended to these stakeholders and members of the

general public to identify industry representatives and/or individuals who would formulate program advisory committees (e.g., the new Green Industry Statewide Advisory Board, Center for Pollinator Research's Stakeholder Advisory Board, StrongWomen program leaders, PROSPER program collaborators, etc.).

Surveys and/or focus group meetings of traditional and non-traditional stakeholder groups and/or individuals are used to collect more detailed information from stakeholders. For example, the Livestock extension team conducted a needs assessment in cooperation with the Beef Producers Working Group.

Each year, various programs within the College participate in science outreach events, such as the Pennsylvania Farm Show, Ag Progress Days, and events at the university's arboretum. Impromptu, informal discussions at these events bring valuable feedback.

Penn State Extension has implemented a new Program Development Process that all Extension Program Teams will use to leverage our areas of excellence and educational expertise to focus on the most relevant and highest priority issues of our stakeholders and customers. This formal, facilitated process uses market research and requires extensive stakeholder input to define the most impactful areas where the team can engage for the highest impact and return on investment of our resources. It is an objective process to identify areas for investment and disinvestment to ensure the highest and best use of our limited resources.

The Penn State Extension offices in Philadelphia and Pittsburgh greatly expand the reach of our programs to traditionally under-served urban audiences.

No matter the method of engagement, we seek feedback on the quality and relevance of our programs, the quality of our presenters, suggestions of other resources stakeholders need, etc. We sometimes collect more detailed retrospective evaluations to gather information about the number of participants who actually put into practice lessons learned through extension programs. Attempting to measure costs averted or profit increased can show powerful, tangible benefits of our programming.

Faculty use published research by national stakeholder groups to inform their decisions about which research projects to pursue. For instance, a survey of veterinarians by the American Association of Equine Practitioners identified priorities of diseases most needing research, and our faculty are answering that call with research on equine laminitis and colic.

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

1. Method to identify individuals and groups

- Use Advisory Committees
- Use Internal Focus Groups
- Use External Focus Groups
- Open Listening Sessions
- Needs Assessments
- Use Surveys
- 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 such as urban farmers; and, increasingly, those historically underserved by extension. The reorganization of Extension detailed in the report summary was designed to increase both the diversity of our stakeholder groups and our stakeholders' benefits from our programs.

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. The Poultry extension team found that a significant number of commercial industry partners enjoy coming to University Park for educational events.

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
- Meeting with traditional Stakeholder individuals
- Survey of traditional Stakeholder individuals
- Survey of the general public
- Meeting specifically with non-traditional groups
- Survey specifically with non-traditional groups
- Meeting specifically with non-traditional individuals

- Survey specifically with non-traditional individuals

Brief explanation.

To collect stakeholder input, educators and/or faculty held regularly scheduled meetings, such as advisory groups and Penn State Ag Council. For example, the Watershed Education team held 16 stakeholder meetings with key representatives of agencies, nongovernmental organizations, and program partners in urban and agricultural stormwater management in 2017. Most relevant findings were requests for educational materials and trainings to help Pennsylvanians achieve compliance with existing water quality regulations.

Many programs regularly use surveys of traditional stakeholder groups to gauge how current programs meet clients' needs. For example, the Master Gardeners conducted an online evaluation of the garden hotline. Homeowners who used the garden hotline were sent a link to a survey assessing their satisfaction with the information.

Requests for information from extension staff provided additional measures of client needs. If similar information is requested repeatedly, we try to develop a resource to meet that need.

Extension teams very often receive unsolicited emails, calls, and in-person testimonials about the positive impacts extension trainings or information have had on clients' operations. For example, 17 growers provided unsolicited reports to the Vegetable, Small Fruits, and Mushroom Extension team of enhanced yield/plant health resulting from following Penn State Extension recommendations made at meetings and farm visits and through newsletters.

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 gathering information about estimated economic impacts.

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. The College's dean hosted a visit with students to the largest potato farm in the state. Our grape research and extension group hosted the Secretary of PA Department of Agriculture, his staff, and local government representatives.

Most departments and extension units held at least annual meetings with stakeholders to share updates and gather feedback. The Green Industry extension team established a new Green Industry Statewide Advisory Board.

There is a continuing demand for many classes, including those necessary for required certifications, such as those for retail food service managers, despite the fact that other organizations may offer them in shorter, less expensive formats.

The Forest Products extension team recognized a new audience group of wood collectors and wood workers, and began a new blog directed at that group.

The Tree Fruit team sought comments during the 2017 winter meeting from growers for ideas of what they would like to see improved or modified for the 2018-2019 Tree Fruit Production Guide. All suggestions will be incorporated.

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 extramural funding 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. For example, our entomology programming regularly adjusts to provide education about the latest invasive insects, most recently spotted lanternfly.

Redirect Extension Programs: Information collected from stakeholders was used to adjust focus areas for Extension programming. For example, programming to meet the requirements for the Food Safety Manufacturing Act has grown over the past couple of years.

Redirect Research Programs: Information collected from stakeholder groups, such as industry associations, directly influenced applied research activity through local decisions about priorities. For example, a significant outcome of the annual mushroom stakeholder meeting is a \$1 million USDA NIFA grant to develop pest controls for organic mushrooms. This addresses a priority identified in the meeting.

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. The reorganization of Extension described in the report summary above demonstrates our commitment to maximizing our programming's benefit to our clients. Fairly extensive reorganization of staff was needed to implement this plan. We have also hired new faculty and staff to meet emerging needs. For example, the Pest Management extension team added an educator fluent in Spanish to better serve diverse audiences.

In the Action Plans: Our mission is to serve our stakeholders, so we analyzed their feedback and adjusted our action plans to meet their needs. For example, the Dairy extension team now offers programming to help producers transition their farm to the next generation and to educate women on issues that affect dairy farm women and families.

To Set Priorities: Our stakeholders' priorities must be our priorities and we adjusted our programs as needed. For example, there is widespread interest among small and women farmers in adding value to excess products via drying or canning of "seconds" produce. We have added resources to address this interest, which can help to improve farmers' bottom lines.

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 (available for live viewing or via recording), synchronous and asynchronous means--migrating away from the traditional classroom setting. This multitude of resources allows our clients to access the information they need to solve their most pressing problems whenever and wherever they prefer. In addition, stakeholder input helped determine the locations and times that extension programs are offered.

Brief Explanation of what you learned from your Stakeholders

Stakeholder input directly affects how we offer our extension programs. Feedback indicated that participants need adaptations in programs because many have little money or time available for travel. 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, and the number of interactions in a traditional classroom setting is declining. In addition, stakeholder input helps determine the locations, times, and frequencies 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. With travel comes increased threat of epidemics and transfer of diseases from farm animals to people.

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. Most of our programs, including the Biologically Based Materials and Products researchers, the Shale Education team, the Food Science team, and the Integrated Crop Production team, are engaged in some degree of effort in this area.

The Food Safety Modernization Act and Good Agricultural Practices regulations continue to challenge our stakeholders and drive new and continuing programs. We recently added 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. For example, the Green Industry team is working with the Renewable Resources Team to offer the Arborist Short Course. Such collaboration may also raise new questions that open additional avenues for research and extension programming.

IV. Expenditure Summary

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

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	8393989	0	8369700	0
Actual Matching	28819409	0	27997525	0
Actual All Other	22422469	0	36500298	0
Total Actual Expended	59635867	0	72867523	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	3348500	0	4056255	0

V. Planned Program Table of Content

S. No.	PROGRAM NAME
1	Advanced Agricultural and Food Systems
2	Biologically Based Materials and Products
3	Community Resilience and Capacity
4	Environmental Resilience
5	Global Engagement
6	Integrated Health Solutions
7	Positive Future for Youth, Families, and Communities

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
112	Watershed Protection and Management	5%		5%	
133	Pollution Prevention and Mitigation	6%		5%	
201	Plant Genome, Genetics, and Genetic Mechanisms	5%		7%	
202	Plant Genetic Resources	5%		7%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	5%		7%	
204	Plant Product Quality and Utility (Preharvest)	16%		15%	
205	Plant Management Systems	5%		5%	
211	Insects, Mites, and Other Arthropods Affecting Plants	11%		7%	
212	Diseases and Nematodes Affecting Plants	5%		5%	
213	Weeds Affecting Plants	5%		5%	
216	Integrated Pest Management Systems	11%		7%	
302	Nutrient Utilization in Animals	5%		5%	
501	New and Improved Food Processing Technologies	5%		5%	
502	New and Improved Food Products	0%		5%	
503	Quality Maintenance in Storing and Marketing Food Products	6%		5%	
604	Marketing and Distribution Practices	5%		5%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	24.7	0.0	20.5	0.0
Actual Paid	18.2	0.0	23.4	0.0

Actual Volunteer	7.5	0.0	0.0	0.0
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2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
4003803	0	3360098	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
12575090	0	9857271	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
6169152	0	6942845	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Some highlights of our research programs in this area include the release for commercialization of a new variety of high lycopene, high-yielding tomato; corn hybrid evaluation and advanced forage testing; determination of seasonal occurrence of spotted wing drosophila in various fruits and berries in Pennsylvania and Maryland and recommendation of a reduced schedule of pesticide spraying; development of ways to combat weeds while reducing reliance on herbicide; a method for predicting the storage potential of Honeycrisp apples that are prone to bitter pit disorder; and help for grape growers in meeting the climatic challenges of the Northeast.

Other teams are working on consumer preference for fresh apples in the Mid-Atlantic; potato cultivar evaluation; the discovery of a previously unknown mechanism that triggers gene silencing in corn; identification of an indigenous predator of invasive brown marmorated stink bugs; and the effects of climate change on livestock in the Northeast and strategies for adaptation.

The Dairy extension team piloted precision dairy technology that monitors cow vital signs, activity, and rumination/eating time. The case study farm decreased expenses and increased revenues by nearly \$23,000. Improvements in production and reproduction resulted in a payback period of 14.8 months for purchase of the system. The savings do not include any labor savings associated with the use of the technology.

Through the Dairy team's milk quality management program, PA dairy farmers learned to implement practices to reduce the somatic cell count (SCC) in their milk. High SCC can mean that milk must be discarded rather than sold. The increase in milk quality brought approximately \$9,200 in increased profit per farm per year.

The Livestock extension team reports estimated total actual economic impact of their sheep/lamb, meat goat, and beef programs in 2016-2017 at more than \$230,000 through changes in feeding practices, record keeping, health care and breeding practices, and animal selection principles, among other factors.

Biosecurity training in vigilance for avian influenza continues to be a focus for the Poultry extension team. Other programs support poultry nutrient management and career awareness of the industry for students.

The Integrated Crop Production Practices team worked on development of growing recommendations for industrial hemp as a grain and on development of alternative crops such as hulless barley and malting barley.

By implementing recommendations from the winter commercial tree fruit school given by the Tree Fruit and Grape extension team, growers estimated cost savings and increased profits totaling \$120, \$130, and \$170 per acre for management of diseases, insects and mites, and cropload, respectively.

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
- Nonprofit associations/Organizations

3. How was eXtension used?

At least some members of most extension units answer "Ask an Expert" questions and use the system's webinars and other resources for professional development and as a resource for clientele. They also provide webinars and e-newsletters to the eXtension community that are accessed by participants from all over the world.

The Vegetable, Small Fruit, and Mushroom extension team used eXtension as a resource for information to answer client questions and to acquire personal knowledge by reading articles and participating in webinars and communities of practice. In addition, to advance the sustainability of pollinator populations in commercial horticultural production, collaboration with the Xerces Society (an NGO) provided an opportunity to contribute to an eXtension Bee Health webinar series (Fleischer, S. J. 2017. "Ensuring pumpkin pollination: conserving wild bees helps get the job done," (<http://icpbees.org/home/videos/#Webinars>)). The extension publication titled "Integrated crop pollination for squashes, pumpkins, and gourds" was developed by K. Ullmann, J. Cane, S. Fleischer, E. Treanore, and C. McGrady for growers and is available at <http://ento.psu.edu/publications/integrated-crop-pollination-for-squashes-pumpkins-and-gourds>.

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

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	131373	533405	21453	2447

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

Patent Applications Submitted

Year: 2017
 Actual: 4

Patents listed

Serial No. 15/700,724; Filed 9/11/2017; Title: Processes and Treatment Systems for Treating High Phosphorous Containing Fluids

Serial No. 15/368,073; Filed 12/3/2016; Title: Genomic Regions with Epigenetic Variation that Contribute to Phenotypic Differences in Livestock

Serial No. 62/483,651; Filed 4/10/2017; Title: Compositions and Methods Comprising Viral Reverse Transcriptase

Serial No. 15/704,502; Filed 9/14/2017; Title: Targeted Modification of Maize Roots to Enhance Abiotic Stress Tolerance

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	82	158	240

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants in extension education classes and workshops.

Year	Actual
2017	45873

Output #2

Output Measure

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

Year	Actual
2017	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	Estimated yearly value (in US\$) of managing 30% of Honeycrisp apples in Pennsylvania using new test and best management practices to reduce bitter pit occurrence.
10	Finding that cultivar selection for late-bursting bud varieties is a more reliable strategy for frost-prone areas than is a potassium-based fertilizer with potential frost-protectant activity.

Outcome #1

1. Outcome Measures

New crop varieties or lines.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Northeastern tomato growers are challenged by plant diseases, primarily early blight and late blight. Consumers also want improved fruit taste, which has often taken a back seat to extended shelf life. It typically takes 10-15 years to build up enough germplasm to begin commercializing varieties.

What has been done

Valentine, a high-yielding, disease-resistant variety of grape tomato developed in the breeding program of a Penn State plant scientist, now is available commercially after nearly two decades in development. Penn State partnered with Johnny's Selected Seeds to launch the variety in 2018. Valentine was named an All-America Selections winner for 2018. Valentine produces sweet, firm fruit and is high in lycopene, a powerful antioxidant. The Penn State program patented the high-lycopene trait.

Results

With funding from the College of Agricultural Sciences' Research Applications for InNovation (RAIN) grant program, the researcher has contracted with a seed production company in Costa Rica, with its longer growing season, to mass-produce seed from 18 of his most promising hybrid varieties to share with several seed companies and grower organizations for evaluation and possible commercialization.

The Penn State research team expects to have other varieties on the market by 2020. Future discoveries are likely to help society increase food production to feed a growing world population, adapt crops to a changing climate, and reduce the environmental impact of farming.

Tomatoes are the most popular vegetable crop in the world and the second largest in Pennsylvania after sweet corn. In 2009, Pennsylvania produced about 30 million pounds of fresh

and processing tomatoes, for a total farm value of at least \$21 million.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
502	New and Improved Food Products

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.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	10000000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Growing high-yielding, high quality crops can make a difference in long-term farm sustainability. Penn State Extension and researchers run yearly variety trials for corn silage hybrids. The goal is to provide unbiased, comprehensive, accurate, and assessable corn hybrid testing results to industry and producers. Funding comes from a fee charged to seed companies to enter a hybrid

in the trial.

What has been done

A Penn State team worked with seed and dairy nutrition industry professionals to continue to improve the collaborative corn silage hybrid evaluation program in concert with the Professional Dairy Managers of PA. They introduced new methods of assessing fiber and starch digestibility of hybrids and are working on developing new methods of interpreting the data. The seed industry responded by entering more hybrids than ever in the program and providing additional support to work on starch digestibility.

Results

This program provides growers unbiased information for hybrid selection, provides industry some more relevant forage quality targets for corn hybrid development, and is a vehicle to share with producers what new forage characteristics are being used to develop dairy rations. Nearly all seed companies that market seed for silage production are testing hybrids for quality using some of the measures the team had previously evaluated. If we estimate that the program has contributed to a modest improvement of \$25/acre on 400,000 acres of corn grown for silage in Pennsylvania, this equates to added farm revenues of \$10,000,000 each year.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
302	Nutrient Utilization in Animals

Outcome #4

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Spotted wing drosophila (SWD) (*Drosophila suzukii*), a major invasive pest of small fruit crops, was first found in Pennsylvania and Maryland during the 2011 crop season, and since then, it has been established throughout both states.

What has been done

A season-long field study was conducted to assess the seasonal occurrence of SWD in several fruit crops (e.g., blueberry, cherry, raspberry, blackberry, and table grapes) in Pennsylvania and Maryland in 2014. This was the first study determining seasonal occurrence of SWD using standard commercial lure-baited traps in this region. Additional monitoring in these states using different lures has been conducted since 2012. We issued grower alerts of our findings each season.

Results

In PA, SWD adults were not consistently captured prior to July, and populations of SWD were found to build up in fruit crops only from mid-July on. This indicates early-season fruit crops or varieties are not at risk from SWD fruit injury in PA. These early fruit crops--for instance, strawberry, sweet and tart cherry--are generally harvested before SWD populations build up in this region.

Based on data from 2015, 2016, and 2017, we estimate that growers of early-season fruit crops in PA saved about \$158,700 total in pesticides not applied because of demonstration through this monitoring effort that SWD were present in the area only after early-season crops are already harvested. This accounts only for pesticide costs and does not include savings on tractor and sprayer use, fuel, and operator time. Nor does this estimate account for environmental benefits of pesticide not sprayed.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
211	Insects, Mites, and Other Arthropods Affecting Plants
216	Integrated Pest Management Systems

Outcome #5

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	24000000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

There are more than 150 kinds of herbicide-resistant weeds in the U.S. They compete with crops for nutrients, water, and sunlight; can reproduce rapidly; and have few natural controls to keep them at bay. Herbicides are the most common tool available to farmers to control weeds, but herbicide resistance and the potential for environmental pollution make it necessary to rely less on herbicides and to diversify the way we control weeds.

What has been done

Penn State agronomists are developing ways to combat weeds while reducing reliance on herbicides. The team assessed standard versus reduced herbicide use in a 6-year crop rotation including canola, soybean, corn, and alfalfa. Reduced herbicide in soybean and corn involved banded herbicide application, in which herbicide is applied at planting in a band just over the crop row, followed by post-cultivation using a high-residue, inter-row cultivator to control weeds between crop rows.

Results

The reduced herbicide systems for corn were more profitable than the standard herbicide practices consistently over the past six years. The results for soybean were more mixed, mostly because of soybean establishment issues in the no-till systems. In corn, for the past three years, banded herbicide plus post-planting cultivation reduced herbicide use by almost 75%, for a savings of more than \$73/acre. The cultivator controls weeds between crop rows by cutting them just below the soil surface to limit soil disturbance. If 25% of all corn acreage in Pennsylvania were managed using this system growers could save more than \$24 million yearly in herbicides not applied.

In banded herbicide plus post-planting broadcast herbicide treatment in corn, about 50% less herbicide was used than for standard herbicide treatment, saving about \$45/acre. Application of this management system to 25% of all corn acreage in Pennsylvania could save growers more than \$15 million yearly in herbicides not applied.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
213	Weeds Affecting Plants

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

Estimated yearly value (in US\$) of managing 30% of Honeycrisp apples in Pennsylvania using new test and best management practices to reduce bitter pit occurrence.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	1000000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Honeycrisp apples are crunchier than other apples and consumers prefer them. More Honeycrisp trees have been planted recently than other varieties because consumer preference brings 30-40 cents more a pound at wholesale. But the variety is susceptible to bitter pit, a disease that shows up as corky brown spots in the flesh weeks or months after picking. In most cases, if growers knew their apples would develop bitter pit in storage, they would sell them immediately, before the disorder shows up.

What has been done

Through a three-year study with leveraged funds, Penn State researchers developed a test to determine whether bitter pit will develop in stored Honeycrisp apples. Growers need to know which apples can be stored because the market can handle only so much fruit at harvest time. The team developed specific recommendations for nutrient management, pruning, thinning, harvest timing, and fruit storage to reduce bitter pit.

Results

The percentage of fruit on a tree that developed bitter pit ranged from 0 to 74%, with hot, dry years being worse. In average years in Pennsylvania, about 23 percent of Honeycrisp apples end up with bitter pit.

The test and management recommendations promise to save millions of dollars annually in wasted fruit. A study in western New York found losses from bitter pit averaged about \$260/bin, which equals about 20 bushels of apples. About \$1 million per year may be saved if 30% of Honeycrisp apples in Pennsylvania are managed using the new test and best management practices to reduce bitter pit occurrence.

The team has gotten inquiries about the test from as far as Washington State. The general research findings are pertinent to other fruit-growing regions, but the tool will need to be adapted to local growing conditions.

4. Associated Knowledge Areas

KA Code	Knowledge Area
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
212	Diseases and Nematodes Affecting Plants
503	Quality Maintenance in Storing and Marketing Food Products

Outcome #10

1. Outcome Measures

Finding that cultivar selection for late-bursting bud varieties is a more reliable strategy for frost-prone areas than is a potassium-based fertilizer with potential frost-protectant activity.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Climatic variability in the eastern U.S. is a major challenge to grape growing. Excessive precipitation often occurs during the growing season, and winter and late spring cold can damage plants. Crop losses and delay in fruit ripening caused by post-bud-burst freeze damage represent economic challenges for wine-grape producers in Pennsylvania. Most frost protection methods, such as deploying wind machines or helicopters, are too expensive for small vineyards.

What has been done

Penn State's Grape and Wine Team offers cutting-edge research and outreach addressing grape and wine production and quality challenges, with particular emphasis on PA and the eastern U.S. Grape variety trials help to identify the most suitable varieties for the region. Advancements in cultural and disease and insect management strategies and winemaking practices improve product quality. Increased understanding of consumer attitudes and effective marketing methods can raise the bottom line.

Results

As an example of research helping to meet climatic challenges of growing grapes in PA and the Northeast, the team found that cultivar selection for late-bursting bud varieties is a more reliable strategy for frost-prone areas than is KDL, a potassium-based fertilizer with potential frost-protectant activity. This study was done with leveraged funds from the PA Wine Marketing and Research Program.

The university's multipronged approach to advancing the wine industry contributes significantly to PA's grape and wine industry, which pours an estimated \$4.8 billion into the state's economy through employment, wine sales, tourism, tax revenue, and related avenues, according to the National Association of American Wineries. That impact is expected to grow as the industry continues to branch out. The number of in-state wineries has increased from 64 in 2000 to 257 today. The industry is responsible for nearly 44,000 jobs, including direct, supplier, and induced jobs, in Pennsylvania.

4. Associated Knowledge Areas

KA Code	Knowledge Area
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants

211	Insects, Mites, and Other Arthropods Affecting Plants
216	Integrated Pest Management Systems
501	New and Improved Food Processing Technologies
604	Marketing and Distribution Practices

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

Natural disasters

Weather conditions can drive clients' requests for programs and advice. The Equine Health team developed new fact sheets in response to mold and mycotoxin formation in hay from the prolonged rain and high humidity.

Weather conditions can necessitate changes in field research plans and workshops.

To address significant emerging issues with invasive and emerging pests such as the allium leaf miner, phorid fly, and spotted lanternfly, our team had to reallocate both time and money resources.

Economy

The dairy industry was affected greatly after 2008, and we continue to see farmers and the industry in economic hardship. The price of milk has remained low for three years and is projected to remain below average. This causes economic hardship for producers.

Calf prices were significantly less this year than last.

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 23. All pesticide exams will move to closed book as study materials and exams are rewritten.

Government Regulations

In 2016, the Pennsylvania state government made alterations to their wine shipping law. Many wineries are now able to sell local beers and spirits at their tasting rooms. This has led to new business ventures as wineries may start to expand into other products (e.g., beer, hard cider, and distilled spirits). However, integration of these products has come with challenges for producers. Furthermore, shipping policies as well as direct sales to R-licensed facilities (e.g., Wegmans, Giant) were integrated into Pennsylvania's liquor laws. This has created new retail opportunities for Pennsylvania wineries.

Competing Programmatic Challenges

The increased paper work required to conduct youth programs continues to make getting volunteers to help with 4-H youth poultry programming difficult.

Funding

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

Increased engagement by team members in seeking funding increased our capacity to address grower-based issues related to but not limited to sustainable hops production in Pennsylvania, Phytophthora blight management in pumpkins, pumpkin cultivar evaluations, etc.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The strongest evaluation of our programs comes from gathering pre- and post-training responses and the use of retrospective evaluation to assess whether participants actually put into practice lessons learned through extension programs. More statewide extension programs are performing these kinds of meaningful evaluations, so our programs continue to grow stronger and our results continue to become more quantifiable and impactful. We are also finding greater willingness to estimate potential earnings or cost savings as a result of research outcomes.

A customer relationship management tool was implemented in September 2017. That will lead to more consistent implementation of post-event evaluations, which should allow for assessment of change in practice and possibly estimates of economic impacts. These post-event assessments will be used more broadly in 2018 as time passes from events held in late 2017 and beyond.

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
112	Watershed Protection and Management	20%		15%	
131	Alternative Uses of Land	20%		10%	
133	Pollution Prevention and Mitigation	0%		15%	
403	Waste Disposal, Recycling, and Reuse	0%		15%	
511	New and Improved Non-Food Products and Processes	20%		25%	
601	Economics of Agricultural Production and Farm Management	20%		10%	
606	International Trade and Development Economics	20%		10%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	11.9	0.0	1.9	0.0
Actual Paid	2.4	0.0	3.8	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
466158	0	477780	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
1663803	0	1719103	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
867491	0	975959	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Some research highlights in this area include assessment and development of the croton nut value chain in East Africa and development of a new biomaterial that could replace plastic laminates and eliminate millions of tons of petroleum-based plastics each year.

Additional bioenergy research involves analysis of drivers and barriers to adoption of sustainable jet fuel; biorefinery site selection; economic and life cycle analyses of biomass utilization for bioenergy products in the Northeast; the use of dry steam as a low energy preprocessing step in the pelletization of switchgrass; improved understanding of the thermal role of hemicelluloses in wood cell wall relaxation; economic and life cycle analyses of biomass utilization for bioenergy products; and opportunities and challenges for the U.S. biofuels industry.

Other research projects on biobased products involve optimizing the polysaccharide-based foam for wound care and tissue engineering described in last year's report; increasing the length of crystalline nanocellulose; making mechanically improved bacterial cellulose; and improving a 3-D printing bio-ink.

Extension work in biologically based materials and products includes 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 online outreach programs.

2. Brief description of the target audience

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

3. How was eXtension used?

The Renewables and Bioenergy extension team used eXtension as a repository of information for both the NEWBio bioenergy consortium and the Farm Energy IQ program, and 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

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	17772	213181	2928	1809

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

Patent Applications Submitted

Year: 2017

Actual: 2

Patents listed

Serial No. 62/531.206; Filed 7/11/2017; Title: Radio Frequency Treatment to Phytosanitize Wood Packaging Materials Used in International Shipping

Serial No. 15/484,329; Filed 4/11/2017; Title: Composite Materials

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	10	48	58

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants in extension education classes and workshops.

Year	Actual
2017	9665

Output #2

Output Measure

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

Year	Actual
2017	2

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.

Outcome #1

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Smallholder farmers in East Africa could take advantage of a wider array of crops to help lift their families from poverty. Recently, the long-overlooked nuts of common croton trees were found to be the source of an oil that can power generators, water pumps, and other engines, and, with processing, can be used in place of diesel fuel. After oil is extracted, seed cake made from remains of the nuts is a high-protein poultry feed, and the husks can be sold as fertilizer or biofuel.

What has been done

A Penn State researcher, with leveraged funding from the World Agroforestry Centre, surveyed hundreds of subsistence farmers in Kenya to help Eco Fuels Kenya (EFK) assess its supply chain. EFK's goal is to launch a tree-based biofuel initiative that could have major implications for Africa and its millions of subsistence farmers. EFK is selling both croton oil and by-products.

Results

EFK is currently collecting croton nuts from more than 3,000 subsistence farming households in central Kenya. They estimate that a midrange producer could earn about \$200/year (US\$) from this income source. This translates into about \$600,000 annually, not including expansion of collection throughout croton's natural range and not including potential collection from newly planted croton trees. This is an area where people typically live on less than \$1.25/day.

The farmer surveys showed that subsistence farmers are eager to capitalize on potential income from croton nuts. Almost all households have croton trees on their land and said they were willing to produce croton nuts. More importantly, most would be willing to plant more croton trees. This would help with reforestation, erosion control, climate change adaptation, provision of shade, and water quality management.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
131	Alternative Uses of Land
511	New and Improved Non-Food Products and Processes
601	Economics of Agricultural Production and Farm Management
606	International Trade and Development Economics

Outcome #2

1. Outcome Measures

New or improved use for agricultural waste product.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Global production of plastic is approaching 300 million tons per year. In a recent year, more than 29 million tons of plastic became municipal solid waste in the U.S. It is anticipated that 10 percent of all plastic produced globally will become ocean debris, representing a significant ecological and human health threat. About half of the plastic that we dispose of in recycling bins has typically been shipped to China, which has recently issued new restrictions on these imports.

What has been done

A Penn State team developed a completely compostable material consisting of treated cellulose pulp from wood or cotton, and chitosan, which is derived from the mountains of leftover shells from lobsters, crabs, and shrimp consumed by humans. Both of these building blocks, which are already used in the food industry and other industries, are inexpensive, plentiful, and renewable. They have applied for a patent on the material.

Results

These environmentally friendly barrier coatings have applications ranging from water-resistant paper, to coatings for ceiling tiles and wallboard, to food coatings to seal in freshness. The

material may be a competitive barrier alternative to synthetic polymers, such as Styrofoam, solid plastic used in cups and bottles, and the laminate applied to paper board.

The material's strong, insoluble adhesive properties are useful for packaging and other applications, such as better-performing natural wood-fiber composites for construction and flooring.

The material could be incorporated into foods to reduce fat uptake during frying and maintain crispness. Since the coating is essentially fiber-based, it is a means of adding fiber to diets.

The potential reduction of pollution is immense if these barrier coatings replace millions of tons of petroleum-based plastic every year.

The team is working to develop commercialization partners in different industry sectors for a wide variety of products.

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Public Policy changes
- Government Regulations
- Other (Funding)

Brief Explanation

Economy

Continued low prices for fossil fuels have dampened enthusiasm for renewable energy, although improvements to the economy have also spurred interest in sustainable practices.

Public Policy changes

Ongoing changes to rules (both real and perceived) at the federal level make long-term investment in energy a challenge. States often rely on guidance or perceived trends set by the federal government for policy guidance and needed adjustments. Inconsistent or fluctuating policy decisions create uncertainty and risk in new and developing markets.

Government Regulations

Land use regulations, access limitations to the electrical distribution system, and air- and water-quality regulations all affect renewable energy feasibility.

Funding

Renewable and Bioenergy extension activities are guided largely by grant opportunities such as the State Wood Energy Team grant and the (recently concluded) NEWBio Bioenergy

Consortium.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The strongest evaluation of our programs comes from gathering pre- and post-training responses and the use of retrospective evaluation to assess whether participants actually put into practice lessons learned through extension programs. More statewide extension programs are performing these kinds of meaningful evaluations, so our programs continue to grow stronger and our results continue to become more quantifiable and impactful. We are also finding greater willingness to estimate potential earnings or cost savings as a result of research outcomes.

A customer relationship management tool was implemented in September 2017. That will lead to more consistent implementation of post-event evaluations, which should allow for assessment of change in practice and possibly estimates of economic impacts. These post-event assessments will be used more broadly in 2018 as time passes from events held in late 2017 and beyond.

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
601	Economics of Agricultural Production and Farm Management	25%		25%	
602	Business Management, Finance, and Taxation	25%		0%	
605	Natural Resource and Environmental Economics	25%		50%	
609	Economic Theory and Methods	0%		25%	
903	Communication, Education, and Information Delivery	25%		0%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	2.9	0.0	3.6	0.0
Actual Paid	6.6	0.0	3.6	0.0
Actual Volunteer	18.0	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
332238	0	603288	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
1261708	0	1579285	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
1131429	0	1179264	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Penn State resource economists recalculated the economic impact of development of Marcellus shale natural gas resources in Pennsylvania and found that initial figures were overestimated by about half. Accurate initial estimates of resource potential are important because elected officials and voters form opinions about whether to support initiatives based on these figures.

The Shale Energy Extension team conducted workshops for farmers receiving shale energy royalties to improve royalty management and increase earnings. They are working on economic development opportunities surrounding construction of an ethane cracker plant in western Pennsylvania. The team also continues to be in demand by government officials from foreign countries for advice in wisely developing the shale gas resources in those areas.

Interdisciplinary teams of the college's scientists studied consumer and market demand for varieties of fresh ethnic greens; the economic impact of organic ag hotspots in the U.S.; and the influence on diet quality of grocery shopping at supercenters versus drug and convenience stores.

Some members of the enology group explored what drives Mid-Atlantic wine consumers to visit tasting rooms.

Our rural sociologists studied rural and urban differences in opioid abuse among teens, recession and the geography of unemployment, and aging and access to services in rural America.

The Economic and Community Development extension team taught under-served and specialty crop producers the methods, risks, and costs of adding value by drying surplus and "ugly" fruits and vegetables. They hosted workshops on Farm Biodiversity and Climate Change and Designing for Climate Resiliency, and on food and agriculture for urban/rural revitalization. They supported the Ag Alternatives, Start Farming, and A Guide to Farming websites and provided education for local officials on land use, community planning, and the environment. Team members assisted local governments and citizens in grant-seeking for trails and other projects. They assisted the hard cider and wine industries in meeting business-related challenges.

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
Military
Policy Makers

3. How was eXtension used?

The Economic and Community Development team used eXtension to create an online course, deliver webinars, create an annotated bibliography of relevant peer review research for a discipline area, create national networks through the Community of Practice, share PSU programs, for professional development

and access to leaders in the field, and to provide input on "Ask an Expert" questions.

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

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	30962	258913	11407	559

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

Patent Applications Submitted

Year: 2017

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	10	34	44

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants in extension education classes and workshops.

Year	Actual
2017	63267

Output #2

Output Measure

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

Year	Actual
2017	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	Estimated value (in US\$) by which economic impact of Marcellus shale natural gas development was overstated due to incorrect assumptions in initial non-peer-reviewed studies.

Outcome #1

1. Outcome Measures

Average cost savings from implementation of program suggestions.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	30000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Farm royalty owners face many legal and financial risks associated with oil and natural gas leasing. Many farmers have used royalty income streams to supplement farm income and to make important capital investments. However, shale well production declines and price volatility introduce significant levels of risk to the royalty income stream and ultimately to the farm business.

What has been done

Using leveraged funds, Penn State Extension hosted workshops specifically for farm royalty owners to help them understand royalty income volatility and more effectively manage the associated risks. The workshops also addressed how current natural gas production and utilization trends can affect royalties, tax implications of this income, important records to maintain, and decision-making strategies for limiting farm business exposure to risk.

Results

The 32 farm operations, totaling 4,768 acres, represented at the workshops will receive a conservative \$593,750 per farm in lifetime natural gas royalties. These farm families can now more effectively manage an estimated \$19 million in royalty income over several generations. If we assume that the educational workshops increase total royalty yields for these farms by 5% over the life of the wells, the value of the education is \$950,000. This equates to about \$30,000 per farm, of which about \$20,000 will be realized within three years.

Most farms were represented at the workshops by more than one person (113 total attendees), often indicating a multigenerational stewardship benefit that bodes well for farm preservation and legacy planning. Families gained a greater understanding of the long-term ramifications of the royalties, which often entice younger generations to return to farming. Several farmers noted that the royalties allow them to "farm" the subsurface and apply the earnings to the surface farm.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
602	Business Management, Finance, and Taxation
605	Natural Resource and Environmental Economics
903	Communication, Education, and Information Delivery

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

Estimated value (in US\$) by which economic impact of Marcellus shale natural gas development was overstated due to incorrect assumptions in initial non-peer-reviewed studies.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	1980000000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

During the onset of shale gas development in Pennsylvania, various economic impact studies were released through the gray literature without formal peer review and were widely cited by the media. Due to the lack of peer review, estimates of the play's economic impacts varied widely because different assumptions were used. Because policy makers and voters consider these studies when deciding whether to support drilling activities, it's important that the studies use realistic assumptions.

What has been done

A third-party review (Kinnaman, 2011) of six such impact reports identified several major issues. The central critique focused on assumptions of how industry spending is represented and how leasing and royalty dollars are spent.

A Penn State team used leveraged funds to study detailed county records and to survey affected landowners to directly address these assumptions. They compared their results to the findings of the most cited impact study (Considine et al., 2010).

Results

Considine et al. estimated that Pennsylvania's Marcellus industry supported about 44,000 jobs, with total value added of \$3.9 billion (2010 dollars). The 2017 study found upper-bound estimates that the industry supports almost 24,000 jobs, with roughly \$1.9 billion in total value added (2009 dollars), less than half of that found by Considine et al. The results confirm Kinnaman's theory that some ex ante studies use unrealistic assumptions that lead to gross overestimates of the impacts. The authors suggest a method for more realistic ex ante analysis in future situations such as this.

4. Associated Knowledge Areas

KA Code	Knowledge Area
605	Natural Resource and Environmental Economics
609	Economic Theory and Methods

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

Natural Disasters

A longer growing season and irregular rainfall lead to challenges in growing and sourcing products to meet farm or food business cash flow.

Pennsylvania's shale energy production is an important driver for economic development

and revenue generation, so it's important for extension to participate in this dialogue given the range of our expertise. As the demand for energy grows and shifts toward more natural gas and renewables, PA's role as the top producer of shale gas gives Penn State a strong rationale for research and outreach in this space. Shale gas investment will continue to expand in the near- to mid-term.

Economy

The economy directly affects new businesses' ability to open and expand; this directly affects our program attendees and their participation.

Public Policy changes

Operation in a Farm Bill year, PA urban ag zoning ordinance development, and local land use zoning changes can all present challenges.

Increased interest in environmental, tax, and land planning policy in PA at the local and state levels related to regional energy development has heightened the importance of the public dialogue on shale gas. Climate concerns and economics are driving investments to revamp the energy sourcing and distribution models to allow for lower carbon fuels.

Governmental Regulations

Government regulations at all levels directly affect our clients and their ability to expand or open businesses and thereby their participation in our programs.

Requirements of the Food Safety Modernization Act are having large impacts on farms.

Interest in PA's comprehensive regulatory environment and its successes and weaknesses is of interest to many PA residents. This interest extends to the many international delegations we have hosted in immersive shale trainings in FY16/17, as does an interest in fiscal and infrastructure issues. The Shale team has offered insights on how to successfully make the transition to a lower carbon energy portfolio. Our participation in TeamPA's Energy Futures visioning process in 2017 is an example of how the College has offered science-driven data to allow for better policy and regulatory outcomes as the group expands its scenario planning through 2040.

Population changes

New and beginning farmers need technical assistance. Parts of Pennsylvania have increasing immigrant/refugee populations, driving the need for more language options in trainings and print and online information.

Funding

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

The Shale team has grants related to pipeline development in the state, outreach education on energy development in a "train the trainer" format, risk management and energy for agricultural producers, and best management practices for rights-of-way. We also have a grant from the State Department allowing the team to convey its research-based outreach on technical, environmental, and socioeconomic policy to the government of Argentina, the largest emerging shale gas region in the world outside of North America. These grants allow better educational experiences for our extension clients.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The strongest evaluation of our programs comes from gathering pre- and post-training responses and the use of retrospective evaluation to assess whether participants actually put into practice lessons learned through extension programs. More statewide extension programs are performing these kinds of meaningful evaluations, so our programs continue to grow stronger and our results continue to become more quantifiable and impactful. We are also finding greater willingness to estimate potential earnings or cost savings as a result of research outcomes.

A customer relationship management tool was implemented in September 2017. That will lead to more consistent implementation of post-event evaluations, which should allow for assessment of change in practice and possibly estimates of economic impacts. These post-event assessments will be used more broadly in 2018 as time passes from events held in late 2017 and beyond.

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
112	Watershed Protection and Management	0%		8%	
123	Management and Sustainability of Forest Resources	0%		8%	
133	Pollution Prevention and Mitigation	15%		8%	
135	Aquatic and Terrestrial Wildlife	0%		8%	
136	Conservation of Biological Diversity	15%		16%	
211	Insects, Mites, and Other Arthropods Affecting Plants	0%		10%	
216	Integrated Pest Management Systems	15%		10%	
402	Engineering Systems and Equipment	0%		8%	
511	New and Improved Non-Food Products and Processes	15%		8%	
605	Natural Resource and Environmental Economics	20%		8%	
723	Hazards to Human Health and Safety	20%		8%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	10.6	0.0	11.8	0.0
Actual Paid	5.9	0.0	14.1	0.0
Actual Volunteer	36.6	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
1198088	0	1616789	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
4010618	0	6779443	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
1990176	0	7239479	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 scientists helped lead research to determine that neonicotinoids in seed coats are riskier than thought to predatory insects; to save ash trees from the invasive emerald ash borer; and to determine that a common crop chemical leaves bees susceptible to deadly viruses.

In a related entomology topic, an interdisciplinary team developed a radio-frequency treatment to phytosanitize wood packing materials for international shipping against invasive insects.

Other research into environmental resilience dealt with monitoring for DNA of Asian carp in the Ohio River valley; assessing benefits of using non-Bt corn hybrids; measuring concentrations of estrogens and pharmaceutical byproducts in vernal ponds; impacts of natural gas wastewater disposal; the spread of invasive plants on and around natural gas well pads; breeding disease-resistant American chestnut trees; developing a method to remove arsenic and alkali simultaneously from alkaline wastewater; and environmental benefits of reseeding horse pastures, among other projects.

A critical research/extension activity is educational and technical support for the implementation of the Chesapeake Bay Total Maximum Daily Load. Specialists from the Nutrient Management extension team have developed more than 2,000 nutrient management plans for Pennsylvania farms. As a result the latest Chesapeake Bay report card again gave the upper Chesapeake Bay, which is dominated by the Susquehanna River flowing out of PA, the highest score, indicating that our efforts are having a significant positive impact. The Nutrient Management team released a new software program used by all nutrient management planners in Pennsylvania to write plans.

The Green Industry extension team worked with staff of a golf course on the banks of a Class A wild trout stream on stream restoration and nutrient management planning. Team members advised the PA Department of Agriculture about revising a fertilizer bill, developed an education program on interpreting irrigation water test reports, and delivered education programs about the recently arrived invasive, nonnative spotted lanternfly, including some of the first available chemical control measures.

The Community and Urban Natural Resources team collaborates with Pennsylvania Bureau of Forestry on the TreeVitalize program for street tree care and management. They helped numerous municipalities complete street tree inventories and/or develop new tree commissions.

The Safe Drinking Water extension team continues to support the Master Well Owner Network and offer

safe drinking water workshops. They report over \$75,000 in cost savings from their programs.

Members of the Sustaining Pennsylvania's Forests extension team completed and launched three online courses in 2017.

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
- Local, Regional, State, and Federal agencies
- Nonprofit Associations/Organizations
- Policy makers

3. How was eXtension used?

Some members of most teams serve as topic experts and answer questions submitted to eXtension's "Ask an Expert." The Master Gardener team answered 980 questions.

The Pest Management extension team used eXtension as a platform to provide online recertification credit opportunities for licensed pesticide applicators.

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

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	86428	343868	31215	2320

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

Patent Applications Submitted

Year: 2017
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	27	159	186

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants in extension education classes and workshops.

Year	Actual
2017	18225

Output #2

Output Measure

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

Year	Actual
2017	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	Calculation of potential annual reduction in methyl bromide use (in pounds) for quarantine and preshipment purposes in the U.S. resulting from 5% adoption of the patent-pending radio frequency (RF) technology as an alternative to methyl bromide.
5	Annual value (in US\$) of loss of predatory insects due to use of neonicotinoids as seed coatings on U.S. corn, soybean, and cotton land.
6	Potential loss in value (in US\$) of U.S. Great Lakes sportfishery if nonnative, invasive Asian carp enter the Great Lakes, assuming just a 5% reduction in value of the sportfishery.

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

Calculation of potential annual reduction in methyl bromide use (in pounds) for quarantine and preshipment purposes in the U.S. resulting from 5% adoption of the patent-pending radio frequency (RF) technology as an alternative to methyl bromide.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	81600

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Wood packaging material (WPM), which is widely used throughout commerce, may contain insect pests that could then move internationally in the packaging material. This potential issue represents a threat to forest resources and the domestic wood products industry.

The International Plant Protection Convention guidelines state that WPM shipped internationally must be heat treated or fumigated with methyl bromide. But methyl bromide is toxic to workers and contributes to ozone depletion.

What has been done

Penn State researchers discovered a way to kill destructive pests, such as emerald ash borers and pinewood nematodes, in wood for pallets and other shipping materials. They developed a patent-pending, wood-treatment chamber that heats wood in a unique configuration using RF waves, making the process more energy-efficient than RF alone. RF waves penetrate several meters into wood while methyl bromide, the current treatment method, does not.

Results

This technology innovation has significant ramifications to help control new pest introductions from destroying our valuable forests and urban tree ecosystems, which would help eliminate further multi-billion-dollar economic losses from destructive pests.

The treatment is poised to replace the process of fumigating wood with methyl bromide -- a chemical that is being phased out -- and help the U.S. wood products industry to retain export markets likely to reject chemical-treated wood, which has sparked increased demand for plastic shipping pallets. About 40% of U.S. logs are processed into wooden shipping pallets, so it's important to the U.S. wood industry that wood packaging continue to be acceptable internationally.

If we assume a conservative 5% reduction in methyl bromide use in the U.S. for quarantine and preshipment purposes due to the adoption of the patent-pending RF technology, 81,600 pounds of toxic methyl bromide would not be released into the atmosphere each year.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
133	Pollution Prevention and Mitigation
402	Engineering Systems and Equipment
511	New and Improved Non-Food Products and Processes
723	Hazards to Human Health and Safety

Outcome #5

1. Outcome Measures

Annual value (in US\$) of loss of predatory insects due to use of neonicotinoids as seed coatings on U.S. corn, soybean, and cotton land.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	625680000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Predatory insects contribute billions of dollars a year to agriculture through the elimination of crop pest insects. The use of neonicotinoids -- the most widely used class of insecticides -- has risen dramatically in recent years, especially in corn, soybeans, and cotton. The insecticide is often applied to seeds as a coating. Upon planting, the insecticide enters the soil where some of it is taken up by plant roots. The chemical then runs through the plant, protecting seedlings from insect pests.

What has been done

A Penn State team used a statistical method called meta-analysis to combine the results of more than 1,000 observations from 20 field studies across North America and Europe that tested the effects of seed-applied neonicotinoids on predatory insects.

Results

They found that neonicotinoids used as seed coatings reduce populations of predatory insects in these systems by 10-20 percent. Losey and Vaughan (2006) estimated that the annual cost associated with native pest species at current levels of suppression by natural enemies in the U.S. was \$7.32 billion. About 57% of U.S. cropland in 2012 was corn, soy, and cotton. Assuming 15% reduction in natural enemies from neonicotinoids, the annual value of loss of predatory insects due to neonicotinoids as seed coatings on U.S. corn, soybean, and cotton land is about \$626 million.

This finding challenges the belief that neonicotinoid seed coatings have little to no effect on predatory insect populations. The work suggests that neonicotinoids reduce populations of insect predators as much as broadcast applications of commonly used insecticides.

These results may help farmers and pest management professionals better weigh the costs and

benefits of neonicotinoid seed treatments versus alternatives.

4. Associated Knowledge Areas

KA Code	Knowledge Area
136	Conservation of Biological Diversity
211	Insects, Mites, and Other Arthropods Affecting Plants
216	Integrated Pest Management Systems

Outcome #6

1. Outcome Measures

Potential loss in value (in US\$) of U.S. Great Lakes sportfishery if nonnative, invasive Asian carp enter the Great Lakes, assuming just a 5% reduction in value of the sportfishery.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	225000000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Four species of Asian carp threaten the ecological balance of the Great Lakes. Fisheries experts have been trying to keep them out of the lakes using a system of underwater electric barriers. In the Mississippi River they consume vast amounts of phytoplankton and zooplankton, leaving less for native fish.

What has been done

A Penn State team performed eDNA sampling for Asian carp in the Ohio River valley. They collected data on the genome of Asian carp. They collected and analyzed water samples where Asian carp are known to exist.

Results

To date the team has found no evidence of Asian carp in Pennsylvania waters. The U.S. part of the Great Lakes sportfishery has been valued at \$4.5-7 billion per year. If Asian carp do get into the Great Lakes, we conservatively assume a loss of at least 5% of this value, which is \$225 million annually. This figure does not include the value of the commercial fishery or Canadian sportfishing expenditures. Efforts to monitor Asian carp spread and block their entry into the Great

Lakes must be continued to protect this essential resource.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
605	Natural Resource and Environmental Economics

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

Natural Disasters

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

Economy

The economy influences clients' interest in and ability to implement tactics suggested. Some clients lack the equipment necessary to implement suggestions.

The home construction industry has been flat over the past 10 years, resulting in many construction and component companies going out of business or laying off employees. 2017 brought an upswing in the housing economy and forest products companies are suddenly increasing production and employment levels.

Economic factors drive clients to participate in free or reduced-fee water testing programs and also affect which water testing packages clients select.

Appropriations changes

Changes in USDA appropriations affect the ability to staff the Forest Products team and also the amount of operational funding available. With small cuts every year the team is facing a point where there will be no operational funds from the grant that funds the Extension Urban Forestry Program.

Public Policy changes

State government agencies established a Chesapeake Bay Program Reboot. This changed

the emphasis within state-related nutrient management policies.

Government Regulations

The EPA and Pennsylvania Department of Agriculture have mandated changes to pesticide laws that have changed the way we approach the Pesticide Applicator Short Course. Tests are now closed book for most categories we teach. All pesticide exams will move to closed book as study materials and exams are rewritten.

Manure management regulations continue to be a regular education topic in our programs and farm visits. Despite widespread educational offerings and train-the-trainer efforts over the past few years, many horse farm owners are not aware of these regulations and need guidance.

Competing Programmatic Challenges

Competing priorities and staffing changes often mean that it's not possible to complete all desired work.

Balancing recent expectations to create online content and courses, while maintaining a selection of face-to-face training opportunities and having time to help clients solve landscape issues can be challenging.

Problems with invasive species that require immediate attention compete with other opportunities for further development of general program efforts.

Population changes

New and growing ethnic populations are important clients.

Funding

Some of our programs are affected by 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 strongest evaluation of our programs comes from gathering pre- and post-training responses and the use of retrospective evaluation to assess whether participants actually put into practice lessons learned through extension programs. More statewide extension programs are performing these kinds of meaningful evaluations, so our programs continue to grow stronger and our results continue to become more quantifiable and impactful. We are also finding greater willingness to estimate potential earnings or cost savings as a result of research outcomes.

A customer relationship management tool was implemented in September 2017. That will lead to more consistent implementation of post-event evaluations, which should allow for assessment of change in practice and possibly estimates of economic impacts. These post-event assessments will be used more broadly in 2018 as time passes from events held in late 2017 and beyond.

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	0%		8%	
111	Conservation and Efficient Use of Water	0%		8%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%		8%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	10%		16%	
204	Plant Product Quality and Utility (Preharvest)	10%		8%	
205	Plant Management Systems	10%		8%	
211	Insects, Mites, and Other Arthropods Affecting Plants	10%		8%	
212	Diseases and Nematodes Affecting Plants	10%		8%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	12%		8%	
723	Hazards to Human Health and Safety	13%		6%	
805	Community Institutions and Social Services	13%		6%	
903	Communication, Education, and Information Delivery	12%		8%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	1.4	0.0	0.3	0.0
Actual Paid	0.1	0.0	0.5	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
11077	0	80907	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
43097	0	149354	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
41781	0	225585	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research highlights in global engagement include assessment of the potential for building the croton tree nut value chain; supporting efforts to replace illicit coca plants with cacao plants in post-conflict Colombia and to enhance the growth of the cacao industry in that country; the development of new common bean varieties that yield about 79% more than standard varieties; determining the optimal format for food safety management classes in Armenia, with similar programs planned for Ukraine and several countries in Africa; and study of the effects of climate change in driving population shifts to urban areas in South America.

Ag-related global engagement projects include assessment of food security, sweet potato, and proximity to markets in Ghana; management of invasive stink bugs in the Republic of Georgia; and analysis of climate signals in the crop yield record of Sub-Saharan Africa.

Human services projects with a global component include comparison of youth perceptions of entrepreneurship in Pennsylvania and Nicaragua; technical and vocational training and education in Nicaragua and Burkina Faso; and capacity development for ag education in Cambodia.

Additional global health-related research efforts are aimed at understanding and eliminating malaria and other tropical diseases such as zika, dengue, chikungunya, and Rift Valley fever.

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

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

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	151	356	99	355

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

Patent Applications Submitted

Year: 2017
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	0	2	2

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants in extension education classes and workshops.

Year **Actual**
 2017 325

Output #2

Output Measure

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

Year	Actual
2017	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 life cycle of organisms involved in transmission of globally important diseases, such as malaria.
3	Successful strategy for engaging youth, women, or minorities in social action or leadership.
4	Annual reduction in incidences of global foodborne illness, assuming that the tested food safety education program is delivered in Armenia, Ukraine, Ethiopia, Uganda, and Mozambique and causes a 0.01% reduction in global foodborne illness.
5	Estimated expected increase (in US\$) in cacao revenues for Colombian farmers if 750 farmers adopt growing practices recommended by the Cacao for Peace program.

Outcome #1

1. Outcome Measures

Enhanced knowledge of drought tolerance in plants.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The United Nations reported in 2017 that global hunger affects more than 815 million people, including more than 760 million in Asia and Africa. The greatest limits to crop production are drought and low soil fertility, and global climate change is making these problems worse.

What has been done

Using leveraged funds, a Penn State-led research group is developing varieties of beans better suited to high-stress environments by breeding for heat and drought tolerance.

The larger research program includes work on three continents to develop breeder-friendly selection methods for common bean, which is the most important food legume on earth, and corn, which is the most important U.S. crop and one of the most important crops in the world.

Results

The group has discovered a number of root traits for improved capture of water and nutrients, developed tools so breeders can select for these traits, and, in collaboration with bean breeders, developed crops with better root systems that have been released to growers in Africa, Asia, and Latin America.

With partners in Mozambique, for example, they developed new common bean varieties that yield on average 79% more than the standard bean even with no addition of phosphorus fertilizer. This increase in yield equates to increased earnings of 215% over growing the standard bean variety. The new varieties are now being grown in southeast Africa in research station and on-farm trials.

Drought can be a problem throughout the U.S. too. Nitrogen fertilizer is a major cost of growing crops, and fertilizer runoff is a major threat to water quality. The group's work directly addresses national and regional agricultural problems as well.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
201	Plant Genome, Genetics, and Genetic Mechanisms
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants

Outcome #2

1. Outcome Measures

Improved understanding of life cycle of organisms involved in transmission of globally important diseases, 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

Annual reduction in incidences of global foodborne illness, assuming that the tested food safety education program is delivered in Armenia, Ukraine, Ethiopia, Uganda, and Mozambique and causes a 0.01% reduction in global foodborne illness.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	60000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Food safety practices that Americans take for granted, such as refrigeration and washing hands with soap, are not widely practiced all around the world.

The World Health Organization estimates that every year, 600 million people, almost 10% of the world's people, get sick after eating contaminated food. 420,000 people die annually from foodborne illness. This global health challenge is especially significant with the increase in international trade of food and food-related commodities.

What has been done

A program developed by Penn State food scientists trained students in Armenia through an intensive four-week course on food safety practices and procedures, with the goal of improving the safety of the country's food supply chain--from crop production and processing to packaging, handling, marketing, and consumption. The training was based on a Penn State Extension food-safety certificate program. There are plans to replicate the program in Ukraine, Ethiopia, Uganda, Mozambique, and Latin America.

Results

Through the Armenia program, the researchers developed modules, lab activities, break-out sessions, and projects that can be replicated and reused, and also trained future instructors. The program provides a sustainable model to train future food science and safety professionals in Armenia and other countries.

The team assessed the food safety knowledge, behavior, attitude, and skills of participants before and after the program. All improved significantly, and a follow-up survey done three months later suggested the training had made a lasting difference.

Internationalization of the state university extension system, which has been vital to establishing food safety in the United States, would greatly benefit the world. If education reduces foodborne illnesses by just 0.01% globally, there will be 60,000 fewer incidences yearly. The value of practical training and the application of research principles have enormous value for global agriculture and food systems.

4. Associated Knowledge Areas

KA Code	Knowledge Area
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
723	Hazards to Human Health and Safety
903	Communication, Education, and Information Delivery

Outcome #5

1. Outcome Measures

Estimated expected increase (in US\$) in cacao revenues for Colombian farmers if 750 farmers adopt growing practices recommended by the Cacao for Peace program.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	646000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The initiative Cacao for Peace (CfP) is an outgrowth of the historic peace accord signed in 2016 ending Colombia's 53-year conflict. CfP brings scientists and agricultural experts to Colombia to help poor farmers make the switch from growing coca, from which cocaine is derived, to growing cacao, the principal ingredient in chocolate. Coca had previously been the only option for a cash crop in the area. The end of hostilities brought new urgency to the need for sustainable crop replacement.

What has been done

With assistance from Fedecacao, Colombia's cacao extension service, and Peace Corps volunteers, Penn State organized a training for farmer-leaders representing three communities already growing cacao. They learned techniques for pruning, grafting, and preventing the most common cacao diseases and pests that they can share back in their villages. CfP aims to foster collaborations and ensure growers can get the sustained technical assistance and disease-resistant cacao plants they need.

Results

Cacao is not easy to grow, and the beans are tricky to process after harvest. Most cacao is still grown by small farmers with little access to technology, training, or markets. CfP seeks to bridge that gap to make cacao farming sustainable and profitable. The program also seeks to make Colombia a major player in world cacao markets, which would also benefit the U.S. chocolate industry.

With leveraged funding from USDA and the U.S. Agency for International Development, Penn State researchers are sharing their prowess in the genetics and cultivation of cacao.

The global demand for chocolate is increasing all the time, and so is demand for its raw material, including fine flavor cacao beans. Estimates are that farmers with current low productivity of cacao (~200 kg/ha) who adopt CfP good practices will increase their yields and income by three times (204%). If 750 farmers adopt the good practices, the project will generate an additional \$646,000 in revenue for Colombian farmers.

4. Associated Knowledge Areas

KA Code	Knowledge Area
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Diseases and Nematodes Affecting Plants
805	Community Institutions and Social Services

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Funding

Some of our programs are affected by 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 strongest evaluation of our programs comes from gathering pre- and post-training responses and the use of retrospective evaluation to assess whether participants actually put into practice lessons learned through extension programs. More statewide extension programs are performing these kinds of meaningful evaluations, so our programs continue to grow stronger and our results continue to become more quantifiable and impactful. We are also finding greater willingness to estimate potential earnings or cost savings as a result of research outcomes.

A customer relationship management tool was implemented in September 2017. That will lead to more consistent implementation of post-event evaluations, which should allow for assessment of change in practice and possibly estimates of economic impacts. These post-event assessments will be used more broadly in 2018 as time passes from events held in late 2017 and beyond.

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
301	Reproductive Performance of Animals	0%		10%	
311	Animal Diseases	0%		15%	
503	Quality Maintenance in Storing and Marketing Food Products	20%		10%	
701	Nutrient Composition of Food	0%		10%	
702	Requirements and Function of Nutrients and Other Food Components	0%		10%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	20%		15%	
723	Hazards to Human Health and Safety	40%		10%	
724	Healthy Lifestyle	0%		20%	
903	Communication, Education, and Information Delivery	20%		0%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	8.7	0.0	14.1	0.0
Actual Paid	30.5	0.0	13.2	0.0
Actual Volunteer	15.5	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
768192	0	2100031	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
2876469	0	7751621	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
3718903	0	19777025	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. Food scientists examined the prevalence and phylogenetic characterization of Escherichia coli and hygiene indicator bacteria isolated from leafy green produce, beef, and pork obtained from farmers' markets in Pennsylvania. Another team is studying and attempting to control Listeria monocytogenes in fruit packing houses.

Diet-related research in the College includes the determinations that flavonoid intake is inversely associated with obesity in U.S. adults and that a whole food diet may help prevent colon cancer and other chronic diseases.

Other researchers explored salmonella; avian influenza; anemia; malaria, zika, and other tropical diseases; and selenium deficiency, among other diseases, disorders, and deficiencies.

Veterinary science researchers found that supplementing dairy cows with capsicum oleoresin before and after calving supports milk production and reduces clinical mastitis. The Veterinary Medicine extension team has a new USDA-NIFA-funded research and extension program to reduce the use of antibiotics on dairy farms. Dairy breeding and genetics are other areas of active research.

The state has seen decreasing incidences of pesticide exposure in conjunction with the Pest Management extension team's long-term education efforts.

The requirements of the Food Safety Modernization Act are driving much of our extension programming in this planned program. Farms with over \$25,000 in sales growing fresh produce likely to be eaten raw are required under the Produce Safety Rule to meet farm food safety standards and keep certain records. Under the Preventive Controls Rules for Human or Animal Food, all FDA-registered facilities are required to develop and implement preventive control food safety systems. Faculty have developed trainings to meet these needs. These offerings are expanding and well received. Extension teams are also providing industry partners help in writing Preventive Controls plans. These partners value our ability to provide continuing unbiased support in helping them implement best practices learned in trainings.

The ServSafe and Retail Manager training curricula are frequently presented to meet regulatory requirements for commercial food service operations. We offer specialized food safety trainings for specific industries as requested.

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.

The Health and Wellness extension team offers Dining with Diabetes, Strong Women, Nutrition Links, Totally Veggies, Everybody Walks, Seniors Eating Well, and Mediterranean Cuisine Comes to You.

We continue to offer food safety and animal care 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
- Business/Industry
- Community Groups
- Education
- General Public
- Government Personnel
- Human Service Providers
- Local, Regional, State, and Federal agencies
- Nonprofit Associations/Organizations
- Policymakers

3. How was eXtension used?

Extension associates are active participants on eXtension and regularly respond to questions. In 2016, the Food Safety and Quality team fielded over 150 questions.

One of the Veterinary Medicine extension team members serves on the dairy eXtension program team and on the webinar team as a moderator and solicited speakers for DAIReXNET.

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. We also support the professional development offered through eXtension.

V(E). Planned Program (Outputs)

1. Standard output measures

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	53506	6440	8261	329

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

Patent Applications Submitted

Year: 2017
 Actual: 6

Patents listed

Serial No. 15/336,917; Filed 10/28/2016; Title: Device for Obtaining Small Volumes of Fluid from Animals

Serial No. 15/343,810; Filed 11/4/2016; Title: Compounds, Compositions and Methods for Coloring Edible Materials

Serial No. 62/522,521; Filed 6/20/2017; Title: Stabilization of Carrageenan Free Chocolate Milk

Serial No. 15/371,032; Filed 12/6/2016; Title: Inhibitors of the Farnesoid X Receptor and Use Thereof in the Prevention of Weight Gain

Serial No. 15/383,324; Filed 12/19/2016; Title: Paramyxovirus Virus-Like Particles as Protein Delivery Vehicles

Serial No. 62/543,174; Filed 8/9/2017; Title: Low-Temperature Plasma Catheter for Less-Invasive, Localized Treatment of Endocarditis and Atherosclerosis

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	1	159	160

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants in extension education classes and workshops.

Year	Actual
2017	10930

Output #2

Output Measure

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

Year	Actual
2017	6

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	Estimated value (in US\$) of preventing 1% of new colorectal cancer cases/year in the United States via research and education about the value of a whole food diet.
6	Percentage decrease in reported pesticide exposure incidents in Pennsylvania from 2011 to 2016, coincident with pesticide safe handling and poison control education.
7	Potential estimated health cost savings by reducing U.S. obesity by 0.5% through research and education about the value of flavonoids in the diet.
8	Estimated annual cost savings (in US\$) if research and education on prevalence and phylogenetic characterization of Escherichia coli and hygiene indicator bacteria isolated from leafy green produce, beef, and pork obtained from farmers' markets in Pennsylvania reduces foodborne illness in the state by 1%.

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.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The transition period of three weeks before and after calving is the most critical period in the life of a dairy cow, so anything that can decrease metabolic diseases then could be significant. During this "transition cow" period, diseases can result in milk yield decreases of 5-10 pounds per day at peak lactation, a considerable economic loss for the producer. So, dairy-nutrition researchers have been experimenting with dietary supplements to bolster the immune systems of transition cows.

What has been done

Researchers are using capsicum oleoresin to supplement the feed of transition dairy cows because this extract from chili peppers had the most pronounced effect on the animals' health of the phytonutrient compounds tested. The extract acts as an antimicrobial and antiseptic. Research indicates that the extract has positive physiological effects on the immune response in ruminants, and in lactating dairy cows in particular.

Results

The regulatory effects of phytonutrients seem to be beneficial for immune suppression of inflammation disease in dairy cows. Let's conservatively assume that 33% of transition dairy cows in the U.S. will experience one or more metabolic or infectious diseases following calving, and that clinical mastitis is the prevalent disease of transition cows. We'll also assume 1% adoption of capsicum use nationally, and that use of capsicum prevents clinical mastitis in 50% of cows receiving it. Bar et al. (2008) found that the average cost of a case of clinical mastitis was \$179. Therefore, the savings in milk yield not lost, mortality not experienced, and treatment costs foregone would be more than \$2.5 million per year. Follow-on studies are underway to develop a rumen-protected capsicum product to reliably deliver the benefits of phytonutrients to cows' immune systems.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
311	Animal Diseases

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

Estimated value (in US\$) of preventing 1% of new colorectal cancer cases/year in the United States via research and education about the value of a whole food diet.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	140000000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Colon cancer is the second leading cause of cancer-related deaths in the United States and a leading killer in many other Western countries, where diets tend to include more meat and less fruits and vegetables. We know that foods can contribute to chronic diseases such as colon cancer, but we are finding that some foods may also help prevent these diseases. We don't yet fully understand how these foods work on a molecular level.

What has been done

Pigs were fed a high-fat diet supplemented with purple-fleshed potatoes. Purple potatoes were used as a model of a food high in anti-inflammatory and anti-oxidant compounds. Pigs were used because their digestive system is very similar to the human digestive system, more so than mice. The level of colonic mucosal interleukin-6 (IL-6) was compared between the treatment pigs and a control group. IL-6 is a key regulator of chronic intestinal inflammation and colon carcinogenesis.

Results

Pigs fed a high-fat diet supplemented with purple-fleshed potatoes had six times less colonic mucosal IL-6 compared to a control group. Eating whole foods, including plenty of colorful vegetables and fruits that contain macronutrients, micronutrients, and phytonutrients, such as vitamins, carotenoids, and flavonoids, may be effective in altering the IL-6 pathway. Understanding how these compounds work on a molecular level in pigs could be an initial step toward finding treatments for people with inflammation-promoted chronic diseases such as colorectal cancer.

The Centers for Disease Control and Prevention estimated the direct medical cost of colorectal cancer care in 2010 at \$14 billion. If we assume that research and education about the value of a whole food diet, including colorful fruits and vegetables, could prevent even 1% of new colorectal cancer cases each year in the U.S., the cost savings would be about \$140 million.

4. Associated Knowledge Areas

KA Code	Knowledge Area
701	Nutrient Composition of Food
724	Healthy Lifestyle

Outcome #6

1. Outcome Measures

Percentage decrease in reported pesticide exposure incidents in Pennsylvania from 2011 to 2016, coincident with pesticide safe handling and poison control education.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	12

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Correct use of pesticides is essential to protect human, animal, and plant health as well as the environment. Unsafe storage of pesticides can be costly or even fatal. Penn State's Pesticide Education program strives to educate pesticide applicators and users about pest management alternatives, including pesticides, to promote responsible decision-making.

What has been done

The Pesticide Education Program provides and supports educational opportunities to prevent pesticide exposures. Each year staff reach about 17,000 adults and youth with pesticide safety information and teach about 3,700 people at pesticide applicator recertification events. More than 28,000 pesticide applicators participate in the program's trainings each year. With cooperation from Master Gardeners the program expanded a statewide poison prevention classroom outreach for first-graders from 3,200 in 2011 to 17,350 in 2017.

Results

Since 2011, there has been a 12.3% drop in the number of reported pesticide exposures, intentional, unintentional, and of unknown origin, in Pennsylvania--from 3,321 in 2011 to 2,913 in 2016. Five of six years saw a decrease in number of incidents. There may be other factors at work here besides the Pesticide Education program, but no doubt their extensive, multi-front program plays an important role in reducing incidents.

4. Associated Knowledge Areas

KA Code	Knowledge Area
723	Hazards to Human Health and Safety
903	Communication, Education, and Information Delivery

Outcome #7

1. Outcome Measures

Potential estimated health cost savings by reducing U.S. obesity by 0.5% through research and education about the value of flavonoids in the diet.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	735000000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Over the past few decades, the rates of obesity have risen markedly. Overweight and obesity are known risk factors for chronic diseases, including cardiovascular disease, diabetes, and cancer. Recent studies have demonstrated the importance of flavonoid intake and disease risk, but the association between total flavonoid intake (found in tea, citrus, berries, red wine, apples, legumes, and other plant foods) and obesity has not been evaluated in a nationally representative sample of U.S. adults.

What has been done

Food science researchers evaluated the association between flavonoid consumption and established risk factors for obesity and obesity-related inflammation. Data from a nationally representative sample of 9,551 adults who participated in the 2005-2008 National Health and Nutrition Examination Survey were analyzed.

Results

Flavonoid consumption was inversely associated with obesity in both men and women in multivariate models. Adults in the highest quartile of flavonoid intake had significantly lower body mass index and waist circumference than those in the lowest quartile of flavonoid intake. Flavonoid intake was inversely related to C-reactive protein levels, a marker of inflammation, in women. These findings support a growing body of laboratory evidence that flavonoid consumption may be beneficial for disease prevention.

The Centers for Disease Control and Prevention estimates that the annual medical care costs of obesity in the United States were about \$147 billion (2008 dollars). So a reduction in obesity rates by just 0.5% would be expected to bring savings of about \$735 million per year.

4. Associated Knowledge Areas

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

Outcome #8

1. Outcome Measures

Estimated annual cost savings (in US\$) if research and education on prevalence and phylogenetic characterization of Escherichia coli and hygiene indicator bacteria isolated from leafy green produce, beef, and pork obtained from farmers' markets in Pennsylvania reduces foodborne illness in the state by 1%.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	20167

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

More than 8,400 farmers' markets operated in the U.S. in 2015. As farmers' markets have increased in size and complexity in the kinds of foods sold, so have the potential food safety risks. Since 2008, seven major foodborne illness outbreaks and two recalls have occurred with food products from farmers' markets. Various researchers have observed vendors performing high-risk food safety retail behaviors, and others have identified microbiological hazards in foods sold at farmers' markets.

What has been done

The presence of hygiene indicators (coliforms, fecal coliforms, Listeria spp., and Escherichia coli) was assessed in select samples of leafy green produce and meat obtained from farmers' markets in Pennsylvania. E. coli isolates were further characterized by phylogenetic profile and virulence potential.

Results

E. coli was present in beef (40%) and pork (18%) samples, and in kale (28%), lettuce (29%), and spinach (17%) samples. Listeria spp. were found in beef (8%), kale (2%), lettuce (4%), and spinach (7%) samples. Among the 10 Listeria spp. isolates, 3 were L. monocytogenes. The E. coli isolates possessed the genes associated with extraintestinal pathogenic E. coli and enteropathogenic E. coli.

According to a 2015 report, in Pennsylvania the cost per foodborne illness case ranges from \$1,190 to \$1,960. The Centers for Disease Control and Prevention identified an average of 1,280 cases of foodborne illness yearly in Pennsylvania from 1998 to 2016. Using the average per case cost (\$1,575), a reduction in these cases by 1% due to research and education could bring about \$20,000 in health care cost savings yearly.

4. Associated Knowledge Areas

KA Code	Knowledge Area
503	Quality Maintenance in Storing and Marketing Food Products
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
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
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)
- Other (Funding)

Brief Explanation

Natural Disasters

Many participants in Health and Wellness programs will not travel in bad weather.

Economy

Many potential participants in Health and Wellness programs live on a fixed income and paying for a class is prohibitive. Dining with Diabetes does not accept insurance reimbursement, which can also be a deterrent.

Government Regulations

The Food Safety Modernization Act (FSMA) continues to have a major impact on food processors and others in the food supply chain, increasing the need for training and support.

Although PA Department of Agriculture is the primary regulatory agency, many municipalities have their own enforcement entities, which can result in differences in regulations and certification.

Competing Public priorities

There is continued demand for other food industry technical programs, including those required by industry audit standards or sought by companies trying to improve their food safety and quality systems.

ServSafe and other certification programs are offered by other organizations and companies and tend to be more heavily marketed and lower cost. Extension educators believe that a two-day format is more conducive to a positive test result.

The team held a Master Food Preserver training. With the addition of new educators and volunteers, we greatly increased the number of workshops and outreach activities this year.

Some YMCAs, community centers, and senior centers offer for free a program similar to Strong Women, though lacking in nutrition education.

Competing Programmatic Challenges

Many educators in Health and Wellness programs are trying to juggle several major programs and supervise paraprofessionals over a large geographic area.

Loss of staff through retirements and attrition has left many counties without the oversight of Family and Consumer Sciences educators to administer Health and Wellness programs.

Population changes

More participants have English as a second language, and several curricula are available in other languages, but often the issue of literacy in any language arises. We have offered classes in Spanish, but we have had difficulty filling the class.

We have recently trained several educators to deliver the Dining with Diabetes program in Spanish in select counties in 2017-2018. We are hoping that the online course will help us reach those 40 years old and younger.

The only trained "Strong Women Ambassador" retired, so this limited having any new instructor training this year.

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 strongest evaluation of our programs comes from gathering pre- and post-training responses and the use of retrospective evaluation to assess whether participants actually put into practice lessons learned through extension programs. More statewide extension programs are performing these kinds of meaningful evaluations, so our programs continue to grow stronger and our results continue to become more quantifiable and impactful. We are also finding greater willingness to estimate potential earnings or cost savings as a result of research outcomes.

A customer relationship management tool was implemented in September 2017. That will lead to more consistent implementation of post-event evaluations, which should allow for assessment of change in practice and possibly estimates of economic impacts. These post-event assessments will be used more broadly in 2018 as time passes from events held in late 2017 and beyond.

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	12%		14%	
723	Hazards to Human Health and Safety	22%		14%	
724	Healthy Lifestyle	22%		30%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	11%		14%	
804	Human Environmental Issues Concerning Apparel, Textiles, and Residential and Commercial Structures	11%		0%	
805	Community Institutions and Social Services	11%		14%	
806	Youth Development	11%		14%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	20.7	0.0	0.7	0.0
Actual Paid	40.1	0.0	0.7	0.0
Actual Volunteer	103.8	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
1614433	0	130807	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
6388624	0	161448	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
8503537	0	160141	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 six new communities and generated more than \$530,000 in support of the program through grants, contracts, donations, and fundraisers. The PROSPER program was found to be effective in reducing young adults' abuse of prescription and other drugs even after high school graduation.

Penn State researchers led an investigation of the effectiveness of a new partnership with a church in creating a community health outreach event.

Another team examined the relationship between fruit and vegetable intake and obesity risk in Mexican American children.

After the PA Amish Safety Committee asked for help reducing the number of children getting run over by farm equipment, Penn State personnel partnered on a grant to buy and distribute back-up cameras for Amish farm equipment. The committee also brought to the team the issue of children suffering head injuries by falling through hay holes in barns. The extension team worked with medical personnel and others to design, order, and distribute hay hole covers to reduce the threat of this injury.

Other rural health and safety efforts include leadership on the Safety in Agriculture for Youth project. An outcome of that project is a 10-hour safety course for entry-level ag workers completed by more than 10,000 youth since 2014.

4-H hosted a State Leadership Conference and a Junior State Leadership Conference for 4-H'ers ages 8-18 to help develop leadership skills and self-confidence, and to build connections. Over 1,000 youth from across Pennsylvania attended one of 11 week-long, overnight summer camp experiences. Camp counselors and volunteer leaders build skills helpful to their personal lives and careers through their interactions with youth.

The 4-H Science team reports measurable improvements in interest among participating youth in having a job in science and in experimenting and testing ideas. In 2017, the team noted significant growth in the areas of Engineering and Technology (12% over 2016). The school enrichment embryology program has the largest enrollment.

The Better Kid Care program continued to expand its online offerings with more than 200 online modules. They are partnering on applied research with funders and stakeholders to continue to document the

evidence base for individual modules and topics and to further dissemination to practitioners.

Other extension activities include a focus on diabetes education, grand-families, an intergenerational leadership institute, the Strengthening Families Program for Parents and Youth, and the Bringing the Protective Factors Framework to Life in Your Work curriculum.

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
Local, Regional, State, and Federal Agencies
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 team uses eXtension as a peripheral 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 (CoP) within eXtension. The new PA 4-H Computer Science team is connected to the Computer Science Resources site because that is the location of all 4-H Google Computer Science Grant materials.

Team members in 4-H Volunteer Management and Development completed professional development training modules.

Better Kid Care (BKC) provides a link to eXtension on our website and eXtension provides a link on their site to BKC. Educators share eXtension resources at their events. Members of the BKC program team answer questions for eXtension.

Penn State continues to be the lead institution for the Farm and Ranch in eXtension for Safety and Health (FReSH) CoP. The CoP consists of over 100 members who are 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. Grant funding was used this year to host the FReSH Leadership Team meeting in Washington, DC, and a review of the National Research and Extension Agenda for Agricultural Safety and Health. Penn State Ag Safety and Health's role in eXtension has enabled our program to generate close to \$2 million over an eight-year period for staff, program development, and expansion. During this reporting period, there were over 80,000 visits to the FReSH site, compared to 64,000 visitors the previous year. USDA-NIFA emphasizes the use of eXtension in grant applications for their youth farm safety grants and since Penn State has a primary role in FReSH, it enables us to write or be included in grant applications. During this year, we partnered with the Women in

Agriculture Learning Network and University of Missouri to work on agricultural safety and health information for women involved in production agriculture.

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

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	142053	769402	97940	10296

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

Patent Applications Submitted

Year: 2017
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	20	13	33

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants in extension education classes and workshops.

Year	Actual
2017	307707

Output #2

Output Measure

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

Year	Actual
2017	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	Participants will show improvement in one or more key health metrics.
3	Participants will show measurable changes in life skills.
4	Youth and families will illustrate skills in healthy lifestyles.
5	People who attended a community-based health program, including African American families, students from the local universities, church parishioners, and stakeholders from the local community, demonstrating the effectiveness of partnering on community education projects with a faith-based organization.

Outcome #1

1. Outcome Measures

Additional way to educate about farm safety.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

It's not uncommon for a child to fall through a hay hole, through which hay is thrown from the upper level of a barn to cows below. Children may be working, they may be bystanders to others working, or they may be playing. It's usually a 10- to 12-foot fall onto concrete below, which results in head injuries. The Anabaptist population is at high risk for these injuries and are typically uninsured, so the financial toll of an injury and rehabilitation is high to the family and the community.

What has been done

Members of a team including Penn State Children's Hospital, Penn State Extension, and the Pennsylvania Amish Safety Committee met with Anabaptists on their farms to talk about farm safety and children. Using leveraged funds, the team developed a hay hole cover constructed as a square metal frame with netting fastened and stretched across the middle of the frame to serve as a fall protection barrier but allow loose hay to pass through. The covers were given free to Anabaptist farmers and others.

Results

Based on the number of hay hole covers provided, intervention manufacturing costs were \$14,875, which indicates a significant economic relief to the hospitalization costs associated with traumatic brain injuries. Each hay hole cover costs about \$85, versus potential costs of about \$162,000 to treat a traumatic brain injury. This is a low-cost solution to a high-risk problem.

A Lancaster County extension agent said that in her 24 years doing safety education in Amish schools, this is the first year that hay holes aren't the number one cause of head injury. The project team continues to investigate the reduction of falls from hay holes.

It's important to target the Anabaptist population because they have no other avenues to learn

this information. They don't watch TV, use the Internet, or attend FFA or 4-H meetings.

4. Associated Knowledge Areas

KA Code	Knowledge Area
723	Hazards to Human Health and Safety
804	Human Environmental Issues Concerning Apparel, Textiles, and Residential and Commercial Structures

Outcome #2

1. Outcome Measures

Participants will show improvement in one or more key health metrics.

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.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Research shows that the earlier a teen starts using substances, the more likely the teen is to develop dependence or serious substance-use related problems down the road. Prevention programs like PROMoting School-community-university Partnerships to Enhance Resilience (PROSPER) can help delay experimentation with substances at an early age.

What has been done

With leveraged funding from the National Institute on Drug Abuse, PROSPER is a community-based preventive intervention delivery system offered to middle school youth. PROSPER is a partnership among university Extension educators and school, community, and parent stakeholders. Researchers surveyed more than 1,900 19-year-olds, randomly selected from the full PROSPER sample of over 11,000 youth, about their drug use.

Results

Researchers found a 41 percent reduction in lifetime use of methamphetamine for youth in PROSPER communities compared to control communities after high school graduation. Study results also showed reductions in lifetime cocaine use and marijuana use of more than 30 percent, and a reduction of prescription drug misuse of 20 percent. At age 19, youth in PROSPER communities reported a significantly lower level of drug-related problems than youth in control communities.

This study was the first to show that the benefits of participation in PROSPER extend into emerging adulthood, which is important because the prevalence of illicit drug use is highest among people aged 19-22.

If implemented broadly across communities, the PROSPER system has the potential to reduce drug and alcohol addiction over the long term and benefit everyone.

4. Associated Knowledge Areas

KA Code	Knowledge Area
723	Hazards to Human Health and Safety
724	Healthy Lifestyle
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
805	Community Institutions and Social Services
806	Youth Development

Outcome #5

1. Outcome Measures

People who attended a community-based health program, including African American families, students from the local universities, church parishioners, and stakeholders from the local community, demonstrating the effectiveness of partnering on community education projects with a faith-based organization.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	275

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

In many urban communities, there has been a steady decline in healthy living practices among minority families. Obesity among African American children is increasing more rapidly than among white children. These issues are often due to a lack of health services and health knowledge. To better reach these audiences, scholars and practitioners are now focusing on community-based programming and exploring new partnerships to reach under-served audiences and create healthier families.

What has been done

A partnership among Penn State, a local church, and community organizations in an urban area east of Washington, DC, cooperated to offer a community health fair to increase healthy eating and active living in youth and families. The activities encouraged youth to think about how to make and execute healthy choices and parents/guardians to model these behaviors and choices. The format encouraged conversations among participants to stimulate future healthy behaviors.

Results

Nearly 300 people attended the five-hour event. Nearly 95% of youth who participated in educational activities found them informative and said they provided ways to think about their health and the health of their families. If neighborhoods and cities come together to create community-based health programs, better public action and policies can be created for long-term effect. The partnership with a faith-based organization was innovative and provided a comfortable venue for previously difficult-to-reach populations. Feedback from the day of the event showed that social media outlets and church bulletins were the most successful strategies in reaching audiences.

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Public Policy changes
- Competing Public priorities
- Other (Funding)

Brief Explanation

Economy

Funding is limited to conduct agricultural safety and health trainings and for emergency responders to participate in agricultural rescue training.

PROSPER programs are fully sustained by community teams. Since funding sources are limited, funding PROSPER infrastructure and programs has been challenging.

Some clientele could not participate in statewide programming because of costs.

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.

Appropriations changes

Extension educators who deliver the Better Kid Care (BKC) program often do so as part of their contract with PA Keys. Last year, given the state budget deficit, there were fewer dollars available via the contracts, and many of the requested programs fell into the mandated and required category.

Public Policy changes

Recent federal legislation (reauthorization of the Child Care Development Fund) mandates minimum health and safety training for all child care professionals. BKC responded to this need again in 2016-2017 with an online course that has reached more than 50,000 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 BKC program. BKC is providing the mandated health and safety training for seven states. Many states and the Administration for Children and Families identify BKC as a reliable source of training to meet federal mandates for child care health and safety.

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

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.

There are many activities, programs, and organizations competing for the time of our youth and volunteers. Volunteers are able to deliver programming only to the youth we draw to the program, so the number of youth affected can be limiting. Some counties struggle to get enough volunteers to help deliver programming and start or maintain clubs.

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 \$361,500 to support new curriculum initiatives and staff development.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The strongest evaluation of our programs comes from gathering pre- and post-training responses and the use of retrospective evaluation to assess whether participants actually put into practice lessons learned through extension programs. More statewide extension programs are performing these kinds of meaningful evaluations, so our programs continue to grow stronger and our results continue to become more quantifiable and impactful. We are also finding greater willingness to estimate potential earnings or cost savings as a result of research outcomes.

A customer relationship management tool was implemented in September 2017. That will lead to more consistent implementation of post-event evaluations, which should allow for assessment of change in practice and possibly estimates of economic impacts. These post-event assessments will be used more broadly in 2018 as time passes from events held in late 2017 and beyond.

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)	
1	Number of new crop varieties, animal breeds, and genotypes with 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.