

2019 Annual Report of Accomplishments and Results

Pennsylvania
The Pennsylvania State University
Combined Research and Extension Efforts

I. Report Overview

The NIFA reviewer will refer to the executive summary submitted in your Plan of Work. Use this space to provide updates to your state or institutions as needed.

<p>1. Executive Summary (Optional)</p> <p>The College of Agricultural Sciences at Penn State will provide comprehensive support to the residents of Pennsylvania through the activities of the Pennsylvania Agricultural Experiment Station (AES) and Penn State Extension (PSE). We will be responsive to stakeholder needs through translational research and delivery of science-based programs to clientele, but we will also conduct internationally relevant fundamental research that generates baseline data to solve future problems and actively seek new and better ways to communicate our programs to new audiences. Our faculty and staff, supported by federal base funding, will effectively leverage this investment against many other funding sources to conduct programs of the highest caliber. We are committed to excellence in research, educating the next generation of agricultural professionals and citizens, and promoting life-long learning among the citizens of Pennsylvania.</p> <p>Our College's mission is clear: "The mission of the College of Agricultural Sciences is to discover, integrate, translate, and disseminate knowledge to enhance the food and agricultural system, natural resources and environmental stewardship, and economic and social well-being, thereby improving the lives of people in Pennsylvania, the nation, and the world."</p> <p><i>Evolving outlook on the future of agriculture</i></p> <p>Agriculture faces challenges of rising energy costs, weather extremes, an expanding human population, environmental degradation, loss of biodiversity, and labor shortages. To help meet these challenges, we are developing a conceptual framework based on the science of agricultural sustainability--defined as the integration of natural and social sciences to inform practice and policy for productive, working landscapes, healthy watersheds, and resilient economies. This innovative approach to agricultural research, engagement, and education centers on the impacts and synergies of contiguous rural and urban landscapes. This mosaic of densely populated areas next to forests and agricultural landscapes is unique to Pennsylvania and the Mid-Atlantic region and requires an integrated strategy to achieve healthy and thriving agriculture, natural systems, economies, and communities. From forests to crops to animal facilities, the location of economically significant agricultural systems in Pennsylvania adjacent to and sometimes within highly populated regions creates distinct challenges and opportunities for the integration of natural and social sciences to inform practice and policy.</p> <p>A primary component of AES and PSE work in our College will be built on the three integrated pillars of intensification, resilience, and regeneration of agricultural landscapes as solutions to some of the most vexing problems confronting Pennsylvania and similar mosaic landscapes worldwide. We will holistically and comprehensively address these critical issues:</p>
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2019 Annual Report of Accomplishments and Results (AREERA)

- increasing the efficiency and profitability of agricultural production while minimizing environmental impacts
- equipping farmers to absorb and recover from short-term or long-term shocks and stresses to their agricultural production and livelihoods
- optimizing plants, animals, and ecosystems for resistance to and/or faster recovery from environmentally related stresses
- developing strategies for better management of nutrient inputs and outputs across complex agricultural and natural resource systems, from field and farm to large watersheds
- harnessing spatial data and remote sensing technologies to map and model predictive simulations of environmental change

This framework represents the College's new organizing outlook and leads to our newly endorsed critical issues.

Our critical issues and highlights from the 2019-2020 reporting year

Our faculty's proficiencies span the gamut from the molecular to plant and livestock breeding, from farm sustainability to ecosystem modeling, and help ensure that solutions to problems are economically viable, socially acceptable, and equitable.

In summer 2020, the College of Agricultural Sciences is expected to have a draft of our next College Strategic Plan that builds upon the accomplishments of the 2014–2019 strategic plan. A future plan of work will reflect the latest realignment of our critical issues with our new strategic plan. Consideration of the suitability of the critical issues outlined below, which are built upon previous planned programs, found them highly relevant to research and issues facing agriculture and communities today.

This plan and the critical issues addressed will evolve with time as new challenges arise, issues evolve, and needs change. Below we highlight some of the noteworthy research and extension efforts from each critical issue this past year, *in addition to the projects featured in Section 4 in more detailed summaries.*

Advancing Agricultural and Food Systems through the use of state-of-the-art technology and interdisciplinary collaboration to increase agricultural resiliency and efficiency.

- Our Livestock Extension Team documented \$1.1 million in increased income and cost savings to producers across some of their main programs, including the beef short course; cattle feeders day; introductory sheep, goats, and cattle raising workshops; lambing and kidding school; and individual requests for assistance and farm visits. Extrapolating these results statewide would be highly impactful to Pennsylvania's livestock industry.
- A Penn State researcher was part of an international team that quantified the global burden of pathogens and pests on major food crops. The team found that pests and diseases are taking a substantial bite out of the world's five major food crops—in some cases, up to 40 percent. Crop losses in food insecurity hot spots were more significant than those in North America. The researchers hope their assessment will be a catalyst for targeted management programs to counteract the destruction.

Developing Biologically Based Materials and Products to meet the promise of sustainable clean energy, beneficial reuse of agricultural waste, and income generation through new, value-added bioproducts to support struggling economies.

- Carabid beetles produce caustic chemicals they spray to defend themselves against predators. Leveraging USDA funds with NSF funds, one Penn State research team has found that resilin, the compound that protects carabid beetles' bodies from these toxic substances, shows promise for use in bioengineering or biomedical applications. Since it is impermeable, highly resistant to chemicals, and flexible, resilin appears to be a strong candidate for a barrier material in applications where we need to keep two different chemicals away from each other but within the same environment.
- An extract from the seeds of avocados exhibits anti-inflammatory properties in a laboratory study, according to Penn State researchers, and it represents a potential source for new anti-inflammatory compounds that could be developed as functional food ingredients or pharmaceuticals. Work also continues to commercialize as a food colorant the orange-colored compound previously extracted from avocado pits.

Building Community Resilience and Capacity through integrated research and extension programming that promotes economic and social well-being by encouraging agritourism and entrepreneurship, community health, and sustainability in infrastructure, food, and energy systems.

- The Forestry and Wildlife Extension team's lumber grading course resulted in a \$19 million increase in value for participants' facilities from more accurate grading. Based on pre- and post-test results of grading actual boards, participants increased grading accuracy by 31%. The participants work at facilities that grade 222 million board feet of lumber annually.
- Scientists from Penn State's Population Research Institute and the Social Science Research Institute leveraged federal funds to predict future demands on interstate highway systems based on population projections. Although the U.S. will experience population growth across all age groups in the next 50 years, there are expected to be growth hot spots in the West, South, and East, and declines in the Great Lakes area, along the Mississippi River, and in the Deep South. Highway demands will be driven by the aging population, millennials, and immigrants, and by telecommuting and autonomous vehicles.

Promoting Environmental Resilience by assessing and protecting ecosystems and ecosystem services, helping agriculture meet its environmental challenges, promoting ecosystem resilience and health, and mitigation and adaptation to climate change.

- Green ash, an ecologically and economically valuable tree species native to eastern and central North America, is under severe threat from the rapid invasion of emerald ash borer (EAB), a wood-boring beetle native to Asia. A team of Penn State and USDA foresters determined that some ash trees have varying degrees of resistance to EAB that will likely just barely ensure the survival of the species. Another multistate team including Penn Staters found that genes in green ash trees that may confer some resistance to attacks by EAB express themselves only once the tree detects the invasive beetle's feeding. Geneticists may be able to selectively breed trees to strengthen them and perhaps move the resistance response earlier to ward off the beetles' onslaught.
- Penn State entomologists were part of an international team that found that the abilities of various bee species to disperse influences the pattern of their population's genetic structure, which, in turn, can constrain how they respond to environmental change. Bees are declining around the world, which is a problem because these pollinators are critically important, both ecologically and economically. The study has major implications for bee species conservation. For example, the ability of a species to disperse farther can enable that species to move to suitable areas under scenarios of climate change.

Supporting Integrated Health Solutions by developing functional foods for positive health outcomes, overcoming food safety concerns, fostering human and livestock health, and fighting insect-borne diseases and parasites.

- The first study since the 1930s to investigate the relationship between temperature and malaria parasite development showed that malaria parasites develop faster in mosquitoes at lower temperatures than previously thought. The findings suggest that even slight climate warming could increase malaria risk to hundreds of thousands, if not millions, of people—including travelers—in areas that are currently too cold for malaria parasites to complete their development. The more rapidly the parasites develop, the greater the chance that the mosquito will survive long enough for the parasites to complete their development and be transmitted to humans.
- The prevalence of the most abundant species of ticks found in Pennsylvania has shifted over the last century, according to research by Penn State scientists, who analyzed 117 years' worth of specimens and data submitted primarily by residents from around the state. Understanding the spatial distribution patterns and host associations revealed by their analysis is important for assessing and reducing the risk of diseases caused by tick-borne pathogens.

Fostering a Positive Future for Youth, Families, and Communities by providing a wide range of evidence-based programming to support healthy families, build positive youth skills, strengthen intergenerational relationships within communities, and promote farm safety.

- A Penn State professor of youth and international development used her expertise in youth development and organizational capacity-building to help an organization in Kosovo called TOKA, which is a lot like 4-H. TOKA focuses on aspects of life that are important to young people and instills in them some key principles that help throughout their life. This work was supported by the Fulbright program and leveraged USDA funds.
- A study of gender, household food security, and dietary diversity in western Honduras concluded that households in which women have access to credit have higher dietary diversity and lower food insecurity. When women had control over income there was also more dietary diversity in the house. The work calls for interventions both to enhance women's decision-making ability within the household and for programs, including microcredit, to reach women directly. This study leveraged USAID and USDA funds.

Leveraging funding

Penn State's broad and deep portfolio of agricultural and related research and extension is funded by scores of federal, state, and county agencies, private foundations, commodity groups, businesses and corporations, and international governments. This leveraging of resources allows gains in knowledge, behaviors, and conditions that are much greater than could be realized from any single source of support. Some funders include US Environmental Protection Agency, US Department of Interior, US Department of Energy, PA Department of Agriculture, PA Department of Conservation and Natural Resources, and PA Department of Environmental Protection.

II. Merit and Scientific Peer Review Processes

The NIFA reviewer will refer to your Plan of Work. Use this space to provide updates as needed or activities that you would like to bring to NIFA’s attention.

Process	Updates
<p>1. The <u>Merit Review Process</u></p>	<p>Both PSE and AES programs undergo comprehensive review utilizing a number of merit review processes.</p>
<p>2. The <u>Scientific Peer Review Process</u></p>	<p>Internal university panels will be used to review AES projects. The Hatch, McIntire-Stennis, Animal Health, and State projects will be internally reviewed at initiation by at least two qualified faculty. In addition, external university panels are used for Multistate Research Project (MRP) activities. Both extension and academic faculty are encouraged to participate to meet the jointly agreed objectives. These projects are reviewed multiple times through the five-year duration.</p> <p>External non-university panels are used as new PSE programmatic issues or AES projects are implemented. Stakeholder and/or program advisory groups provide ongoing review of programs to ensure a focus on priority needs as identified by advisory groups. Reviewers' comments provide mechanisms for improving our educational and research programs.</p> <p>Combined internal and external university panels are assigned to each of the programmatic issues. These panels are integrated, multidisciplinary State Extension Teams (SETs) made up of field-based extension educators and faculty with split appointments in both extension and research. Team members broadly represent all parts of the Commonwealth, and faculty members are chosen to represent relevant research and extension perspectives. Extension Program Leaders provide overall leadership to the SETs, and programs are reviewed by extension administrators. State administrators and academic unit leaders serve as liaisons to each team. Each SET developed a program plan, based on logic model components, that will guide extension programming and applied research efforts.</p>

III. Stakeholder Input

The NIFA reviewer will refer to your Plan of Work. Use this space to provide updates as needed or activities that you would like to bring to NIFA’s attention.

Stakeholder Input Aspects	Updates
<p>1. Actions taken to seek stakeholder input that encouraged their participation with a brief explanation</p>	<p>College administration and faculty advisory groups will confer regularly with key stakeholder groups, state and federal partners, and relevant industry representatives across the breadth of interests in the College. Listening sessions, targeted invitations, surveys, focus group meetings, and engagement on social media will all seek input from traditional and nontraditional stakeholder groups and/or individuals. A primary avenue for stakeholder input is via the various forms of feedback obtained in connection with extension offerings, from volunteered comments and formally sought assessments of learning and effectiveness to retrospective evaluations that seek to measure outcomes such as costs averted or profit increased from implementing extension program suggestions. All of these forms of feedback will be taken together to help set the course for PSE and AES programs. The results of these assessments will be incorporated into our Extension Program SharePoint site and our Extension Program Activity System (EPAS).</p>
<p>2. Methods to identify individuals and groups and brief explanation.</p>	<p>The Penn State Ag Council (Ag Council) will assist our programs with identification and selection of stakeholder individuals and groups. Ag Council members will be selected to represent diverse program areas, emerging issues, geographic areas, and populations (diverse in, for example, race/ethnicity, age, longevity in the ag field, rural/urban, and those historically underserved by extension). Ag Council meetings will be publicly announced, and broad representation will be constantly reassessed to ensure the inclusion of new and traditionally underserved audiences. Maintaining contact with College alumni builds direct links to our stakeholder groups and industries. Alumni and friends’ banquets and football tailgates are common and well received throughout the College.</p>
<p>3. Methods for collecting stakeholder input and brief explanation.</p>	<p>To collect stakeholder input, educators or faculty will hold regularly scheduled meetings, such as advisory groups and Penn State Ag Council. Ag Council members will work with program teams to develop relevant, science, and industry-based programs to meet the educational needs of the residents of the Commonwealth. This effort is part of the Program Development Process. Meetings will occur with traditional and non-traditional individuals and groups. During and after extension programs, participants may verbally or through surveys request additional programs or updates or provide input about effectiveness, both immediate and long term. To collect more detailed information from traditional and nontraditional stakeholders, sophisticated survey instruments or focus group meetings will be implemented and the data analyzed. All departments and extension programs will maintain websites and distribute regular electronic and/or hardcopy communications and/or social media messages to inform stakeholders and to invite feedback. Many programs will hold field</p>

	<p>tours or site tours, which allow them to hear from stakeholders directly. The dean's industry tour series will bring some of the College's leaders into some of the state's leading agricultural industry facilities to learn about their challenges and about how Penn State researchers might help.</p>
<p>4. A Statement of how the input will be considered and brief explanation of what you learned from your stakeholders.</p>	<ul style="list-style-type: none"> • Budget Process: Availability of funding from certain extramural funding sources will influence resource allocations. • To Identify Emerging Issues: Stakeholder feedback will help to identify emerging issues that would benefit from extension programming and/or research. • Redirect Extension Programs: Information collected from stakeholders will continue to be used to adjust issue areas for extension programming. • Redirect Research Programs: Information collected from stakeholder groups, such as industry associations, will continue to be used to directly influence applied research activity through local decisions about priorities. • In the Staff Hiring Process: Information collected from stakeholders will continue to influence hiring decisions for faculty and extension educators to address unmet needs. Stakeholder feedback also indicates where volunteers and donors would be interested in assisting with programs and initiatives. • In the Action Plans: Our mission is to serve our stakeholders, so we will analyze the information gathered from stakeholders and adjust our action plans as needed to meet their needs. • To Set Priorities: Our stakeholders' priorities must be our priorities, and we will adjust our programs as needed. • To Determine How and Where Programs are Offered: Stakeholder input will continue to directly impact how, where, and when we offer our extension programs. We have developed and implemented many different platforms for information transmittal in response to previous feedback from stakeholders that additional methods of program delivery were needed as demands for resources and/or time increase. We now offer podcasts, online webinars, videos, field tours, etc., by synchronous and asynchronous means, and continue to migrate away from the traditional classroom setting. We continue to innovate with delivery mechanisms to keep our technology fresh, and we continually update our content. We want to maximize the utility of extension educators' time in the field by increasing the depth and breadth of routine educational materials available online.

IV. Planned Program Table of Contents

No.	Program Name in order of appearance
1.	Advancing Agricultural and Food Systems
2.	Developing Biologically Based Materials & Products
3.	Building Community Resilience and Capacity
4.	Promoting Environmental Resilience
5.	Supporting Integrated Health Solutions
6.	Fostering a Positive Future for Youth, Families, & Communities

V. Planned Program Activities and Accomplishments

Please provide information for activities that represent the best work of your institution(s). See Section V of the Guidance for information on what to include in the qualitative outcomes or impact statements. Add additional rows to convey additional accomplishments. You may expand each row as needed.

No.	Title or Activity Description	Outcome/Impact Statement	Planned Program Name/No.
1.	Improved efficiency of operation for livestock production: Know Your Numbers, an educational program offered by the Penn State Extension Dairy Team, had a total financial impact of \$9.5 million and an employment impact of 69 jobs in 2014.	<p>Issue: Documenting the impact of Extension programming is important in many states to help funders and stakeholders understand the value of Extension and to help state Extension systems evaluate program priorities. However, the economic impact of such programming has received little attention. Researchers examined the impact of Know Your Numbers (KYN), an educational program offered by the Penn State Extension Dairy Team.</p> <p>Target audience: Pennsylvania dairy farmers were taught how to analyze their costs and income to improve their cash flow planning skills.</p> <p>Using follow-up evaluation data and the economic impact tool IMPLAN, the team estimated that the program had a total financial impact of \$9.5 million and an employment impact of 69 jobs in 2014. These impacts will occur annually, as participating farmers continue to use farming practices learned at the workshops.</p> <p>If half of the dairy producers in Pennsylvania were to participate in the KYN program and implement the practices taught, the annual financial impact would increase to about \$219.8 million, supporting 1,590 jobs.</p> <p>What has been done: The KYN program focuses on cash flow planning for various situations. In the cash flow planning workshop producers discuss cropping and feed costs, income over feed costs, and risk management strategies for mitigating price risks for both feed and milk production. In the advanced cash flow planning workshop participants evaluate their past year's cash flow and cropping and feeding management practices and evaluate quality of milk, corn silage, and manure. They use their findings to develop a plan for the coming year.</p> <p>Results: PA dairy farmers who consistently use the tools they learn in this workshop have a better chance of their farms being profitable and maintaining their livelihood, self-esteem, health, and often their families' land and home.</p> <p>The overall financial impacts of the Dairy Team, given its abundance of other programming, likely are significantly higher.</p>	1 - Advancing Agricultural and Food Systems

		<p>The approach used for estimating the economic impact of an extension program can be used by others to understand and demonstrate the value of their work.</p> <p>External factors: The heavy rainfall in 2018 caused issues for dairy producers, such as respiratory issues in cattle and poor feed quality due to harvest difficulties, causing low milk production.</p> <p>The dairy industry experienced a record low for the fifth year in a row. Many dairy producers struggled to break even. Many Pennsylvania dairy producers are selling their cattle in hopes of saving their land from foreclosure.</p> <p>Population changes: Dairy producers are experiencing a decrease in labor availability. Hispanic labor was once a more affordable option for producers, but is now increasing in price.</p> <p>Penn State dairy educators worked with area producers to navigate the 2019 Farm Bill, including the Dairy Revenue Protection Program.</p> <p>Other information: Financial Impact of Penn State Extension’s Know Your Numbers Dairy Program. <i>Journal of Extension</i>. Feb. 2019. https://www.joe.org/joe/2019february/rb3.php</p> <p>Penn State Dairy Extension: https://extension.psu.edu/animals-and-livestock/dairy</p>	
<p>2.</p>	<p>Penn State scientists are expanding work to help farmers learn about industrial hemp.</p>	<p>Issue: With the passage of the 2018 Farm Bill and new regulations that allow hemp to be grown for sale for a range of uses, hemp production in Pennsylvania has taken off. The Pennsylvania Department of Agriculture approved more than 300 permits in 2019. Many people want to learn about the crop. Industrial hemp fiber and stalks are used in clothing, carpeting, paper, and biofuel and construction products, and its seeds and flowers can be found in vegetable oils, organic body products, and health foods and supplements, such as cannabidiol (CBD) extract. There is little published research on best management practices for producing hemp.</p> <p>Target audience: Hemp provides opportunities for product development and economic benefit, especially for growers, landowners, and rural communities, and Penn State researchers and extension agents want to help them better understand it. Producers, processors, and sellers stand to profit from careful expansion into this new area, and governmental entities may increase resultant tax revenues.</p> <p>What has been done: Penn State was one of 16 sites approved by the state in 2016 as part of a pilot program for industrial hemp growth and cultivation research. The original work focused on the basics of hemp production for seed. Now the work is expanding to look at fiber and the production of CBD extract. Penn State scientists are developing guidelines for variety selection, fertilization, weed control, harvesting, drying, and marketing. Growing hemp for fiber and CBD</p>	<p>1 - Advancing Agricultural and Food Systems</p>

		<p>production requires some tweaking of systems that work for growing hemp for grain. The researchers are also adapting production systems to the Northeast climate. Other researchers are testing harvest approaches, processing techniques, and equipment for fiber.</p> <p>Results: Working in concert with other hemp growers, processors, and industry partners, most notably the Pennsylvania Hemp Industry Council, Penn State educators have hosted field days on hemp production, and presented information at Ag Progress Days and the Pennsylvania Farm Show. They’ve also developed extension fact sheets and articles about the crop and planted demonstration crop trials. In addition to conducting on-the-ground research under Pennsylvania conditions, the university’s experts are gathering and sharing the best information available about industry standards from people already making this crop work around the country and the world. They are working collaboratively with researchers across the country on impactful experimental design and data sharing. This should help build a robust data set more quickly than working individually on similar projects.</p> <p>External factors: Many Pennsylvania farmers have had to transition their businesses and/or diversify their operations in the past few years. Extension has worked with these clients during their times of transition/diversification.</p> <p>Other information: Industrial Hemp. Penn State Extension. https://extension.psu.edu/hemp. Penn State news release: Penn State scientists expanding work to help farmers learn about industrial hemp. https://news.psu.edu/story/579023/2019/06/27/health-and-medicine/penn-state-scientists-expanding-work-help-farmers-learn</p>	
<p>3.</p>	<p>Reducing dairy cow overcrowding could yield millions for PA dairy industry.</p>	<p>Issue: A dairy farmer with 300 cows in York County, PA, contacted the Veterinary Extension Team; his herd was experiencing low cow fertility. After analyzing the farm records, the team suspected that the management of the transition cow group was affecting herd fertility.</p> <p>Target audience: The farmer with the 300-cow dairy who made the initial inquiry to Extension benefits from reduced costs and increased income of about \$47,700 annually (see Results below) if he continues to follow the veterinary team’s recommendations.</p> <p>The vet team estimates that about 85% of cows in free-stall barns in Pennsylvania are overcrowded and experiencing similar stress-related health impacts. Data indicate that about 60% of dairy cows in the state are kept in free-stall barns, and if we assume that all of these cows could be housed in appropriately sized facilities that would remove the stress and resultant health problems that come with overcrowding, and that disease incidence cost estimates are identical for all these cases (see Results below), the PA dairy industry could save about \$111 million per year on reduced treatment costs and losses, such as low milk production and poor fertility,</p>	<p>1 - Advancing Agricultural and Food Systems</p>

	<p>associated with these prevalent diseases. If we assume that improved health increases the pregnancy rate of all these cows by 4%, the industry statewide would see an increase in income of \$15,616,710. These estimates do not include the cost of any new facilities required to address cow overcrowding.</p> <p>Local, state, and the national economy and dairy and calf processors would benefit from this increased profitability, as would the farm families and rural communities.</p> <p>What has been done: The team investigated to identify the factors affecting reproductive performance in this specific herd. The main findings from the farm visit revealed that the cows were metabolically stressed due to poor management during the transition period. The team suggested implementing a fresh-cow pen with proper stocking density and cow comforts, among other recommendations.</p> <p>Results: The producer followed the recommendations regarding the use of a fresh-cow pen. Three months later, the team did a follow-up farm visit to reassess cow health and fertility. During this visit, the team assessed the same parameters that were evaluated during the first visit and found significant improvements in every single parameter. For instance, the incidence of metritis, an infectious uterine disease that directly affects cow fertility and causes \$650 million in annual losses to the dairy industry in the U.S., had decreased by 74% (4.5% vs. 17.2%). Similarly, the incidence of subclinical ketosis, a metabolic disease that affects cow fertility and causes \$315 million in annual losses to the U.S. dairy industry, decreased by 22% (17.9% vs. 22.7%). This farm milks 300 cows annually, so these decreases mean that 15 cows and 38 cows, respectively, would not develop metritis and ketosis during the next year. Published estimates are that a case of subclinical ketosis costs \$67, while a case of metritis costs \$354. Therefore, this farm would save \$14,457 (ketosis savings = \$1,005; metritis savings = \$13,452) a year due to only the reduction in these diseases.</p> <p>Another important improvement observed after recommendations were implemented was a 7.75% increase in pregnancy rate, a common parameter used to assess reproductive performance on dairy farms, compared to the last 5 years. Based on the number of milking cows and the rolling herd milk production average, this farm will experience an economic benefit of \$33,300 year (calculated using Value of Reproductive Improvement tool, University of Wisconsin) if they are able to maintain this improved pregnancy rate.</p> <p>External factors: The price of milk has continued to affect the profitability of dairy farms and appears to have also reduced, at least to some degree, the openness of dairy producers to attend/participate in programs.</p> <p>Other information: Penn State Dairy Extension. https://extension.psu.edu/animals-and-livestock/dairy</p>	
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		Penn State Veterinary Extension. https://vbs.psu.edu/extension	
4.	<p>Cost savings from more efficient use of pesticide or herbicide: Neonicotinoid seed treatments of soybean provide negligible benefits to U.S. farmers.</p>	<p>Issue: Neonicotinoids are the most widely used insecticides worldwide and are typically deployed as seed treatments (hereafter NST) in many grain and oilseed crops, including soybeans. Approximately 34–44% of planted soybean hectares in the U.S. are treated with NST. However, there is a surprising dearth of information regarding NST effectiveness in increasing soybean seed yield, and most published data suggest weak or inconsistent yield benefit. The U.S. is the key soybean-producing nation worldwide. NST’s persistence and leaching in soil, high water solubility, and potential negative health implications for nontarget organisms such as bees raise some concerns about their use.</p> <p>Target audience: U.S. soybean growers may reduce their costs and thus increase their profits by ending the prophylactic use of NST. The environment and wildlife across this region and downstream may benefit from reduced use of NST.</p> <p>What has been done: A Penn State faculty member was part of a large team that analyzed soybean yield data from 194 randomized and replicated field studies conducted specifically to evaluate the effect of NSTs on soybean seed yield at sites in 14 states from 2006 through 2017.</p> <p>Results: Across the principal soybean-growing region of the country, negligible and management-specific yield benefits have been attributed to NSTs. Across the entire region, the maximum observed yield benefits due to fungicide (FST = fungicide seed treatment) + neonicotinoid use (FST + NST) reached 0.13 Mg/ha. Across the entire region, combinations of management practices affected the effectiveness of FST + NST to increase yield, but benefits were minimal, ranging between 0.01 and 0.22 Mg/ha. Despite widespread use, this practice appears to have little benefit for most soybean producers. Throughout most soybean-producing regions of the U.S., the period of pest protection provided by NSTs does not align with economically significant pest populations. Across the entire region, a partial economic analysis further showed inconsistent evidence of a break-even cost of FST or FST + NST. These results demonstrate that producers and regulators should re-evaluate the current widespread prophylactic use of NST in the key soybean-producing areas of the U.S.</p> <p>External factors: Profitability has been minimal for farmers in recent years, and changing practices can be seen as a liability when many are trying to reduce risk.</p>	1 - Advancing Agricultural and Food Systems

		<p>Other information: Neonicotinoid seed treatments of soybean provide negligible benefits to U.S. farmers. <i>Scientific Reports</i>. Sept. 2019. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6733863/</p>	
<p>5.</p>	<p>Mechanization of fruit-zone leaf removal to control bunch rot could save wine grape growers as much as \$150 per acre on labor costs when compared to application by hand.</p>	<p>Issue: Bunch rot exists in all vineyards worldwide. This disease, caused primarily by the fungus <i>Botrytis cinerea</i>, is commonly associated with the decay of ripe or nearly ripe grapes. Warm temperatures and damp climates favor disease development. Management of bunch rot is best accomplished through a combination of cultural and chemical procedures. Any practice that opens up the canopy and improves air circulation, thereby reducing humidity and facilitating the drying of leaves and clusters, will help reduce bunch rot infection. Even low levels of infection—as low as a 5% bunch rot—have been shown to negatively affect wine quality.</p> <p>Target audience: Vineyard owners will benefit from the identification of cost-effective mechanized ways to control bunch rot through reduced prices for labor and reduced reliance on scarce skilled labor.</p> <p>What has been done: The Penn State Extension wine and grape team continued to evaluate the benefits of mechanization of fruit-zone leaf removal compared to labor-intensive manual application on an increasing number of grape varieties. Mechanization of leaf removal improves its cost-effectiveness, especially where grape acreage is concentrated (as in the Lake Erie region) and equipment can be shared or contracted. Conversely, equipment costs could be prohibitive for small, isolated farms in central and southern PA. Mechanization also improves the effectiveness of prebloom leaf removal at reducing fruit rots by improving the timeliness of this cultural practice.</p> <p>Results: Mechanization could save wine grape growers as much as \$150 per acre on labor costs when compared to application by hand and make them less reliant on increasingly scarce hand labor and expensive fungicide applications for bunch rot control. Growers could reduce their pesticide inputs by one or two sprays per year at an additional potential annual savings of \$80–100 per acre per year.</p> <p>External factors: Fruit-zone leaf removal applied at prebloom may drive reduction in grapes per cluster, which generally results in a reduction in cluster weight and, potentially, yield. But through tactics such as delay of leaf removal application to fruit set or slight downward adjustments in the amount of leaf tissue removed—say four leaves removed per shoot, instead of five—growers can minimize or eliminate yield reduction, while maintaining bunch rot reduction.</p>	<p>1 - Advancing Agricultural and Food Systems</p>

		<p>Other information: How Wine Grape Growers Can Help Minimize Bunch Rot. Growing Produce. March 2019. https://www.growingproduce.com/fruits/grapes/how-wine-grape-growers-can-help-minimize-bunch-rot/</p> <p>Grape Disease—Botrytis Bunch Rot. Penn State Extension. https://extension.psu.edu/grape-disease-botrytis-bunch-rot</p> <p>Botrytis Bunch Rot: Winemaking Implications and Considerations. Penn State Extension. https://extension.psu.edu/botrytis-bunch-rot-winemaking-implications-and-considerations</p>	
<p>6.</p>	<p>Increased knowledge about biologically based materials and products: New biodegradable edible film kills pathogens on seafood.</p>	<p>Issue: Seafood may be contaminated with bacterial pathogens, such as vibrio and salmonella. Vibrio occur naturally in marine environments, and salmonella can contaminate seafood during production or processing. Both types of bacteria are linked to gastrointestinal problems when consumed. Because both vibrio and salmonella can survive long-term freezing, contamination by these bacteria is a concern for the seafood industry. Given recent outbreaks with a number of food products, developing something the industry can use to kill microorganisms on the surfaces of food is a worthy effort. A biodegradable, edible film (bioplastic) made with plant starch and antimicrobial compounds may control the growth of foodborne pathogens on seafood.</p> <p>Target audience: The seafood industry would benefit from commercialization and use of this product through reduced product recalls and reduced incidence of foodborne illnesses. The industry could reduce their liability for the costs of foodborne illnesses, and also reduce their use of plastics. Seafood consumers and society in general would benefit from reduced costs of foodborne illnesses, and less food and plastic waste.</p> <p>What has been done: A team of Thai and Penn State food scientists has developed a bioplastic film with antimicrobial activity that can kill foodborne pathogens on food surfaces. They used a blend of thermoplastic starch, a biodegradable polymer made from cassava—tapioca powder—and a gelatin coating containing antimicrobials known as nisin Z and lauric arginate. By putting the antimicrobial into an edible film, and then dipping the shrimp into the film and pulling it out, that film will form around the shrimp. The bioplastic film then releases the antimicrobials over time.</p> <p>Results: The team of researchers in Thailand created a "culture cocktail" of the bacteria and inoculated slices of tiger prawn and big-eye snapper. After dipping the samples into</p>	<p>2 - Developing Biologically Based Materials & Products</p>

		<p>the edible film containing different compositions of the antimicrobials, the slices were vacuum packaged and chilled for up to a month or frozen for 90 days. The experimentally inoculated seafood samples were then tested to see which variations gave the best kill. The bioplastic film “displayed excellent inhibition” against vibrio and salmonella pathogens on chilled and frozen seafood.</p> <p>This work could contribute to reducing the food industry’s reliance on plastic.</p> <p>External factors: The product would need additional testing to address the stability of the film under various conditions, the effect of the film on shelf life of foods, and consumer acceptability before it could be commercialized.</p> <p>Other information: Thermoplastic starch/polybutylene adipate terephthalate film coated with gelatin containing nisin Z and lauric arginate for control of foodborne pathogens associated with chilled and frozen seafood. <i>International Journal of Food Microbiology</i>. Feb. 2019.</p> <p>https://www.sciencedirect.com/science/article/abs/pii/S0168160518306858?via%3Dihub</p> <p>Penn State news release: Biodegradable, edible film kills pathogens on seafood. https://news.psu.edu/story/552088/2018/12/17/research/biodegradable-edible-film-kills-pathogens-seafood</p>	
<p>7.</p>	<p>New or improved use for agricultural waste: Food scientists find a “bran” new way to preserve healthy food with natural ingredients.</p>	<p>Issue: Currently, there's a big push within the food industry from consumers to replace synthetic ingredients with natural alternatives. The food industry is also supplementing more foods with healthy oils rich in omega-3 fatty acids. However, these oils have a shorter shelf life. Antioxidants are compounds that slow the rate at which omega-3 fatty acids degrade, preserving their health benefits and freshness. The food industry has struggled to find natural antioxidants that are as effective as synthetic ones. A natural antioxidant found in grain bran could preserve food longer and replace synthetic antioxidants currently used by the food industry.</p> <p>Target audience: The food industry would benefit from further development and commercialization of this product because it could turn a waste stream into a profitable product, and it would allow the manufacture of healthier foods that stay fresh longer. This would reduce waste of those products. Consumers would benefit from healthier food products. Grain farmers would benefit from greater demand for their products, which could help more farms stay in</p>	<p>2 - Developing Biologically Based Materials & Products</p>

	<p>business and help with farmland preservation and the continuance of ecosystem benefits that farmland provides.</p> <p>What has been done: Researchers studied a class of compounds called alkylresorcinols (ARs). Plants such as wheat, rye, and barley produce ARs naturally to prevent mold, bacteria, and other organisms from growing on the grain kernels. The researchers noticed similarities in the molecular structures of ARs and conventional antioxidants and wondered if ARs could also preserve food in the same way.</p> <p>The research team developed a technique to extract and purify ARs from rye bran, then studied how well ARs preserve omega-3-rich oils in emulsions, where two fluids do not fully mix—for example, vinegar and oil. The researchers chose to study AR action in emulsions because most people consume oils as emulsions, such as salad dressings.</p> <p>Results: The researchers found that ARs did act as antioxidants in an emulsion, preventing omega-3 oils from spoiling as rapidly as they did in emulsions with no antioxidants added. Then, they compared ARs to two antioxidants widely used by the food industry—one natural and one synthetic. ARs were not as effective as either the natural or the synthetic antioxidant. However, the researchers noted that their AR extracts were not completely pure, which could have reduced the effectiveness of the ARs. Also, the researchers used a blend of different ARs that had different molecular structures. Future work looking at different types of ARs will reveal whether an individual AR type is more or less effective than conventionally used antioxidants.</p> <p>ARs come from the bran layer of cereal plants, which the food industry usually discards or uses for animal feed. Successfully developing a food preservative from ARs would turn a waste product into something useful. The research team hopes that one day this work will lead to ARs being available on the market, providing more options for the food industry.</p> <p>External factors: An alternative to the industry standard should be less costly to produce than the standard to foster its widespread adoption.</p>	
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<p>8.</p>	<p>The Intergenerational Leadership Institute for older adults effectively builds participants' intergenerational programming and leadership skills so they can contribute to innovation and change in their communities.</p>	<p>Issue: The U.S. population is graying. The 65+ population is expected to grow from 49 million (15% of population) in 2016 to nearly 95 million (25% of population) by 2060. Older adults can make positive contributions to their families, communities, and broader society, but there is a shortfall of meaningful and accessible opportunities. Intergenerational programs help unlock the potential of older adult volunteers to contribute to the social good. Generations are connected in purposeful, mutually beneficial activities that promote greater understanding and respect and help build more cohesive communities.</p> <p>Target audience: Participants in the program benefit emotionally and probably physically as they grow and challenge themselves to plan and lead community groups. The people that the participants interact with in programs they lead benefit from social interactions, networking, and skill- and self-esteem building. Communities where participants lead programs benefit from volunteer community-building efforts and can allocate scarce employee resources to other uses.</p> <p>What has been done: The Intergenerational Leadership Institute (ILI) is a yearlong certificate training program developed for older adults (55+) seeking new lifelong learning and civic engagement experiences and opportunities to contribute to innovation and change in their communities. The ILI also functions as an incubator for new intergenerational programs that address priority needs at the local level. The ILI model embraces three objectives—lifelong learning, meaningful civic engagement, and new intergenerational program development (or enhancement). The model was launched in two different contexts, a university-based intergenerational research and practice center and a large senior volunteer program administered through a regional nonprofit.</p>	<p>3 - Building Community Resilience and Capacity</p>

		<p>Results: Data from participant surveys and observations of ILI-related training and sessions indicate growth in participants' intergenerational programming and leadership skills in translating intervention ideas into concrete plans and programs.</p> <p>ILI participants gained a general introduction to intergenerational practice, generated new ideas and plans for intergenerational programs, and, in most cases, were successful in implementing their program plans. In the process, they gained confidence and competence as budding intergenerational practitioners. They demonstrated wide-ranging skills development, including in conducting effective outreach to organizations, building consensus and teams, and planning and facilitating compelling intergenerational activities.</p> <p>The success of ILI participants has implications for Extension and other organizations looking to expand their bases of motivated and skilled adult volunteers who could play significant roles in local programs designed to improve quality of life. ILI participants have solid communication, teaching, and intergenerational programming skills they could put to use in Extension programs that rely on volunteers, such as 4-H and Master Gardeners. Additional ILI chapters have now been established in the U.S., Spain, and Mexico.</p> <p>External factors: It takes time and extended training and experience for individuals to develop the confidence and skills to take on leadership roles, particularly for those who are new to this field of practice.</p> <p>Other information: Unlocking the Potential of Older Adult Volunteers: The Intergenerational Leadership Institute Model as a Resource for Bolstering Extension. Journal of Extension. Oct. 2019. https://joe.org/joe/2019october/a3.php</p> <p>Penn State Intergenerational Leadership Institute. https://aeese.psu.edu/extension/intergenerational/program-areas/intergenerational-leadership-institute</p>	
<p>9.</p>	<p>Two-thirds of grant-writing education program participants wrote at least one grant proposal that was</p>	<p>Issue: In an increasingly competitive environment for financial resources from both public and philanthropic sources, many small nonprofit and other community organizations and agencies have limited access to training and information about grant writing. A common misconception in the grant writing process is that the actual proposal is the major component of the grant-seeking</p>	<p>3 - Building Community Resilience and Capacity</p>

	<p>successfully funded. Participants who attributed the success of the grant application to their attendance at the program were awarded a total of \$2,783,700.</p>	<p>process. To be successful, grant writing is a process that entails careful planning, research, and outreach, as well as cultivating relationships.</p> <p>Target audience: The Getting the Most from Your Grant Writing Efforts program targets people who work for, volunteer for, or are involved with a nonprofit organization, an educational institution, or local government. Six-month to two-year follow-up showed that 66% of respondents wrote at least one grant proposal that was successfully funded. Of the 36 successful grant awardees, 92% said the program contributed to their success in acquiring the grant. The dollar value of these grants totaled \$2,783,700.</p> <p>Participants gain valuable skills for the grant-seeking process. Participating organizations may gain external funding to use toward achieving their missions. Taxpayers benefit because funds assist with the cost of highly valued public projects and services. Communities benefit by meeting community needs and strengthening societal bonds.</p> <p>What has been done: Getting the Most from Your Grant Writing Efforts is a Penn State Extension program designed to help participants gain an understanding of the grant writing and fundraising process. The program teaches how to identify and partner with funding organizations whose missions align with the funding request. Participants learn to search, respond to, and work effectively with public and private funding sources throughout the grant-seeking and -writing process. This program helps increase efficiency in preparing and organizing grant proposals, finding funders and sources, and writing and submitting successful proposals.</p> <p>Results: Among other uses the grants received helped agencies and organizations continue to provide services for low-income participants; award grants to others; purchase equipment and supplies for firefighters and emergency medical services, students, mothers, and babies; improve technology; remodel restrooms for people with disabilities; increase green space; address stormwater and other infrastructure needs; support new farm businesses; expand youth and adult recreation programs; and implement STEM programming in a library and expand library collections. The funding allowed some staff to retain their jobs and made possible the addition of at least two new full-time staff.</p> <p>External factors: At few times in recalled history has there been so much change, and ideological difference, in governance at local, state, and national levels. Further, the demographic shift occurring in the workforce and in communities has affected stability in decision-making processes, based on generational and cultural differences. There is a growing rural/urban divide in values and resources that affects the development and delivery of programming.</p>	
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<p>10.</p>	<p>Twenty-eight participants in Toss Your Hat in the Ring workshops ran for local office and 25 were elected.</p>	<p>Issue: Local government in Pennsylvania is the unit of government that affects us most directly. However, local government, including boroughs, townships, and school districts, are in need of people to serve. Penn State Extension developed the Toss Your Hat in the Ring workshops to help citizens determine if and how they could become involved in local government by seeking elected or appointed office.</p> <p>Target audience: The target audience was people who were interested in running for local office, exploring the possibility of running, or being appointed to a local board or commission. Based on the high percentage (89%) of participants who ran and were successful in their races, it seems that the workshop provided valuable information to local candidates. Local governments and Pennsylvania residents benefited from this program by an increase in the pool of talented, committed, and informed candidates.</p> <p>What has been done: Seven Toss Your Hat workshops and two Toss Your Hat webinars were conducted in January and February 2019 and were attended by 155 people. The workshops were conducted in Monroe, Northampton, Franklin, Chester, Lancaster, Delaware, and Pike Counties. The workshops discussed PA local government and the processes of running for local office. A panel of recently elected local officials discussed their reasons for running for local office, as well as their experiences serving in local office. The workshops were conducted in collaboration with county election offices. The workshops didn't offer campaign tips or strategies; the focus was on understanding the roles, responsibilities, and personal rewards that come with public service.</p> <p>Results: Forty-one percent of the participants indicated that the Toss Your Hat program either considerably or significantly increased their ability to run for elected office or seek an appointed office with their local government. Another thirty-five percent indicated that the program somewhat increased their ability to run for elected office or seek an appointed office with their local government.</p> <p>A 6-month evaluation revealed that 28 workshop and webinar participants ran for local office in the May primary and 25 were successful in their race. In addition, another 16 participants were appointed to a local government board or commission.</p> <p>External factors: N/A</p>	<p>3 - Building Community Resilience and Capacity</p>

		<p>Other information: Toss Your Hat in the Ring. Penn State Extension. https://extension.psu.edu/toss-your-hat</p>	
<p>11.</p>	<p>Improved strategy to address nutrient pollution in Chesapeake Bay: Shallow-disk injection appears to be an effective practice to reduce dissolved and total phosphorus losses from fields without negating the erosion-reducing benefits of no-till.</p>	<p>Issue: The Chesapeake Bay watershed faces challenges related to water runoff from the land, which brings pollution to the bay. Much of this runoff comes from Pennsylvania farmland. Penn State researchers and extension educators work collaboratively with farmers and landowners to implement land management practices to help clean up water in PA before it reaches the bay. If most dairy farms in PA fully adopt conservation best management practices, the state may be able to achieve its total maximum daily load water-quality target.</p> <p>Target audience: Pennsylvania farm owners benefit from methods that can help them reduce manure nutrients and sediment from their farm fields. More efficient manure application reduces their costs for chemical fertilizer and should increase the yield of their crops, thereby helping their farms to be profitable and allowing them to continue farming. Citizens and government agencies in Pennsylvania and other bay watershed states benefit from cleaner waterways and the enhanced tourism that can bring. The U.S. economy benefits from a stronger economy in the Mid-Atlantic region.</p> <p>What has been done: In a four-year study, USDA-ARS scientists collected samples of overland and subsurface flows from 12 hydrologically isolated research plots at Penn State's research farm. They analyzed samples for all phosphorus (P) constituents and total solids during and after precipitation events. During that period, the plots were planted with corn in summer and cereal rye cover crop in winter. Half the plots received broadcast manure applications, while the others had manure injected into the soil. A Penn State–led team analyzed the data.</p> <p>Results: Researchers evaluated loads of total, dissolved, and particulate P and total solids against flow volumes to learn how P and solids losses differed among plots. Shallow-disk injection of manure was more effective than broadcasting manure in promoting dilution of dissolved P and, to a lesser extent, total P. The broadcast manure plots experienced more runoff of particulate P than did the injection plots. But even at a small scale, the effectiveness of a practice in accomplishing water quality benefits varies.</p> <p>Importantly for no-till advocates, no difference was detected between application methods for total solids in the runoff, meaning manure injection, with its slight disturbance of the soil surface, did not appear to cause sedimentation. The slightly more</p>	<p>4 - Promoting Environmental Resilience</p>

		<p>than half of PA dairy farmers who use no-till have been slow to adopt manure injection due to concerns about muddying streams.</p> <p>Widespread adoption by dairy farmers of injecting manure into the soil instead of spreading it on the surface could be crucial to restoring Chesapeake Bay water quality.</p> <p>External factors: The research/extension team predicts it will be difficult to persuade farmers to change practices.</p> <p>Manure injection equipment is expensive and it takes longer and requires more fuel for farmers to apply manure to their fields using injection than broadcasting or spreading it. For shallow-disc manure injection to be broadly implemented in the Chesapeake Bay drainage, it will require substantial financial support from government or other off-farm sources.</p> <p>Other information: Load-discharge relationships reveal the efficacy of manure application practices on phosphorus and total solids losses from agricultural fields. <i>Agriculture, Ecosystems, and Environment</i>. Feb. 2019. https://www.sciencedirect.com/science/article/abs/pii/S0167880918304559?via%3Dihub</p> <p>Penn State news release: Manure injection offers hope, challenge for restoring Chesapeake water quality. https://news.psu.edu/story/557850/2019/02/06/research/manure-injection-offers-hope-challenge-restoring-chesapeake-water</p>	
<p>12.</p>	<p>Greater understanding of invasive pests or new strategies to combat them: Multifaceted work to stop the spread of spotted lanternflies continues.</p>	<p>Issue: The spotted lanternfly (SLF), a native of Asia, has spread from Berks County, PA, to 25 other counties in Pennsylvania and has been found in New Jersey, Virginia, Maryland, and Delaware. The pest threatens Pennsylvania's grape, tree fruit, hardwood, and nursery industries, which collectively are worth about \$18 billion. The spotted lanternfly potentially could drain Pennsylvania's economy of at least \$324 million annually and cause the loss of about 2,800 jobs.</p> <p>In 2018 several vineyards reported large amounts of vine mortality and failure to set fruit, apparently due to the sheer amount of feeding and sap loss from dense populations of the pest.</p> <p>Penn State researchers and extension educators are taking an aggressive multipronged approach to stop SLF spread and control them where they're established.</p> <p>Target audience: Mid-Atlantic area grape, tree fruit, hardwood, and nursery owners, as well as growers of other crops, benefit from information gathered through this research and education campaign. Workers and customers of these farms, and processors of their products, benefit from</p>	<p>4 - Promoting Environmental Resilience</p>

		<p>stable markets. Homeowners, gardeners, and economies at all levels benefit from effective control strategies for SLF that are being developed for agricultural markets. This information can advance the effectiveness of synthetic and organic controls for this aggressive exotic pest by recommending the most effective products and timing of applications so that lesser amounts of less toxic chemicals can be applied to minimize nontarget effects on biological control agents and pollinators.</p> <p>What has been done: Entomologists are studying the how and why of spotted lanternfly flight so they can gain insight into where the infestation might spread.</p> <p>Entomologists from Penn State and Cornell University are testing whether naturally occurring soilborne fungi found nearly everywhere in North America can help control SLF. Early studies in 2018 in the Philadelphia region show some promise and will be more comprehensively tested on a larger scale in Berks County this season.</p> <p>A Penn State team has tested more than 50 commercial insecticides, both organic and conventional, to determine their effectiveness and residual effectiveness in controlling SLF on grapevines, peach trees, and ornamental trees. Information about the least toxic effective products is shared with the public, including fruit growers, tree care professionals, and homeowners.</p> <p>Extension educators are monitoring for the pest, teaching people how to identify the various life stages of SLF, and also how to control them using nonchemical means, such as sticky bands and removal of preferred host trees.</p> <p>Extension educators have developed an online training that Penn State employees traveling to and from the quarantine zone must take to reduce the possibility of spreading this pest. They also developed outreach materials to inform football-season visitors and others to University Park how they can help prevent the spread.</p> <p>Results: Studies show that the spotted lanternfly is not a strong or frequent flyer, which may hinder its ability to travel long distances by air. The researchers found that adult spotted lanternflies crawl to the top of the nearest vertical surface and launch themselves into the wind. On very hot days, rising air increases the insects' lift, sometimes carrying them more than eight times farther than on most days. SLFs' strong visual response to vertical silhouettes, coupled with their tendency to stay visible on these surfaces for a long time, may provide an effective way to document SLF populations and possibly to predict their next move.</p>	
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<p>13.</p>	<p>Improved strategy to address nutrient pollution in Chesapeake Bay: Penn State creates model nutrient management plan for bay drainage golf courses.</p>	<p>Issue: Lost Creek Golf Club, in Fayette Township, Juniata County, is unusual because a high quality, extremely productive wild trout stream runs through it. The 18-hole golf course opened in 1965 and was built on land that previously was farmed as pasture. The property is approximately 150 acres and is surrounded by farmland and some wooded areas. The stream floods on occasion, and during periods of peak flow some stream bank erosion occurs.</p> <p>Target audience: Golf course superintendents, owners, and workers will benefit from this work because golf course management can become more economically viable by optimizing fertilizer applications. Golfers may benefit from reduced need to raise course fees and a reduction of flooded or substandard course conditions. Downstream neighbors and local tourism, and therefore state and regional budgets, may benefit from improved water quality and associated wildlife and ecosystem services.</p> <p>What has been done: Penn State turfgrass scientists recently developed a nutrient management plan for the golf course to protect the creek. A golf course nutrient management plan helps superintendents keep track of the nutrient status of soils and turfgrasses and provides a strategy for meeting their nutrient requirements through proper application timing and amounts of fertilizer. Efforts are underway to stabilize stream banks in several locations on the course, and the course superintendent has been working with Penn State to achieve improved fertilizer efficiency and eliminate runoff of nitrogen and phosphorus into Lost Creek. The innovative project—believed to be the first comprehensive nutrient management plan created for a</p>	<p>4 - Promoting Environmental Resilience</p>

		<p>Pennsylvania golf course—was funded by the Chesapeake Bay Program and was part of the Juniata County Conservation District's restoration of the Lost Creek watershed.</p> <p>Results: This effort was unique because it included water monitoring and a stream bank restoration project on the course. State environmental officials hope that the private/public cooperative project will serve as a model for the 600 or so other Pennsylvania golf courses to follow in a wider effort to protect and enhance water quality by limiting the runoff of nutrients.</p> <p>External factors: N/A</p> <p>Other information: Penn State news release. Penn State creates model nutrient management plan for Bay drainage golf courses. https://news.psu.edu/story/548437/2018/11/19/impact/penn-state-creates-model-nutrient-management-plan-bay-drainage-golf</p> <p>Pennsylvania Turfgrass Council. Developing a Golf Course Nutrient Management Plan. https://theturfzone.com/podcast_association/pennsylvania-turfgrass-council-developing-a-golf-course-nutrient-management-plan/</p>	
<p>14.</p>	<p>Pathogenic bacteria that stubbornly lurk in some apple-packing facilities may be sheltered and protected by harmless bacteria known to form biofilms.</p>	<p>Issue: Multistate foodborne disease outbreaks and recalls of apples and apple products contaminated with <i>Listeria monocytogenes</i> demonstrate the need for improved pathogen control in the apple supply chain. Apple-processing facilities have been identified in the past as potential sources of persisting <i>L. monocytogenes</i> contamination. Penn State’s extensive food safety research and extension education efforts help processing facilities comply with standards set forth in the federal Food Safety Modernization Act.</p> <p>Target audience: Owners and workers of apple-processing facilities benefit from investigation into the causes of persistent populations of foodborne bacteria and mechanical and chemical ways to fight them and improve food safety. Other food-processing facilities may also benefit from application of the knowledge gained. Consumers benefit from fewer food recalls and foodborne illnesses. Local, state, and national economies benefit from savings of foodborne illness costs.</p> <p>What has been done: In three tree-fruit-packing facilities in the Northeast, scientists sought to understand the composition of microbiota in apple and other tree fruit processing built environments and its association with the occurrence of <i>L. monocytogenes</i>. The research was an effort to better understand the microbial ecology of food-processing facilities. The ultimate goal</p>	<p>5 - Supporting Integrated Health Solutions</p>

		<p>is to leverage this knowledge and identify ways to improve pathogen control in the apple supply chain to avoid foodborne disease outbreaks and apple recalls.</p> <p>Results: Testing revealed that a packing plant with a significantly higher <i>L. monocytogenes</i> occurrence was uniquely dominated by the bacterial family Pseudomonadaceae and the fungal family Dipodascaceae. Pathogenic bacteria that lurk in some apple-packing facilities may be protected by harmless bacteria from the family Pseudomonadaceae known to form biofilms. Biofilms are collections of microorganisms that attach to a surface and secrete slime that slows down the penetration of cleaners and sanitizers. Further research will explore the role of biofilm formation in <i>L. monocytogenes</i> persistence in food-processing plants despite reported efforts to kill and remove it.</p> <p>The discovery could lead to development of alternative foodborne-pathogen-control strategies. Some equipment in fruit-processing plants, such as brush conveyors, is difficult to clean and sanitize. The researchers will work with the apple industry to devise complementary cleaning and sanitizing strategies to achieve better reduction of <i>Listeria</i>. Other food processing facilities may face similar challenges with biofilms sheltering pathogens.</p> <p>External factors: There are limited funds to conduct agricultural safety and health training and to implement safety measures.</p> <p>Other information: The occurrence of <i>Listeria monocytogenes</i> is associated with built environment microbiota in three tree fruit processing facilities. <i>Microbiome Journal</i>. Aug. 2019. https://microbiomejournal.biomedcentral.com/articles/10.1186/s40168-019-0726-2</p> <p>Penn State news release: Foodborne pathogen sheltered by harmless bacteria that support biofilm formation. https://news.psu.edu/story/583970/2019/08/21/research/foodborne-pathogen-sheltered-harmless-bacteria-support-biofilm</p>	
<p>15.</p>	<p>Change in knowledge related to our understanding of a disease mechanism, diagnostic testing, prevention strategy, or treatment for a livestock and/or human disease: Food scientists demonstrated that whole</p>	<p>Issue: The USDA Economic Research Service estimates that all <i>Shigella</i> and <i>Salmonella</i> foodborne illnesses in the U.S. cost \$4.7 billion annually. <i>Shigella</i>, which causes severe diarrhea and stomach discomfort, is typically passed through the stool, often at public swimming areas. The quicker officials who run those facilities are alerted about a possible outbreak, the quicker they can take preventive action and issue warnings. <i>Salmonella</i> can be associated with contaminated retail meats. A new technique helps identify bacterial strains more quickly and accurately than the previous standard test.</p>	<p>5 - Supporting Integrated Health Solutions</p>

	<p>genome sequencing is faster and more accurate than the previous standard test in distinguishing among strains of common foodborne bacterial pathogens, potentially leading to reductions in illnesses and related costs.</p>	<p>Target audience: Owners and workers of food-processing facilities benefit from faster, more reliable ability to identify the particular strain of bacteria causing foodborne illness, thereby reducing the size and timeline of product recalls. Consumers benefit from smaller, more rapid food recalls and fewer foodborne illnesses. Local, state, and national economies benefit from savings of foodborne illness costs.</p> <p>What has been done: There are five different lineages of <i>Shigella sonnei</i>, and whole genome sequencing identified signatures in the genomes of these organisms that allow rapid segregation by lineage. This helps public health officials see how they can use whole genome technology for research. The technique might even be used to develop a new diagnostic tool.</p> <p>The research team also showed that whole genome analysis can distinguish between <i>Salmonella</i> isolates that appear identical using the previous standard test, pulsed-field gel electrophoresis (PFGE).</p> <p>Results: The Pennsylvania Department of Health had used PFGE and concluded that the <i>Salmonella</i> human and meat isolates were identical. But using whole genome sequencing allowed the research team to see that the isolates from people differed from isolates from contaminated retail meats. That allowed the scientists to determine that the people had not been sickened by meats contaminated with those particular strains.</p> <p>Because different strains of foodborne pathogens may require different treatments, identifying the correct strain quickly could give public health officials a critical head start on both informing the public about the outbreak and alerting medical staff of best treatment options. Whole genome sequencing technology may give epidemiologists and health care workers a powerful weapon in tracking and possibly controlling outbreaks of serious diseases.</p> <p>External factors: There are limited funds to conduct agricultural and food safety and health training and to implement safety measures.</p>	
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<p>16.</p>	<p>Change in knowledge related to our understanding of a disease mechanism, diagnostic testing, prevention strategy, or treatment for a livestock and/or human disease: New tuberculosis test paves way for cow vaccination programs.</p>	<p>Issue: Tuberculosis (TB) kills more people globally than any other infectious disease. Three people die every minute from the disease. Many people don't realize that cattle in many low- and middle-income countries are not only infected with and suffer horribly from TB, but also represent important reservoirs for transmission of the disease to humans through the consumption of unpasteurized milk or dairy products and cohabitation with infected animals.</p> <p>Target audience: This test was developed mainly for use in low- and middle-income countries where test-and-slaughter strategies are not affordable or feasible for socioeconomic or cultural reasons. This test will allow implementation of cattle vaccination programs, which will reduce the incidence of TB worldwide.</p> <p>What has been done: An international team of scientists, led at Penn State by Dr. Vivek Kapur, has created a skin test that can distinguish between cattle that are infected with TB and those that have been vaccinated against the disease. Kapur leveraged federal funds for salary with grant funding from the Bill & Melinda Gates Foundation and the Department for Environment, Food and Rural Affairs and Department for International Development in the United Kingdom.</p> <p>The traditional TB skin test shows a positive result for cows that have the disease, as well as those that have been vaccinated against the disease. By distinguishing between these two groups, the new test will facilitate the implementation of vaccination programs that could considerably reduce the transmission of this infectious bacterial disease from cattle to cattle and humans.</p>	<p>5 - Supporting Integrated Health Solutions</p>

		<p>The team created its test by targeting specific previously identified proteins that are missing from, or not secreted by, the widely used vaccine strain, called BCG. The ability to express these proteins was lost when the bacterium was adapted for use as a vaccine more than 100 years ago. By indicating the presence or absence of reactivity to these “missing” proteins, the new test can distinguish between an animal that is infected with the natural form of the disease and one that has been vaccinated.</p> <p>The inability to tell whether a cow has the disease or has simply been vaccinated has prevented governments from implementing cow vaccination programs, leaving both animals and humans vulnerable to infection.</p> <p>Instead of vaccinating cattle, many countries have used a “test and slaughter” approach to control TB in these animals. This method is highly successful in controlling the transmission of TB from cattle, but it is not feasible in most low- and middle-income countries, where small and marginal cattle owners cannot afford to lose what often represents their primary source of income and nutrition. Additionally, in some countries, such as India, the slaughter of cattle is illegal due to the animal's cultural and spiritual importance.</p> <p>Results: The team assessed the usefulness of its test in cattle in the U.K., Ethiopia, and India. It worked very well, exceeding the performance of the traditional test by clearly differentiating vaccinated from infected cattle.</p> <p>The novel diagnostic test could replace the current standard test that has been in use for close to a century. It is economical and easy to manufacture and to standardize quality control. Access to such a test paves the way for implementation of vaccination as an intervention strategy where test-and-slaughter strategies are not affordable for socioeconomic reasons.</p> <p>External factors: N/A</p> <p>Other information: A defined antigen skin test for the diagnosis of bovine tuberculosis. <i>Science Advances</i>. July 2019. https://advances.sciencemag.org/content/5/7/eaax4899.full</p> <p>Penn State news release: New tuberculosis tests pave way for cow vaccination programs. https://news.psu.edu/story/581002/2019/07/17/research/new-tuberculosis-tests-pave-way-cow-vaccination-programs</p>	
<p>17.</p>	<p>Study of occurrence, concentrations, and risks of pharmaceutical compounds</p>	<p>Issue: Over-the-counter and prescription medications are routinely present at detectable levels in surface and groundwater bodies. The presence of these emerging contaminants has raised both environmental and public health concerns, particularly when the water is used for drinking either</p>	<p>5 - Supporting Integrated Health Solutions</p>

<p>in private wells in Central Pennsylvania finds minimal human health impacts likely.</p>	<p>directly or with additional treatment. However, the frequency of occurrence, range of concentrations, and potential human health risks are not well understood, especially for groundwater supplies. Private wells are often not tested for contaminants regulated by drinking water standards and are even less frequently tested for emerging contaminants.</p> <p>Target audience: More than one million private water wells in Pennsylvania serve about 3.5 million people in rural areas. Approximately 20,000 new wells are drilled each year. Pharmaceuticals are emerging contaminants, and people with private drinking water systems benefit from knowing whether this is something they should be concerned about.</p> <p>What has been done: By partnering with the Pennsylvania Master Well Owner Network, water samples were collected from 26 households with private wells in the West Branch of the Susquehanna River basin in central Pennsylvania in winter 2017. All samples were analyzed for six pharmaceuticals (acetaminophen, ampicillin, naproxen, ofloxacin, sulfamethoxazole, and trimethoprim) and one over-the-counter stimulant (caffeine).</p> <p>Results: At least one compound was detected per groundwater sample at ng L^{-1} to $\mu\text{g L}^{-1}$ levels. On average, concentrations were higher in private wells than in nearby surface water. Concentrations were generally highest for the most frequently detected compounds. Concentrations were low enough that no adverse human health effects are expected. Ofloxacin and naproxen were the most and least frequently detected compounds, respectively.</p> <p>Concentrations from groundwater wells were higher than those of nearby surface water samples. However, risk calculations revealed that none of the concentrations measured in groundwater samples posed significant human health risk. A simple, physicochemical-based modeling approach was used to predict pharmaceutical transport from septic absorption field to groundwater and further elucidate variations in detection frequencies. Findings indicate that although septic tanks may act as contaminant sources for groundwater wells, the human health impacts from trace-level pharmaceuticals that may be present are likely minimal. Funding for this work came from Pennsylvania Sea Grant.</p> <p>External factors: N/A</p> <p>Other information: Occurrence, Concentrations, and Risks of Pharmaceutical Compounds in Private Wells in Central Pennsylvania. <i>Journal of Environmental Quality</i>. June 2019. https://dl.sciencesocieties.org/publications/jeq/abstracts/48/4/1057</p>	
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<p>18.</p>	<p>Change in knowledge related to our understanding of a disease mechanism, diagnostic testing, prevention strategy, or treatment for a livestock and/or human disease: Livestock disease risk is tied to herd management style in Tanzania.</p>	<p>Issue: About 330 million people worldwide rely on sheep and goats for their livelihood, so understanding how major livestock diseases spread is critical. Peste des petits ruminants virus (PPRV), also known as sheep and goat plague virus, has been reported in more than 70 countries in Asia, the Middle East, and Africa, threatening about 80 percent of the world’s population of sheep and goats. PPRV typically kills 50–80 percent of the sheep and goats it infects.</p> <p>Target audience: Owners of sheep and goats in affected areas will benefit from knowing how aspects of livestock management in a pastoral herd may drive increased risk of PPRV. This greater understanding could improve vaccine effectiveness and elevate the standard of living for subsistence farmers throughout the affected area.</p> <p>What has been done: Leveraging federal USDA salary funds with major funding from the Bill and Melinda Gates Foundation, an international team led at Penn State by Ottar Bjørnstad studied the prevalence of PPRV in northern Tanzania and explored factors that affect how the disease is transmitted. They compared infection rates in herds from pastoral villages, where people rely almost solely on livestock, and from agropastoral villages, where people rely on a mix of livestock and agriculture.</p> <p>Results: Herds from pastoral villages had 3.8 times the risk of becoming infected and developing detectable antibodies compared to those from agropastoral villages.</p> <p>The presence of cattle may affect infection risk, even though they are not typically considered important hosts for the virus. Cattle are often managed alongside sheep and goats and can become infected, although it is unclear if cattle can transmit the disease. Understanding whether cattle can transmit to sheep or goats ahead of the upcoming global eradication campaign is a top priority.</p> <p>Understanding prevalence and infection risk could improve researchers’ ability to predict how the disease will spread and to refine management techniques to minimize disease risk. The team next plans to investigate which aspects of the livestock management system within a pastoral herd may be driving this increased risk. For example, herd size, herd age structure, contact rates among livestock and wildlife, and access to veterinary services may all play a role in infection risk.</p> <p>PPRV is considered an attractive target for eradication due to its socioeconomic importance and the availability of a vaccine, which provides protection for sheep and goats from the disease for up to 3 years. The researchers hope their work will clarify the ecological mechanisms driving PPRV transmission, allowing us to improve vaccination accessibility for at-risk herds and optimize other prevention strategies.</p>	<p>5 - Supporting Integrated Health Solutions</p>
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<p>19.</p>	<p>Additional way to educate about farm safety: Evaluation research shows that social marketing campaigns can be useful for reducing farm injuries. This type of campaign in New York focused on rollover protective structures on farm tractors saved \$4.2 million from injuries averted from 2007 to 2017.</p>	<p>Issue: Tractor overturns are the leading cause of farm fatalities. Rollover protective structures (ROPS) prevent these deaths. This study updated a 2011 cost-effectiveness assessment of a New York State intervention to increase use of ROPS. The barriers to ROPS retrofitting are significant and include finding the right ROPS, availability of the ROPS, transport to a dealer for installation, and cost.</p> <p>Target audience: The total cost of the injuries averted from 2007 to 2017 was \$6 million versus a total program cost of \$1.8 million. The one-time retrofit costs will continue to prevent injuries as long as the tractors are used, generating additional (projected) future savings of \$12.1 million, \$15.8 million, and \$18.9 million if retrofitted tractors remain in operation 15, 20, or 25 years after their retrofit.</p> <p>Farmers and their families benefit physically, emotionally, and financially from fewer tractor rollover accidents. If farmers stay healthy and able to work, neighbors, municipalities, and downstream watersheds benefit from preservation of farmland, open space, and ecosystem services provided by the farms. Local, state, and national economies benefit from savings of rollover accident costs and the preservation of viable rural economies.</p> <p>What has been done: An existing social marketing campaign by the New York Center for Agricultural Medicine & Health identified at-risk segments of the farm community and their barriers to ROPS, designed incentives and relevant messages, and piloted elements of the campaign. The Penn State team evaluating the campaign subtracted</p>	<p>6 - Fostering a Positive Future for Youth, Families, & Communities</p>

		<p>intervention costs from the cost of injuries averted, then divided this figure by the number of averted injuries. To calculate the program’s cost-effectiveness, they used related probabilities and costs of fatalities and injuries from published literature.</p> <p>Results: The evaluation team concluded that social marketing was cost-effective for reducing injuries from tractor overturns.</p> <p>These results indicate that the intervention model (rebate program and social marketing campaign) is effective from both a public health and economic standpoint and should be expanded to other states.</p> <p>This study serves as a model for implementation research in public health. The team’s use of a longitudinal time line, cost-benefit analysis, and multiple interventions, among other elements, was critical in evaluating a complex public health intervention.</p> <p>External factors: There are limited funds to conduct agricultural safety training and to implement farm safety measures.</p> <p>Other information: Rollover Protective Structures, Worker Safety, and Cost-Effectiveness: New York, 2011–2017. <i>American Journal of Public Health</i>. Oct. 2018. https://ajph.aphapublications.org/doi/abs/10.2105/AJPH.2018.304644</p>	
<p>20.</p>	<p>New 4-H curriculum, Manure Management for Youth Projects, produces significant potential reductions in nutrients to waterways.</p>	<p>Issue: In Pennsylvania, everyone responsible for farm animals needs a manure management plan, including 4-H youth, because manure can have significant impacts on our local waterways. Farm animals are enclosed in pastures, barnyards, and barns. This leads to concentrated areas of manure. Even when just a few animals, or a single animal, are being raised for a couple months before summer fair season, manure can build up quickly.</p> <p>Manure can leach into groundwater and run downhill in the rain and melting snow, ending up in creeks and ponds. Manure can carry pathogens, like bacteria, into our drinking water and favorite fishing holes. It also adds nutrients to the water, which can cause algae to bloom. A thick coat of algae on the water looks bad and depletes oxygen</p>	<p>6 - Fostering a Positive Future for Youth, Families, & Communities</p>

		<p>dissolved in the water, which is critical for fish and other aquatic life. High nitrates in drinking water is also a health risk.</p> <p>Target audience: This new 4-H curriculum targets 4-H, FFA, and ag-ed classroom livestock raisers. Participants benefit by learning why it’s important to ecosystem and human health to manage manure in farm areas, and how to write and implement a plan to do so. People with small farms and hobby farms may also benefit from the curriculum. Pennsylvanians and downstream residents benefit by improved ecosystem services from cleaner waterways.</p> <p>What has been done: Penn State Extension created this new resource to help fill the gap on manure management planning for a small number of livestock. With support from the PA Department of Environmental Protection and contributions from the Lancaster County Conservation District and Manheim Central ag-ed program, Manure Management Planning for Youth Animal Projects is full of hands-on activities, career exploration, and more. It includes chapters on manure composition, soil types, how plants use manure, manure impacts on water, mapping for planning, and the basics of a PA Manure Management Plan.</p> <p>151 facilitators and 504 youth participated in trainings and workshops using the new curriculum.</p> <p>Results: 79% (n=383) of 4-H youth participating in a workshop indicated that they intend to write or improve their manure management plan as a result of participation.</p> <p>20% (n=20) of youth responding to a 6-month follow-up survey indicated they had already written a new manure management plan or made improvements to their existing plan since their participation in the workshop. An additional 55% took an action to reduce the impact of their manure on the environment (identified environmentally sensitive areas, moved their manure stack, or created a farm map).</p> <p>Those youth already taking action represent about 430 acres of land in Pennsylvania. Proper manure management planning in their barnyards/heavy use areas represents a potential reduction of 244,038 lbs/year of nitrogen and 18,585 lbs/year of phosphorus being delivered to local waters. The total cost savings of that proper manure management could range from \$1.4 million to \$21.5 million. This work moves Pennsylvania in the right direction in relation to required reductions in nutrients to help safeguard Chesapeake Bay.</p> <p>93% (n=383) of youth indicated that they would or probably would share with others what they learned at the workshop.</p> <p>85% (n=20) of youth responding to a 6-month follow-up survey indicated they had already shared what they learned.</p>	
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		<p>Completing this curriculum gives youth a solid understanding of nutrient management issues in Pennsylvania, and the knowledge and tools to be part of the solution.</p> <p>External factors: It can be difficult to find financial support for programs. Expectations for educators and office managers are outpacing county-level funding.</p> <p>Other information: Manure Management Planning for Youth Animal Projects. Penn State Extension. https://extension.psu.edu/manure-management-for-youth-projects</p>	
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