

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)

External factors which affected outcomes

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

Brief Explanation

Natural Disasters (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.