V(A). Planned Program (Summary)

Program # 3

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		10%		10%
102	Soil, Plant, Water, Nutrient Relationships		10%		10%
123	Management and Sustainability of Forest Resources		10%		10%
201	Plant Genome, Genetics, and Genetic Mechanisms		10%		20%
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants		10%		10%
403	Waste Disposal, Recycling, and Reuse		25%		20%
511	New and Improved Non-Food Products and Processes		25%		20%
	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	0.0	1.0	0.0	7.3
Actual Paid Professional	0.0	0.0	0.0	2.5
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	0	361417
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	0	255775
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

During the past year, the primary focus of our research was to understand bacterial metabolism in a unique thermophilic anaerobic digester that utilizes poultry litter as substrate. We used both modeling and experimentation to evaluate the metabolic parameters that most affect the efficiency of this process. A model known as ADM1 has been used to explain the anaerobic digestion process. However, this model is complicated and contains 110 parameters. To simply and improve the model, we first used Global Sensitivity Analysis (GSA) to identify those kinetic parameters that have major influence on the levels of acetate, propionate and methane, which are key metabolites. GSA showed that K_m was more sensitive than K_S for explaining the kinetics of these metabolites. We then experimentally tested the production and consumption of fatty acid intermediates by this digester microbiome. Short chain fatty acids are the primary metabolite intermediates produced during primary fermentation in anaerobic digestion, and are indicators of the stability of the system. We also experimentally measured fatty acid kinetics using replicate microcosms derived from the thermophilic digester and gas chromatography for fatty acids analysis. The kinetics of acetate, propionate, butyrate, isobutyrate and valerate were followed. Modeling of fatty acid kinetics was done with the ADM1 model. The metabolism of fatty acids was also studied in a pilot scale thermophilic plugflow digester. In addition, microbial diversity analysis of a circumneutral Appalachian river in West Virginia was continued.

2. Brief description of the target audience

Digester manufacturers and users, poultry farmers, other agricultural waste producers, environmentally concerned citizens, undergraduate and graduate students, engineers and scientists who study bioreactors and anaerobic microbial processes. Mine operators, mine reclamation contractors, land owners

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	7	0	0	0

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	0	2	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Train students in digester operation, biochemical analysis, microbial analysis [Huber]

Year	Actual
2013	9

Output #2

Output Measure

- Improve the operation of thermophilic poultrywaste digesters. [Huber]

Year	Actual
2013	0

Output #3

Output Measure

- Add an extension component to the digester program
  Not reporting on this Output for this Annual Report

Output #4

Output Measure

- Evaluate the feasiblility of adopting anaerobic digestion on poultry farms in WV through extension outreach to farmers [Huber]
  Not reporting on this Output for this Annual Report

Output #5

Output Measure

- Develop novel technique for soil remediation on reclaimed mine lands. [Hass]
  Not reporting on this Output for this Annual Report

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Improve the operational parameters thhat have beensed to contreermophilic poultry waste digester.
2	New knowledge concerning how microbial diversity gives rise to anaerobic microbial energy conversion and anaerobic digestion.
3	Increase awareness of soil remediation technology among mining operators and agencies.

Outcome #1

1. Outcome Measures

Improve the operational parameters thhat have beensed to contreermophilic poultry waste digester.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

KA Code	Knowledge Area
403	Waste Disposal, Recycling, and Reuse

Outcome #2

1. Outcome Measures

New knowledge concerning how microbial diversity gives rise to anaerobic microbial energy conversion and anaerobic digestion.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Microbial diversity is the foundation of agricultural productivity, biotechnology, and environmental sustainability. The microbial processes that undergird these important resources depend on communities of diverse microorganisms. These processes have been poorly understood but new technologies are now enabling rapid progress toward understanding and manipulating microbial diversity. This research will apply genomics technology for understanding microbial community-level processes in three environments that are important to biotechnology and environmental sustainability.

What has been done
During the past year, the primary focus of our research was to understand bacterial metabolism in a unique thermophilic anaerobic digester that utilizes poultry litter as substrate. We used both modeling and experimentation to evaluate the metabolic parameters that most affect the efficiency of this process. A model known as ADM1 has been used to explain the anaerobic digestion process. However, this model is complicated and contains 110 parameters. To simply and improve the model, we first used Global Sensitivity Analysis (GSA) to identify those kinetic parameters that have major influence on the levels of acetate, propionate and methane, which are key metabolites.

Results
GSA showed that K_m was more sensitive than K_S for explaining the kinetics of these metabolites. We then experimentally tested the production and consumption of fatty acid intermediates by this digester microbiome. Short chain fatty acids are the primary metabolite intermediates produced during primary fermentation in anaerobic digestion, and are indicators of the stability of the system. We also experimentally measured fatty acid kinetics using replicate microcosms derived from the thermophilic digester and gas chromatography for fatty acids analysis. The kinetics of acetate, propionate, butyrate, isobutyrate and valerate were followed. Modeling of fatty acid kinetics was done with the ADM1 model. The metabolism of fatty acids was also studied in a pilot scale thermophilic plugflow digester. In addition, microbial diversity analysis of a circumneutral Appalachian river in West Virginia was continued.

4. Associated Knowledge Areas

KA Code	Knowledge Area
403	Waste Disposal, Recycling, and Reuse

Outcome #3

1. Outcome Measures

Increase awareness of soil remediation technology among mining operators and agencies.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

KA Code	Knowledge Area
403	Waste Disposal, Recycling, and Reuse

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes

Brief Explanation

{No Data Entered}

V(I). Planned Program (Evaluation Studies)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}