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
133	Pollution Prevention and Mitigation			10%	
403	Waste Disposal, Recycling, and Reuse			20%	
511	New and Improved Non-Food Products and Processes			40%	
605	Natural Resource and Environmental Economics			15%	
610	Domestic Policy Analysis			15%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	2.0	0.0
Actual Paid	0.0	0.0	0.6	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	9319	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	51056	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	107104	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

This program focuses on biofuel and bioenergy production. We have increased activity and funding of this area as indicated in the Plan of Work. The program so far is focused on examining different biomass feedstocks for the production of biofuels (ethanol, biodiesel, syngas) and biomaterials, nondestructive methods for characterizing the physical and chemical properties of lingo-cellulosic biomass, and syngas production from co-firing coal and biomass. The feedstocks examined so far include algae, switchgrass and mixed grasses, and residual woody biomass from forestry operations.
A continuing project focuses on production of biofuels and bioproducts from biomass. Woody biomass is being examined as the potential main feedstock for a wide array of bioenergy projects due to the fact that it can be used as either a combustion fuel or as a feedstock for the development of liquid fuels, while simultaneously creating environmental and economic benefits for the region. However, the development of these bioenergy projects will be incumbent on the ability to source feedstocks at sufficient quantities and competitive prices for economically feasible biofuel production.
A mathematical model to maximize profit in the biomass utilization processes was developed. This model considers the costs in harvest, transportation of raw materials, storage, transportation of stored materials, intermediate processing, transportation of processed material and conversion to final product. All the possible pathways to utilize biomass are considered in the study. The objective function of this mathematic model is to maximize the profit. This is the total revenue less the sum of the cost in harvest, transportation, storage, processing and final conversion. The constraints are included by considering the biomass availability, biomass handling system, storage system balance, woody biomass demand and number of facilities. Some preliminary applications were obtained which proved the good performance of the model. The final solution of this model will also provide the optimal choice of pathway. This type of model is essential to determine the economic feasibility of using forest biomass in the production of biofuels.

2. Brief description of the target audience

The target audience for this program area includes the bio-fuels and materials industries, the electricity generating industry, researchers, regulators, policy makers, and foresters.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

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

Patent Applications Submitted

Year: 2014

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	5	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Presentations on research at professional meetings

Year	Actual
2014	12

Output #2

Output Measure

- Energy policy papers

Year	Actual
2014	0

Output #3

Output Measure

- Completed graduate degree programs

Year	Actual
2014	3

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Work with the electrical generation industry to increase the percentage of renewable sources of biomass co-fired with coal (% increase per year)
2	Develop new processes for converting lignocellulose to usable sources of energy (number of new processes).
3	Percentage of participants in workshops held in the State on sustainable energy production and use who gain an understanding of the issue (% who report gains in knowledge).
4	Examine the economic profitability in WV of utilizing biomass to produce biofuels and biomaterials

Outcome #1

1. **Outcome Measures**

   Work with the electrical generation industry to increase the percentage of renewable sources of biomass co-fired with coal (% increase per year)

   Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

   Develop new processes for converting lignocellulose to usable sources of energy (number of new processes).

   Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

   Percentage of participants in workshops held in the State on sustainable energy production and use who gain an understanding of the issue (% who report gains in knowledge).

   Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

   Examine the economic profitability in WV of utilizing biomass to produce biofuels and biomaterials

2. **Associated Institution Types**

   - 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
WV is the most heavily forested State in the Nation and thus has abundant supplies of biomass, both in situ and as a by product of the forest products industry. Unfortunately, the economic feasibility of utilizing this biomass is not known, due to the complexity of feedstock sourcing, feedstock logistics, and conversion processes.

What has been done
A mathematical model to maximize profit in the biomass utilization processes was developed. This model considers the costs in harvest, transportation of raw materials, storage, transportation of stored materials, intermediate processing, transportation of processed material and conversion to final product. All the possible pathways to utilize biomass are considered in the study. The objective function of this mathematic model is to maximize the profit. This is the total revenue less the sum of the cost in harvest, transportation, storage, processing and final conversion. The constraints are included by considering the biomass availability, biomass handling system, storage system balance, woody biomass demand and number of facilities.

Results
Some preliminary applications were obtained which proved the good performance of the model. The final solution of this model will also provide the optimal choice of pathway. This type of model is essential to determine the economic feasibility of using forest biomass in the production of biofuels.

4. Associated Knowledge Areas

KA Code	Knowledge Area
511	New and Improved Non-Food Products and Processes
605	Natural Resource and Environmental Economics

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Experiment Station research program evaluation will take place at two levels and on two different time cycles. All programs will using these general criteria plus additional criteria

tailored to each program as detailed in the Plan of Work under Outputs and State Defined Outputs and Outcomes.

Annual evaluation will continue as before, looking at productivity in terms of immediate impact:

- Referee journal articles and books
- Professional presentations
- General audience papers and news reports
- M.S. and PhD graduates
- Trends in terms of competitive funding

And in terms of longer-term impact:

- Citations in scientific journals
- Patents
- Successful technology transfer or start-ups based on research programs
- Awards based on continuing impact and research excellence

In addition, every five years we will have a full portfolio review of our research programs in terms of:

- Long term productivity
- Relevance to our constituent groups and the State and Region
- The allocation of research inputs among the programs
- Consideration of eliminating some research programs that are not productive or have diminished relevance given NIFA and State priorities
- Consideration of adding additional program areas given NIFA and State priorities

Our standard annual evaluation results are detailed in the state defined outputs and state defined outcomes sections of this report. This program has been very successful in terms of attracting external funding from DOE and AFRI. We plan to continue this program but we do not have plans to add additional scientists at this time. We are expanding our focus to look at biomaterial from biomass feedstocks, and joint production bioenergy and biomaterials in order to increase the economic feasibility of bioenergy production from residual biomass.

Key Items of Evaluation

This program has been very successful in terms of attracting external funding from DOE and AFRI. We plan to continue this program but we do not have plans to add additional scientists at this time. We are expanding our focus to look at biomaterial from biomass feedstocks, and joint production bioenergy and biomaterials in order to increase the economic feasibility of bioenergy production from residual biomass.