

2013 Pennsylvania State University Combined Research and Extension Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

Penn State's Agricultural Experiment Station (AES) and Cooperative Extension Service (CES) operate in concert within the College of Agricultural Sciences to address present and future needs in agriculture at local, state, national, and international scales.

The College has been very proactive in its planning. Recognizing the need for organizational change, the College began a process several years ago designed to develop and implement a new business model and address budget strategies. The initiative--called AG Futures--identified opportunities for strategic growth and resulted in an aggressive College strategy.

As a result, the College has taken bold measures to reduce costs, increase operational efficiencies, and maintain the highest possible level of services to our students and stakeholders. Specifically, to date, the following has been accomplished:

- Consolidating the College's graduate/undergraduate degree programs under nine (from 12) new academic departments (See footnote 1). The new departments were officially launched on July 1, 2012, and reorganization efforts continue.
- Shifting to a district model to provide administrative services to Penn State Extension county offices to improve operational efficiency, eliminate duplication, and maximize productivity. The new district model continued to be operational in 2013 and district directors are working collaboratively with their respective counties to develop a new district business model.
- Shifting from a geographically based extension program model to a program-team approach structured around areas of excellence, expertise, and agricultural sectors. New extension program leaders are in place and are working with their program teams and stakeholders to provide access to relevant and high quality programming across the state.
- Basing program priorities on core mission areas of the College and identifying areas for disinvestment, including family financial management, emergency preparedness, elder care staff development, grant writing, tourism, workforce training in prisons, and adult leadership. Extension has shifted resources and leveraged cost-sharing dollars from counties to add positions in Pennsylvania priority areas, including ag entrepreneurship, dairy, poultry, food safety/quality, field and forage crops, vegetable production, and mushrooms.
- Evaluating all cost-saving options in programs, farms/facilities, extension, administration, and academic units. The College has cut more than \$19 million out of its permanent budget over the last six years and continues to look at implementing new technologies to increase effectiveness and efficiency and at shifting to private market solutions where outsourcing is appropriate.
- Partnering with Pa. Department of Agriculture on three resource centers to engage Pennsylvania stakeholders around priority topics to include food safety, plant protection, and animal care. The centers will better connect regulatory development and compliance with research, education, and solutions; serve as educators and information consolidators; better leverage the resources of each organization; and provide a focus for programs and stakeholders while serving as umbrellas to address a broad spectrum of issues and connections between respective staff and stakeholders.

We are confident that these new initiatives will result in increased focus on College-wide thematic research areas, key opportunities to innovate, intra-college connections, university partnership opportunities, academic programs, and extension alliances.

In light of the restructuring, our College continues to operate on the basis of shared decision-making regarding investment of AES and CES resources.

The college is in the midst of updating its strategic plan. The last plan (<http://agsci.psu.edu/about/strategic/CAS-2008-2013-Strategic-Plan.pdf/view>) was developed in 2008. The new plan, which will be finalized by July 1, 2014, is incorporating broad internal and external stakeholder feedback. Because the plan is still in flux, the college leadership has decided to wait until next year to incorporate its revisions into the Combined Research and Extension Plan of Work for 2016. At that time, we will present a reorganization of planned programs to reflect the following seven strategic themes:

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

Biologically Based Materials and Products- Discovering novel approaches to using genetic systems and biological materials for value-added commercial and consumer products.

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

Environmental Stewardship and Resilience- Providing innovative research and extension programming to enhance and protect managed and natural ecosystems, ecosystem services, and human well-being.

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

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

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

Likewise, we have identified topics that will be embedded or integrated across all of the themes identified above: Sustainability, Climate change, Human dimensions, Entrepreneurship, and Diversity.

The College of Agricultural Sciences is addressing complex societal issues that transcend disciplines to impact people on scales ranging from local to global. The finalized cross-cutting themes will utilize the interdisciplinary expertise of our faculty, extension educators, and staff in all mission areas within the college to generate and disseminate knowledge that can be translated into solutions for these critical issues. Faculty focus groups were created to address a specific set of questions that will strategically direct team-based activities within the college.

Research and extension are integrated largely through joint appointments in the College of Agricultural Sciences. Of 607 administrators, faculty and staff at University Park, 211 have a combination of research and extension funds supporting their positions. Within PA CES we continue to work with the 13 statewide extension teams (SETs) that serve to unite faculty and county-based educators in a common goal of generating new knowledge; offering high quality, focused extension education programs on stakeholder-identified subjects; and identifying and addressing science gaps on the basis of feedback from these educational programs. We connect in research with resources across campus through the Penn State Institute system (Life Sciences, Materials, Social Science, Environment and Energy, Sustainability, Rock Ethics), and the CES SETs provide a mechanism to connect with and leverage research expertise outside the AES purview from across campus.

Our programs continue to focus on high profile problems that, in addition to their impact in Pennsylvania, frequently represent regional and national priorities. Our work on nutrient management in the Chesapeake Bay is a regional issue of great interest to the U.S. government, and this work is quite possibly setting benchmarks by which other U.S. watersheds will be approached. Our continued efforts in Marcellus shale natural gas, now much more focused on environmental and community problems related to extraction, demonstrate how we are addressing issues in energy and the environment. For example, Extension education programs increased lease payments by a conservative \$250 million for Pennsylvania landowners. We are building predictive models that allow more targeted pest management, examining how best to preserve pollinators in support of the food supply, and studying the impact of invasive species on Pennsylvania and U.S. agriculture. PA AES and CES must be responsive to new societal needs, investing our federal funds in a manner that furthers national agricultural goals but also addressing the local implications of those national priorities.

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

¹Old units: Food Science, Agricultural and Biological Engineering, Dairy and Animal Science, Poultry Science, Veterinary and Biomedical Sciences, Agricultural Economics and Rural Sociology, Agricultural Extension Education, Plant Pathology, Entomology, Horticulture, School of Forest Resources, Crop and Soil Sciences.

New units: Food Science, Agricultural and Biological Engineering, Animal Science, Veterinary and Biomedical Sciences, Agricultural Economics, Sociology, and Education, Plant Pathology and Environmental Microbiology, Entomology, Plant Science, Ecosystem Science and Management

A few explanatory notes are necessary regarding the report that follows. First, PA CES captures data on contacts (direct and indirect) and participants. We consider participants to be the number of individuals who attend the educational programs that we offer. Our contact numbers are derived from the number of people each of our extension educators and/or faculty have contacted. Direct contact numbers are only those from face-to-face meetings; indirect contacts are through e-mail, telephone conversations, Adobe Connect sessions, etc.

In the planned program descriptions, we highlight specific projects with notable results. Many more projects are underway that are not specifically mentioned in the state-defined outcomes.

Publication numbers have historically been gleaned from the USDA Accomplishment Reports as submitted to the Current Research Information System (CRIS). With the implementation of REEport, the information submitted cannot be exported for data manipulation. The numbers reported in the Publications section include only the extension publications reported by the SETs. The college will explore possible avenues to secure this information without redundancy of efforts.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	418.8	0.0	623.3	0.0
Actual	337.9	0.0	552.8	0.0

II. Merit Review Process

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

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

2. Brief Explanation

Both Cooperative Extension and Agricultural Experiment Station programs undergo very thorough and comprehensive review processes.

As discussed in the "Stakeholder Input Process" section, all extension state planning efforts are thoroughly grounded in the needs identified during our statewide needs assessment process. After the needs assessment and program identification process was completed, each of the identified programmatic issues was assigned to one of eleven integrated, multidisciplinary State Extension Teams (SETs) made up of field-based extension educators and faculty with split appointments in both extension and research efforts. Team members from the field were chosen to broadly represent all parts of the Commonwealth and faculty members were chosen to represent the research and extension perspectives of all relevant disciplines. Extension Program Leaders (EPLs) provide overall leadership to the SETs with district and state administrators and academic unit leaders serving in liaison roles to each team. All of the programs have been reviewed by research and/or extension administrators. Additionally, logic models were developed by each SET to guide the programming efforts of field-based educators and faculty members with extension appointments, and they contribute to applied research priorities.

Pennsylvania Agricultural Experiment Station projects, which partially comprise our planned programs, are reviewed by qualified and knowledgeable scientists. Non-multistate projects are reviewed internally, while multistate projects are reviewed by external reviewers.

As new Penn State extension programmatic issues or agricultural experiment station projects are implemented, stakeholder groups and/or program advisory groups will provide ongoing review of the educational and research programs to ensure that programs are focusing on priority needs as identified by key advisory groups in the college. All reviewers' critiques and comments provide us with mechanisms for enriching and improving our educational and research programs. Ag Council, Penn State Extension Council, and SET Advisory committees serve in an advisory capacity for extension teams.

Through the evaluation process that is part of the logic model, feedback from stakeholders provides areas that applied research needs to address. In addition, after resources have been identified to direct extension program areas where limited knowledge occurs, fundamental and applied research are identified to be carried out during the period of the program. Fundamental research is largely driven by availability of extramural funding sources and the peer review process associated with that funding.

III. Stakeholder Input

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

- Use of media to announce public meetings and listening sessions
- Targeted invitation to traditional stakeholder groups
- Targeted invitation to non-traditional stakeholder groups
- Targeted invitation to traditional stakeholder individuals
- Targeted invitation to non-traditional stakeholder individuals
- Targeted invitation to selected individuals from general public

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

Brief explanation.

Stakeholder input is actively sought to help set the course for CES and AES programs. Our primary stakeholder input is received through extension. CE engages in periodic statewide needs assessments, and the results of these assessments were incorporated into our Extension Program SharePoint site and our Extension Program Activity System (EPAS). These tools, which are built on components of the logic model, are used to prepare the annual extension programs. Thus, stakeholder input is a key attribute of extension programming. This, in turn, provides input into our research agenda, especially through faculty who are jointly appointed on extension and research funding. In addition, extension county-based personnel confer with their program advisory groups as they determine the local focus of their educational programs. College administration and faculty advisory groups confer regularly with key stakeholder groups. The Penn State Agricultural Council (<http://agcouncil.cas.psu.edu>) provides us with direct contact to nearly 100 member organizations and groups representing the agricultural industry across Pennsylvania. Also part of the Ag Council membership are such organizations as the Chesapeake Bay Foundation and the County Commissioners Association of Pennsylvania--we seek input for all sectors representing the interests of Pennsylvania citizens. In addition, we meet multiple times per year with stakeholder groups including, but not limited to, the Pennsylvania Farm Bureau, PennAg Industries, State Horticultural Association of Pennsylvania, Pennsylvania Agronomic Education Society, Pennsylvania Association for Sustainable Agriculture, Penn State Extension Council, the Pennsylvania Christmas Tree Growers Association, and the Pennsylvania Floral Industry Association. Through direct faculty and extension educator contacts, we have regular contact with the private sector to assess their specific needs. For example the following groups provide valuable feedback--Pennsylvania Nutrition Education Network, the Intergenerational Initiatives Advisory Group, the StrongWomen program leaders, the PROSPER program collaborators, and the PA Office of Financial Education. Penn State has a well-developed organizational structure for interacting with industry; our Industrial Research Office serves as a liaison to specific industrial partners. Also in our stakeholder base are state and federal partners; we have regularly scheduled meetings with agencies such as the Pennsylvania Department of Agriculture, the Pennsylvania Department of Environmental Protection, the Pennsylvania Department of Health, and the US Department of Agriculture's Agricultural Research Service and Animal and Plant Health Inspection Service. These stakeholder meetings provide feedback on programming for Hatch, McIntire-Stennis, Smith Lever, and Animal Health funds.

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

1. Method to identify individuals and groups

- Use Advisory Committees
- Use Internal Focus Groups
- Use External Focus Groups
- Open Listening Sessions
- Needs Assessments
- Use Surveys

Brief explanation.

County, district, and SET program advisory committees continue their role in providing valuable information on extension programming needs. Program advisory committee members are selected to represent program areas, emerging issues, geographic areas, and population diversity. These groups help extension educators with program design and implementation, which may include identifying resources to support the programs, tailoring the content to specific audience needs, and marketing the programs to targeted audiences and communities.

In the establishment of program advisory committees, our policy is that these committees need to represent the demographics of the commodity, community, or workforce. District and county extension boards and program advisory committees are representative of demographics of the county/district, and where appropriate, Hispanics, African Americans, Asians or other minorities, such as Anabaptists, serve on these groups and provide input to extension programs. Annual reports from counties/districts document these efforts. The same is true in the establishment of internal and external focus groups. Penn State Agricultural Council meetings are publicly announced and our broad representation is constantly reassessed to ensure that new and traditionally underserved audiences are included.

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

1. Methods for collecting Stakeholder Input

- Meeting with traditional Stakeholder groups
- Survey of traditional Stakeholder groups
- Meeting with traditional Stakeholder individuals
- Survey of traditional Stakeholder individuals
- Meeting with the general public (open meeting advertised to all)
- Survey of the general public
- Meeting specifically with non-traditional groups
- Survey specifically with non-traditional groups
- Meeting specifically with non-traditional individuals
- Survey specifically with non-traditional individuals
- Meeting with invited selected individuals from the general public
- Survey of selected individuals from the general public
- Other (Focus Groups)

Brief explanation.

To collect stakeholder input, educators or faculty met with program advisory committees or individuals or solicited input at educational meetings. During and after extension educational programs, program participants request additional programs, updates, or make suggestions on new topics where an educational program would be helpful to them.

This input may be verbal only or collected in meeting survey instruments. To collect more detailed information from traditional and non-traditional stakeholders, sophisticated survey instruments or focus group meetings are implemented and the data collected are summarized. The requests for information from county extension offices through telephone calls is also a measure regarding needs of clientele. If similar information is requested repeatedly, that is a sign that an issue is of concern to the public.

3. A statement of how the input will be considered

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

Brief explanation.

Information collected from stakeholders was used to adjust issue areas that determined extension programming. These stakeholder priorities also directly influenced applied research activity through local decisions about research priorities, availability of funding from certain extramural funding sources, including stakeholder groups such as industry associations, and hiring decisions for faculty and extension educators. Stakeholder input not only informs planning, but also influences resource allocations. Stakeholder feedback also indicates where volunteers and donors would be interested in assisting with the program.

As part of the implementation plan for our current strategic plan, we have engaged representatives of the Penn State Agricultural Council as key team members on our internal implementation teams. This serves to inform our programs on the real-world demands for new information and programs.

Both Ag Council and Penn State Extension Council serve in an advisory capacity to the SETs structure implemented in CES; advisory committees for SETs will seek membership from a large stakeholder base. Commodity groups within Pennsylvania provide research directions based on grower inputs to faculty and educators. Such directions come in the form of grower surveys, research project support, and direct communication through commodity research boards.

Brief Explanation of what you learned from your Stakeholders

Stakeholders provide a grassroots view of what is important. Marcellus shale public meetings continue to have high attendance; many meetings extended to other issues related to this emerging issue, such as water resources and forest management. Stakeholders statewide are concerned about water quality and quantity and the long range effect the natural gas drilling will have on PA natural resources. Extension aided many county governments to form county Marcellus task forces; these efforts were through extension work at the state organization of County Commissioner's Association of Pennsylvania (CCAP).

Our most popular programs continue to be in 4-H youth development and horticulture and green industry; both programs engage volunteers in their delivery, therefore allowing larger participant numbers. Other programs with high participation are agronomic production, agricultural profitability, animal production, strengthening and supporting families, and diet nutrition and health. Programs that are growing are related to renewable resources, agricultural profitability and diet, nutrition and health. Stakeholders in agricultural programs continued to be focused on the safe production of food and profitability of such enterprises. New Good Agricultural Practices (GAP) regulations in edible horticulture production are key for producers' profitability. Diet, nutrition, and health programs are focused on childhood obesity, diabetes, and older women's health, all key public health issues. Extension continues to strategically work with diverse audiences in many programs. Minorities serve on extension boards and advisory committees and are key to helping market extension programs in their communities.

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
9534819	0	6961877	0

2. Totaled Actual dollars from Planned Programs Inputs				
Extension			Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	8486176	0	5686864	0
Actual Matching	19221279	0	27588301	0
Actual All Other	17984194	0	41942629	0
Total Actual Expended	45691649	0	75217794	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	2889803	0	3447807	0

V. Planned Program Table of Content

S. No.	PROGRAM NAME
1	Childhood Obesity, Chronic Health Issues, and Healthy Lifestyles
2	Climate Change
3	Food Safety
4	Global Food Security and Hunger
5	Sustainable Energy
6	Economic and Community Development
7	Environmental Management
8	Food and Fiber Systems

V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Childhood Obesity, Chronic Health Issues, and Healthy Lifestyles

Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
311	Animal Diseases	10%		0%	
501	New and Improved Food Processing Technologies	5%		10%	
602	Business Management, Finance, and Taxation	10%		0%	
607	Consumer Economics	5%		8%	
701	Nutrient Composition of Food	5%		2%	
702	Requirements and Function of Nutrients and Other Food Components	5%		20%	
703	Nutrition Education and Behavior	5%		10%	
721	Insects and Other Pests Affecting Humans	5%		10%	
722	Zoonotic Diseases and Parasites Affecting Humans	10%		0%	
723	Hazards to Human Health and Safety	10%		25%	
724	Healthy Lifestyle	10%		0%	
802	Human Development and Family Well-Being	10%		15%	
805	Community Institutions, Health, and Social Services	10%		0%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	184.6	0.0	52.4	0.0
Actual Paid Professional	110.8	0.0	32.0	0.0
Actual Volunteer	28.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
768967	0	97927	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
1850031	0	2366501	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
5530313	0	5356002	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Food and lifestyle choices are often inextricably linked to health issues that are costing our nation in terms of dollars, productivity, and quality of life. Research and extension programs that focus on these complex, interrelated issues are ongoing activities in this planned program area.

The problem of obesity, with its links to other health problems such as diabetes and early onset heart disease, must be addressed through a combination of approaches. An understanding of the underlying biological and sociological bases of health-related problems is needed to promote activities that lead to healthier lifestyles. Families are a crucial link in teaching healthy behaviors. It is important that those behaviors involve good nutrition and physical activity as the cornerstone of preventing obesity in children and adolescents.

Community health spans a broad range of issues with public health implications. The value-added aspects of commodities and availability of foods with improved nutritional values are important to the Pennsylvania agricultural industry and stakeholders. Pest control, especially of those pests that carry disease, and improper pesticide application can have public health risks. We continue to provide education to the general public and governmental agencies to reduce the risk of these pests and treatments.

Extension programs use innovative interdisciplinary approaches to discover, translate, and apply how nutrition and physical activity can prevent disease and promote good health and well-being. Programs use the socio-ecological model as a framework to address multiple factors that influence an individual's ability to change. Youth organizations, such as 4-H, offer programs that help young people increase their knowledge and offer opportunities to improve healthy eating and physical activity habits. Extension activities also focus on diverse programs that affect rural health and farm safety.

2. Brief description of the target audience

- Nonprofit Associations/Organizations
- Community Groups
- Education
- General Public
- Government Personnel
- Human Service Providers
- Military
- Special Populations (at-risk and underserved audiences)
- Students/Youth
- Volunteers/Extension Leaders

3. How was eXtension used?

Penn State is the lead institution for the Farm & Ranch in eXtension for Safety and Health (FReSH) Community of Practice (CoP). We have expanded the CoP to over 90 members who are actively involved in developing and reviewing content for the site. The FReSH site is the official ag safety and health website for the Agricultural Safety and Health Council of America (ASHCA), which is linked to industry. eXtension is used for information dissemination, webinars (Learn), mobile app promotion, and online courses (Moodle). Grant funding was obtained this fiscal year that will continue to enhance and expand the FReSH CoP.

Because the PROSPER team is working within state, they did not engage in eXtension as a group. However, the project PI attended and contributed to the eXtension CYFAR group by actively participating in the discussion about evidence-based programs and practices. Specifically, PROSPER was described in detail as an example of an evidence-based program.

eXtension's Extension Alliance for Better Child Care is cross-referenced on our website as a means of providing additional resources for early learning and school-age practitioners. Some educators on the team serve in the "ask the expert" role for eXtension.

One program used eXtension as an informational resource for content.

One program did not use eXtension this past year, but intends to use it in FY 2014.

V(E). Planned Program (Outputs)

1. Standard output measures

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

Patent Applications Submitted

Year: 2013
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	34	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of college-initiated technology disclosures.

Year	Actual
2013	2

Output #2

Output Measure

- Number of participants in extension education classes and workshops.

Year	Actual
2013	103522

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Percentage of extension class/workshop participants who expect to implement/adopt practices. (This is a short-term outcome measure.)
2	Percentage of extension class/workshop participants who respond to a follow-up survey with a self-report that they have implemented/adopted practices. (This is a medium-term outcome measure.)
3	Potential cost savings (in \$) to society from avoiding 5-10% of fatal farm accidents in PA by use of new Spanish-language farm safety materials.
4	Refinement of biobased pesticide effective against bed bugs.
5	Patent received for technique that boosts vitamin D in mushrooms using intense ultraviolet light flashes.
6	Number of tires collected for proper disposal, thereby reducing mosquito breeding habitat.

Outcome #1

1. Outcome Measures

Percentage of extension class/workshop participants who expect to implement/adopt practices. (This is a short-term outcome measure.)

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Percentage of extension class/workshop participants who respond to a follow-up survey with a self-report that they have implemented/adopted practices. (This is a medium-term outcome measure.)

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Potential cost savings (in \$) to society from avoiding 5-10% of fatal farm accidents in PA by use of new Spanish-language farm safety materials.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	2600000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Although agricultural safety and health training material and general information about getting started in various farm operations does exist, it is primarily available only in English. This is not very useful to Spanish-speakers, who represent a large portion of the nation's agricultural workforce.

What has been done

A Penn State program translated existing farm safety curricula into Spanish and included culturally appropriate examples and illustrations, an instructor manual, and video clips in Spanish -- all available on hand-held electronic devices. The materials are online and available to instructors and extension agents across the country.

Results

Offering more extension information in Spanish helps to meet the changing demographics of the country and agriculture. Participants indicate that the sessions improve their work performance and on-the-job safety.

The National Safety Council estimates the costs of fatal work injuries per worker. Data from 2009 show that in that year fatal injury cost was \$1.3 million per worker. In 2012 Pennsylvania had 28 fatal farm and agricultural incidents. Therefore, we can estimate that fatal agricultural incidents in Pennsylvania in 2012 posed at least an estimated \$37 million burden on society. If we assume that use of these new materials could have prevented just 5-10% of the fatal incidents (say, 2 incidents), that's a cost savings to society of at least \$2.6 million.

4. Associated Knowledge Areas

KA Code	Knowledge Area
602	Business Management, Finance, and Taxation
723	Hazards to Human Health and Safety

Outcome #4

1. Outcome Measures

Refinement of biobased pesticide effective against bed bugs.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The U.S. has recently seen a resurgence in bed bugs that may be linked to increased resistance to pesticides, more widespread travel, and the continuing reduction or elimination of pest control programs at public health agencies. Bed bugs seem not to transmit disease, but they are a significant and costly public health issue.

A 2006 Australian study estimated that bedbugs cost the Australian tourism industry \$75 million annually. The cost of treating one hotel room is estimated at \$6,000-7,000.

What has been done

Beginning with USDA appropriated support, Penn State researchers developed a biopesticide that exploits bed bugs' behavior of gathering in harborages. Studies show that the team's novel formulations of a fungal isolate (*Beauveria bassiana*) can be applied as a long-lasting barrier

treatment. Bed bugs crossing the barrier acquire fungal spores and spread them among insects in the harborages, resulting in debilitating morbidity within 2 days and more than 95 percent mortality within a week.

Results

The research team has filed patent applications for the technology, which has garnered strong interest from the hotel industry. They have also secured a Penn State technology commercialization grant, which will support efforts to collect additional data needed to secure U.S. Environmental Protection Agency registration of the product for in-home use.

Use of a naturally occurring biopesticide addresses concerns about the safety of traditional chemicals in the home. The biopesticide is relatively easy to produce in the lab and is stable, so it can be used much like chemical pesticides. Indirect exposure of bedbugs that remain in harborages cannot be achieved with traditional chemicals.

4. Associated Knowledge Areas

KA Code	Knowledge Area
721	Insects and Other Pests Affecting Humans

Outcome #5

1. Outcome Measures

Patent received for technique that boosts vitamin D in mushrooms using intense ultraviolet light flashes.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Vitamin D has health benefits for bone health and regulating the immune system. It also improves the mobility of vitamin D-deficient elderly people who may be more at risk of falling. The human body naturally uses ultraviolet light from the sun to convert cholesterol in the skin into most of the vitamin D it needs. However, as more people work inside and use sunblock outside, they receive less sunlight and have more chance to be vitamin D-deficient.

What has been done

Penn State researchers focused an ultraviolet light that flashes high energy light waves several times a second onto the surface of mushrooms. A patent has been awarded for the method. The treatment converts ergosterol into vitamin D₂, raising the level in a serving of mushrooms from

nearly 0 to more than 100% of the recommended dietary allowance. This method more efficiently boosts vitamin D than the previous method because it takes only a few seconds to significantly increase levels.

Results

Because this method is more efficient than previous treatments, and because it offers another selling point for mushrooms, profitability of the mushroom industry is increased.

Mushroom shipments set record levels in 2012, and they were up another 6% in early 2013. U.S. mushroom sales totaled 900 million pounds for the 2011-12 crop, at a value of \$1.10 billion.

This research applies technology to turn mushrooms into an even healthier food. Mushrooms are low in calories and considered a good source of vegetable proteins, potassium, fiber, and essential minerals, such as selenium. They are also the best dietary source of ergothioneine, an antioxidant that some researchers think is a potential new vitamin.

The high energy ultraviolet light wave treatment does not negatively affect the appearance or taste of the mushrooms, as previous treatments have. The vitamin D remains in the mushrooms even after a week in storage.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies

Outcome #6

1. Outcome Measures

Number of tires collected for proper disposal, thereby reducing mosquito breeding habitat.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	20139

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

West Nile encephalitis had never been documented in the Western Hemisphere before late summer 1999, when an outbreak occurred in the New York City area. In 1999, the Centers for Disease Control and Prevention confirmed 62 human cases of this encephalitis, including 7 deaths, although the actual infection rate was much higher. The best ways to fight this disease are to reduce the population of mosquitoes that carries it and to educate people about reducing

their risk of being bitten.

What has been done

Penn State Extension performs mosquito surveillance following IPM and provides education by way of press releases, educational programs, displays, and phone and email contacts. Individuals create programs and carry out activities dependent upon additional local needs and funding.

In an effort to have residents reduce mosquito breeding habitat, Lebanon and York County programs coordinate tire collections. In 2013, they had 535 participants properly dispose of more than 20,000 tires.

Results

West Nile virus continues to affect human and animal health in Pennsylvania. Protecting the general public and agriculture from public health concerns such as vectored diseases and other pests is essential to maintaining stable social and economic systems that our communities depend on. Educating the general public is the best way to reduce health care costs.

Four percent of West Nile virus cases in the U.S. are fatal, according to the Centers for Disease Control and Prevention. The disease can also have major economic consequences, with the 2012 outbreak in Texas causing an estimated \$47 million in losses, largely due to lost workdays.

4. Associated Knowledge Areas

KA Code	Knowledge Area
311	Animal Diseases
722	Zoonotic Diseases and Parasites Affecting Humans
805	Community Institutions, Health, and Social Services

V(H). Planned Program (External Factors)

- Appropriations changes
- Competing Public priorities
- Competing Programmatic Challenges
- Other (Extramural Funding)

Brief Explanation

Natural Disasters (drought, weather extremes, etc.)

- Circumstances resulting from natural disasters require more of our time to serve a limited amount of people.

Economy

- The down economy increases the demand for programs due to increased pest problems (i.e., abandoned properties from bank foreclosures).
- Most counties are providing some sort of financial scholarships, reduced fees for returning participants, and alternative payment models, such as installments.
- More participants are asking if insurance plans subsidize the program (a few do).
- Funding is limited to conduct agricultural safety and health trainings and for people (e.g., EMS, volunteer fire fighters, etc.) to participate in training.

Appropriations changes

- Appropriation Changes affected both the research and extension functions of the College of Agricultural Sciences and resulted in fewer faculty and staff across all areas of the college.

Public Policy changes

- Public Policy Changes require us to continually meet the public health need related to vectored diseases.

Government Regulations

- Government Regulations are counterintuitive to following IPM. An NPDES permit is now needed for mosquito control.

Competing Public priorities

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

Competing Programmatic Challenges

- The College of Agricultural Sciences' restructuring process allowed for continued focus on cost-effective program deliverables and strategic elimination of programs.

Populations changes (immigration, new cultural groupings, etc.)

- Population Changes continue to create new pest concerns, from bed bugs to dengue fever.

Other - Extramural Funding

- Programs in this area rely heavily on extramural funding for program development and delivery, curriculum, etc. However, funding opportunities are highly competitive.
- Funding for many of our community partners was reduced or eliminated, making it challenging in some counties to reach our target audiences.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The generation of outcomes from existing programs and the development of new programs require improved evaluation that identifies pre- and post- responses to information and monitoring for long-term behavioral changes that result in improved environmental outcomes. The evaluations conducted thus far provide initial measures of implementation, but long-term monitoring is needed to ensure that the practices are successfully managed over time. We are attempting to incorporate more economic valuations of the results of our research and extension work.

Key Items of Evaluation

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

V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Climate Change

Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
101	Appraisal of Soil Resources	10%		5%	
102	Soil, Plant, Water, Nutrient Relationships	10%		5%	
103	Management of Saline and Sodic Soils and Salinity	5%		0%	
111	Conservation and Efficient Use of Water	10%		5%	
123	Management and Sustainability of Forest Resources	5%		5%	
132	Weather and Climate	10%		3%	
133	Pollution Prevention and Mitigation	6%		20%	
141	Air Resource Protection and Management	5%		5%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	6%		11%	
206	Basic Plant Biology	5%		5%	
306	Environmental Stress in Animals	6%		10%	
603	Market Economics	7%		5%	
605	Natural Resource and Environmental Economics	7%		5%	
608	Community Resource Planning and Development	8%		16%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	5.1	0.0	18.7	0.0
Actual Paid Professional	8.9	0.0	25.9	0.0
Actual Volunteer	9.6	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
370068	0	599068	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
820825	0	1737415	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
517885	0	1553868	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Programs will address the full breath of climate change sciences spanning physical, biological, and social uncertainties, risks, and responses--those that are underway as well as those on the frontier. Robust research and extension will foster interdisciplinary, multifunctional teams and approaches that will link multiple institutions and span, connect, and garner resources that can measure, forecast, and specify the complexities of climate change in context to priority sectors, including water quality and quantity, air quality (greenhouse gas emissions, carbon sequestration in working lands), risk assessment, and decision-making, as well as the emerging paradigms for sustainable agriculture and forestry.

Research and extension will support carbon sequestration, mitigation of greenhouse gases, and development of science-informed policies for supporting management of multifunctional working lands with enhancement of the ecosystem services they can provide. Furthermore, the stresses of change on biodiversity from the molecular through population levels will be critically addressed within this approach. Interdisciplinary, multifunctional teams are essential to the identification of critical gaps and for addressing the emerging frontiers within climate change that will enable the integrated approaches necessary for addressing the complexities of climate change.

The issues and impacts that PA AES and CES will address through research and outreach include climate change uncertainties, risk management, climate futures and forecasts, water resources, forests and wildlife, aquatic ecosystems and fisheries, agriculture production and insurance, energy, and economic barriers and opportunities. Research and extension emphasis will be placed on forecasts, impacts, and regional vulnerabilities for agriculture, forests, and human populations, as well as decision-making tools for adaptive management by sector.

2. Brief description of the target audience

- Agricultural Producers/Farmers/Landowners
- Agriculture Services/Businesses
- Nonprofit Associations/Organizations
- Business and Industry
- Community Groups
- Education
- General Public
- Government Personnel
- Students/Youth
- Volunteers/Extension Leaders

3. How was eXtension used?

Members of most teams serve as topic experts and answer questions from participants of the ask the expert program.

The eXtension website was regularly used to locate research-based information for water quality, well, and on-lot sewage disposal system management to provide to clientele.

On the horticulture team, some members used eXtension for professional development; some referred clients to obtain information; and others used it for the development of online courses. Many green industry sub-team members are concerned with the utility of eXtension for extension educational programs.

V(E). Planned Program (Outputs)

1. Standard output measures

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

Patent Applications Submitted

Year: 2013
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	18	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of college-initiated technology disclosures.

Year: 2013
 Actual: 0

Output #2

Output Measure

- Number of participants in extension education classes and workshops.

Year: 2013
 Actual: 13941

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Percentage of extension class/workshop participants who expect to implement/adopt practices. (This is a short-term outcome measure.)
2	Percentage of extension class/workshop participants who respond to a follow-up survey with a self-report that they have implemented/adopted practices. (This is a medium-term outcome measure.)
3	New drought vulnerability assessment tool for PA that accounts for soil variability and corn's sensitivity to soil moisture deficit during critical stages of crop development.
4	Linkage of models to assess how changes in labor supply due to climate change-related migration may affect the regional magnitude of migration.
5	Investigation of how simulated expected future climate conditions may affect the future state of recently harvested forests.
6	Investigation of previously unstudied traits that make essential crops more drought tolerant.
7	Analysis of private sector role in greening the agro-food chain.
8	Development of first empirically based model estimating fine root lifespan and turnover, providing an important tool in efforts to accurately model the effects of future climate change.

Outcome #1

1. Outcome Measures

Percentage of extension class/workshop participants who expect to implement/adopt practices. (This is a short-term outcome measure.)

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Percentage of extension class/workshop participants who respond to a follow-up survey with a self-report that they have implemented/adopted practices. (This is a medium-term outcome measure.)

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

New drought vulnerability assessment tool for PA that accounts for soil variability and corn's sensitivity to soil moisture deficit during critical stages of crop development.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Many farmers are unaware of long-term historic drought conditions, their vulnerability to crop losses, or how climate change may increase their vulnerability. Agricultural drought occurs when soil moisture can't meet plants needs and crop yields fall. An accurate drought vulnerability assessment accounts for soil variability and crop sensitivity to soil moisture deficit during critical stages of crop development. Many drought indices now used do not meet these criteria.

What has been done

This research developed a field-scale long-term agricultural drought risk assessment tool for corn growers in PA. The tool requires limited data to allow wide implementation.

The effects of soil moisture stress on corn production were quantified along with the vulnerability

of PA's soils to agricultural drought under various climatic conditions. A drought vulnerability index representing conditions likely to occur once every 4 years was mapped over 9 PA counties and related to yield reductions.

Results

Drought is the primary contributor to crop failure in the U.S., resulting in estimated annual losses of more than \$5 billion. USDA estimated that the 1999 drought caused \$500 million in crop losses in PA, and in some counties crop losses were 70-100%.

This study showed that the drought vulnerability of a location stems from the complex interaction of climate and soil properties.

More than half the study area will likely experience drought-related relative corn yield reductions between 80 and 100% in 1 of every 4 years. Drought vulnerability mapping, which helps farmers determine if they should purchase crop insurance, is an aspect of PaOneStop (<http://paonestop.org>), which allows farmers to map features important to planning. The system's 2,000+ users have mapped more than 12,000 farms.

Numerous workshops and other events will be conducted to extend this information to user groups, and website use has been monitored and tracked.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water

Outcome #4

1. Outcome Measures

Linkage of models to assess how changes in labor supply due to climate change-related migration may affect the regional magnitude of migration.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Future climate change is expected to drive migration of people north to escape more extreme heat. Previous models of climate change-related migration have not accounted for changes in labor wages as a result of migration. Having an accurate understanding of expected future social

patterns related to climate change, such as choice of household location, will allow society to better plan for and adapt to those changes.

What has been done

This study linked a model of location choice with a model of regional economic activity to account for how changes in the supply of labor due to migration may affect the regional magnitude of migration.

Results

Extreme temperatures and precipitation reduce people's preference for a location. This study found that predicted future changes in climate will result in greater migration to the Northeast from the South due to fewer extremely cold days in the North and more extremely hot days in the South. The Northeast's gross regional product (GRP) is forecasted to increase by 3.4%, while the South's GRP drops by 2.1% when climate change-induced migration is compared with the baseline scenario -- business as usual -- in the year 2065. Accounting for labor wages dampens regional economic impacts from climate change-induced migration. Wage effects tend to dominate climate effects on household location choice. The results suggest that ignoring feedback from the labor market overestimates climate change-related migration and its economic impacts. Having accurate models of expected future responses to climate change will allow society to better plan for its effects.

4. Associated Knowledge Areas

KA Code	Knowledge Area
132	Weather and Climate
608	Community Resource Planning and Development

Outcome #5

1. Outcome Measures

Investigation of how simulated expected future climate conditions may affect the future state of recently harvested forests.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Pennsylvania and the Northeast rely on forests to deliver ecosystem services such as providing wood, cleaning the air and water, and sustaining wildlife. Research suggests that the composition and function of these ecosystems will change as the climate warms.

What has been done

Field experiments examined how simulated expected future climate conditions may affect the trajectory that a recently harvested forest takes. Experiments examined effects on (i) the soil carbon and nitrogen cycles, (ii) plant and soil microorganism populations, and (iii) forest microclimate measures such as growing-degree days and frost-free days.

Results

These experiments showed that ecosystem responses to predicted changes in climate are so complex that it is unrealistic to think about the reaction of an individual plant species. This research emphasizes the importance of competition for resources among species, and shows that biotic interactions drive northeastern forest dynamics. Indirect impacts on species interactions trump direct impacts on species of predicted increases in temperature and precipitation. Accurate future models really must account for microclimatic effects as well, such as changes in number of growing-degree days and frost-free days. Therefore, accurate modeling of expected climate change effects on northeastern forests is more difficult and complicated than previously thought.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
132	Weather and Climate

Outcome #6

1. Outcome Measures

Investigation of previously unstudied traits that make essential crops more drought tolerant.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Climate change is expected to degrade soil quality and fertility because more extreme rainfall events will mean more drought and more erosion. Developing crop lines that are more drought tolerant and efficient in acquiring nitrogen will help to reduce hunger and water pollution and increase crop production efficiency. Nitrogen fertilizer is the largest input cost for corn production, and its manufacture and use causes greenhouse gas emissions and water pollution.

What has been done

Penn State researchers and partners are identifying previously unstudied traits that make

essential crops more drought tolerant. They applied for a patent on laser ablation tomography (LAT) to replace a laborious process of preparing root samples for phenotype analysis. LAT allows researchers to easily examine traits, such as cortical cell file number and size, that increase drought tolerance. The team is identifying the genes controlling those traits, which will facilitate crop breeding.

Results

Plant roots are the key to making plants more drought resistant. This work is identifying ways to make roots function more efficiently in important crops such as corn and common bean--staple foods in the diet of millions of people around the world--thereby increasing yield. The researchers would also expect to find similar increases in yield under drought in cereal crops when these previously unstudied traits are selected for in breeding.

This research aims to make agricultural production systems more resilient to climate change and to produce more food in an environmentally sensitive manner. This will ensure access to nutritious and safe foods and address the emerging challenges of climate change and natural resource scarcity.

Having corn varieties that acquire nitrogen more efficiently will reduce fertilizer costs, thereby increasing profitability, and reduce air and water pollution. These advances will also decrease the environmental costs of driving cars because about half of the corn grown in the U.S. is now used for fuel.

4. Associated Knowledge Areas

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

Outcome #7

1. Outcome Measures

Analysis of private sector role in greening the agro-food chain.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

By 2050 the world's population is expected to be roughly one-third higher than today, and global average demand for meat will increase more than 20%, due to growth in emerging markets. This growth, coupled with the potential effects of climate change, will increase pressure on agriculture, on natural resources, and on environmental quality. There will be increasing interest in programs that balance the desire for abundant food at reasonable prices against the desire to preserve the environment.

What has been done

A Penn State researcher identified incentives for the private sector to help in greening the agro-food industry, both with inputs to farmers and with processing and sales of farm products. He examined energy and water use, green labeling, and product waste, among other topics.

Results

The researcher concluded that there are many incentives for the food industry to reduce its environmental footprint, the greatest being that the prices of many inputs are rising. He noted that government standardization of green labeling, such as "climate-friendly," could help this process along, just as it has for certified organic products. With standardization of green labeling, consumers could trust that they were getting a certain quality of product, and some consumers would be willing to pay a premium for that. Companies embrace standardized labeling because it allows them to differentiate their products.

4. Associated Knowledge Areas

KA Code	Knowledge Area
603	Market Economics
605	Natural Resource and Environmental Economics

Outcome #8

1. Outcome Measures

Development of first empirically based model estimating fine root lifespan and turnover, providing an important tool in efforts to accurately model the effects of future climate change.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Root responses to environmental conditions can have a major influence on plant growth and production, the carbon and water cycles, and ecosystem services. Yet we have only very limited understanding of root function under field conditions. Climate change will strongly influence and be influenced by terrestrial carbon and water fluxes, a significant fraction of which is associated

with root water uptake, root turnover, and root respiration.

What has been done

Penn State researchers combined species-specific estimates of fine root dynamics with a model that predicts current distribution and future suitable habitat of temperate tree species across the eastern U.S. Estimates of fine root lifespan and turnover are based on empirical observations and relationships with fine root and whole-plant traits. The estimates apply explicitly to the fine root pool that is relatively short-lived and most active in nutrient and water uptake.

Results

Results from the combined model identified patterns of faster root turnover rates in the north central U.S. and slower turnover rates in the southeast U.S. Parts of MN, OH, and PA were predicted to experience >10% increases in root turnover rates given potential shifts in tree species composition under future climate scenarios, while root turnover rates in other parts of the East were predicted to decrease. Despite potential regional changes, the average estimates of root lifespan and turnover for the study area remained relatively stable between current and future climate scenarios.

The model provides the first empirically based and spatially explicit and extensive estimates of fine root lifespan and turnover. It is a potentially powerful tool allowing researchers to identify reasonable approximations of forest fine root turnover where no direct observations are available. The model is important as researchers attempt to more accurately model the effects of future climate change.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
123	Management and Sustainability of Forest Resources
206	Basic Plant Biology

V(H). Planned Program (External Factors)

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

Brief Explanation

Natural Disasters (drought, weather extremes, etc.)

· Adverse weather factors continue to influence clientele participation, both from extended periods of rain in summer and winter snow and ice events.

Economy

· The economic climate continues to have a significant impact on the ability of clientele to attend meetings and conferences.

Appropriations changes

- Appropriation Changes affected both the research and extension functions of the College of Agricultural Sciences and resulted in fewer faculty and staff across all areas of the college.

Competing Public priorities

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

Competing Programmatic Challenges

- The College of Agricultural Sciences' restructuring process allowed for continued focus on cost-effective program deliverables and strategic elimination of programs.

Other - Extramural Funding

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

V(I). Planned Program (Evaluation Studies)**Evaluation Results**

The generation of outcomes from existing programs and the development of new programs require improved evaluation that identifies pre- and post- responses to information and monitoring for long-term behavioral changes that result in improved environmental outcomes. The evaluations conducted thus far provide initial measures of implementation, but long-term monitoring is needed to ensure that the practices are successfully managed over time. We are attempting to incorporate more economic valuations of the results of our research and extension work.

Key Items of Evaluation

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

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Food Safety

- Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
306	Environmental Stress in Animals	5%		5%	
307	Animal Management Systems	5%		5%	
311	Animal Diseases	5%		5%	
315	Animal Welfare/Well-Being and Protection	5%		5%	
402	Engineering Systems and Equipment	5%		5%	
501	New and Improved Food Processing Technologies	13%		13%	
503	Quality Maintenance in Storing and Marketing Food Products	13%		13%	
504	Home and Commercial Food Service	13%		13%	
601	Economics of Agricultural Production and Farm Management	5%		5%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources	13%		13%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	13%		13%	
723	Hazards to Human Health and Safety	5%		5%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	17.4	0.0	12.7	0.0
Actual Paid Professional	19.1	0.0	12.8	0.0
Actual Volunteer	0.4	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
683508	0	325185	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
1529014	0	811295	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
909996	0	324775	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Food safety concerns have revealed the complex nature of the modern food system with its multifaceted distribution networks that extend from the farm-gate to the consumer's plate. Research and extension programs focus on issues of food quality and safety to address concerns of producers, processors, and consumers. Collaboration with industry partners to mitigate the risks of food safety incidents and to develop functional and improved nutritional characteristics of foods and ingredients are an important driver of food science and related research. New technologies are required for producing and processing foods that retain or enhance nutritional value, while ensuring quality and safety. Enhanced diagnostic tools are being developed to detect, identify, and track foodborne pathogenic microorganisms, with a focus on approaches that will reduce the potential of food contamination at multiple levels in the food system.

Scientists and communicators with strengths in plant and animal sciences, food science, animal and human nutrition, veterinary medicine, economics, and business contribute to research and extension on complex, interrelated aspects of food safety. Extension programming addresses food safety issues with consumers, producers, and the processing industry by providing training for certifications and informing the public and industry of food safety guidelines, policies, and recommendations. This enhances Pennsylvania's role as a reliable producer and supplier of high quality, safe, and nutritious food and food products and helps ensure Pennsylvania's economic future.

2. Brief description of the target audience

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

3. How was eXtension used?

The consumer food safety program does not use eXtension. The team, in collaboration with the food safety and quality team, has established a food safety hotline/listserv for internal customers. This hotline/listserv allows client calls to the counties to be posted to the team with an available educator responding to the call in a short time. This allows counties that do not have access to a food safety educator or who have an educator but the person is not available to respond to client needs in an efficient and timely manner.

eXtension was not used in retail manager training or wine quality.

V(E). Planned Program (Outputs)

1. Standard output measures

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

Patent Applications Submitted

Year: 2013
 Actual: 2

Patents listed

Serial No. 11/060,136; Filed 2/17/2005; Title: Gas Treatment Chamber

Serial No. 13/563,065; Filed 7/31/2012; Title: Methods and Compositions for Improving the Nutritional Content of Mushrooms and Fungi

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	3	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of college-initiated technology disclosures.

Year: 2013
 Actual: 0

Output #2

Output Measure

- Number of participants in extension education classes and workshops.

Year:
 Actual:

2013

6808

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Percentage of extension class/workshop participants who expect to implement/adopt practices. (This is a short-term outcome measure.)
2	Percentage of extension class/workshop participants who respond to a follow-up survey with a self-report that they have implemented/adopted practices. (This is a medium-term outcome measure.)
3	Food safety professionals certified in Hazard Analysis and Critical Control Points training this program year.
4	Finding that the heat generated during the traditional composting process to make mushroom growth substrate is adequate to eliminate human pathogens.
5	Percent of PA winery representatives attending a Penn State extension winery sanitation workshop that learned that a simple method adjustment would make their wine of higher quality and reduce potential costs of rebottling because of re-fermentation in the bottle.
6	Potential increase (in \$) in bird quality and livability if 5% of Pennsylvania broiler farms used CUBO-S fans in poultry houses, resulting in 5% greater bird performance.
7	Work towards improved understanding of the biology and pathogenesis of mycobacterial diseases, and the development of improved diagnostic tests and new vaccine for Johne's disease.

Outcome #1

1. Outcome Measures

Percentage of extension class/workshop participants who expect to implement/adopt practices. (This is a short-term outcome measure.)

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Percentage of extension class/workshop participants who respond to a follow-up survey with a self-report that they have implemented/adopted practices. (This is a medium-term outcome measure.)

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Food safety professionals certified in Hazard Analysis and Critical Control Points training this program year.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	165

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The Food Safety Modernization Act (FSMA) has had and will have an enormous impact on the food supply chain in the coming years. It will especially affect farmers and food processors as they grapple with new regulations. Foodborne illnesses and food recalls continue to grab news headlines, with a dramatic impact on the food chain. Food producers and processors have need for improved practices under increased scrutiny from the public, law makers, and regulators.

What has been done

Of increased importance with changing regulations, specifically FSMA, is Hazard Analysis and Critical Control Points (HACCP) training, which provides a risk-based control approach to ensuring safety in food production. This training is required for meat and poultry processors and will be required for all PA food manufacturers who fall under U.S. Food and Drug Administration jurisdiction. In this reporting period, Penn State Extension trained and certified 165 participants in HACCP.

Results

An estimated 48 million foodborne illnesses, including 3,000 deaths, occur each year in the United States (Centers for Disease Control and Prevention, 2010). Two 2012 studies estimated the costs of illnesses caused by 14 major foodborne pathogens at about \$15 billion per year in the U.S. (USDA-ERS).

Fundamentals of HACCP is a 3-day course taught by certified instructors with extensive experience in food safety training. Particular emphasis is on FDA-regulated food products, including fresh-cut fruits, vegetables, and mushrooms, juice and cider, baked goods, confections, snack foods, and egg and dairy products.

More companies and industries need a HACCP-certified employee under the FSMA, so demand for the training is rising. FSMA regulations apply to smaller companies that previously were exempt from such requirements.

Penn State's HACCP training supports the economic well-being of the sizable food industry in PA and the region.

4. Associated Knowledge Areas

KA Code	Knowledge Area
503	Quality Maintenance in Storing and Marketing Food Products
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #4

1. Outcome Measures

Finding that the heat generated during the traditional composting process to make mushroom growth substrate is adequate to eliminate human pathogens.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Strict requirements on the use of animal manures in fresh produce production imposed by the new federal Food Safety Modernization Act (FSMA) threatened to adversely affect the mushroom industry, which relies on horse and poultry manure for a specialized growth substrate.

What has been done

Penn State researchers conducted studies that show the heat generated during the traditional composting process--originally developed to kill insect and fungal pests of mushrooms--is adequate to eliminate human pathogens that might be present.

As a result of these findings, there will be no restrictions on the mushroom industry composting process. More than 3.5 million cubic yards of mushroom compost are produced yearly in PA.

Results

The FSMA may be the most sweeping reform of U.S. food safety laws in more than 70 years. Its intent is to change the way we as a country ensure the safety of our food supply. Instead of responding to an occurrence of contamination or an outbreak of foodborne illness, food industries now are challenged to be proactive in recognizing potential food-safety hazards in their operations and establishing control measures to prevent them from occurring.

Mushroom shipments set record levels in 2012, and they were up another 6% in early 2013. U.S. mushroom sales totaled 900 million pounds for the 2011-12 crop, at a value of \$1.10 billion. Pennsylvania accounts for 61% of total U.S. mushroom production.

4. Associated Knowledge Areas

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

Outcome #5

1. Outcome Measures

Percent of PA winery representatives attending a Penn State extension winery sanitation workshop that learned that a simple method adjustment would make their wine of higher quality and reduce potential costs of rebottling because of re-fermentation in the bottle.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	100

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Penn State's wine quality improvement series assists people with the decision to start a winery, discusses the equipment needed for safe winemaking, and assists wineries with implementing

quality assurance programs based on standardized wine sensory evaluation techniques.

What has been done

In the winery sanitation workshop, 100% of the audience (41 attendees) learned that they had been making a critical error in mixing their acidulated sulfur dioxide sanitizer solutions. Instead of using hot water to make the sanitizer, cold water should be used because it more effectively retains sulfur dioxide, the antimicrobial agent, in solution. Ensuring proper sanitation helps prevent wine from re-fermenting after it is bottled, which can cause bottles to bubble through or expel the closure.

Results

If wine begins to re-ferment in storage, the winery has to collect and open each bottle to reprocess it. This could cost approximately \$1,000-\$3,000 or more in supplies for a batch of 500 bottles (750 mL each). This does not include the cost of the previous packaging (i.e., bottle, label, closure) that may now be useless or the labor for reprocessing.

Even greater costs are incurred when re-fermentation occurs at the consumers' residences. Then costs associated with insurance and property damage are usually involved, as well as possibly irreparable damage to the winery's brand.

The Pennsylvania Liquor Control Board reports that PA wine production increased from 560,000 gallons in 2000 to 1.8 million gallons in 2010. The state's wine, wine grape, and related industries generated about \$870 million in economic value in 2007, including \$32 million in retail wine sales (MKF Research, 2009).

4. Associated Knowledge Areas

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

Outcome #6

1. Outcome Measures

Potential increase (in \$) in bird quality and livability if 5% of Pennsylvania broiler farms used CUBO-S fans in poultry houses, resulting in 5% greater bird performance.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
-------------	---------------

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Air and litter quality are critical for bird health and performance. Investing in technologies that enhance poultry house environmental quality must also improve bird performance to be economically viable. Some undesirable conditions in a poultry house include cooler temperatures for chick brooding and high litter moisture and ammonia release. CUBO-S fans may reduce the concentration of noxious gases, improve temperature uniformity, enhance bird performance, and reduce energy expenditures.

What has been done

The objective of this research was to evaluate the impact of CUBO-S fans, which mix air and eliminate temperature and noxious gas stratification, in commercial broiler housing on the bird performance, poultry house environmental conditions, and energy consumption. Use of these fans resulted in greater bird performance and revenue in two field evaluations.

Results

Results of two trials indicated that CUBO air mixing equipment consistently resulted in a warmer environment at bird level and reduced temperature stratification at the ceiling. Propane consumption declined by 6.6 and 13.0% in trials I and II, respectively, and body weight and feed:gain ratio consistently improved. Other significant observations included lower house ammonia levels, higher litter temperature, better litter scores and livability, and fewer carcass condemnations at processing. These findings indicate the potential for CUBO fans to improve energy consumption, poultry house environmental conditions, and broiler performance on commercial farms.

The Pennsylvania broiler industry is worth about \$432 million per year. If 5% of the industry used these fans and obtained a 5% improvement in bird quality and livability, that would equal \$1.08 million annually. Increased farm profitability preserves farmland and ecosystem services, and helps maintain rural community life.

4. Associated Knowledge Areas

KA Code	Knowledge Area
306	Environmental Stress in Animals
307	Animal Management Systems
315	Animal Welfare/Well-Being and Protection
402	Engineering Systems and Equipment
601	Economics of Agricultural Production and Farm Management

Outcome #7

1. Outcome Measures

Work towards improved understanding of the biology and pathogenesis of mycobacterial diseases, and the development of improved diagnostic tests and new vaccine for Johne's disease.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Johne's disease (pronounced "yo-knees") (JD) is a contagious, chronic, inflammatory intestinal disease to which all ruminants are susceptible. JD, which is usually fatal, is caused by *Mycobacterium avium* subspecies paratuberculosis, a hardy bacteria related to the agents of leprosy and tuberculosis. The disease occurs worldwide. Recent evidence of the presence of *M. paratuberculosis* in retail milk sources is of concern from a milk quality and potential food safety standpoint.

What has been done

Penn State researchers are working to improve our understanding of the biology and pathogenesis of mycobacterial diseases and the host response to infection, and to develop and implement new generations of diagnostic tests and a vaccine for JD.

Results

JD remains a major concern for producers. There are very high prevalence rates: 68% of all U.S. dairy herds and 95% of those with more than 500 cows have at least one JD-positive animal. A national study of US dairies (Dairy NAHMS 96) found that on approximately 22% of U.S. dairy farms at least 10% of the herd is infected with JD.

JD results in more than \$200 million in annual losses to the U.S. dairy industry each year. This loss reflects reduced milk production, early culling, and poor conditioning at culling. The cost of JD in beef herds and other species is still to be determined.

Understanding more about the biology and pathogenesis of the disease and the development of efficient and effective diagnostic tests and vaccines could help cut down these economic losses and potentially make the milk supply safer.

4. Associated Knowledge Areas

KA Code	Knowledge Area
311	Animal Diseases
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

V(H). Planned Program (External Factors)

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

Brief Explanation

Natural Disasters (drought, weather extremes, etc.)

- The widespread late-season frost in late May hindered attendance for our annual research symposium.

Economy

- Most of the information obtained from people who did not attend workshops for this reporting period indicated that cost and time were the greatest hindering factors.
- Increasing public awareness of food safety and potential economic impact of a foodborne illness outbreak on an organization have led nonprofit organizations that depend on food fundraisers for financial survival to seek food safety training for their volunteers.
- There has been a renewed interest in gardening, which has led to more inquiries about how to preserve fruits and vegetables.
- The availability of the Internet has allowed the home consumer to access a lot of information. However, much of the information on preserving food available via the Internet is often biased, lacking evidence-based research and safety information.

Appropriations changes

- Appropriation Changes affected both the research and extension functions of the College of Agricultural Sciences and resulted in fewer faculty and staff across all areas of the college.

Government Regulations

- Public awareness of foodborne illness has been enhanced by the ability to view restaurant health inspections online.

Competing Public priorities

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

Competing Programmatic Challenges

- The College of Agricultural Sciences' restructuring process allowed for continued focus on cost-effective program deliverables and strategic elimination of programs.

Populations changes (immigration, new cultural groupings, etc.)

- The workforce in restaurants and food service operations is diverse, including many people with limited English speaking and reading skills.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The generation of outcomes from existing programs and the development of new programs require improved evaluation that identifies pre- and post-responses to information and monitoring for long-term behavioral changes that result in improved environmental outcomes. The evaluations conducted thus far provide initial measures of implementation, but long-term monitoring is needed to ensure that the practices are successfully managed over time. We are attempting to incorporate more economic valuations of the results of our research and extension work.

Key Items of Evaluation

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

V(A). Planned Program (Summary)

Program # 4

1. Name of the Planned Program

Global Food Security and Hunger

Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
201	Plant Genome, Genetics, and Genetic Mechanisms	5%		13%	
202	Plant Genetic Resources	5%		6%	
206	Basic Plant Biology	5%		8%	
211	Insects, Mites, and Other Arthropods Affecting Plants	10%		5%	
212	Pathogens and Nematodes Affecting Plants	10%		5%	
301	Reproductive Performance of Animals	10%		5%	
302	Nutrient Utilization in Animals	5%		10%	
303	Genetic Improvement of Animals	5%		6%	
304	Animal Genome	5%		7%	
311	Animal Diseases	5%		13%	
502	New and Improved Food Products	5%		5%	
606	International Trade and Development	5%		4%	
610	Domestic Policy Analysis	5%		4%	
611	Foreign Policy and Programs	5%		5%	
704	Nutrition and Hunger in the Population	10%		0%	
722	Zoonotic Diseases and Parasites Affecting Humans	5%		4%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	8.6	0.0	202.8	0.0
Actual Paid Professional	32.9	0.0	140.8	0.0
Actual Volunteer	7.2	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
507702	0	1126589	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
1081281	0	6853350	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
1610461	0	12355489	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Work in this area focuses on and captures the efforts of multidisciplinary program teams across the system to provide the science and outreach required to boost U.S. agricultural production, improve global capacity to meet the growing food demand, and foster innovation in fighting hunger by addressing food security for everyone, but especially for vulnerable populations. Research and extension program areas addressing agriculture productivity are rooted in an understanding of the underlying genetic mechanisms as they relate to the fundamental biology of plants and animals and translating that information into practice. Improving the productivity of plant and animal systems is a balance between maximizing the genetic potential of organisms and minimizing losses due to pests and poor agricultural practices. Programs help producers increase production, while improving sustainability. New discoveries in biotechnology add value as exports to developing nations.

Research and extension continues to provide growers with science-based information to enhance production without negative environmental impact. As world populations increase, U.S. food production capability will become instrumental in addressing the need for more food. Penn State-developed technology and modern science-based resources can be a solution to help solve world hunger when exported and adopted by food-producing nations around the world. Hunger is real, but can be minimized, if not eliminated, by adoption of sustainable food production methods based on research and extension programs that focus on efficiently increased production with a sustainability and environmental stewardship focus.

Processing and manufacturing of food products is a major economic contributor for local, state, regional, and national food sectors. Pennsylvania is a leader in the industry. Research and extension programs continue to partner with the food manufacturing and processing industries to ensure safe, wholesome products entering the food chain from Pennsylvania growers and processors.

2. Brief description of the target audience

- Agricultural Producers/Farmers/Landowners
- Agriculture Services/Businesses
- Nonprofit Associations/Organizations
- Business and Industry
- Community Groups
- Education
- General Public
- Special Populations (at-risk and underserved audiences)
- Government Personnel

- Human Service Providers
- Military
- Students/Youth
- Volunteers/Extension Leaders

3. How was eXtension used?

Several Extension team members in dairy, equine, livestock, poultry, family consumer sciences, and veterinary medicine are topic experts for eXtension.org, and have answered questions from participants of the ask-the-expert program.

Two members of the equine team participate in the Horsequest community of practices. They have conducted national webinars dealing with equine environmental stewardship through MyHorseUniversity and HorseQuest eXtension. They have answered 69 questions dealing with equine health and management and have hosted meetings. They have added content for the HorseQuest eXtension Facebook and Twitter accounts. The Penn State Extension Equine website (<http://extension.psu.edu/animals/equine>) and on-line materials (newsletter, events, fact sheets, PowerPoints, etc.) were developed to provide educational opportunities for managers of equine operations. From our site they have shared articles and releases with eXtension on Facebook and off the national site to supplement the PSU equine programming.

eXtension's Extension Alliance for Better Child Care is cross-referenced on our website as a means of providing additional resources for early learning and school-age practitioners.

eXtension was not used by every team, but at least one indicated intentions to begin using it next year.

V(E). Planned Program (Outputs)

1. Standard output measures

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

Patent Applications Submitted

Year: 2013
 Actual: 3

Patents listed

Serial No. 11/060,136; Filed 2/17/2005; Title: Gas Treatment Chamber

Serial No. 13/563,065; Filed 7/31/2012; Title: Methods and Compositions for Improving the Nutritional Content of Mushrooms and Fungi

Serial No. 13/668,859; Filed 11/5/2012; Title: High Lycopene Content Tomato Plants and Markers for Use in Breeding for Same

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	27	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of college-initiated technology disclosures.

Year	Actual
2013	2

Output #2

Output Measure

- Number of participants in extension education classes and workshops.

Year	Actual
2013	33675

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Percentage of extension class/workshop participants who expect to implement/adopt practices. (This is a short-term outcome measure.)
2	Percentage of extension class/workshop participants who respond to a follow-up survey with a self-report that they have implemented/adopted practices. (This is a medium-term outcome measure.)
3	Genes sequenced on the bovine Y chromosome.
4	Species of fusaria fungi associated with invasive, nonnative ambrosia beetles described.

Outcome #1

1. Outcome Measures

Percentage of extension class/workshop participants who expect to implement/adopt practices. (This is a short-term outcome measure.)

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Percentage of extension class/workshop participants who respond to a follow-up survey with a self-report that they have implemented/adopted practices. (This is a medium-term outcome measure.)

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Genes sequenced on the bovine Y chromosome.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1274

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

For 60 years, cattle breeders selected for milk or beef production, but animal fertility dropped concurrently. U.S. farmers measure cow fertility by daughter pregnancy rate (DPR)--the percentage of nonpregnant cows that become pregnant during a 21-day period. DPR of Holsteins declined by about 7% (28 days open) from 1960-2000. Every 1% increase in DPR is likely worth at least \$8-10/U.S. dairy cow/year. A lack of knowledge about genes on the male Y chromosome contributed to low fertility.

What has been done

Penn State researchers identified 1,274 genes on the bovine Y chromosome, significantly more than that of other mammals. This discovery may help biologists better understand how cattle and other mammals evolved, and help animal breeders better maintain and enhance cattle fertility. We can now better understand how to maintain male genetic diversity, particularly in a breed such as Holsteins that has been extensively selected and whose breeding is almost all based on

artificial insemination.

Results

Understanding genetic diversity may give farmers another tool for managing their herds to improve male fertility. Cows bred to high-fertility bulls yield more profit, because they bear more calves earlier in the season who can gain more weight before weaning and marketing. Fertility issues occur in 15-20% of beef bulls. A 1% increase in fertility in the U.S. beef industry equals a net profit of \$55-60 million. The ability to understand factors affecting higher fertility in bulls and other livestock species could help feed millions of food-insecure people and would be worth billions of dollars globally.

The female bovine genome sequence was published in 2009. The findings of the bovine Y chromosome study are a significant contribution to the completion of the bovine genome project.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
304	Animal Genome

Outcome #4

1. Outcome Measures

Species of fusaria fungi associated with invasive, nonnative ambrosia beetles described.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	9

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Ambrosia beetles, which first appeared in the U.S. in CA in 2011, bore into trees and cultivate Fusarium fungi as food. The fungi carried by the ambrosia beetle damage or kill trees, including avocado crops in the U.S., Israel, and Australia. Avocado sales in 2011 were \$2.9 billion, up 11% from 2010. Sales in the first half of 2012 were 30% greater than in the same period of 2011. Ambrosia beetle infestation is also a global concern because they can be transported worldwide in wood pallets.

What has been done

Penn State researchers published an article describing the diversity of 9 fusaria fungi associated

with ambrosia beetles. The fungi include 4 lineages that currently threaten avocado crops. The beetle threatening avocado crops is similar to many others, including one that attacks Ailanthus trees. The researchers are studying this system to see how the beetles and fungi interact.

Results

Over the past 4 or 5 years, ambrosia beetle populations have increased, and there is evidence that the fungi associated with the beetles easily form hybrids. Researchers are worried that hybrid versions of either the beetle or fungus could pose a larger threat to farms and forests. Understanding the molecular phylogeny of the genus *Fusarium* and characterizing new and emerging lineages will help researchers guard against the possibility of more virulent hybrids able to infest more species of plants. It may also help control the spread of the beetles and/or the fungi.

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

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

Brief Explanation

Natural Disasters (drought, weather extremes, etc.)

- There have been weather extremes with too wet or too dry conditions that had major implications for somatic cell count and feed quality and quantity. This can have huge impacts on a producer's income, due to decreased milk production and milk premium earned, and increased feed costs.
- Floods and droughts create issues with needing to reseed experimental plots and adapt plans in other ways.
- Circumstances resulting from natural disasters require more of our time to serve a limited amount of people.

Economy

- The volatility of the grain and milk markets has forced dairy producers to be more involved in how to use risk management to cover their margin and produce an increased amount of high quality milk.
- Because of the recession, banks are requiring a cash flow plan before any consideration will be given to making loans, so our programs are popular.
- Increase in expense of grains made profitability of operations decrease, and therefore, many producers were unable to attend meetings or afford suggested changes in production techniques.

- Economy continues to increase pest problems due to abandoned properties from bank foreclosures.

Appropriations changes

- Appropriation Changes affected both the research and extension functions of the College of Agricultural Sciences and resulted in fewer faculty and staff across all areas of the college.

Public Policy changes

- Public Policy Changes continue to meet the public health need related to Lyme Disease and other vectored diseases.

Government Regulations

- The Chesapeake Bay is under the microscope for improving impaired watersheds for nitrogen and phosphorus. Feed management is being recognized as an important means of reducing the nutrients before being excreted. It also allows improvements in feed efficiency and reductions in manure volume.
- Because of the new Pennsylvania state regulation, the equine team took this opportunity to reach horse farm managers with writing manure management plans. We began advertising the Equine Environmental Stewardship course as a workshop to help with the development of a farm's manure management. This increased our participation in the program.
- Government Regulations are counterintuitive to following IPM. An NPDES permit is now needed for mosquito control.

Competing Public priorities

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

Competing Programmatic Challenges

- The College of Agricultural Sciences' restructuring process allowed for continued focus on cost-effective program deliverables and strategic elimination of programs.

Populations changes (immigration, new cultural groupings, etc.)

- Population Changes continue to create new pest concerns, from bed bugs to introducing dengue fever.

Other - Extramural Funding

- Extramural Funding continues to decline.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The generation of outcomes from existing programs and the development of new programs require improved evaluation that identifies pre- and post- responses to information and monitoring for long-term behavioral changes that result in improved environmental outcomes. The evaluations conducted thus far provide initial measures of implementation, but long-term monitoring is needed to ensure that the practices are successfully managed over time. We are attempting to incorporate more economic valuations of the results of our research and extension work.

Key Items of Evaluation

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

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Sustainable Energy

Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
101	Appraisal of Soil Resources	0%		10%	
123	Management and Sustainability of Forest Resources	10%		40%	
125	Agroforestry	10%		12%	
131	Alternative Uses of Land	12%		3%	
402	Engineering Systems and Equipment	15%		15%	
602	Business Management, Finance, and Taxation	12%		0%	
605	Natural Resource and Environmental Economics	13%		10%	
606	International Trade and Development	13%		0%	
723	Hazards to Human Health and Safety	15%		10%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	13.6	0.0	23.8	0.0
Actual Paid Professional	9.1	0.0	13.3	0.0
Actual Volunteer	8.1	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
303594	0	96680	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
799321	0	855044	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
608833	0	740064	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

The Marcellus shale and Utica shale natural gas reserves in Pennsylvania have resulted in an opportunity to develop a domestic energy resource in the state. In response, comprehensive research and outreach programs have been initiated to understand the potential community, economic, and environmental issues associated with the development of these resources in the state. Extension educational programs include the development of webinars, conferences, newsletters, tours, and factsheets on understanding the potential of the resource, gas leasing considerations, and other related topics. Engagement with county commissioners, state government agencies and officials, and the industry is a critical part of the outreach effort.

Renewable energy development that has minimal environmental impacts and limited effects on food and feed prices presents new opportunities and challenges. The development of alternative energy strategies is also a function of federal, state, and local policies that either subsidize or restrict development. Regionally adapted renewable energy solutions are sought as priorities to establish the supporting research and outreach programs required to foster the appropriate advancement of these technologies.

Outreach programs have continued to be developed that address the potential of various alternative energy feedstocks for energy. The public, communities, and potential project developers require a comprehensive understanding of feedstock production and availability, sustainable harvest strategies and cost, feedstock logistics, and the optimum methods of using the resource most efficiently. Research initiatives focus on evaluations of cropping systems on dairy farms, development of novel bioenergy crops and biologically-based materials, development of sustainability criteria for harvesting crop residues, and evaluations of cost and logistic issues associated with the harvest of woody biomass for energy. Emerging markets for ecosystem service credits that are often generated in conjunction with renewable energy project developments are key components of business plans. These include renewable energy credits, carbon credits, and nutrient trading credits.

2. Brief description of the target audience

- Agricultural producers/farmers/landowners
- Agriculture services/businesses
- Nonprofit associations/organizations
- Business and industry
- Community groups
- Education
- General public
- Special Populations (at-risk and underserved audiences)

- Government personnel
- Human service providers
- Military
- Students/youth
- Volunteers/extension leaders
- Wood products industry
- International shipping companies
- USDA/APHIS
- Wood science community
- Invasive species specialists

3. How was eXtension used?

Participation in eXtension COP group webinars provided additional information for workshops. Some faculty and staff participated in "Ask the expert." Several team members gathered resources from eXtension. One individual published a paper on eXtension.

The Marcellus Extension team did not use eXtension.

V(E). Planned Program (Outputs)

1. Standard output measures

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

Patent Applications Submitted

Year: 2013
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	3	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of college-initiated technology disclosures.

Year Actual
 2013 0

Output #2

Output Measure

- Number of participants in extension education classes and workshops.

Year	Actual
2013	15418

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Percentage of extension class/workshop participants who expect to implement/adopt practices. (This is a short-term outcome measure.)
2	Percentage of extension class/workshop participants who respond to a follow-up survey with a self-report that they have implemented/adopted practices. (This is a medium-term outcome measure.)
3	Increase in sales (in \$) of businesses attending Extension workshops on business opportunities related to shale gas development in the Mid-Atlantic region.
4	Investigation of cyanobacteria as renewable source of nitrogen for agriculture.
5	Development of composite brick of coal fines bound with residual agricultural materials.
6	Refinement of dielectric heating as alternative to methyl bromide for phytosanitation of wood packaging materials.
7	Investigation of potential for biomass boiler conversion in eastern United States.

Outcome #1

1. Outcome Measures

Percentage of extension class/workshop participants who expect to implement/adopt practices. (This is a short-term outcome measure.)

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Percentage of extension class/workshop participants who respond to a follow-up survey with a self-report that they have implemented/adopted practices. (This is a medium-term outcome measure.)

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Increase in sales (in \$) of businesses attending Extension workshops on business opportunities related to shale gas development in the Mid-Atlantic region.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	24000000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

There is a strong need to acquaint existing or aspiring business owners of the business development opportunities associated with the emerging natural gas industry in the state, both as a way to increase sales, and to retain or expand the workforce.

What has been done

The Penn State Marcellus Extension team conducted 10 workshops across PA in partnership with local chambers of commerce or other business development units. The participants (282) studied a range of topics from how the drilling process works, goods and services linked to that process, ancillary businesses providing goods and services to the industry in other U.S. markets, and how to contract with companies in the market. They also learned unique attributes of the gas industry and ways to build sustainable business relationships.

Results

From follow-up interviews regarding the benefits of the meetings, the group collectively reported a \$24 million increase in sales. Further analysis of the evaluations indicated that 327 jobs were either newly created or retained by the businesses whose representatives attended these sessions.

The team has also globalized their shale initiative extension effort to work with federal and state agencies, Congressional delegates, potential 2014 PA governor candidates, and state legislative representatives. Their outreach allows these groups to better understand the implications of shale development in PA and related public policy and legislative issues. They are working to establish the Penn State brand as the go-to entity in the Commonwealth, the U.S., and globally on shale-related issues.

4. Associated Knowledge Areas

KA Code	Knowledge Area
602	Business Management, Finance, and Taxation
606	International Trade and Development

Outcome #4

1. Outcome Measures

Investigation of cyanobacteria as renewable source of nitrogen for agriculture.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Industrial fertilizer production requires high fossil fuel inputs and accounts for 1/3 of all energy consumed in agriculture. Increased use of biologically fixed nitrogen gas (N₂) could help reduce agricultural energy demands. Cyanobacteria (CB) are free-living, N₂-fixing, photosynthetic soil bacteria that grow naturally in thin films on soil surfaces. Estimates for annual soil N contributions by free-living bacteria are 1-25 kg N/ha. CB are used extensively as renewable N sources in rice production in Asia, but they have received little consideration for U.S. agricultural use.

What has been done

With USDA-appropriated support, a university research commercialization grant was obtained to support development of soil amendments consisting of free-living, N-fixing CB. Observations of agricultural soils at Penn State's agronomy farm over the past 12 years show that naturally established CB films regrow yearly and are most noticeable after wet periods. Local CB strains have been isolated and identified from agricultural soils in research plots at the agronomy farm.

Growth trials with CB strains obtained from the Culture Collection of Algae at the University of Texas-Austin have been conducted using semi-batch growth in photobioreactors.

Results

The growth of the CB in photobioreactors have increased in efficiency and are yielding 1-2 grams dry biomass per liter within 10 days. This work will facilitate the production levels required for efficacy trials in the field. Suspensions of CB applied to soils in petri dishes typically reach a carrying capacity of 13 grams per square meter within 3 months. Laboratory tests have been developed to measure soil biofilm cohesion. Additional research to measure C and N uptake by CB following soil application under field conditions has the potential to develop EPA-approved protocols for assessing C sequestration and N fertilizer reduction credits. Such credits could include CO₂ fixed by CB and lower CO₂ emissions due to reduced use of fossil fuel-based N fertilizers.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources

Outcome #5

1. Outcome Measures

Development of composite brick of coal fines bound with residual agricultural materials.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Foundries typically manufacture heavy bulky products by pouring molten metal into molds. In this manufacturing sector, transportation costs inherently constrain imports, thus securing some American competitive advantage. It is a matter of grave concern to U.S. foundries that there are only 3 North American plants that make foundry-grade coke. Also, there is a limited mineable supply of the type of bituminous coal that offers the coking properties that foundries need.

What has been done

Beginning with USDA-appropriated support and continuing with leveraged funds, including a university research commercialization grant, Penn State researchers and an industry partner developed a composite brick of coal fines bound with residual agricultural materials. The inputs to the brick are otherwise wasted or underused. These bricks require less energy to make than traditional coke because they are processed at ambient temperature. This improves economic

feasibility and energy sustainability.

Results

Two full-scale trials run at partner foundries were successful. A patent has been filed.

The bricks make beneficial use of wastes from coal, bioenergy, and rice processing operations to promote green sustainable manufacturing. Using lignin from bioenergy crops increases bioenergy's economic competitiveness.

The raw materials and the net cost/ton will be less than for coke. The bricks have an energy density (BTU/ft³) 35% higher than coke.

U.S. energy use and CO₂ releases could be cut by 0.5-1.5 million tons/yr if just 10% of U.S. iron foundries and steel mills replaced 30-70% of their coke with the bricks. The researchers are pushing the formulation toward higher ratios of the most economically viable materials.

Industry partners have verbally agreed to finance a pilot plant.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment

Outcome #6

1. Outcome Measures

Refinement of dielectric heating as alternative to methyl bromide for phytosanitation of wood packaging materials.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The use of methyl bromide (MeBr) contributes significantly to the destruction of the earth's stratospheric ozone layers. MeBr is used to treat wood packaging materials for invasive species before international shipping. The use of fumigation for quarantine and pre-shipment continues to rise as world trade expands. The U.S. wood products industry will continue to request critical use exemptions for MeBr of wood packaging and other wood commodities as long as alternative treatments are unavailable, ineffective, or cost-prohibitive. MeBr is highly toxic, mainly at the site

of use, causing ill effects throughout the body.

What has been done

In prior work with USDA-appropriated support and leveraged funds, Penn State researchers got tentative approval of dielectric heating as the first alternative to MeBr under the international standards of the Commission on Phytosanitary Measures. This project facilitates final approval of the technology for wood products. The researchers are optimizing the treatment oven and developing a universal treatment schedule for different species and conditions in commercial settings.

Results

The U.S. committed to a near-complete ban on MeBr use by 2005. However, critical use exemptions by postharvest mills and processors still amount to more than 74 metric tons annually.

This project is developing and delivering the knowledge base needed to promote adoption of this technology by the wood packaging industry. Data will also be useful for treatment of related food and food packaging. It will lead to a dramatic reduction in the use of MeBr for phytosanitary treatment for quarantine and pre-shipment purposes.

The researchers will complete a cost-benefit analysis of dielectric heating in comparison with currently approved treatments to show the industry that dielectric is cost-effective. They will conduct extension activities to promote the adoption of this technology.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment
723	Hazards to Human Health and Safety

Outcome #7

1. Outcome Measures

Investigation of potential for biomass boiler conversion in eastern United States.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Companies need consistent, efficient, and cost-effective energy sources. Wood is a renewable resource that could help contribute to the nation's energy needs for an indefinite period. Reduced dependence on international sources for fuel strengthens the country's position in the world.

What has been done

Penn State researchers found that some companies could economically convert their operations to wood boilers for heat and power. The researchers used databases from the U.S. Energy Information Administration to estimate that 163,000 industrial and commercial boilers are in use in the U.S. Of those, 31,776 oil, coal, and propane boilers are in 37 states in the Midwest, Northeast, and South, the target region of the study. Those boilers generate the energy equivalent of 287 million barrels of oil a year.

Results

The conversion to wood-powered burners would make the most sense for larger commercial and industrial operations in areas with access to large timber resources and with a friendly regulatory environment. Companies are more likely to have the resources to receive, store, and load tons of wood chips and wood pellets that will fuel the boiler.

Most wood boilers use wood chips or pellets. The country's paper industry once consumed most of the wood chips to make paper, but the remaining paper mills consume far less wood now. That availability makes wood more accessible for other purposes, including power and heat generation.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment
605	Natural Resource and Environmental Economics

V(H). Planned Program (External Factors)

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

Brief Explanation**Natural Disasters (drought, weather extremes, etc.)**

- Superstorm Sandy caused postponement of two Community Capacity programs. When rescheduled, some participants were unable to attend.

Economy

- The stagnant growth in the economy may be a factor in decreased attendance for some offerings.

- There is growing awareness with a widening array of stakeholders as to the importance of Marcellus shale development to many aspects of their communities, businesses, educational institutions, and organizations.
- New "Financial Considerations" workshops are conducted to assist landowners receiving or planning to receive bonus and/or lease payments.
- We are also offering more programs in conjunction with external expertise on business development related to the emerging shale gas exploration and development industrial sector.

Appropriations changes

- Appropriation Changes affected both the research and extension functions of the College of Agricultural Sciences and resulted in fewer faculty and staff across all areas of the college.

Public Policy changes

- Changes in public policy and regulations are steady and provide opportunities for us to incorporate the changes, and their implications, into programming.

Government Regulations

- Communities are becoming more engaged in decision making and the consideration of ordinances.

Competing Public priorities

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

Competing Programmatic Challenges

- The College of Agricultural Sciences' restructuring process allowed for continued focus on cost-effective program deliverables and strategic elimination of programs.

Other - Extramural Funding

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

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The generation of outcomes from existing programs and the development of new programs require improved evaluation that identifies pre- and post- responses to information and monitoring for long-term behavioral changes that result in improved environmental outcomes. The evaluations conducted thus far provide initial measures of implementation, but long-term monitoring is needed to ensure that the practices are successfully managed over time. We are attempting to incorporate more economic valuations of the results of our research and extension work.

Key Items of Evaluation

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

V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Economic and Community Development

Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
134	Outdoor Recreation	5%		0%	
206	Basic Plant Biology	0%		5%	
401	Structures, Facilities, and General Purpose Farm Supplies	5%		5%	
512	Quality Maintenance in Storing and Marketing Non-Food Products	5%		2%	
601	Economics of Agricultural Production and Farm Management	10%		1%	
602	Business Management, Finance, and Taxation	10%		3%	
603	Market Economics	5%		8%	
604	Marketing and Distribution Practices	5%		12%	
608	Community Resource Planning and Development	5%		4%	
609	Economic Theory and Methods	5%		2%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	0%		5%	
801	Individual and Family Resource Management	10%		7%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	5%		13%	
804	Human Environmental Issues Concerning Apparel, Textiles, and Residential and Commercial Structures	5%		0%	
805	Community Institutions, Health, and Social Services	5%		4%	
806	Youth Development	10%		7%	
901	Program and Project Design, and Statistics	5%		7%	
903	Communication, Education, and Information Delivery	5%		15%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	44.8	0.0	40.5	0.0
Actual Paid Professional	68.0	0.0	23.5	0.0
Actual Volunteer	31.9	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
2133686	0	443659	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
5260905	0	1403516	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
4647799	0	979019	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Strong communities are built upon a foundation of resilient individuals and families. These foundations, however, are being stressed by globalization of our economy, resulting in a displaced workforce, and by the changing demographics of our citizens. Shifting workforce needs require opportunities to help train or retrain workers for new job opportunities.

Penn State demonstrates commitment to the citizens of the Commonwealth through a diverse array of research and extension programs that address long-standing and emerging issues, such as the Marcellus shale gas drilling and regional food systems. Many of our research efforts in this planned program address civic engagement and effective community institutions to provide residents and businesses with the proper tools to address local problems that affect their community.

This research is delivered via extension programming in a variety of forms, including work with local governments and nongovernmental organizations, advice to businesses new and old, and facilitation of community strategic planning and visioning. Experiences gained during our first 150 years now must be adapted to apply to a changed and continually changing environment.

In the early days of our research and extension programs, we focused primarily on a rural audience, and Pennsylvania, although still highly rural in nature, is now a much more tightly woven patchwork of communities. The success of our traditional rural audience is becoming more and more dependent on the interconnections between our rural, suburban, and urban centers. Many regions that are key agricultural production zones are also now preferred residential locales. This mix creates a variety of tensions that can be resolved only through creative translation of the latest social science and agricultural research into programs that help to provide solutions for previously unknown problems. A current example of rural-urban interface tensions is the definition of "customary agricultural practices." Such definitions were unnecessary in the recent past, but now are important to crafting sensible solutions to conflicting pressures on land use.

In addition to these pressures, the drilling of the Marcellus and Utica shales is stressing Pennsylvania communities in many ways. Communities are faced with impacts on infrastructure (roads, school systems, etc.), social services, housing, etc.

Although there are many challenges facing our communities, there are many opportunities that research and extension can help. Our contributions to these and other community-based conflicts are central for ensuring a high quality of life for Pennsylvania residents.

2. Brief description of the target audience

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

3. How was eXtension used?

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

Several faculty and staff gathered resources from eXtension. One individual published a paper on eXtension.

Several team members are topic experts for eXtension.org, and a few have answered questions from participants in the ask the expert program.

We have cited eXtension as a resource for audiences and used it as a resource when developing new curricula.

V(E). Planned Program (Outputs)

1. Standard output measures

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

Patent Applications Submitted

Year:	2013
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	36	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of college-initiated technology disclosures.

Year	Actual
2013	0

Output #2

Output Measure

- Number of participants in extension education classes and workshops.

Year	Actual
2013	181603

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Percentage of extension class/workshop participants who expect to implement/adopt practices. (This is a short-term outcome measure.)
2	Percentage of extension class/workshop participants who respond to a follow-up survey with a self-report that they have implemented/adopted practices. (This is a medium-term outcome measure.)
3	New mathematical model to determine optimal locations for wholesale food distribution centers.
4	Number of additional extension educators trained to deliver extension workshops -- Food for Profit and Managing Risk for Food Businesses -- in PA, MD, WV, and TN.
5	New automated system for fruit thinning.
6	Young people participating in Young Growers Alliance.
7	Potential dollar increase in farm revenues with the adoption of high tunnel technology by 5% of PA's vegetable and small fruit growers.
8	Application of genetic knowledge to Easter lilies to enhance their marketability.

Outcome #1

1. Outcome Measures

Percentage of extension class/workshop participants who expect to implement/adopt practices. (This is a short-term outcome measure.)

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Percentage of extension class/workshop participants who respond to a follow-up survey with a self-report that they have implemented/adopted practices. (This is a medium-term outcome measure.)

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

New mathematical model to determine optimal locations for wholesale food distribution centers.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The location of wholesale food distributors has a big impact on the efficiency of a food system. Most products are trucked from processing facilities to wholesale distributors, and then on to retail stores. If we sited distribution centers in optimal locations, we could minimize transportation costs, which improves profitability and reduces environmental impacts, and maximize the number of producers and retailers they serve.

What has been done

Penn State researchers developed a new mathematical model to help business owners and policy makers determine the optimal locations for wholesale food distribution centers. The model considers transportation and distributor-construction costs. The constraints in the model clarify how certain changes, including distributor size and capacity, road conditions, and gas prices, might affect the optimal locations of wholesale hubs.

Results

The model will be useful to private-sector firm owners, who can use this information to plan new distribution businesses or to change the locations of their existing distribution centers to maximize their profits and to help lower producers' costs through aggregation. The research team applied the model to the meat supply chain in the Northeast. They identified counties containing slaughtering or meat-processing facilities and counties containing retail meat markets. Inserting these data into their mathematical model, they conducted several simulations to determine the optimal locations for wholesale hubs connecting these slaughter and processing facilities with retail markets. They will also apply the model to fresh fruits and vegetables.

4. Associated Knowledge Areas

KA Code	Knowledge Area
604	Marketing and Distribution Practices

Outcome #4

1. Outcome Measures

Number of additional extension educators trained to deliver extension workshops -- Food for Profit and Managing Risk for Food Businesses -- in PA, MD, WV, and TN.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	22

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Since 1992, Penn State Extension has offered the workshop Food for Profit (FFP), targeting farmers and local food entrepreneurs. The session covers many aspects of food business start-up and development, so participants can make an informed decision about whether to start and operate a food venture. In 2011, the Food Safety Modernization Act (FSMA) raised the bar for all food business owners. FSMA now affects small-scale food producers as well as large, often at great expense in time and money.

What has been done

As a result, a second Penn State workshop, Managing Risk for Food Businesses (MRFB), was designed to build on FFP, as a more comprehensive training about the unique risks of food businesses and specific strategies for mitigating these risks.

Since 2010, demand for FFP and MRFB has continued to rise in PA, MD, and WV, with classes filled to capacity (30-45) and wait lists. Until 2012, only 5 extension educators were qualified to teach sessions and offer post-workshop individualized support.

Results

To respond to this demand, a Northeast SARE project was launched to provide professional development training to 22 extension personnel and agricultural professionals in PA, MD, WV, and TN. The project team used 7 webinars and 14 field trips to empower the trainees to plan and deliver standardized FFP and MRFB workshops in their regions, as well as to provide customized follow-on support. Once trainees received this base of education, they apprenticed with seasoned project team members to offer 8 FFP workshops in October and November, 2013, enabling 151 farmers and food entrepreneurs to determine whether their situation and interests would support a food venture. The project team is now collecting information under the SARE grant to determine if a 'graduate' of the class started a business, what kind of net revenue was realized in the first year.

4. Associated Knowledge Areas

KA Code	Knowledge Area
602	Business Management, Finance, and Taxation
604	Marketing and Distribution Practices
801	Individual and Family Resource Management

Outcome #5

1. Outcome Measures

New automated system for fruit thinning.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

It takes only 10% of a tree's fruit to produce a profitable crop. If too much fruit is left on a tree, all of that season's fruit turns out extremely small and next year the tree will not produce enough fruit to turn a profit. The only reliable current strategy for removing excess fruit in peaches is hand-thinning. This practice can require as much as 100 laborer hours per acre, or 10 people who each work for 10 hours on each acre of orchard. Depending on the region, this can cost \$750 to \$1,120 per acre.

What has been done

An integrated team led by Penn State developed an automated system for fruit thinning that can reduce the labor requirement by 50 percent. For peach crops, these tractor-mounted or handheld thinners also resulted in better fruit quality and yield to an average net economic output of \$694

per acre. Nationally, the annual economic benefit to peach growers is \$82.5 million and a labor reduction of 5.9 million hours, which could increase the revenue of rural economies by \$181.5 million per year.

Results

The project is expanding from peaches into other crops (apple, cherry, and plum) with similar results. If adoption is widespread across all potential crops, growers can realize increased economic output of over \$440 million per year, which will translate to a positive economic impact on rural economies of almost \$1 billion per year.

4. Associated Knowledge Areas

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

Outcome #6

1. Outcome Measures

Young people participating in Young Growers Alliance.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	250

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Many older farmers wonder who will take over their farm when they retire. At the same time, many young people want to get started in farming, but the costs and knowledge gap can seem prohibitive.

What has been done

Penn State's Young Grower Alliance (YGA), with additional support from the State Horticultural Association of PA, supports more than 250 young people as they transition into a career as a specialty crop grower. YGA offers education, support, and networking to young people interested in or just beginning their horticultural career. YGA fulfills their desire to learn, meet peers who have chosen a similar lifestyle, take on leadership opportunities in the industry, and give back through service.

Results

One of the most overlooked aspects of farming is what happens to the farm when the person who currently makes the major decisions decides to retire or passes away. Effective transitional planning can help to alleviate the obstacles that successors will face, while ensuring the continued financial health of the family and business. Preservation of farmland and its associated

ecosystem services are other benefits to successful farm transition planning.

4. Associated Knowledge Areas

KA Code	Knowledge Area
602	Business Management, Finance, and Taxation
801	Individual and Family Resource Management
806	Youth Development

Outcome #7

1. Outcome Measures

Potential dollar increase in farm revenues with the adoption of high tunnel technology by 5% of PA's vegetable and small fruit growers.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1400000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

High tunnels offer plants protection from wet, saturated soils and low temperatures in the spring and fall, thereby extending the growing season. High tunnels are nonpermanent structures generally constructed of a metal frame covered with a single layer of greenhouse-grade plastic. High tunnels differ from greenhouses in that plants typically are grown directly in the ground instead of in pots, and high tunnels do not have permanent heating or automated ventilation systems.

What has been done

Pennsylvania growers are using high tunnels to extend the season and grow more food year round for consumers' tables. Penn State Extension hosted 9 high tunnel twilight sessions and intensive schools to help more growers adopt this new technology and improve their high tunnel production. Two hundred eighty growers participated. Eighty-two percent planned to put this new knowledge to practice on their farms, representing 231 acres of vegetables and small fruit.

Results

In general, the crops grown in high tunnels at Penn State's experimental farm have had higher yields and better quality than those grown outdoors. Few pests occur in high tunnels, which can mean less pesticide compared to crops grown outdoors. High tunnels are lower priced than greenhouses at a cost of about \$2.38 per square foot compared to \$20-\$37 per square foot for a greenhouse.

New high tunnel owners typically generate \$6000-11,000 in gross revenues from a 30' x 96' tunnel--about \$3-5 per square foot. This translates into a conservative net income increase for farmers of 6-8%. There are about 3,400 growers of vegetables and small fruit in PA. If we assume that just 5% of them install a high tunnel, and that they each earn average revenues, this translates into \$1.4 million.

Raising farm profits increases the likelihood that farm operations continue and farmland is preserved, along with the tremendous ecosystem services it provides.

4. Associated Knowledge Areas

KA Code	Knowledge Area
401	Structures, Facilities, and General Purpose Farm Supplies
601	Economics of Agricultural Production and Farm Management

Outcome #8

1. Outcome Measures

Application of genetic knowledge to Easter lilies to enhance their marketability.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Easter lilies had a wholesale value of \$37.4 million in 1995 (USDA), making them the 4th largest crop in wholesale value of US potted plants. Pennsylvania is 3rd in the country for producing Easter lilies. Of the 4 top crops, Easter lily has the narrowest holiday sales window, only about 2 weeks. The time it takes a plant to switch from vegetative to reproductive phase profoundly affects the market value of lilies, which should have their first flower open 2 weeks prior to Easter for best sales.

What has been done

This research is examining how flowering is controlled in Easter lilies. Plants need to gauge when both internal and external cues are optimal before they start flowering. Penn State researchers are applying new information on flowering time genes in Arabidopsis to Easter lily with the ultimate goal of triggering flowering by expressing specific flowering time genes. They are evaluating growth parameters of Easter lilies for the complete growth cycle and analyzing genes regulating flowering time.

Results

Basic knowledge obtained with Arabidopsis can now be applied to solve many practical problems in the horticulture industry. Flowers have special meanings to people and they are in high demand on specific days. This high demand makes it vital for specific flower types to be available in a narrow window of time. This research with Easter lilies builds on our previous research with Arabidopsis to provide a clearer understanding of how flowering is controlled by environmental conditions and developmental regulation. Knowledge gained will help Easter lily growers maximize profitability by helping the plants to flower at the desired time.

4. Associated Knowledge Areas

KA Code	Knowledge Area
206	Basic Plant Biology

V(H). Planned Program (External Factors)

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

Brief Explanation

Natural Disasters (drought, weather extremes, etc.)

· Weather extremes with too wet or too dry conditions had major implications for somatic cell count and feed quality and quantity. This can have huge impacts on a producer's income, due to decreased milk production and milk premium earned, and increased feed costs.

Economy

- Stagnant growth in the economy has had mixed effects. It may be a factor in decreased attendance for some offerings. It may also drive people to explore entrepreneurship, thus increasing attendance at courses such as Food for Profit.
- The volatility of the grain and milk markets has forced dairy producers to be more involved in how to use risk management to cover their margin and produce an increased amount of high quality milk.
- Banks are requiring a cash flow plan before any consideration is given to making loans. To use risk management properly, producers need to know their breakeven income over feed cost and milk margin so they can make smart decisions.
- The new "Financial Considerations" workshops were added to assist landowners receiving or planning to receive bonus and/or lease payments for shale gas drilling.
- We are offering more programs in conjunction with external expertise on business development related to the emerging shale gas exploration and development industrial sector.

Appropriations changes

- Appropriation Changes affected both the research and extension functions of the

College of Agricultural Sciences and resulted in fewer faculty and staff across all areas of the college.

Public Policy changes

- Changes in public policy and regulations are steady and provide opportunities to incorporate the changes and their implications into programming.

Government Regulations

- The Food Safety Modernization Act trickled down to smaller businesses, so more people came to workshops to learn what they must do.
- There is also a growing awareness with a widening array of stakeholders as to the importance of Marcellus shale development to many aspects of their communities, businesses, educational institutions, and organizations. Communities are becoming more engaged in decision making and the consideration of ordinances. Considerable discussion is taking place on the local level as municipal officials discuss their options for some local regulation.

Competing Public priorities

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

Competing Programmatic Challenges

- The College of Agricultural Sciences' restructuring process allowed for continued focus on cost-effective program deliverables and strategic elimination of programs.
- Some other groups are providing competitive educational programming. But others, such as Ag Choice Farm Credit, are more actively connecting with extension to reach their audiences.
- Loss of farm management educators with no replacement meant that educators were redirected to SET projects, and could not do as much entrepreneurship programming.

Other - Extramural Funding

- The PA 4-H Science Team was successful in obtaining funding totaling \$241,278 to support new curriculum initiatives and staff development.
- The USDA RMA grant we had in 2012 was not re-awarded to us in 2013. We had to search for alternative sources of funding for travel and program resources.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The generation of outcomes from existing programs and the development of new programs require improved evaluation that identifies pre- and post- responses to information and monitoring for long-term behavioral changes that result in improved environmental outcomes. The evaluations conducted thus far provide initial measures of implementation, but long-term monitoring is needed to ensure that the practices are successfully managed over time. We are attempting to incorporate more economic valuations of the results of our research and extension work.

Key Items of Evaluation

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

V(A). Planned Program (Summary)

Program # 7

1. Name of the Planned Program

Environmental Management

- Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
101	Appraisal of Soil Resources	5%		5%	
102	Soil, Plant, Water, Nutrient Relationships	10%		5%	
112	Watershed Protection and Management	10%		5%	
123	Management and Sustainability of Forest Resources	0%		5%	
133	Pollution Prevention and Mitigation	5%		5%	
135	Aquatic and Terrestrial Wildlife	5%		5%	
136	Conservation of Biological Diversity	5%		4%	
202	Plant Genetic Resources	5%		5%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	5%		5%	
204	Plant Product Quality and Utility (Preharvest)	5%		5%	
211	Insects, Mites, and Other Arthropods Affecting Plants	5%		5%	
212	Pathogens and Nematodes Affecting Plants	5%		5%	
213	Weeds Affecting Plants	0%		5%	
214	Vertebrates, Mollusks, and Other Pests Affecting Plants	5%		5%	
215	Biological Control of Pests Affecting Plants	5%		5%	
216	Integrated Pest Management Systems	5%		5%	
301	Reproductive Performance of Animals	0%		5%	
306	Environmental Stress in Animals	5%		5%	
403	Waste Disposal, Recycling, and Reuse	5%		6%	
601	Economics of Agricultural Production and Farm Management	10%		5%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890

Plan	45.1	0.0	72.6	0.0
Actual Paid Professional	40.2	0.0	85.6	0.0
Actual Volunteer	23.5	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
1288999	0	742847	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
2925705	0	3154131	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
1918470	0	4402610	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Linked to the Food and Fiber Systems program, the reliance of Pennsylvania agriculture on livestock production, especially dairy and poultry, creates significant environmental challenges. The increased focus on the health of the Chesapeake Bay means that new policies are introduced here in Pennsylvania and other states within the watershed before being applied to other watersheds nationwide. We are balancing the application and demonstration of current best management practices with the need to develop and validate new technologies and to insert the best available science into policy making.

Unexpected natural climate variation continues to influence priority identification. Changing demographics and land use decisions are key drivers for environmental management.

2. Brief description of the target audience

- Agricultural Producers/Farmers/Landowners
- Agriculture Services/Businesses
- Nonprofit Associations/Organizations
- Business and Industry
- Community Groups
- Education
- General Public
- Government Personnel
- Students/Youth
- Volunteers/Extension Leaders

3. How was eXtension used?

Members of every team serve as topic experts and answer questions from participants in the ask the expert program.

Two members of the equine team participate in the Horsequest community of practices. They have conducted national webinars dealing with equine environmental stewardship through MyHorseUniversity and HorseQuest eXtension. They have answered 69 questions dealing with equine health and

2013

1

Output #2

Output Measure

- Number of participants in extension education classes and workshops.

Year

Actual

2013

44693

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Percentage of extension class/workshop participants who expect to implement/adopt practices. (This is a short-term outcome measure.)
2	Percentage of extension class/workshop participants who respond to a follow-up survey with a self-report that they have implemented/adopted practices. (This is a medium-term outcome measure.)
3	Assessment framework for valuing ecosystem services provided by cover crops.
4	Percent reduction in average milk production if dairy drinking water has at least one water quality issue.
5	Upper Chesapeake Bay, which is dominated by the Susquehanna River flowing out of PA, again received the highest possible score on the latest Chesapeake Bay report card, indicating the positive impacts of our nutrient management efforts.
6	Potential cost savings (in \$) if just 5% of soybean acreage statewide was not sprayed with pesticide unless the economic threshold was met.
7	Finding that queen bees convey nuanced signals through pheromones to worker bees about their reproductive status, possibly helping to explain recent rapid rate of queen bee loss.
8	Development of Fertilizer Forecaster, a research-driven support tool for nutrient management that identifies the relative probability of runoff or infiltrating events in Pennsylvania landscapes.
9	Analysis of statewide spread of invasive, nonnative Ailanthus trees since introduction, as tied to human history.
10	Potential cost savings (in \$) to growers if 62% of corn acres planted statewide were IPM-friendly non-Bt.
11	Potential cost savings (in \$) to Mid-Atlantic tree-fruit growers from planting new size-controlling rootstock and concomitant reduction in pesticide usage.
12	Discovery that mixing fresh mushroom compost into mulch greatly reduces artillery fungus.

Outcome #1

1. Outcome Measures

Percentage of extension class/workshop participants who expect to implement/adopt practices. (This is a short-term outcome measure.)

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Percentage of extension class/workshop participants who respond to a follow-up survey with a self-report that they have implemented/adopted practices. (This is a medium-term outcome measure.)

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Assessment framework for valuing ecosystem services provided by cover crops.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Cropping systems that provide ecosystem services beyond crop production are gaining interest from farmers, policy makers, and society, yet we lack frameworks to evaluate and manage for multiple ecosystem services. These services include important safeguards against climate change (soil carbon storage, N₂O reduction), protection of water quality (nitrate retention), conservation of beneficial insects, and weed and pest suppression, allowing less use of pesticides and herbicides.

What has been done

Using the example of integrating cover crops into annual crop rotations, we developed an assessment framework that estimates the temporal changes of various ecosystem services, illustrates ecosystem multifunctionality, and identifies key times for optimizing ecosystem service benefits and minimizing tradeoffs. We applied the framework to analyze the changes in 11 ecosystem services and 2 economic metrics when introducing cover crops into a 3-year

soybean--wheat--corn rotation in the Mid-Atlantic.

Results

By managing crop fields simultaneously for profitability and ecosystem services, such as by planting cover crops, we can optimize total production. Penn State researchers estimated that cover crops could increase 8 of 11 ecosystem services without negatively affecting crop yields. They demonstrated that when we measure ecosystem services matters and that cumulative assessments can be misleading due to the episodic nature of some services. Trade-offs occurred between cover crop ecosystem benefits, production costs, and management risks. Differences in production costs with and without cover crops varied 3-fold over 10 years, largely due to changes in fertilizer prices. So cover crop use will become more economical with increasing fertilizer prices or if modest cost-sharing programs are established. This framework provides a means to quantify ecosystem services and ease the transition to more multifunctional agricultural systems.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
133	Pollution Prevention and Mitigation
213	Weeds Affecting Plants

Outcome #4

1. Outcome Measures

Percent reduction in average milk production if dairy drinking water has at least one water quality issue.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	10

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Dairy farms rely on good quality water to ensure maximum milk production and herd health. Most dairy farms routinely test their water supplies for bacteria, but additional testing for salts, metals, and other parameters that can affect herd performance is conducted less frequently. These less-tested parameters may explain chronic herd performance issues.

What has been done

Penn State researchers analyzed samples from 174 water supplies from Pennsylvania dairy farms in 41 counties. They found that about a quarter of those tested had at least one water-

quality issue. Average milk production for these farms was about 10% lower than farms with good water quality.

Results

Ninety-eight percent of the water samples came from private water wells or springs on the dairy farms. The farms in the study encompassed 51,000 acres and 18,000 cows with an average milk production level ranging from 20 to 90 pounds of milk per cow per day.

Overall, 26% of the water supplies had at least one water-quality issue. Average milk production for these farms was 56 pounds per cow per day, compared to 62 pounds on the farms with good water quality.

None of the farms with high milk production (above 75 pounds of milk per cow per day) had existing water quality problems, while 32% of farms with low milk production (below 50 pounds of milk per cow) had at least one potential water-quality problem.

Farm profitability affects the sustainability of farms. If farms are sold because of low profitability, society loses some or all of the ecosystem services that farmland provides.

Some of the water quality issues may also be a concern for people drinking from the same water source.

4. Associated Knowledge Areas

KA Code	Knowledge Area
306	Environmental Stress in Animals
601	Economics of Agricultural Production and Farm Management

Outcome #5

1. Outcome Measures

Upper Chesapeake Bay, which is dominated by the Susquehanna River flowing out of PA, again received the highest possible score on the latest Chesapeake Bay report card, indicating the positive impacts of our nutrient management efforts.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Impaired water quality in Chesapeake Bay has long been a concern. Environmental health of aquatic life and biodiversity are compromised by nonpoint source pollution, with significant social, economic, and environmental costs to citizens of the bay watershed.

What has been done

Nutrient management planners were trained and successfully completed the requirements for certification in PA. More than 2,000 nutrient management plans have been developed and approved by specialists trained by this extension program. This program continued to provide educational and technical support to government agencies and NGOs for the development of nutrient management programs to maximize economic benefit from nutrients while minimizing the environmental impact.

Results

The latest Chesapeake Bay report card again gave the upper Chesapeake Bay, which is dominated by the Susquehanna River flowing out of PA, the highest score, indicating that our efforts in nutrient management are having a significant positive impact.

A critical activity of this project has been educational support for the Pennsylvania Manure Management Manual (MMM). About 40,000 farms in PA will have to develop manure management plans over the next several years. This extension program has collaborated extensively on research on manure management in no-till production systems.

4. Associated Knowledge Areas

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

Outcome #6

1. Outcome Measures

Potential cost savings (in \$) if just 5% of soybean acreage statewide was not sprayed with pesticide unless the economic threshold was met.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	275000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Many growers routinely spray pesticide because they are worried about the threat of pests. But spraying when the pest is below the economic threshold is a waste of money and can harm the environment.

What has been done

With leveraged support of the PA Soybean Board, Penn State extension educators regularly scout 18 "typical" soybean fields in 13 counties across the state. They report the populations of plant pathogens and insect pests they find in these sentinel plots in Field Crop News and on an entomology website.

Scouting efforts discovered a wide range of insects and diseases, but none exceeded economic thresholds, so none of the fields required pesticide treatments. This was also the case in 2012.

Results

Pest populations are not pervasive and always threatening soybean yield. In fact, in many locations and in most years, pest populations do not develop even to the economic threshold level, so pesticide use should provide no advantage. It adds unnecessary expense to farm operations. Let's conservatively assume the cost of fuel, pesticide, and time may be \$10/acre. About 550,000 acres of soybean were planted in PA in 2013. So if we assume just 5% adoption statewide of waiting until the pest economic threshold is reached to spray, that could mean an extra \$275,000 in PA soybean growers' profits. More profitable farms mean more farmland preservation, including the ecosystem services it provides, and preservation of rural economies.

Unnecessary pesticide application could also kill beneficial insects, harm human health, and impair water quality and aquatic life.

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
216	Integrated Pest Management Systems
601	Economics of Agricultural Production and Farm Management

Outcome #7

1. Outcome Measures

Finding that queen bees convey nuanced signals through pheromones to worker bees about their reproductive status, possibly helping to explain recent rapid rate of queen bee loss.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
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3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Beekeepers report that their queens seem to be lasting only a few weeks or months instead of 1 or 2 years. Worker bees replace their queens when they are not performing well. If worker bees can detect poorly mated queens and remove them, that may explain the rapid rate of queen loss.

When workers replace failing queens, it takes up to 3 weeks for the new queen to begin laying eggs and another 3 weeks for the new workers to become adults. This reduces honey production and pollination efficiency.

What has been done

Penn State researchers found that queen bees convey nuanced signals through pheromones to worker bees about their reproductive status. The queens "tell" the workers whether or not and how well they are mated. Workers can adjust their behavior accordingly. Why do worker bees care if their queen is well mated? Previous research has shown that colonies headed by more promiscuous queens are more genetically diverse, healthier, more productive, and less likely to collapse.

Results

Worldwide, at least 450 crop plant species depend on pollination by bees and other insects. Pollinators are important in the production of more than 150 U.S. food crops. Almost all fruit and grain crops require pollination to produce the crop. Estimates of the annual value of honey bee pollination of U.S. agricultural crops range from \$6-14 billion.

In addition to signaling queen bee reproductive status and quality, queen bee pheromones regulate how fast workers mature and transition from taking care of developing larvae to foraging outside the hive. It is possible that changing the quality of the pheromone could disrupt this and other processes, which could have large-scale effects on colony organization and survival.

The more we know about what affects queen bees' health, the better chance we have of creating high-quality queens and disease-resistant stocks of honey bees.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
306	Environmental Stress in Animals

Outcome #8

1. Outcome Measures

Development of Fertilizer Forecaster, a research-driven support tool for nutrient management that identifies the relative probability of runoff or infiltrating events in Pennsylvania landscapes.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Mandated nutrient-management plans are designed to provide guidance for farmers to help them make prudent decisions. But these plans may not provide the day-to-day support required to make operational decisions, particularly when and where to apply nutrients in the short term. These short-term decisions can make the difference between whether the nutrients affect water quality or are efficiently used by crops.

What has been done

Beginning with USDA appropriated support, Penn State researchers developed the Fertilizer Forecaster, a web-based decision-support tool that producers use before applying fertilizer to assess the risk of nutrients running off into surface water. The tool helps farmers improve water quality by making better decisions about when and where to apply fertilizer. It supports field-specific decisions by farmers on when and where to apply fertilizers and manures over 24-, 48-, and 72-hour periods.

Results

Rainfall that infiltrates the soil on the heels of a broadcast fertilizer application is beneficial, because it washes soluble nutrients into the soil where crops can use them. Conversely, rainfall events that generate runoff shortly after fertilizer applications can lead to significant nutrient loss from the site, ultimately polluting bodies of water, such as streams, rivers, and Chesapeake Bay.

Data from on-farm trials is being used to assess farmers' fertilizer and manure- and tillage-management decisions before and after conscientious use of the Fertilizer Forecaster. This will increase understanding not only about the effectiveness of the tool, but also about characteristics of farmers with the greatest potential to benefit from such a tool. Feedback from on-farm trials is being used to refine a prototype tool for delivery to the Pennsylvania Conservation Commission.

The Fertilizer Forecaster could serve as the basis for state, regional, and national changes in nutrient-management planning.

4. Associated Knowledge Areas

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

Outcome #9

1. Outcome Measures

Analysis of statewide spread of invasive, nonnative Ailanthus trees since introduction, as tied to human history.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Ailanthus, or tree of heaven, native to China, is the number one cause of native tree regeneration failure in clearcuts in PA. Ailanthus was first imported to PA in the late 1700s as a status symbol for rare plant collectors. Ailanthus can invade quickly in clearcuts and displace slower-growing native trees. The species's change from prized possession to forest management nightmare serves as a lesson in the unpredictability of nonnative species mixing with human interactions.

What has been done

Penn State researchers analyzed the statewide spread of ailanthus trees since introduction. This occurred in spurts connected with stages of human history, such as cross-state railroad construction in the mid-1800s.

In the 1980s, gypsy moth infestation killed large oak stands in the state forests. Crews had to build roads to harvest the trees. The roads became avenues for ailanthus's spread. Ailanthus grew faster than competing species in the clearcuts and quickly dominated the forests.

Results

There are other invasive tree species in Pennsylvania, but ailanthus, by far, has been here longer and does more damage than any other invasive tree.

The Pennsylvania Department of Transportation spends about \$4 million annually for vegetative management programs, including herbicide application, brush and tree trimming, and removal of undesirable plant species. Most vegetative management programs rely heavily on use of herbicides, which require annual reentry and reapplication for many years.

Besides the cost of vegetation management along state roadways, which of course includes many plants besides ailanthus, the loss of timber value and costs of forest plot management caused by invasion of clearcuts by ailanthus is great.

Recent drilling operations in PA forests may cause the species to expand farther.

Analysis of the spread of an invasive nonnative plant can help land managers recognize and manage situations that might lead to the spread of other similar plants.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources

Outcome #10

1. Outcome Measures

Potential cost savings (in \$) to growers if 62% of corn acres planted statewide were IPM-friendly non-Bt.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	22600000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

European corn borer (ECB) used to be the most important pest of corn in the U.S. Not that long ago, it caused crop losses that annually approached \$1 billion nationwide. To protect crops from ECB, many farmers grow genetically modified corn that expresses insecticide to kill the worms. The toxins, which come from the bacterium *Bacillus thuringiensis* (Bt), kill 99.9% of larvae when they feed on this type of corn. But the high cost of purchasing the seeds can decrease potential profits.

What has been done

Penn State researchers found that populations of ECB have declined significantly in the eastern U.S. With less ECB damage, non-Bt and Bt hybrids yielded comparably. The decline in ECB could allow growers to generate greater profits by planting non-Bt seed, which costs about \$50 less per 50 pound bag than Bt seed. The researchers also found that the PestWatch network, which traps ECB and provides data about their prevalence, can inform decisions about whether to choose Bt or non-Bt hybrids.

Results

The researchers urge growers to scout their non-Bt acreage toward the end of the growing season. If growers have low ECB, and PestWatch reflects low moth captures in their area, the researchers recommend that growers try competitive non-Bt hybrids the next season on some of their acres.

Across years, this project has found that 62% of sites could have grown non-Bt corn and earned a better profit. If these results are assumed for 62% of the 1.46 million acres of corn planted statewide, the savings in seed would be \$22.6 million.

More profitable farms mean more farmland preservation, including the ecosystem services it provides, and preservation of rural economies.

Growers planting Bt corn hybrids must plant set amounts of non-Bt corn to help prevent evolution of ECB populations resistant to the Bt toxins expressed in corn hybrids. Reducing the amount of Bt corn reduces the potential for ECB to develop resistance to Bt toxins, as corn rootworms have done in about 12 states.

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
215	Biological Control of Pests Affecting Plants
601	Economics of Agricultural Production and Farm Management

Outcome #11

1. Outcome Measures

Potential cost savings (in \$) to Mid-Atlantic tree-fruit growers from planting new size-controlling rootstock and concomitant reduction in pesticide usage.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	150000000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

With market competition, demand for high quality fruit, and pressure to reduce chemical use, tree-fruit growers focus on economically and environmentally sustainable production. For improved profitability, growers can establish high-density plantings with smaller trees using new cultivars. More closely spaced trees reduce pesticide use and increase efficiency.

What has been done

Penn State researchers on this multistate project evaluated the influence of rootstocks on temperate-zone fruit tree characteristics. They studied labor-efficient tree fruit production and made recommendations for Mid-Atlantic peach and dwarf apple rootstocks. Most new apple

rootstocks are size-controlled with substantially reduced canopy volume per acre, so pesticide usage is reduced by nearly 40%. This reduces the environmental impact and saves growers pesticide and application costs.

Results

The use of recommended rootstocks will result in a 50% reduction in canopy volume and a concomitant 50% reduction in pesticide usage on 200,000 acres. The reduction in pesticide use will net environmental benefits and save \$150 million in pesticide cost and application. The recommended, disease-resistant rootstocks and better selection against susceptible rootstocks will reduce tree losses by 10%.

This project's recommendations and educational programs will guide the planting of 200,000 acres of fruit trees in the next 5 years, resulting in a more economically sustainable fruit industry. Using recommended rootstocks, mature yields will increase by 20%, fruit size by 10%, and the percent of fruit meeting the highest grade category by 20%. The financial benefit to U.S. fruit growers from earlier returns, greater yield, and higher fruit quality will be \$250 million as a direct result of using these recommendations.

Cumulative, measurable benefits to the U.S. temperate tree-fruit industries will be more than \$400 million.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
601	Economics of Agricultural Production and Farm Management

Outcome #12

1. Outcome Measures

Discovery that mixing fresh mushroom compost into mulch greatly reduces artillery fungus.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Artillery fungus (AF) colonizes and thrives in moist mulch. It is common across the U.S., but especially in the East and Mid-Atlantic. It propels its spores (gleba) like a cannon toward sunlight or light-colored objects, including houses and cars, leaving small, tar-like black specks. Dry gleba are extremely difficult to remove, leave a permanent stain, and may warrant material replacement, creating financial issues for homeowners, landscape contractors, insurance companies, and garden centers.

What has been done

Penn State researchers studied AF growth in various mixtures of landscape mulch with fresh mushroom compost (MC), a byproduct of PA's button mushroom industry. Mixing 60% mulch and 40% fresh MC gave 95% control of AF sporulation compared to mulch alone. Mixtures of about 75:25 to 50:50 mulch:MC significantly reduced AF sporulation.

Results

More than 3.5 million cubic yards of MC are produced yearly in PA. Finding a beneficial reuse for it may improve the profitability of the state's mushroom growers while fighting costly AF. Pennsylvania accounts for 61% of total U.S. mushroom production, which totaled 900 million pounds for the 2011-12 crop, at a value of \$1.1 billion.

According to the Pennsylvania Landscape and Nursery Association, more than about 3 million cubic yards of landscape mulch are sold annually to homeowners in the southeastern part of Pennsylvania alone. Landscape mulch is big business, and using a waste or underutilized product to help reduce the problem of mulch contamination with AF makes economic sense.

4. Associated Knowledge Areas

KA Code	Knowledge Area
214	Vertebrates, Mollusks, and Other Pests Affecting Plants

V(H). Planned Program (External Factors)

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

Brief Explanation**Natural Disasters (drought, weather extremes, etc.)**

- Floods and droughts create issues with needing to reseed experimental plots and adapt plans in other ways.
- Adverse weather factors continue to influence clientele participation, both from extended periods of rain in summer and winter snow and ice events.

Economy

- The economic climate continues to have a significant impact on the ability of

clientele to attend meetings and conferences.

- The economy may have impaired implementation of best management practices.
- Increase in expense of grains made profitability of operations decrease, and therefore, many producers were unable to attend meetings or afford suggested changes in production techniques.

Appropriations changes

- Appropriation Changes affected both the research and extension functions of the College of Agricultural Sciences and resulted in fewer faculty and staff across all areas of the college.

Public Policy changes

- State-mandated manure management planning creates opportunities for new workshops and new contacts with producers.

Competing Public priorities

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

Competing Programmatic Challenges

- The College of Agricultural Sciences' restructuring process allowed for continued focus on cost-effective program deliverables and strategic elimination of programs.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The generation of outcomes from existing programs and the development of new programs require improved evaluation that identifies pre- and post- responses to information and monitoring for long-term behavioral changes that result in improved environmental outcomes. The evaluations conducted thus far provide initial measures of implementation, but long-term monitoring is needed to ensure that the practices are successfully managed over time. We are attempting to incorporate more economic valuations of the results of our research and extension work.

Key Items of Evaluation

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

V(A). Planned Program (Summary)

Program # 8

1. Name of the Planned Program

Food and Fiber Systems

Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships	5%		5%	
121	Management of Range Resources	5%		0%	
204	Plant Product Quality and Utility (Preharvest)	5%		2%	
205	Plant Management Systems	5%		10%	
206	Basic Plant Biology	5%		5%	
211	Insects, Mites, and Other Arthropods Affecting Plants	5%		14%	
212	Pathogens and Nematodes Affecting Plants	5%		14%	
213	Weeds Affecting Plants	5%		4%	
214	Vertebrates, Mollusks, and Other Pests Affecting Plants	5%		1%	
215	Biological Control of Pests Affecting Plants	5%		2%	
216	Integrated Pest Management Systems	10%		5%	
301	Reproductive Performance of Animals	5%		10%	
305	Animal Physiological Processes	5%		7%	
306	Environmental Stress in Animals	5%		5%	
307	Animal Management Systems	5%		4%	
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals	5%		3%	
315	Animal Welfare/Well-Being and Protection	5%		1%	
402	Engineering Systems and Equipment	5%		4%	
404	Instrumentation and Control Systems	0%		2%	
511	New and Improved Non-Food Products and Processes	5%		2%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890

Plan	99.6	0.0	199.8	0.0
Actual Paid Professional	49.0	0.0	218.9	0.0
Actual Volunteer	53.9	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
2429652	0	2254909	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
4954197	0	10407049	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
2240437	0	16230802	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research and extension program areas employ a comprehensive, systems-based approach to address the complex issues surrounding the production, processing, and utilization of food and fiber. The drivers for the food and fiber systems are undergoing a fundamental shift that increasingly emphasizes consumer needs and desires in combination with those of producers. Research and extension programs focus on the farm-to-fork continuum, with emphasis on research-based educational programs for the producers and consumers of our agricultural commodities. Our work is responsive to consumers who are demanding that safe, wholesome food is produced in an environmentally and ethically responsible manner. With agriculture as the largest industry in Pennsylvania, Penn State will continue to provide educational science-based programs that improve the profitability and sustainability of production agriculture.

Actions to increase the value of goods and services within the food and fiber sector increase profitability at the local and regional levels. These efforts take into consideration and address the changing societal awareness and interest in animal welfare. The health and welfare of production animals is a priority for producers and consumers; furthermore, a fundamental understanding of animal health can translate to issues that affect human health care. Agencies at the state and federal levels and the consuming public have a heightened awareness and expectation for environmental issues as important factors in plant and animal production. Producers are informed and educated on best management practices that increase the level of profitability and sustainability of food and fiber systems in an environmentally acceptable manner. The interrelationships among plants, animals, people, and the environment are reflected in regulatory policies that influence decision-making relative to agricultural production.

Consumer desires for high quality, pest- and pathogen-free agricultural products that are produced with a minimum of pesticides are a continuing challenge. Effective pest management strategies, with a focus on a systems approach, in both plant and animal agriculture have been at the heart of Penn State excellence for many years. As new pests emerge, as our portfolio shifts, and as environmental knowledge and rules change, we are faced with the continued need to devise new strategies that acknowledge these changes and take advantage of emerging technologies. The development of monitoring and predictive tools to assess pest presence and spread, the accurate identification of pest species, and the integration of pest control into other management decisions are all key areas in our AES and CES portfolios.

2. Brief description of the target audience

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

3. How was eXtension used?

Members of every team serve as topic experts and answer questions from participants of the ask the expert program.

The forage team has several pages on the Livestock and Poultry Environmental Learning Center eXtension page.

On the horticulture team, some members used eXtension for professional development; some referred clients to obtain information; and others used it for the development of online courses. Many green industry sub-team members are concerned with the utility of eXtension for our extension educational programs.

V(E). Planned Program (Outputs)

1. Standard output measures

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

Patent Applications Submitted

Year: 2013
 Actual: 1

Patents listed

Serial No. 13/668,859; Filed 11/5/2012; Title: High Lycopene Content Tomato Plants and Markers for Use in Breeding for Same

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	100	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of college-initiated technology disclosures.

Year	Actual
2013	6

Output #2

Output Measure

- Number of participants in extension education classes and workshops.

Year	Actual
2013	57340

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Percentage of extension class/workshop participants who expect to implement/adopt practices. (This is a short-term outcome measure.)
2	Percentage of extension class/workshop participants who respond to a follow-up survey with a self-report that they have implemented/adopted practices. (This is a medium-term outcome measure.)
3	Potential yearly additional corn production (in dollars) in Pennsylvania assuming 5% adoption of new interseeder technology.
4	Discovery of serious toxic effects on developing honeybee larvae by dietary pesticides at concentrations that currently occur in hives.
5	Number of first reports of plant pathogens made for quinoa in Pennsylvania.
6	Estimated dollars in apple crop losses averted through surveys and education programs.
7	Finding that symbiotic bacteria living inside potato beetles cause plants to resist the wrong invader.

Outcome #1

1. Outcome Measures

Percentage of extension class/workshop participants who expect to implement/adopt practices. (This is a short-term outcome measure.)

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Percentage of extension class/workshop participants who respond to a follow-up survey with a self-report that they have implemented/adopted practices. (This is a medium-term outcome measure.)

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Potential yearly additional corn production (in dollars) in Pennsylvania assuming 5% adoption of new interseeder technology.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	3800000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

With cover crops gaining favor for their ability to reduce soil erosion, take up excess nutrients, suppress weeds, and provide forage and biofuel feedstock, researchers are seeking ways to improve cover-crop establishment before harvest of the primary crop.

What has been done

Beginning with Hatch funding and supplemented with SARE, NRCS-CIG, and College of Agricultural Sciences' research innovation grants, research and extension staff have designed, built, tested, and refined a machine that interseeds a cover crop into no-till corn, while also applying fertilizer and post-emergent herbicide. Multiyear on-farm tests are going on in PA, MD, VT, and NY. Accomplishing three tasks in one pass can save growers time and money, making cover crops more economically feasible.

Results

The interseeder establishes cover crops, while potentially spraying and sidedressing fields, using modest seeding rates of species that supply N, improve soil quality, or provide late-season grazing for wildlife.

Corn yields could rise by 7-10 bu/ac with the interseeding system. If we assume 5% adoption in PA and 7% yield boost, growers could see corn sales rise by \$2.6 million/yr. If we estimate a similar yield increase in silage corn, the value of the added silage is \$1.2 million. So the total yearly benefit of 5% adoption could be an additional \$3.8 million in corn production in PA alone.

At 5% adoption, fertilizer N needs should drop by at least 30 lb/ac due to legume effects or enhanced manure N recovery, which means about 2.2 million lb/yr less of N for corn production. This savings would likely result from reduced overwinter losses of soil N -- an environmental benefit.

The team is marketing the interseeder for licensing and has applied for a patent. They are testing it in soybean.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
402	Engineering Systems and Equipment

Outcome #4

1. Outcome Measures

Discovery of serious toxic effects on developing honeybee larvae by dietary pesticides at concentrations that currently occur in hives.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Research suggests that honey bees and other bees are in decline worldwide and that inactive ingredients in pesticides may be partly to blame. Worldwide, at least 450 crop plant species depend on pollination by bees and other insects. Pollinators are important in the production of more than 150 U.S. food crops. Almost all fruit and grain crops require pollination to produce the crop. Estimates of the annual value of honey bee pollination of U.S. agricultural crops range from

\$6-14 billion.

What has been done

Penn State researchers found that 4 of the pesticides most commonly used on crops to kill insects and fungi also kill honeybee larvae in the hive. N-methyl-2-pyrrolidone (NMP)--an inert chemical commonly used as a pesticide additive--is highly toxic to honeybee larvae. The negative effects of pesticides are sometimes greater when they occur in combination in the hive. Pollen brought back to the hive as food for larvae contains an average of 6 different pesticides.

Results

This is the first study to report serious toxic effects on developing honeybee larvae of dietary pesticides at concentrations that currently occur in hives. Increasing amounts of NMP corresponded to increased larval mortality, even at the lowest concentration tested. Because pesticide safety is judged almost entirely on adult honeybee sensitivity to individual pesticides and does not consider mixtures of pesticides, the risk assessment process that the Environmental Protection Agency uses should be changed.

Along with possibly unanticipated effects on bees and other animals, a growing body of research has reported a wide range of adverse effects of inactive ingredients to human health, including enhancing pesticide toxicities across the nervous, cardiovascular, respiratory, and hormone systems. The bulk of synthetic organic chemicals used and released into U.S. environments are formulation ingredients like NMP, which are generally recognized as safe. They have no mandated limits on their use and their residues remain unmonitored.

4. Associated Knowledge Areas

KA Code	Knowledge Area
306	Environmental Stress in Animals

Outcome #5

1. Outcome Measures

Number of first reports of plant pathogens made for quinoa in Pennsylvania.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

U.S. quinoa imports grew from nearly 0 in 2004 to 65 million pounds per year in 2013. It has been considered one of the world's most perfect foods. It is higher in protein content, energy value, calcium, phosphorus, iron, fiber, and B vitamins than other cereal grains. Bolivia and Peru produce 90% of the crop worldwide. Efforts to grow quinoa in other climates have been mixed.

What has been done

During summer 2011, quinoa trials were established to determine the ability of quinoa to grow under Mid-Atlantic conditions and to monitor for regional disease problems. After cool, rainy conditions, researchers made first U.S. reports of 3 plant pathogens on quinoa: Passalora leaf spot caused by Passalora dubia, downy mildew caused by Peronospora variabilis, and Aschochyta leaf spot caused by Ascochyta sp.

Results

The impact of these pathogens on domestic and global quinoa production is unknown, but management of foliar diseases of quinoa may be critical if the crop is to be planted widely in the Mid-Atlantic region. If these and other similar diseases can be controlled, it might be possible for quinoa to become an important specialty crop in this region.

Various fungal pathogens have been reported on quinoa grown outside of its native range.

4. Associated Knowledge Areas

KA Code	Knowledge Area
212	Pathogens and Nematodes Affecting Plants

Outcome #6

1. Outcome Measures

Estimated dollars in apple crop losses averted through surveys and education programs.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1500000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Pennsylvania produces 400 to 500 million pounds of apples per year and ranks fifth in the nation for apple production. Apple scab is Pennsylvania's most important apple disease, attacking wild and cultivated apple and crabapple. In 2011, an outbreak of apple scab in orchards threatened farmers' profitability.

What has been done

Extension educators in cooperation with scientists at the Penn State Fruit Research and Extension Center in Biglerville responded immediately by conducting extensive surveys and fungicide resistance trials and by offering in-depth educational programs and regular disease alerts. Disease alerts in 2013 increased 10-fold.

Results

Producers estimated statewide losses from the 2011 outbreak to be \$1.9 million. Impact analyses of extension efforts demonstrated that apple scab was reduced by 81% for participants who previously had a scab outbreak. Statewide 2012 and 2013 losses to apple scab were reduced by \$1.5 million by timely extension workshops and disease alerts.

4. Associated Knowledge Areas

KA Code	Knowledge Area
212	Pathogens and Nematodes Affecting Plants
216	Integrated Pest Management Systems

Outcome #7**1. Outcome Measures**

Finding that symbiotic bacteria living inside potato beetles cause plants to resist the wrong invader.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

To better protect plants from the effects of chewing herbivores such as beetles, scientists first need to understand all the factors in how plants respond biochemically to herbivory.

The Colorado potato beetle (CPB) attacks tomato, eggplant, and potato plants. It is one of the most economically significant pests of potato in cooler climates. It rapidly develops resistance to pesticides, and has done so at an increasingly fast rate to all major pesticide classes.

What has been done

Penn State researchers investigated how plants identify chewing insects and how herbivores subvert plant defenses. They identified exactly what was turning off tomato plants' response to chewing. The researchers allowed CPB larva to eat antibiotic-treated leaves (killing bacteria) and

natural leaves. They found that on the antibiotic-treated leaves, the beetles suffered from the plant's anti-herbivore defense, but on the natural leaves the larva gained more weight and thrived.

Results

The researchers investigated expression of genes in the anti-herbivore pathway and the production of enzymes. They found that the presence of bacteria decreases the anti-herbivore response.

The researchers isolated and grew bacteria from CPB guts. They found 22 types of bacteria, but only 3 types suppressed the anti-herbivore response. They found that in all cases presence of the bacteria that suppress the anti-herbivore response led to healthier beetles.

The researchers are now beginning to look for the bacteria in CPB all over the U.S. and Europe.

In the future CPB might be controlled via an antibiotic to kill the symbiotic bacteria found on plant leaves, thereby reducing CPB crop losses and the use of chemical pesticides.

The U.S. produces 46.7 billion pounds of potatoes annually, with a production value of \$3.9 billion (USDA, 2012). About 1.3 million pounds of active ingredients of insecticides are applied to potato crops to control CPB in the top 8 potato-producing states.

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

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

Brief Explanation

Natural Disasters (drought, weather extremes, etc.)

- There have been weather extremes with too wet or too dry conditions that had major implications for somatic cell count and feed quality and quantity. This can have huge impacts on a producer's income, due to decreased milk production and milk premium earned, and increased feed costs.
- Adverse weather factors continued to influence clientele participation, both from extended periods of rain this summer and winter snow and ice events.
- Natural Disaster events require more of our time to serve a limited amount of people.

Economy

- The volatility of the grain and milk markets has forced dairy producers to be more involved in how to use risk management to cover their margin and produce an increased amount of high quality milk.
- Because of the recession, banks are requiring a cash flow plan before any consideration will be given to making loans. To use risk management properly, producers need to know their breakeven income over feed cost and milk margin so they can make smart decisions.
- The economic climate continues to have a significant impact on the ability of clientele to attend meetings and conferences.
- With federal and state government employees, spending policy, competing public priorities, and government regulations influenced attendance at meetings.
- The economy influenced the ability of clientele to change the tactics being used to manage healthy plants.
- The down economy continues to increase pest problems due to abandoned properties from bank foreclosures.

Appropriations changes

- Appropriation Changes affected both the research and extension functions of the College of Agricultural Sciences and resulted in fewer faculty and staff across all areas of the college.

Public Policy changes

- Public Policy Changes continue to meet the public health need related to Lyme disease and other vectored diseases.

Government Regulations

- The Chesapeake Bay is under the microscope for improving impaired watersheds for nitrogen and phosphorus. Feed management is being recognized as an important means of reducing the nutrients before being excreted. It also allows improvements in feed efficiency and reductions in manure volume.
- -Government Regulations are counterintuitive to following IPM. An NPDES permit is now needed for mosquito control.
- -Government farm food safety regulations are in draft form now. As they become finalized, it is expected that grower interest will rise.

Competing Public priorities

- Competing Public Priorities force us to continually align our program priorities with budget realities.
- Although the awareness and knowledge is increased, the implementation of best management practices may have been impaired by the economy and public policy priorities.
- Competing Public Priorities continue to be an issue as program funding declines.

Competing Programmatic Challenges

- The College of Agricultural Sciences' restructuring process allowed for continued focus on cost-effective program deliverables and strategic elimination of programs.

Populations changes (immigration, new cultural groupings, etc.)

- Population Changes continue to create new pest concerns, from bed bugs to dengue fever.

Other - Extramural Funding

- GAP activities and coordination of the statewide program have been supported by external dollars.
- Extramural Funding continues to decline. All those currently involved in the West Nile

virus team are primarily grant-funded through PA Department of Environmental Protection.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The generation of outcomes from existing programs and the development of new programs require improved evaluation that identifies pre- and post- responses to information and monitoring for long-term behavioral changes that result in improved environmental outcomes. The evaluations conducted thus far provide initial measures of implementation, but long-term monitoring is needed to ensure that the practices are successfully managed over time. We are attempting to incorporate more economic valuations of the results of our research and extension work.

Key Items of Evaluation

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