V(A). Planned Program (Summary)

Program # 14

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	0%	0%	5%	
102	Soil, Plant, Water, Nutrient Relationships	0%	0%	7%	
131	Alternative Uses of Land	0%	0%	3%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%	0%	10%	
202	Plant Genetic Resources	0%	0%	3%	
205	Plant Management Systems	0%	0%	12%	
206	Basic Plant Biology	0%	0%	7%	
212	Pathogens and Nematodes Affecting Plants	0%	0%	3%	
215	Biological Control of Pests Affecting Plants	0%	0%	2%	
402	Engineering Systems and Equipment	0%	0%	3%	
404	Instrumentation and Control Systems	0%	0%	7%	
501	New and Improved Food Processing Technologies	0%	0%	3%	
511	New and Improved Non-Food Products and Processes	0%	0%	28%	
512	Quality Maintenance in Storing and Marketing Non-Food Products	80%	80%	2%	
601	Economics of Agricultural Production and Farm Management	0%	0%	2%	
603	Market Economics	10%	10%	0%	
605	Natural Resource and Environmental Economics	10%	10%	0%	
610	Domestic Policy Analysis	0%	0%	3%	
	Total	100%	100%	100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Extension	Research

Year: 2012	1862	1890	1862	1890
Plan	9.0	1.0	57.0	0.0
Actual Paid Professional	4.0	1.0	74.5	0.0
Actual Volunteer	2.0	0.2	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**
98365	28018	1572039	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1040747	28018	6131184	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	5307033	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Our economic research is developing national ethanol, biodiesel, electric, and bioproduct demand quantities and incorporating them into an existing dynamic agricultural sector econometric simulation model (POLYSYS). Regional feedstock supply curves necessary to meet national bioenergy and bioproduct demand quantities are being estimated by modifying POLYSYS to include cellulosic feedstock in addition to existing agricultural grain and oilseed crops. Regional bioenergy and bioproduct supply curves are being developed using regional feedstock supply curves, representative transportation costs, and representative costs for each feedstock-technology-product combination considered. A national expansion curve for the bioenergy and bioproduct industry is being estimated. Key indicators of agricultural sector performance including net farm income, agricultural prices, and government cost in meeting national bioenergy and bioproduct demand quantities are being evaluated.

As part of our engineering research, we are documenting drying rates and methods for corn stover, and quantifying the distribution and quality of the above ground biomass. For existing biomass densification systems, we areidentifying relations between particle size, biomass type, final density, compression pressures and energy, and other engineering factors. We are determining optimum particle sizes based on a balance between expended energy, final density, and integrity of compressed pellet or wafer. We are using these optimum particle sizes to identify or invent technologies to achieve the size based on theoretical cutting lengths due to feed speed, cutter speed, and other engineering factors. We are applying the developed technologies in laboratory-scale granulation tests to verify sizes using laser, image analyzer, sieve, and manual methods. We are comparing the developed methods in particle size reduction to existing technologies.

In terms of downstream processing, we are conducting fundamental studies on the fractionation of various free fatty acid (FFA) mixtures to test whether the mathematical modeling approach used by us for

rapeseed oil is more widely applicable.Additionally, the food safety of the purified FFA products is being assessed. We will then complete the cost analysis of this fractionation process using results predicted by the mathematical model using chemical plant design software. A bench-scale continuous reactor is being assembled and we will attempt to maintain the same productivity (moles of product per time per mass of enzyme) as achieved for batch-mode experiments from previous experiments.We are also attempting the further development of microemulsion-based protein extraction as a rapid low-cost and scalable means of selectively isolating and purifying proteins of interest from aqueous media.

2. Brief description of the target audience

This planned program is targeted to Tennessee farmers. Secondary audiences include consumers of both basic and applied research and the general public.

3. How was eXtension used?

Tennessee is represented by 108 eXtension members in 42 of the 59 approved Communities of Practice (CoP). Tennessee Extension personnel have addressed over 800 Frequently Asked Questions through eXtension.

This Sustainable Energy Planned Program was enhanced through the service of five Tennessee Extension personnel on the "Sustainable Ag Energy" CoP. Tennessee Extension personnel shared implementation strategies, outcome measurement, and evaluation protocols with their CoP colleagues

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	2870	1048849	46	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	1	69	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Peer-reviewed technical resource pages in online BioWeb resource (Rials).
  Not reporting on this Output for this Annual Report

Output #2

Output Measure

- Number of research-based publications distributed as part of Extension biofuels programs.

Year	Actual
2012	33

Output #3

Output Measure

- Identify the prevalent foliar and root diseases of switchgrass in Tennessee and the major fungal pathogens associated with seed (Ownley).
  Not reporting on this Output for this Annual Report

Output #4

Output Measure

- We have demonstrated that high value cellulose nanocrystals (CNCs) can be produced by sulfuric acid hydrolysis from switchgrass. Those findings will help other researchers to better design cellulose nanocomposites. (Wang)

Year	Actual
2012	0

Output #5

Output Measure

- Lignin has been optimized through a series of organic fractionations and an organosolv pulping process. This results in a lignin with a thermal and viscoelastic properties to facilitate the production of lignin based fibers from a melt spinning process. This will allow the production of carbon fibers at a fraction of the cost of other carbon fibers. (Harper)

Year	Actual
2012	0

Output #6

Output Measure

- High-tonnage switchgrass-supply research showed advantages of integrating 1st-stage size-reduction processing with harvest logistics to enable economies of automated bulk-format handling. Low moisture switchgrass chopped at improved uniform particle lengths exhibited

increased handling and flow behaviors than wide particle size distributions created from tub ground bales. (Womac)

Year	Actual
2012	0

Output #7

Output Measure

- Switchgrass becomes more competitive with traditional enterprises on the less productive soil, but the risk-preferred contract terms differ based on risk behavior of different producers. Less productive soils are more suited to cow-calf production and switchgrass production than to row-crop production. Subsidies and risk-deferring contract terms could make switchgrass production on less productive soils a more profitable enterprise than traditional enterprises and entice producers to grow switchgrass. (English)

Year	Actual
2012	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Majority of first-pass biomass size reduction done with knife grids or other techology more efficient than rotary (Womac).
2	In-field size reduction and/or compacting done on majority of cellulosic biomass harvested in Tennessee (Womac).
3	Number of growers producing switchgrass as an energy crop. (Jackson)
4	Number of acres of switchgrass grown in Tennessee as an energy crop. (Jackson)
5	Farmer-owned biomass cooperative to help capture economic advantage of bioenergy production (Tiller).
6	Be evaluating precision-farming / variable-rate technology for switchgrass and other bioenergy crops (Tyler).
7	Mills using integrated process to produce bioenergy plus enhanced-strength OSB (Wang).
8	Process Analytics of Bio-Based Products (Young)
9	Switchgrass Storage (English)

Outcome #1

1. **Outcome Measures**

Majority of first-pass biomass size reduction done with knife grids or other techology more efficient than rotary (Womac).

Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

In-field size reduction and/or compacting done on majority of cellulosic biomass harvested in Tennessee (Womac).

Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

Number of growers producing switchgrass as an energy crop. (Jackson)

Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

Number of acres of switchgrass grown in Tennessee as an energy crop. (Jackson)

Not Reporting on this Outcome Measure

Outcome #5

1. **Outcome Measures**

Farmer-owned biomass cooperative to help capture economic advantage of bioenergy production (Tiller).

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Be evaluating precision-farming / variable-rate technology for switchgrass and other bioenergy crops (Tyler).

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Mills using integrated process to produce bioenergy plus enhanced-strength OSB (Wang).

Not Reporting on this Outcome Measure

Outcome #8

1. Outcome Measures

Process Analytics of Bio-Based Products (Young)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Wood product producers need to minimize costs and improve quality.

What has been done
The commercial-ready statistical software system that predicts real-time strength properties of manufactured materials has improved performance at forest products and biobased manufacturers in the southeastern U.S.

Results

The potential of a larger impact to North American and global industries is feasible. The new and emerging biofuels industry could directly benefit from optimization of throughput and improved quality of bioenergy and biofuels from use the system.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment
404	Instrumentation and Control Systems
511	New and Improved Non-Food Products and Processes

Outcome #9

1. Outcome Measures

Switchgrass Storage (English)

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)
The impact of storage dry matter losses on the profitability of producing switchgrass is poorly understood.

What has been done
Initiated a bale storage study examining switchgrass storage methods and bale decomposition.

Results
A cost savings of 12 to 18 cents per gallon of ethanol could be realized depending on whether the alternative was square or round bales. Densification could create additional savings. Feedstock costs are close to those needed as indicated by Industry to make biofuels economically competitive.

4. Associated Knowledge Areas

KA Code	Knowledge Area
511	New and Improved Non-Food Products and Processes
512	Quality Maintenance in Storing and Marketing Non-Food Products
601	Economics of Agricultural Production and Farm Management
603	Market Economics
605	Natural Resource and Environmental Economics

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
- Other (International conflict)

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Our research programs are evaluated by acceptance of publications in peer-reviewed, archival journals, grant proposals that receive funding from government, industry, and foundation sources, and our ability to attract promising graduate and post-doctoral students.

Key Items of Evaluation

Our research programs are evaluated by acceptance of publications in peer-reviewed, archival journals, grant proposals that receive funding from government, industry, and foundation sources, and our ability to attract promising graduate and post-doctoral students.