

# 2008 West Virginia State University Research Annual Report of Accomplishments and Results

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## I. Report Overview

### 1. Executive Summary

West Virginia State University, through its Gus R. Douglass Institute's Agricultural and Environmental Research Station (WVSU AERS), continues delivering (since 2000) Land-Grant related research programs that are responsive to the needs of the University, the State, and the Country's stakeholders. These research programs were structured and are reported within the United States Department of Agriculture's prescribed 5 national priorities (goals) framework. As the University builds research infrastructure and capacity, and is able to secure additional funding resources, existing research programs are further strengthened and new programming is developed to better serve the needs of the University's stakeholders. Federal fiscal year 2008, the year currently being reported, was a successful year for the University from a research development perspective. All research programs, with exception of one, experienced growth in terms of funding and achieving proposed goals. The University's establishments of graduate programs have further benefited the development of research programs in that more graduate students and faculty were able to participate in agricultural and environmental research.

The funding received from US appropriations, through USDA Cooperative State Research, Extension and Education Service (USDA-CSREES) agency, was allocated to these programs and tracked in terms of its impact through the Plan of Work database means. Below is a detailed summary of each of the plan of work program's components, including inputs, outputs, outcomes and impacts, funding and human resources distribution.

#### Total Actual Amount of professional FTEs/SYs for this State

Year:2008	Extension		Research	
	1862	1890	1862	1890
<b>Plan</b>	0.0	0.0	0.0	14.8
<b>Actual</b>	0.0	0.0	0.0	16.6

## II. Merit Review Process

### 1. The Merit Review Process that was Employed for this year

- Combined External and Internal University External Non-University Panel

### 2. Brief Explanation

During the months of April and May, all research programs were subjected to a review process. This process included an internal and external evaluation. An oral presentation at the WVSU Annual Research Symposium is also a key component of the overall evaluation and is required for all land-grant sponsored researchers. Stakeholders identified by procedures outlined below were invited to participate in the Symposium. The internal evaluation consisted of an Office and/or Department appraisal by the executive staff. Additionally, all participants in land-grant sponsored research critically assess the work of their peers for developmental purposes. As an internal review procedure, the University has also appointed a committee (Land-Grant Advisory Committee) comprised of faculty and staff with the main purpose of tracked progress and provide guidance to some of the programming.

An external research advisory panel conducts the external evaluation component of the overall Land-Grant research programs offered by the University. This panel consists of local scientists with a wide variety of backgrounds, business leaders and community members considered to be suitable stakeholders for research programs. The evaluations from these panels were utilized to restructure research programming and help rank and allocate funds to specific land-grant programs. Evaluation of research productivity versus resources spent is included in the ranking of continuing projects to facilitate funding decisions for the 2009 budget year.

### III. Stakeholder Input

#### 1. Actions taken to seek stakeholder input that encouraged their participation

- Targeted invitation to traditional stakeholder groups
- Targeted invitation to non-traditional stakeholder groups
- Targeted invitation to traditional stakeholder individuals
- Targeted invitation to non-traditional stakeholder individuals

#### Brief Explanation

Potential stakeholders were identified and invited to participate on the review panel to evaluate the land-grant research programs at the University. The invitation stressed the importance and requirement of our programs to have and input reviewed processed by a diverse stakeholder group. Research administrators and scientists sought individuals and groups within a specific area of expertise or understanding to provide input and guide the direction of the research programs in order to better address the needs of those individuals and groups. Several collaborations have been formed as a result of these activities. Traditional stakeholder groups include industry, departments of agriculture, and farmers (e.g. small farmers). Non-traditional groups include non-profit organizations, alternative energy groups and under-served landowners who have been impacted by mineral extraction.

#### 2(A). A brief statement of the process that was used by the recipient institution to identify individuals and groups stakeholders and to collect input from them

##### 1. Method to identify individuals and groups

- Use Advisory Committees
- Other (Researcher Interactions)

#### Brief Explanation

Research administrators and research scientists sought individuals and groups within a specific area of expertise or understanding to provide input and guide the direction of the research programs in order to better address the needs of our targeted stakeholders. These individuals and organizations were invited directly to participate through a written invitation. Other individuals were encouraged by previous members or other University staff. Thus the research advisory committee consisted of several individuals representing the different areas addressed by the research programs. Target areas were defined based on the research portfolio at the institution. Within each target area, individuals were identified and invited to participate in the advisory process. These individuals advised the scientists on possible stakeholders and issues important to those stakeholders. Also all individual research scientists attended professional seminars, special interest meetings and other relevant conferences, and have identified stakeholders through interactions with groups or individuals interested in their research programs.

#### 2(B). A brief statement of the process that was used by the recipient institution to identify individuals and groups who are stakeholders and to collect input from them

##### 1. Methods for collecting Stakeholder Input

- Meeting with traditional Stakeholder groups
- Meeting with traditional Stakeholder individuals
- Meeting specifically with non-traditional groups

#### Brief Explanation

As a major component of the semiannual research advisory meetings, advisors, faculty, staff, and administrators engaged in a dialog to discuss major observations or issues the advisors put in front of the University's programs. Also, input in writing was collected after or during the two semiannual reviews. Specific questions formulated in a survey format were handed out before and during the meeting for the advisors to answer. Finally, to document all the discussions that took place during the meetings from committee participants, minutes were assembled and all survey information collected, analyzed and used to guide the programming process of the following research year.

#### 3. A statement of how the input was considered

- To Identify Emerging Issues
- Redirect Research Programs
- In the Staff Hiring Process
- To Set Priorities

**Brief Explanation**

All input received from the research advisory committee was collected in writing as well as from verbal discussion during those meetings. This feedback was used to guide the programming process of the following year's research programming cycle. This input has normally an effect on the distribution of efforts or overall share of research programs. Seldom has this input resulted in the total elimination of a planned research program but it is strongly considered if the recommendation is provided.

**Brief Explanation of what you learned from your Stakeholders**

Through the stakeholder input, it was learned that some research projects needed additional and enhanced support as they were perceived as critically important to the Institution and the goals under which programs are established by the committee members. Additionally, stakeholders were keenly interested in learning more about the student involvement and interactions with faculty and other research staff in all research programs. To that fact, during the advisory meetings we have now incorporated a student and research staff (non faculty) poster session in which the stakeholder has an opportunity to directly interact and learn more about the work and contributions these members make in terms of research programs. Some stakeholders were also interested in seeing some of this research being commercialized or find an application outside of the University.

**IV. Expenditure Summary**

<b>1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)</b>			
<b>Extension</b>		<b>Research</b>	
<b>Smith-Lever 3b &amp; 3c</b>	<b>1890 Extension</b>	<b>Hatch</b>	<b>Evans-Allen</b>
0	0	0	1188353

<b>2. Totaled Actual dollars from Planned Programs Inputs</b>				
	<b>Extension</b>		<b>Research</b>	
	<b>Smith-Lever 3b &amp; 3c</b>	<b>1890 Extension</b>	<b>Hatch</b>	<b>Evans-Allen</b>
<b>Actual Formula</b>	0	0	0	1185903
<b>Actual Matching</b>	0	0	0	851718
<b>Actual All Other</b>	0	0	0	675905
<b>Total Actual Expended</b>	0	0	0	2713526

<b>3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous years</b>				
<b>Carryover</b>	0	0	0	420220

**V. Planned Program Table of Content**

<b>S. NO.</b>	<b>PROGRAM NAME</b>
1	Natural Resource Management
2	Aquaculture
3	Environmental Microbiology
4	Plant Genomics
5	Agricultural Biotechnology
6	Alternative Agriculture

**Program #1****V(A). Planned Program (Summary)****1. Name of the Planned Program**

Natural Resource Management

**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				100%
	<b>Total</b>				100%

**V(C). Planned Program (Inputs)****1. Actual amount of professional FTE/SYs expended this Program**

Year: 2008	Extension		Research	
	1862	1890	1862	1890
<b>Plan</b>	0.0	0.0	0.0	2.5
<b>Actual</b>	0.0	0.0	0.0	0.5

**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	45000
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	0	20000
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**

Two projects in this planned research program were terminated end of year 2007. The first, involving metal-ion binding technology in water, had no progressed as much as expected. The second project involving carbon sequestration was terminated due to lack of focus and feasibility of the researcher. Neither project had any meaningful activity in FY 2008.

The newest project in this program studies the microbial-soil-plant interactions applicable to restoration of mined-land soils. An important component was the use of treated solid waste (anaerobically fermented chicken litter) to improve the organic properties of the soil to increase the microbial-soil-plant interaction. Preliminary studies are showing promising results in relation to land and vegetative restoration of mined/reclaimed soils. Related research at West Virginia University has involved soil and water quality and is studying the impact of human activity on both.

**2. Brief description of the target audience**

- Watershed groups - Mine operators - Power generation utilities - Chemical manufacturers - Environmental regulators

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

**Target for the number of persons (contacts) reached through direct and indirect contact methods**

	<b>Direct Contacts Adults</b>	<b>Indirect Contacts Adults</b>	<b>Direct Contacts Youth</b>	<b>Indirect Contacts Youth</b>
<b>Year</b>	<b>Target</b>	<b>Target</b>	<b>Target</b>	<b>Target</b>
<b>Plan</b>	5	0	0	0
2008	2	0	0	0

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

**Patent Applications Submitted**

<b>Year</b>	<b>Target</b>
<b>Plan:</b>	0
2008 :	0

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

	<b>Extension</b>	<b>Research</b>	<b>Total</b>
<b>Plan</b>	0	0	
2008	0	0	0

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Scientific presentations and publications

<b>Year</b>	<b>Target</b>	<b>Actual</b>
2008	1	2

**V(G). State Defined Outcomes****V. State Defined Outcomes Table of Content**

<b>O No.</b>	<b>OUTCOME NAME</b>
1	Increased awareness among power generators of carbon sequestration technology (#)
2	Increased awareness of water remediation technology among stakeholders (%)
3	Development of novel types of environmental remediation (#)
4	Increased sequestration of carbon dioxide in WV (%)
5	Reduced cost of metal remediation in water (%)

### **Outcome #1**

#### **1. Outcome Measures**

Increased awareness among power generators of carbon sequestration technology (#)  
*Not reporting on this Outcome for this Annual Report*

### **Outcome #2**

#### **1. Outcome Measures**

Increased awareness of water remediation technology among stakeholders (%)  
*Not reporting on this Outcome for this Annual Report*

### **Outcome #3**

#### **1. Outcome Measures**

Development of novel types of environmental remediation (#)  
*Not reporting on this Outcome for this Annual Report*

### **Outcome #4**

#### **1. Outcome Measures**

Increased sequestration of carbon dioxide in WV (%)  
*Not reporting on this Outcome for this Annual Report*

### **Outcome #5**

#### **1. Outcome Measures**

Reduced cost of metal remediation in water (%)  
*Not reporting on this Outcome for this Annual Report*

### **V(H). Planned Program (External Factors)**

#### **External factors which affected outcomes**

- Economy
- Public Policy changes
- Government Regulations
- Competing Public priorities

#### **Brief Explanation**

Although this research program was discontinued for the lack of scientific progress, research on carbon sequestration continues being popular in that regulations (domestic and abroad) and new world policies encourage scientific participation.

### **V(I). Planned Program (Evaluation Studies and Data Collection)**

#### **1. Evaluation Studies Planned**

- Retrospective (post program)
- During (during program)

#### **Evaluation Results**

The two major projects in this program were eliminated from the plan of work due to lack of acceptable performance and progress.

#### **Key Items of Evaluation**



The two major projects in this program were eliminated from the plan of work due to lack of acceptable performance and progress.

**Program #2****V(A). Planned Program (Summary)****1. Name of the Planned Program**

Aquaculture

**V(B). Program Knowledge Area(s)****1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
302	Nutrient Utilization in Animals				75%
307	Animal Management Systems				25%
	<b>Total</b>				100%

**V(C). Planned Program (Inputs)****1. Actual amount of professional FTE/SYs expended this Program**

Year: 2008	Extension		Research	
	1862	1890	1862	1890
<b>Plan</b>	0.0	0.0	0.0	1.7
<b>Actual</b>	0.0	0.0	0.0	2.5

**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	207650
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	0	160284
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	0	94687

**V(D). Planned Program (Activity)****1. Brief description of the Activity**

Juvenile channel catfish were fed fish meal/soybean meal based containing different levels of recovered protein from thermophilic anaerobic digestion of poultry wastes. Undergraduate students in General Zoology class taught for spring 2008 used the feeding trial as part of their laboratory exercise on live observation of fish feeding, thus advancing their knowledge on fish feeding behavior.

**2. Brief description of the target audience**

- Fish Farmers
- Aquaculture industry (feeds suppliers)
- Government Regulatory Agencies

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

**Target for the number of persons (contacts) reached through direct and indirect contact methods**

	<b>Direct Contacts Adults</b>	<b>Indirect Contacts Adults</b>	<b>Direct Contacts Youth</b>	<b>Indirect Contacts Youth</b>
<b>Year</b>	<b>Target</b>	<b>Target</b>	<b>Target</b>	<b>Target</b>
<b>Plan</b>	5	0	0	0
2008	17	0	0	0

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

**Patent Applications Submitted**

<b>Year</b>	<b>Target</b>
<b>Plan:</b>	0
2008 :	0

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

	<b>Extension</b>	<b>Research</b>	<b>Total</b>
<b>Plan</b>	0	0	
2008	0	0	0

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Presentations and/or publications

<b>Year</b>	<b>Target</b>	<b>Actual</b>
2008	1	2

**V(G). State Defined Outcomes****V. State Defined Outcomes Table of Content**

<b>O No.</b>	<b>OUTCOME NAME</b>
1	Lower feed costs (%)
2	Reduce nitrogen and phosphorus in discharge water (%)
3	Increased profitability of aquaculture operations (%)

**Outcome #1****1. Outcome Measures**

Lower feed costs (%)

**2. Associated Institution Types**

•1890 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

Year	Quantitative Target	Actual
2008	10	0

**3c. Qualitative Outcome or Impact Statement****Issue (Who cares and Why)**

The target audience includes fish feed industries and researchers that are looking for alternative sources of protein for use in fish feeds. Undergraduate students in General Zoology, class taught in spring 2008, used the feeding trial as part of their laboratory exercise titled live observation of fish dealing with fish feeding and locomotion. The feeding trial was utilized as teaching resource for the General Zoology course and one final year undergraduate student performed proximate analyses and used that in fulfillment of practicum experience.

**What has been done**

Data such as weight gain, feed efficiency, survival, feed consumed, specific growth rate, body composition, visceral fat content, viscerosomatic and hepatosomatic indices were collected and analyzed.

**Results**

Two students that participated in the feeding trial are considering pursuing a career in fisheries management/aquaculture and five out of seventeen undergraduate students that observed channel catfish feeding behavior from the study during the General Zoology laboratory exercise are now interested in doing aquaculture research and /or pursuing career in fisheries management/aquaculture.

**4. Associated Knowledge Areas**

KA Code	Knowledge Area
307	Animal Management Systems
302	Nutrient Utilization in Animals

**Outcome #2****1. Outcome Measures**

Reduce nitrogen and phosphorus in discharge water (%)

**2. Associated Institution Types**

•1890 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

Year	Quantitative Target	Actual
2008	0	0

**3c. Qualitative Outcome or Impact Statement****Issue (Who cares and Why)**

The target audience includes fish feed industries and researchers that are looking for more, environmentally friendly, alternative sources of protein for use in fish feeds.

#### **What has been done**

#### **Results**

Results suggest that recovered protein in diets at higher levels (greater than 20%) had significant deleterious effects. These data may provide a guide for the greater use of recovered protein from anaerobic digester in place of fish meal in diets of channel catfish, thereby reducing fish feed cost

#### **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
307	Animal Management Systems
302	Nutrient Utilization in Animals

#### **Outcome #3**

##### **1. Outcome Measures**

Increased profitability of aquaculture operations (%)

*Not reporting on this Outcome for this Annual Report*

#### **V(H). Planned Program (External Factors)**

##### **External factors which affected outcomes**

- Economy
- Government Regulations

##### **Brief Explanation**

The high cost of feed in fish production continues to be an important economic issue in terms of overall cost of production. As feed cost continues raising, this research and its outcomes become more valuable.

#### **V(I). Planned Program (Evaluation Studies and Data Collection)**

##### **1. Evaluation Studies Planned**

- Retrospective (post program)

##### **Evaluation Results**

This program has slowly grown and it is now ready to develop fully. More resources are coming to this program as the researchers pursue other sources of funding (e.g. NSF, NIH, etc.). The program and its participants will be retained and further supported.

##### **Key Items of Evaluation**

This research is currently being monitored to find a more commercial or off campus applications through extension service.

**Program #3**

**V(A). Planned Program (Summary)**

**1. Name of the Planned Program**

Environmental Microbiology

**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 Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources.				75%
711					25%
<b>Total</b>					100%

**V(C). Planned Program (Inputs)**

**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2008	Extension		Research	
	1862	1890	1862	1890
<b>Plan</b>	0.0	0.0	0.0	2.6
<b>Actual</b>	0.0	0.0	0.0	6.0

**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	260653
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	0	190298
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	0	335358

**V(D). Planned Program (Activity)**

**1. Brief description of the Activity**

The program of research is focused on the microbial ecology of thermophilic anaerobic digestion. West Virginia State University operates a pilot plant thermophilic anaerobic digester facility that consists of a 10,000 gallon continuous stir tank reactor located on the campus. The digester is operated at 55C and has been fed and stabilized on poultry litter for several years. In addition, the operation and sampling of a 15 liter thermophilic biofilm digester was continued. Significant advancement in understanding the microbial ecology of anaerobic digestion has been made. First, study has demonstrated the power of pyrosequencing for revealing previously unknown microbial diversity and for quantitatively analyzing the dynamics of microbial community structure. This technology was applied to anaerobic digesters for the first time and enabled new insights into the relationship of microbial community structure to digester performance. In addition, a large database has been developed, consisting of 16S rRNA genes, comprising 28 Mb of DNA that represents a thermophilic anaerobic digester. This data will be available to other researchers interested in anaerobic digestion. Third, this study has refuted the conventional wisdom concerning biofilm digesters which states that the primary benefit of biofilm growth is the retention of microbial cells when effluent is released. Fourth, the methods developed can be utilized to include microbial population diversity as another performance parameter for studying, monitoring, and engineering waste treatment systems.

**2. Brief description of the target audience**

This research is expected to impact a broad audience. The primary target audience will be research scientists and environmental engineers who work with anaerobic digestion and, more broadly, environmental biotechnology. Undergraduate and graduate students will also be impacted through the principal investigators teaching and research laboratory at West Virginia State University. In addition, anaerobic digester operators, livestock producers and the poultry industry will be benefited as the processes of anaerobic digestion are better understood and knowledge is disseminated.

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

**Target for the number of persons (contacts) reached through direct and indirect contact methods**

	<b>Direct Contacts Adults</b>	<b>Indirect Contacts Adults</b>	<b>Direct Contacts Youth</b>	<b>Indirect Contacts Youth</b>
<b>Year</b>	<b>Target</b>	<b>Target</b>	<b>Target</b>	<b>Target</b>
<b>Plan</b>	5	0	0	0
2008	20	0	0	0

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

**Patent Applications Submitted**

<b>Year</b>	<b>Target</b>
<b>Plan:</b>	0
2008 :	0

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

	<b>Extension</b>	<b>Research</b>	<b>Total</b>
<b>Plan</b>	0	0	
2008	0	1	1

**V(F). State Defined Outputs**

**Output Target**



**Output #1**

**Output Measure**

- Scientific publications and/or presentations

<b>Year</b>	<b>Target</b>	<b>Actual</b>
2008	1	1

**V(G). State Defined Outcomes****V. State Defined Outcomes Table of Content**

<b>O No.</b>	<b>OUTCOME NAME</b>
1	Increase knowledge of anaerobic bacteria (%)
2	Identify antibiotic resistant bacteria in poultry manure (#)
3	Increase digester efficiency (%)

**Outcome #1****1. Outcome Measures**

Increase knowledge of anaerobic bacteria (%)

**2. Associated Institution Types**

•1890 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

Year	Quantitative Target	Actual
2008	10	20

**3c. Qualitative Outcome or Impact Statement****Issue (Who cares and Why)**

The target audience of this research is microbiologists, engineers and environmental biotechnologists who work on anaerobic digestion. Anaerobic digester technology for waste management is becoming a more attractive option for adding value to animal manure and improving nutrient management of associated nitrogen and phosphorus. WVSVU has been operating a pilot plant digester for six years on campus. The function of digesters requires the metabolic cooperation of diverse communities of bacteria and archaea. In order to develop predictive models that link microbial diversity to digester performance, molecular methods are being used to characterize the microbial populations in the pilot plant digester and experimental laboratory-scale reactors that are operated under specific environmental conditions.

**What has been done**

The program of research was focused on the microbial ecology of thermophilic anaerobic digestion. West Virginia State University operates a thermophilic anaerobic digester facility, including a 10,000 gallon pilot plant and laboratory scale reactors. Three principal projects were advanced: culture independent molecular characterization of the digester microbial community, analysis of the long term stability of the microbial populations in the pilot plant digester, and identification of digester populations that metabolize fatty acids.

**Results**

The results of the pyrosequencing analysis were outstanding. More than 28 Mb of DNA were sequenced using this method, providing an unprecedented view of anaerobic digester microbial community structure. More than 9500 pyrosequences were obtained for the pilot plant digester, and more than 40,000 pyrosequences were generated for a biofilm digester. The representation of total microbial diversity from the pyrosequencing was compared to that derived from traditional PCR-based random cloning approach. Whereas a rarefaction analysis of the pilot plant 16S rDNA clone library yielded about 100 OTUs (99% level), pyrosequencing yielded more than 2500 OTUs. This diversity would have been impossible to detect with microarrays. Furthermore, pyrosequencing data allows a comparison of DNA sequence variation which permits the detection of populations which contain microdiverse variation. Such variation could be essential to the performance of any environmental biotechnology system, including anaerobic digestion.

**4. Associated Knowledge Areas**

KA Code	Knowledge Area
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources.
403	Waste Disposal, Recycling, and Reuse

**Outcome #2****1. Outcome Measures**

Identify antibiotic resistant bacteria in poultry manure (#)

**2. Associated Institution Types**

•1890 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

Year	Quantitative Target	Actual
2008	5	0

**3c. Qualitative Outcome or Impact Statement****Issue (Who cares and Why)****What has been done**

This target has changed. The new target for the upcoming POW year is to Increase knowledge of biofilm digesters.

**Results****4. Associated Knowledge Areas**

KA Code	Knowledge Area
403	Waste Disposal, Recycling, and Reuse
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources.

**Outcome #3****1. Outcome Measures**

Increase digester efficiency (%)

**2. Associated Institution Types**

•1890 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

Year	Quantitative Target	Actual
2008	0	0

**3c. Qualitative Outcome or Impact Statement****Issue (Who cares and Why)**

The target audience of this research is microbiologists and engineers who work on anaerobic digestion as well as other environmental biotechnologists interested in biomass to bioenergy production. In addition, anaerobic digester operators and livestock and poultry farmers will benefit.

**What has been done**

The program of research was focused on the microbial ecology of thermophilic anaerobic digestion. West Virginia State University operates a thermophilic anaerobic digester facility, including a 10,000 gallon pilot plant which digests poultry litter and laboratory scale reactors. This research seeks to explain the exceptional performance of the WVSU digester in terms of microbial diversity and ecology.

**Results****4. Associated Knowledge Areas**

KA Code	Knowledge Area
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources.

**V(H). Planned Program (External Factors)****External factors which affected outcomes**

- Economy
- Government Regulations

**Brief Explanation**

The primary goal was to apply new technology to the problem of detecting, quantifying, and economically monitoring microbial population dynamics in anaerobic digesters. The original technology chosen for the project was DNA microarrays. The goal was to develop DNA microarrays that represent the microbial diversity of a model thermophilic anaerobic digester. However, during this grant award period, the unexpected and rapid development of high-throughput, low-cost DNA sequencing technology occurred. Pyrosequencing was tested as an alternative technology for reaching the primary goal. Experiments with pyrosequencing demonstrated that it is superior to DNA microarrays in terms of the objectives of this research. The power of pyrosequencing exceeded the potential of DNA microarrays. Therefore, we prudently adopted the new technology to reach the goals of developing an economical, comprehensive, quantifiable method for simultaneously monitoring the dynamics of hundreds of microbial populations in a bioreactor.

**V(I). Planned Program (Evaluation Studies and Data Collection)****1. Evaluation Studies Planned**

- Retrospective (post program)

**Evaluation Results****Key Items of Evaluation**

**Program #4****V(A). Planned Program (Summary)****1. Name of the Planned Program**

Plant Genomics

**V(B). Program Knowledge Area(s)****1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
201	Plant Genome, Genetics, and Genetic Mechanisms				50%
202	Plant Genetic Resources				35%
204	Plant Product Quality and Utility (Preharvest)				15%
	<b>Total</b>				100%

**V(C). Planned Program (Inputs)****1. Actual amount of professional FTE/SYs expended this Program**

Year: 2008	Extension		Research	
	1862	1890	1862	1890
<b>Plan</b>	0.0	0.0	0.0	5.2
<b>Actual</b>	0.0	0.0	0.0	4.5

**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	385300
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	0	290568
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	0	225860

**V(D). Planned Program (Activity)****1. Brief description of the Activity**

Marker development and mapping in watermelons and peppers, using cDNAFLPs and microarrays for gene expression across ploidy levels. Watermelon populations were evaluated from test sites at Alcorn State University and Florida A&M University. Also, a molecular diversity tree for 5 pepper species was constructed.

Tomato germplasm was evaluated for pest resistance and organoleptic traits. Molecular markers were used to track transfer of gene for Late Blight resistance. Selection for superior plant and fruit qualities continued. Genetic diversity in greenhouse and heirloom tomato varieties was assessed.

**2. Brief description of the target audience**

- Greenhouse industry - Horticulturists - Plant genetics researchers

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

**Target for the number of persons (contacts) reached through direct and indirect contact methods**

	<b>Direct Contacts Adults</b>	<b>Indirect Contacts Adults</b>	<b>Direct Contacts Youth</b>	<b>Indirect Contacts Youth</b>
<b>Year</b>	<b>Target</b>	<b>Target</b>	<b>Target</b>	<b>Target</b>
<b>Plan</b>	0	0	0	0
2008	75	150	0	0

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

**Patent Applications Submitted**

<b>Year</b>	<b>Target</b>
<b>Plan:</b>	2
2008 :	0

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

	<b>Extension</b>	<b>Research</b>	<b>Total</b>
<b>Plan</b>	0	0	
2008	0	2	0

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Scientific publications and/or presentations

<b>Year</b>	<b>Target</b>	<b>Actual</b>
2008	10	7

**V(G). State Defined Outcomes****V. State Defined Outcomes Table of Content**

<b>O No.</b>	<b>OUTCOME NAME</b>
1	Increase profitability of hydroponic tomatoes (%)
2	Gene map for vegetable crops (#)



**Outcome #1****1. Outcome Measures**

Increase profitability of hydroponic tomatoes (%)

**2. Associated Institution Types**

•1890 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

Year	Quantitative Target	Actual
2008	0	0

**3c. Qualitative Outcome or Impact Statement****Issue (Who cares and Why)****What has been done****Results****4. Associated Knowledge Areas**

KA Code	Knowledge Area
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
201	Plant Genome, Genetics, and Genetic Mechanisms

**Outcome #2****1. Outcome Measures**

Gene map for vegetable crops (#)

**2. Associated Institution Types**

•1890 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

Year	Quantitative Target	Actual
2008	2	0

**3c. Qualitative Outcome or Impact Statement****Issue (Who cares and Why)****What has been done****Results**

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
201	Plant Genome, Genetics, and Genetic Mechanisms

#### V(H). Planned Program (External Factors)

##### External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy

##### Brief Explanation

#### V(I). Planned Program (Evaluation Studies and Data Collection)

##### 1. Evaluation Studies Planned

- Retrospective (post program)

##### Evaluation Results

This is one of the most successful programs in terms of resources coming to this program as the researchers aggressively pursue other sources of funding (e.g. NSF, NIH, Capacity Building, etc.). The program and its participants will be retained and further supported.

##### Key Items of Evaluation

This research is currently being monitored to find a more commercial or off-campus applications through extension service.

**Program #5****V(A). Planned Program (Summary)****1. Name of the Planned Program**

Agricultural Biotechnology

**V(B). Program Knowledge Area(s)****1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
206	Basic Plant Biology				100%
	<b>Total</b>				100%

**V(C). Planned Program (Inputs)****1. Actual amount of professional FTE/SYs expended this Program**

Year: 2008	Extension		Research	
	1862	1890	1862	1890
<b>Plan</b>	0.0	0.0	0.0	1.8
<b>Actual</b>	0.0	0.0	0.0	0.6

**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	87650
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	0	40284
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	0	20000

**V(D). Planned Program (Activity)****1. Brief description of the Activity**

This research program has been temporarily halted (mid 2008) due to the lost of research personnel (the faculty in charge of this program accepted a new position at another institution). Since this program has partial funding support from the industry (Dow Chemical former Union Carbide), the program is being currently re-assessed between the organization and University officials in terms of its future focus. It is likely that this program will be restructured with a new focus; still within the agricultural biotechnology area.

**2. Brief description of the target audience**

Plant physiology researchers  
 Biochemists  
 Agriculture biotechnology companies

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

**Target for the number of persons (contacts) reached through direct and indirect contact methods**

	<b>Direct Contacts Adults</b>	<b>Indirect Contacts Adults</b>	<b>Direct Contacts Youth</b>	<b>Indirect Contacts Youth</b>
<b>Year</b>	<b>Target</b>	<b>Target</b>	<b>Target</b>	<b>Target</b>
<b>Plan</b>	5	0	0	0
2008	0	0	0	0

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

**Patent Applications Submitted**

<b>Year</b>	<b>Target</b>
<b>Plan:</b>	0
2008 :	0

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

	<b>Extension</b>	<b>Research</b>	<b>Total</b>
<b>Plan</b>	0	0	
2008	0	0	0

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Scientific presentations/publications

*Not reporting on this Output for this Annual Report*

**V(G). State Defined Outcomes****V. State Defined Outcomes Table of Content**

<b>O No.</b>	<b>OUTCOME NAME</b>
1	Improve plant photosynthesis %

**Outcome #1**

**1. Outcome Measures**

Improve plant photosynthesis %

*Not reporting on this Outcome for this Annual Report*

**V(H). Planned Program (External Factors)**

**External factors which affected outcomes**

- Other (Other research findings)

**Brief Explanation**

**V(I). Planned Program (Evaluation Studies and Data Collection)**

**1. Evaluation Studies Planned**

- Retrospective (post program)
- During (during program)

**Evaluation Results**

The program is currently interrupted and being reassessed in terms of future focus. Upon reassessment, this program area will be restructured and a new researcher will be hired. The new hire will have an opportunity to assemble a proposal congruent with the goals and objectives established for this research area.

**Key Items of Evaluation**

The program is currently interrupted and being reassessed in terms of future focus. Upon reassessment, this program area will be restructured and a new researcher will be hired.

**Program #6**

**V(A). Planned Program (Summary)**

**1. Name of the Planned Program**

Alternative Agriculture

**V(B). Program Knowledge Area(s)**

**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
201	Plant Genome, Genetics, and Genetic Mechanisms				25%
205	Plant Management Systems				75%
	<b>Total</b>				100%

**V(C). Planned Program (Inputs)**

**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2008	Extension		Research	
	1862	1890	1862	1890
<b>Plan</b>	0.0	0.0	0.0	1.0
<b>Actual</b>	0.0	0.0	0.0	2.5

**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	199650
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	0	150284
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**

Overall objective of this project is to develop and demonstrate hydroponic, sustainable/organic and ornamental technology and/or production systems suitable for use by small producers. Four types of research were done in 2008.

- 1) Evaluation of an alternative media component in a vertical hydroponic system
- 2) On farm variety trials
- 3) Development of a cayenne pepper and watermelon lines for release
- 4) Ornamental trials.

**2. Brief description of the target audience**

- Farmers/growers
- Organic farmers/growers
- Hydroponic growers
- Greenhouse growers
- Horticulturists

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

**Target for the number of persons (contacts) reached through direct and indirect contact methods**

	<b>Direct Contacts Adults</b>	<b>Indirect Contacts Adults</b>	<b>Direct Contacts Youth</b>	<b>Indirect Contacts Youth</b>
<b>Year</b>	<b>Target</b>	<b>Target</b>	<b>Target</b>	<b>Target</b>
<b>Plan</b>	10	0	0	0
2008	150	300	0	0

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

**Patent Applications Submitted**

<b>Year</b>	<b>Target</b>
<b>Plan:</b>	0
2008 :	0

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

	<b>Extension</b>	<b>Research</b>	<b>Total</b>
<b>Plan</b>	0	1	
2008	0	0	0

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Scientific presentations/publications

<b>Year</b>	<b>Target</b>	<b>Actual</b>
2008	2	1



**V(G). State Defined Outcomes****V. State Defined Outcomes Table of Content**

<b>O No.</b>	<b>OUTCOME NAME</b>
1	Increase small farm profitability %

**Outcome #1****1. Outcome Measures**

Increase small farm profitability %

**2. Associated Institution Types**

•1890 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

Year	Quantitative Target	Actual
2008	1	1

**3c. Qualitative Outcome or Impact Statement****Issue (Who cares and Why)**

Alternative agriculture products and practices such as organic/sustainable farming and hydroponic systems are becoming an important component in agriculture. Due to the expansion and domination of agribusiness corporations, small farms are unable to remain competitive in traditional crop production and marketing. Alternative approaches to growing crops and production of new or exotic species, can provide a greater return on small farm investment compared to traditional products and practices.

**What has been done**

The overall objective of this project is to develop and demonstrate hydroponic, sustainable/organic and ornamental technology and/or production systems suitable for use by small producers. Four types of research were done: evaluation of a hydroponic strawberry system, assessment of small portable greenhouses, trialing of varieties on organic farms and ornamental plant trials.

**Results**

Winter survival of 2007 ornamental plantings was better with two mum selections and two lavender selections having 100% survival. Lack of space required most of the 2008 ornamental trails to be planted in a new location on campus.

Also, Media trials determined that parboiled rice hulls can be used as a renewable substrate component in vertical hydroponic systems.

**4. Associated Knowledge Areas**

KA Code	Knowledge Area
205	Plant Management Systems
201	Plant Genome, Genetics, and Genetic Mechanisms

**V(H). Planned Program (External Factors)****External factors which affected outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Economy

**Brief Explanation****V(I). Planned Program (Evaluation Studies and Data Collection)****1. Evaluation Studies Planned**

- Retrospective (post program)
- During (during program)

**Evaluation Results**

This program has grown steadily and it is further developing. More resources are coming to this program as the researchers pursue other sources of funding (e.g. Capacity Building, Specialty Crops Programs, etc.). The program and its participants will be retained and further supported.

**Key Items of Evaluation**

This research is well integrated with extension and provides benefit to commercial and off-campus applications -through extension service.