

V(A). Planned Program (Summary)

Program # 7

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
112	Watershed Protection and Management	10%		10%	
125	Agroforestry	5%		5%	
131	Alternative Uses of Land	10%		10%	
201	Plant Genome, Genetics, and Genetic Mechanisms	10%		10%	
202	Plant Genetic Resources	10%		10%	
204	Plant Product Quality and Utility (Preharvest)	10%		10%	
205	Plant Management Systems	10%		10%	
213	Weeds Affecting Plants	10%		10%	
215	Biological Control of Pests Affecting Plants	10%		10%	
402	Engineering Systems and Equipment	5%		5%	
605	Natural Resource and Environmental Economics	10%		10%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	14.0	0.0	4.0	0.0
Actual Paid Professional	14.8	0.0	20.9	0.0
Actual Volunteer	0.3	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
437629	0	228942	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
1113417	0	614710	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
225017	0	1117244	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research in sustainable energy this year has involved densified biomass as a way to cost-effectively mitigate greenhouse gas emissions and address energy security in thermal applications; exploration of gut microbiota in Asian longhorned beetle with potential application to the biofuels industry; investigation of maximum force and energy consumption needed to cut common biofuels crops; and establishment of the NEWBio Consortium to develop a northeast biofuel supply chain from field to fuel tank.

Extension work in sustainable energy involved education about economic and environmental issues surrounding Marcellus shale natural gas drilling. These education programs increased lease payments by a conservative \$250 million for landowners.

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, Scientific community, Biofuels industry, Machinery industry

3. How was eXtension used?

Penn State Cooperative Extension supports faculty and staff use of eXtension and promotes communities of practice as a way of broadening sources of information and outreach. Penn State Cooperative Extension supports the professional development offered through eXtension.org. Pennsylvania is represented by 152 eXtension members in 47 of the 73 approved CoPs.

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	28557	1310000	0	0

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

Patent Applications Submitted

Year: 2012
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2012	Extension	Research	Total
Actual	0	0	82

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of invention disclosures submitted.
Not reporting on this Output for this Annual Report

Output #2

Output Measure

- Number of people enrolled and/or registered in programs.
Not reporting on this Output for this Annual Report

Output #3

Output Measure

- Number of people enrolled and/or registered in all programs related to Sustainable Energy

Year	Actual
2012	27958

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of participants who were evaluated and demonstrated increased knowledge and skills.
2	Number of participants who were evaluated in a follow-up and who implemented/adopted practices.
3	Number of volunteers that helped with program leadership or delivery.
4	Number of participants in all programs related to Sustainable Energy who were evaluated and demonstrated increased knowledge and skills.
5	Number of participants in all programs related to Sustainable Energy who were evaluated in a follow-up and who implemented/adopted practices.
6	Densified biomass can cost-effectively mitigate greenhouse gas emissions and address energy security in thermal applications
7	Exploration of gut microbiota in Asian longhorned beetle with potential application to biofuels industry
8	Education about issues surrounding Marcellus shale natural gas drilling
9	Investigated maximum force and energy consumption needed to cut common biofuels crops
10	Established NEWBio Consortium, a Northeast-wide Penn State-led partnership to develop a northeast biofuel supply chain from field to fuel tank

Outcome #1

1. Outcome Measures

Number of participants who were evaluated and demonstrated increased knowledge and skills.

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Number of participants who were evaluated in a follow-up and who implemented/adopted practices.

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Number of volunteers that helped with program leadership or delivery.

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Number of participants in all programs related to Sustainable Energy who were evaluated and demonstrated increased knowledge and skills.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	828

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
125	Agroforestry
131	Alternative Uses of Land
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
213	Weeds Affecting Plants
215	Biological Control of Pests Affecting Plants
402	Engineering Systems and Equipment
605	Natural Resource and Environmental Economics

Outcome #5

1. Outcome Measures

Number of participants in all programs related to Sustainable Energy who were evaluated in a follow-up and who implemented/adopted practices.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	17

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
125	Agroforestry
131	Alternative Uses of Land
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
213	Weeds Affecting Plants
215	Biological Control of Pests Affecting Plants
402	Engineering Systems and Equipment
605	Natural Resource and Environmental Economics

Outcome #6

1. Outcome Measures

Densified biomass can cost-effectively mitigate greenhouse gas emissions and address energy security in thermal applications

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

There has been significant effort to quantify the lifecycle greenhouse gas emissions for ethanol production from biomass. However, little information is available describing the potential of densified switchgrass for reducing greenhouse gas emissions when used for heat and power

generation.

What has been done

Researchers measured the energy use from switchgrass seed to biomass production and quantified the net lifecycle greenhouse gas emissions of densifying the biomass as pellets, cubes, and briquettes.

Results

We found that switchgrass harvest season, due to feedstock moisture content, and type of densified end product had the largest effect on greenhouse gas emissions. This information will help biomass crop producers and biomass conversion facilities meet their goals of producing a quality product with the greatest greenhouse gas benefits.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems

Outcome #7

1. Outcome Measures

Exploration of gut microbiota in Asian longhorned beetle with potential application to biofuels industry

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Researchers studied the gut microbiota of Asian longhorned beetles (ALB), an invasive, nonnative insect first identified in the U.S. in New York in 1996. ALB are destructive wood-boring pests of maple and other hardwoods. Microbiota active in the ALB gut might in the future aid in conversion of plant matter to biofuels.

What has been done

Many genes were discovered that produce enzymes that have potential application to bioprocessing of lignocellulose to cellulosic ethanol. Several genera of bacteria were detected

that have been previously implicated in lignocellulose, hemicellulose, etc., and may participate in these processes in the beetle gut.

Results

Through the study of ALB gut symbionts, researchers learned about the ability of the gut microbiota to help ALB overcome the nutritional and digestive challenges associated with feeding in healthy host trees, including digestion of lignin, cellulose, hemicellulose, and other prominent plant polysaccharides, detoxification of plant secondary metabolites and allelochemicals, and acquisition of essential nutrients absent from woody tissue.

Results confirmed that a resistant host tree, Chinese maple, which coevolved with ALB in China, markedly influences the gut microbiota, reducing diversity of taxa.

These findings will be of interest to the biofuels industry.

4. Associated Knowledge Areas

KA Code	Knowledge Area
215	Biological Control of Pests Affecting Plants

Outcome #8

1. Outcome Measures

Education about issues surrounding Marcellus shale natural gas drilling

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

State and municipal officials and landowners need information about how to protect their economic, property, and environmental rights and interests before and during drilling for natural gas from the Marcellus shale.

What has been done

Fourteen team members made 478 presentations with 28,557 participants.

Results

Landowners have seen lease payments increase by at least \$250 million through educational programs. They have also indicated a greater satisfaction with the nonmonetary contract addendums they negotiated with land lease agents.

Elected and appointed state and local officials attended the yearly Natural Gas Summit series started in 2008. 47% of officials (n=55) reported that they had received information regarding community planning that would cause them to reconsider or change some practices and/or policies.

Following presentations to landowners, 70% (n=243) indicated that they definitely will have their water wells tested and 77% of landowners (n=271) have already or definitely will contact an attorney before signing an oil and gas lease.

73% of those who viewed a webinar reported being very likely or likely to use the information they had learned.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
605	Natural Resource and Environmental Economics

Outcome #9

1. Outcome Measures

Investigated maximum force and energy consumption needed to cut common biofuels crops

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Mechanical properties of energy crops are important when optimizing power performance of harvesting and processing machines.

What has been done

The most popular dedicated energy crops, switchgrass and miscanthus, were tested using an Instron testing machine. The measured mechanical properties included maximum forces and energy consumption during cutting, bending, and compressing a single plant stem. Two different cutting knives were used to study the effect of cutting mechanisms on energy consumption of processing energy crops.

Results

Design engineers from industry who produce swathers (farm equipment that cuts hay or small grains and pushes them into a windrow) and other farm equipment have asked for and plan to use the experimental data to improve the machines and processing.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment

Outcome #10

1. Outcome Measures

Established NEWBio Consortium, a Northeast-wide Penn State-led partnership to develop a northeast biofuel supply chain from field to fuel tank

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Society is shifting to more sustainable and renewable energy fuels, and woody biomass is one important source. Research and extension activities provide important information about the feasibility, economics, and environmental concerns surrounding the use of wood-based bioenergy to target audiences.

What has been done

Extension materials, including webinars, fact sheets and websites, are sources of reliable information for stakeholders. Developed 2 extension fact sheets: Bioenergy Primer for the

Forestry Community and Bioenergy Primer for Forest Landowners. Hosting monthly webinar series on woody biomass-related topics.

Results

The NEWBio Consortium, a Penn State-led partnership among 20 universities, federal agency labs, and companies, aims to speed development of shrub willow, miscanthus, and switchgrass that can be grown on former strip mines and marginal farmland and abandoned lands. Its goal is to develop perennial feedstock production and supply chains to commercially produce liquid transportation and aviation biofuels. The project will target sustainable production practices to improve yield by 25% and reduce costs by 20%. NEWBio will center on four large demonstration projects, each with biomass production and supply chains operating at commercial scales of thousands of acres. The projects will be geared to produce from 500 to 1,200 tons per day of lignocellulosic biomass suitable for manufacturing advanced transportation fuels.

4. Associated Knowledge Areas

KA Code	Knowledge Area
125	Agroforestry
131	Alternative Uses of Land

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

Drought in the state caused water withdrawals from some rivers to be suspended, affecting the number of wells that could be drilled.

The depressed economy, mild winter, and abundant supply of natural gas dramatically reduced the price of gas. These factors have been responsible for a reduction in the number of wells drilled and the level of economic activity.

Pennsylvania legislation Act 13 enacted an impact fee for unconventional wells and changes in environmental regulations and municipal zoning ordinances. Part of the act has been challenged in court.

Reduced State funding impacted both the research and extension functions of the College of Agricultural Sciences and resulted in retirements and layoffs of key faculty and staff across all areas of the College.

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.

Key Items of Evaluation

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