V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Sustainable Energy

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships			5%	5%
125	Agroforestry			5%	10%
201	Plant Genome, Genetics, and Genetic Mechanisms			5%	5%
202	Plant Genetic Resources			5%	10%
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			5%	5%
205	Plant Management Systems			15%	15%
211	Insects, Mites, and Other Arthropods Affecting Plants			5%	5%
212	Pathogens and Nematodes Affecting Plants			5%	5%
216	Integrated Pest Management Systems			10%	10%
402	Engineering Systems and Equipment			5%	0%
405	Drainage and Irrigation Systems and Facilities			5%	0%
601	Economics of Agricultural Production and Farm Management			10%	10%
603	Market Economics			5%	5%
605	Natural Resource and Environmental Economics			10%	10%
607	Consumer Economics			5%	5%
	Total			100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2011	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	10.0	9.0
Actual Paid Professional	0.0	0.0	10.0	9.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Institution Name: Auburn University

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	550000	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	550000	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	0	0

2. Institution Name: Alabama A&M University

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	332151
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	0	332151
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	0	0

2. Institution Name: Tuskegee University

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	334378
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	0	334378
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

The goal of this program is to increase our knowledge of bioconversion of feedstocks to bioenergy and bioproducts, bioprocessing systems, biomass production, and conversion of byproducts into value-added products and to enhance understanding of the long-term sustainability of feedstock production and bioconversion systems including economics, social issues, land use policies, and energy security and the environment. Specific areas of research include, but are not limited to: alternative crops for efficient production of bioenery feedstocks, biotechnology of bioenergy crops to enhance production or to enhance its utilization as an energy source, and technology development for bioenergy conversion. The ultimate goal of this program is to address issues related to renewable energy using bio-based feedstocks that ultimately contribute to the relief of energy dependence on foreign sources.

Our program on bioenergy and bioproducts includes all three land-grant mission areas (research, instruction, and extension). Overall the program employs a systems approach to developing a biorefining industry in the southeast U.S. that is based mainly on utilizing biomass resources. Within the various types of biomass, most emphasis is currently being placed on woody biomass (both pine and short-rotation hardwoods) to compliment long-running research on herbaceous biomass (e.g. switchgrass) production. Auburn's program includes all aspects of the supply chain that produces woody biomass and converts it to liquid fuels, renewable electrical power, and other high value chemicals and biobased products. In general, our work emphasizes the thermochemical conversion of biomass to these various products. Specific projects underway currently include:

· Production systems for short-rotation hardwoods. We are in the initial stages of establishing research and demonstration plots for hybrid poplar and eucalyptus on marginal lands (in collaboration with Arborgen, Inc.). This research and extension project will examine genetic, silvicultural, and harvesting system factors in the effectiveness of short-rotation hardwood systems. · New harvesting and transportation systems for southern pine energy plantations. Our research and extension work has developed and is field testing a new track-type, shear-head feller buncher; new wheeled skidder; high-capacity whole tree chipper; and high-capacity trucks for harvesting and transporting woody biomass to liquid fuel producers. Additional components of this research are expanding our understanding of the effects of harvesting and processing on biomass quality.

· Harvesting systems for short-rotation hardwoods. We are beginning new research and extension work to identify the optimal systems for harvest of short-rotation hardwoods as grown in the southeast U.S.

· Safety of woody biomass production systems. One component of our logistics system research is the examination of safety and health issues for forest workers, with particular emphasis on workers operating forest harvesting machines.

· Biomass fractionation. Research underway is utilizing biomass fractionation to separate biomass into the basic chemical constituents (cellulose, hemicellulose, and lignin) and subsequent production of higher value chemicals such as polylactic acid.

· Biomass gasification and synthesis gas cleanup for electrical power generation. Research is developing models to predict synthesis gas quality as a function of biomass characteristics and gasifier operating parameters. Also, this work is examining strategies for syngas cleanup.

· Biomass gasification and electrical power generation. Long term research on the use of downdraft gasification and electrical power generation has examined the economic potential of various low-cost residue feedstocks such as urban biomass, pecan shells, forest residues, recycled plastics, and municipal sewage sludge.

· Biomass gasification, syngas cleanup, and liquid fuel production. Research is examining the relationships between biomass compositions, gasification parameters, syngas cleanup, and Fischer-Tropsch conversion to be able optimize liquid fuel production systems.

· Biomass pyrolysis. Research is examining catalytic methods for stabilizing and upgrading pyrolysis

oils.
· Fischer-Tropsch synthesis for production of liquid fuels and chemical. Development of unique, super-critical phase Fischer-Tropsch synthesis has opened the door to new pathways to produce diesel and aviation fuels along with aldehydes and oxygenates.
· Community impacts of the bioeconomy. Research is examining social and economic considerations for developing a biorefining industry in the southeast U.S.
· Graduate education in biorefining. We have embarked on a program of graduate education centered around biorefining. New graduate courses and graduate research will focus on multidisciplinary projects in biorefining.
· Undergraduate fellowships in biorefining. We are leading the development of a new undergraduate fellowship program on biorefining and production of liquid fuels. New courses and concentrated multidisciplinary undergraduate team experiences will foster the solution of biofuel industry problems.

- The School of Forestry and Wildlife Sciences (SFWS) was very active in bioenergy research during 2011 with approximately $1.3M brought into the School from prestigious funding sources such as AFRI and NSF. Most of the research was focused on refining methods to facilitate the conversion of small diameter trees and logging residues into ethanol and related byproducts. In addition, related research explored the socioeconomic factors across rural areas in the southeastern United States which could either facilitate or slow biofuel crop production.
- Scientists continue research on alternative crops such as miscanthus, sweetpotato, sugarcane and sweet sorghum as biomass feedstock for bioethanol production.

2. Brief description of the target audience

Researchers, educators, extension personnel, community leaders, educators, 4H, youth centers, energy consumers, general public.

3. How was eXtension used?

eXtension is not used in this program.

V(E). Planned Program (Outputs)

1. Standard output measures

2011	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	2100	45000	2500	55000

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

Year: 2011
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2011	Extension	Research	Total
Actual	0	17	17

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Publications

Year	Actual
2011	17

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Development of efficient bioenergy crops
2	Increased acreage of bioenergy crops such as corn, switchgrasses, sweetpotatoes, and canola.
3	Increased percentage of bioenergy in the overall consumption of energy

Outcome #1

1. Outcome Measures

Development of efficient bioenergy crops

2. Associated Institution Types

- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2011	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Bioenergy crops need to be identified, evaluated, and tested for their productivity.

What has been done
Our program on bioenergy and bioproducts includes all three land-grant mission areas (research, instruction, and extension). Overall the program employs a systems approach to developing a biorefining industry in the southeast U.S. that is based mainly on utilizing biomass resources. Within the various types of biomass, most emphasis is currently being placed on woody biomass (both pine and short-rotation hardwoods) to compliment long-running research on herbaceous biomass (e.g. switchgrass) production. Our program includes all aspects of the supply chain that produces woody biomass and converts it to liquid fuels, renewable electrical power, and other high value chemicals and biobased products.

Results
Woody plants such as pine and short-rotation hardwoods have been identified as the major bioenergy feedstock species for Alabama. In addition, switchgrasses and sweetpotatoes have also been identified as a suitable bioenergy crop.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
125	Agroforestry
201	Plant Genome, Genetics, and Genetic Mechanisms

202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
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216	Integrated Pest Management Systems
402	Engineering Systems and Equipment
405	Drainage and Irrigation Systems and Facilities
601	Economics of Agricultural Production and Farm Management
603	Market Economics
605	Natural Resource and Environmental Economics
607	Consumer Economics

Outcome #2

1. **Outcome Measures**

Increased acreage of bioenergy crops such as corn, switchgrasses, sweetpotatoes, and canola.

Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

Increased percentage of bioenergy in the overall consumption of energy

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges

Brief Explanation

Research funding limitation is the bottleneck to conduct extensive research in the area of bioenergy and bioproducts.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Good progress was made, but major research funding is needed to make a difference. A number of activities are ongoing and it takes years before meaningful results can be achieved. In 2011, Auburn faculty completed a feasibility study for collection of urban biomass to generate renewable electrical power for a municipality. The study was conducted for the City of Fultondale, Alabama. Fultondale collects approximately 1800 dry tons of biomass per year from urban sources and places it in a construction and demolition waste landfill. The goal of the study was to determine if it would be feasible to use this biomass as a feedstock for a biomass gasification and renewable power generation facility. The results of this project indicate that there are significant seasonal variations in biomass availability. The total annual amount of biomass available was slightly over 3.6 million pounds (dry weight), or 1,810 dry tons. This amount is significantly less than what was projected to be available before the project started. The properties of the biomass make it well suited for use in gasification and power generation systems. Gasification test results showed the urban woody biomass is a feedstock that has the potential to be converted very efficiently to syngas and subsequently used for power production. Insufficient data were available to develop and validate geospatial models to predict urban biomass production for Fultondale. The plant economics of heat and electricity production from urban biomass waste collected in Fultondale were analyzed by using a modular economic model with drying, chipping, gasification and power generation modules. Three gasification systems (fluidizedbed, downdraft and updraft) and three power generation systems (internal combustion, steam turbine and gas turbine) were assessed resulting in nine plant configuration scenarios. The fluidizedbed reactor and internal combustion engine plant configuration resulted in the lowest cost of electricity of $0.15/kWh for an installed capacity of 257 kWe. Overall, while technically feasible, a biomass gasification system designed to use urban biomass wastes from the City of Fultondale will have limited economic feasibility due to the limited amount of biomass available and the resulting small scale of the system.

This project characterized urban biomass collected from a city in the southeast U.S. The results from the biomass characterization research showed that urban biomass is very suitable for use in gasification and power generation facilities. These results are important for public private partnerships by demonstrating that the quality of urban biomass feedstocks is sufficient for renewable energy projects. The project also showed that for a single municipality, it may not be economically feasible to generate renewable electrical power using the biomass from a single municipality. However, if multiple groups can join together and pool biomass resources, the economic feasibility of a power generation facility may improve while also reducing loading on local landfills.

Key Items of Evaluation

NIFA's approach of funding Bioenergy research is through the large CAP projects. While multi-institutional collaborations are positive, the dilution of funds is serious. It may appear that millions are poured into a single project, but at the end, the available funds for each researcher are so limited, which may not achieve the intended objectives. In addition, whoever received the funding can continue the research. However, many others who are not successful in funding may no longer be able to continue research activities without funding.