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
402	Engineering Systems and Equipment	50%		50%	
403	Waste Disposal, Recycling, and Reuse	50%		50%	
	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	0.0	0.0	1.0	0.0
Actual Paid Professional	2.0	0.0	0.6	0.0
Actual Volunteer	22.0	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**
52794	0	15130	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
52794	0	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
66722	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

This research will build a pilot waste anaerobic digester at the Agricultural Experiment Station's Research Farm in Beltsville, Maryland for the production of biomass and demonstrate that using the resources that are easily available makes the production of energy efficient and reliable. The energy producing potential of the different types of waste products will be studied through continuous monitoring of the digestion biochemical processes, operating parameters, the energy content, and the analysis of the biogas products. A Fuzzy Logic Controller of the Anaerobic Digester System will be designed in parallel with the physical digester to enable us to model mathematically or simulate certain aspects of the digester processes for increased efficiencies and process stability.

A comprehensive literature search was conducted to find the most efficient types and designs of a small AnD. The completed design splits AnD into two main parts; Mixer and Housing.

The completed pro-engineering design of the digester can be summarized as follows:

For the Mixer part, the following activities have been completed:

1. Defining the overall specification of the mixer;
2. Developing the kinematic drawing of the mixer;
3. Defining the main components such as gears, and mixing blades;
4. The design of the mixing mechanism;
5. The design of the automated feeding mechanism; and
6. A comprehensive velocity analysis for the mixing mechanism.

For the digester Housing the following activities have been completed:

1. Selection of the main elements of the Housing and the types of material needed for their construction and designing a window to monitor the level of the waste inside the tank;
2. Designing the Housing Skelton;
3. Theoretical evaluation of the fluid dynamics inside the digester tank;
4. Simulation analysis of evaluate the stresses, exerted by the waste, inside the inner tank using the finite element analysis method and approximating the geometry of the entire tank with stress elements (tetrahedrons) ;
5. Calculating the dimensions of the final metal sheets needed for the tank construction;
6. Defining the features of the tank including the types of insulation, temperature and pressure sensors needed, locations of the sensors, and the automatic feeding system.

In addition, the energy content of Bio-gas from various animals (Livestock wastes) was studied and the anticipated Gas yield compared

2. Brief description of the target audience

DCDepartment of the Environment
DC Department of Transportation
DC Department of Public Works
Researchers

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	432	89	57	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	1	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Design of a fuzzy-logic based controller system to optimize the operation of the anaerobic digestion System in terms of operational cost, the produce energy, and the quality of the residual organic matter.

Year	Actual
2012	0

Output #2

Output Measure

- Creation of a set of fuzzy rules to control the input flow rate and to control the concentration of VFA, the concentration of chemical oxygen demand (COD), and digester operating temperatures.

Year	Actual
2012	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Development of better designs for digestion reactor and its data acquisition sensors
2	Control of the concentration of VFA in the digester system through the manipulation of the input flow rate.

Outcome #1

1. Outcome Measures

Development of better designs for digestion reactor and its data acquisition sensors

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)
This research will build a pilot waste anaerobic digester at the Agricultural Experiment Station's Research Farm in Beltsville, Maryland for the production of biomass and demonstrate that using the resources that are easily available makes the production of energy efficient and reliable. The energy producing potential of the different types of waste products will be studied through continuous monitoring of the digestion biochemical processes, operating parameters, the energy content, and the analysis of the biogas products. A Fuzzy Logic Controller of the Anaerobic Digester System will be designed in parallel with the physical digester to enable us to model mathematically or simulate certain aspects of the digester processes for increased efficiencies and process stability.

What has been done
A comprehensive literature search was conducted to find the most efficient types and designs of a small AnD. The completed design splits AnD into two main parts; Mixer and Housing. In addition, the energy content of Bio-gas from various animals (Livestock wastes) was studied and the anticipated Gas yield compared.

Results
The study showed that the estimated gross energy content of approximately 30,000 Btu/head/day for dairy cow manure was two to three orders of magnitude higher than other animal waste products. The Net energy content however, will be dependent on the operating performance of the digester. Thermodynamics Analysis was done to calculate the Combustion of Methane gas and the heat exchange during the reaction. Our calculation shows that 1kg of Organic Material will produce 27.748 MJoules of heat energy. The results of the project were published in two papers presented at the 2010 ASEE conference and one paper in the2012 ASEE Conference.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment

Outcome #2

1. Outcome Measures

Control of the concentration of VFA in the digester system through the manipulation of the input flow rate.

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Appropriations changes
- Government Regulations

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}