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
403	Waste Disposal, Recycling, and Reuse		0%		100%
	Total		0%		100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.0	6.3
Actual Paid Professional	0.0	0.0	0.0	0.8
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	139047
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	0	111565
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

In 2012, sustainable energy research at WVSU continued in studying microbial community interaction involved in anaerobic digestion. Controlled disturbances were utilized to cultivate greater digester microbial diversity and flexibility, in turn creating a more stable and resilient digester to convert

poultry litter biogas (methane). Replicate experimental digesters were set up and a long-term study was started looking at energy thresholds and ecological resilience in the digester microbial communities.

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.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	11	20	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	2	0

V(F). State Defined Outputs

Output Target

<u>Output #1</u>

Output Measure

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

Year	Actual
2012	6

Output #2

Output Measure

- Change in digester operational methodology [Smith]
  Not reporting on this Output for this Annual Report

Output #3

Output Measure

- Add an extension component to the digester program
  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	Change in digester operational methodology [Smith]
2	New knowledge concerning how microbial diversity gives rise to anaerobic microbial energy conversion and anaerobic digestion [Huber]

Outcome #1

1. **Outcome Measures**

Change in digester operational methodology [Smith]

Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

New knowledge concerning how microbial diversity gives rise to anaerobic microbial energy conversion and anaerobic digestion [Huber]

2. **Associated Institution Types**

- 1890 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)

West Virginia poultry farms produce large quantities of wastes that can pollute watersheds. Anaerobic digestion is a method for treating and stabilizing high-strength organic wastes such as animal manures and food manufacturing waste. Anaerobic digestion can also be used to provide sustainable bioenergy from waste biomass. The digestion process utilizes anaerobic bacteria to break down organic wastes and produce bioenergy (methane). Although the general metabolic steps are known, the mechanistic bases for important system properties are still unknown. In particular, we do not understand the reason for variations in the efficiency of individual digesters, the relationship between microbial diversity and bioenergy output, and the basis for system stability and resilience. The economics of digestion is an additional issue, especially for small farms. Digesters also serve as excellent model systems for understanding microbial bioenergy production because we do not yet have sufficient understanding of microbial functional diversity to engineer these processes using individual microorganisms.

What has been done

Variations in bioenergy production were evaluated in six replicate five liter methanogenic bioreactors during a long-term time series experiment. The bioreactors were subjected to varying hydraulic retention times to test their resilience to this environmental change. Microbial diversity

was sampled with pyrosequencing. An experiment was also conducted in the WVSU pilot plant thermophilic digester that tested the co-digestion of poultry litter and herbaceous plant biomass. Hay from a West Virginia farm was used as co-substrate at two different ratios. Performance variables were measured during the pilot plant experiment.

Results

Variations in the performance of six replicate five liter thermophilic continuous stirred-tank reactors (CSTR) were evaluated during changes in hydraulic loading. The bioreactors were operated for more than 400 days using poultry litter substrate. Multivariate ordination of the chemical variables revealed functional resilience following a different response trajectory for each disturbance, and high reproducibility among the replicates. Association mapping of bacterial diversity showed a loss of community dispersion among the replicates during the changes in hydraulic loading. This study showed functional resilience of the microbial communities during changes in hydraulic retention time, as well as changes in microbial community diversity. In a separate experiment, the efficiency and bioenergy production of the WVSU pilot plant digester were not diminished during co-digestion with 20% and 40% hay added to the poultry litter feedstock. The following publication was produced: Shade, A., H. Peter, S.D. Allison, D.L. Baho, M. Berga, H. Burgmann, D.H. Huber, S. Langenheder, J.T. Lennon, J.B.H. Martiny, K.L. Matulich, T.M. Schmidt, J. Handelsman. 2012. Fundamentals of microbial community resistance and resilience. Frontiers in Microbiology 3:417

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
- Other (Personnel changes)

Brief Explanation

Dr. Smith has left the research to serve as Director of CASTEM. A new research faculty position in bioenergy, focusing on anaerobic digestion has been advertised.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Energy program will grow next year as new bioenergy research faculty position is filled. This position will also have a public service and outreach compenent.

Key Items of Evaluation

Energy program will grow next year as new bioenergy research faculty position is filled. This position will also have a public service and outreach compenent.