

V(A). Planned Program (Summary)

Program # 4

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	0%	0%	7%	
123	Management and Sustainability of Forest Resources	0%	0%	2%	
131	Alternative Uses of Land	0%	0%	2%	
135	Aquatic and Terrestrial Wildlife	0%	0%	1%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%	0%	3%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	0%	0%	5%	
205	Plant Management Systems	0%	0%	12%	
206	Basic Plant Biology	0%	0%	2%	
212	Pathogens and Nematodes Affecting Plants	0%	0%	3%	
215	Biological Control of Pests Affecting Plants	0%	0%	2%	
307	Animal Management Systems	0%	0%	1%	
402	Engineering Systems and Equipment	0%	0%	4%	
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%	33%	
512	Quality Maintenance in Storing and Marketing Non-Food Products	80%	80%	3%	
601	Economics of Agricultural Production and Farm Management	0%	0%	3%	
603	Market Economics	10%	10%	1%	
605	Natural Resource and Environmental Economics	10%	10%	5%	
610	Domestic Policy Analysis	0%	0%	1%	
	Total	100%	100%	100%	

V(C). Planned Program (Inputs)

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

Year: 2010	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	42.0	0.0
Actual	2.0	1.0	55.8	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
42918	13206	595317	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
1455985	13206	7159999	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
146826	0	2525254	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Economic research will estimate the capacity of U.S. agriculture to generate a supply of feedstock to sustain a bioenergy and bioproducts industry. Expansion curves for the growth of the bioenergy and bioproducts industries will be developed by estimating a national bioenergy and bioproducts demand for agricultural feedstock, the agricultural resources demanded, and the price and income impacts on the agricultural sector. The economic and land use impacts of alternative sizes of the bioenergy and bioproducts industries and the corresponding economic feasibility to generate feedstock from agricultural sources will also be estimated.

Engineering research objectives are to develop a knowledge base and/or equipment related to the influence particle size on biomass densification, to identify the most economical ways of size-reducing, separating and transporting biomass feedstocks, and to improve existing approaches and develop new approaches to produce valuable chemical products from common agricultural sources such as seed oils, proteins, and carbohydrates. Our research-oriented biorefinery is now online to study the full range of processes involved in converting cellulosic biomass to ethanol. Producers are growing the required biomass feedstock for the biorefinery.

2. Brief description of the target audience

The primary audiences for our sustainable energy research include agricultural and forestry producers, energy consumers (both individuals and businesses), and policy-makers.

V(E). Planned Program (Outputs)

1. Standard output measures

2010	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	0	0	0	0
Actual	4362	116549	494	0

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

Patent Applications Submitted

Year: 2010
 Plan: 1
 Actual: 1

Patents listed

Switchgrass Promoter and Uses Thereof, Stewart, Neal C. (KNOXVILLE, TN, US) , Mann, David George James (KNOXVILLE, TN, US)

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2010	Extension	Research	Total
Plan	0	14	
Actual	0	57	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Peer-reviewed technical resource pages in online BioWeb resource (Rials).

Year	Target	Actual
2010	1400	1400

Output #2

Output Measure

- The discovery that springtails in the genus Pogonognathellus are composed of numerous, mostly geographically-limited species largely invalidates the last century of research in North America on the role of these ecologically important arthropods, since several species often occur together. It is impossible to know to what species earlier researchers were referring; therefore, much of our knowledge of these springtails in our environments must be redone. (Bernard)

Year	Target	Actual
2010	{No Data Entered}	1

Output #3

Output Measure

- A national study of how meeting potential energy and carbon policies might impact the U.S. agriculture and forestry sectors as well as the economy was conducted. Results suggest that under a properly designed RES, economic returns to the agriculture and forestry sectors are significant and are projected to be widespread across the United States. Analysis shows that Agriculture can supply significant quantities of biomass to meet these policies increasing net farm income by \$100 billion over the 15 years period of the study, adding \$200 billion to the nation's economy and 800,000 jobs. (English)

Year	Target	Actual
2010	{No Data Entered}	1

Output #4

Output Measure

- Agricultural mulches formed from biobased poly(lactic acid) using nonwovens textile technology provide the desired balance of strength and biodegradability that enable their large-scale use. (Hayes)

Year	Target	Actual
2010	{No Data Entered}	1

Output #5

Output Measure

- Collaborative research has resulted in an extensive exploration of cellulolytic activity in insect digestive fluids. The range of activities, between species, region of digestive tract, and to different cellulose substrates has directed new exploration with goals of practical application in biofuel production systems. A second thrust clarifies the extent of cellulolytic activity against different cellulose substrates and at several key insect developmental stadia. (Jurat-Fuentes and Klingeman)

Year	Target	Actual
2010	{No Data Entered}	1

Output #6

Output Measure

- Our corporate training seminars in statistical process control and advanced data mining have documented direct financial benefits to the participating companies ranging from approximately \$20,000 to \$300,000 per year. (Young)

Year	Target	Actual
2010	{No Data Entered}	1

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Research-oriented biorefinery to test range of processes for biomass to cellulosic ethanol (Tiller).
2	Majority of first-pass biomass size reduction done with knife grids or other technology more efficient than rotary (Womac).
3	In-field size reduction and/or compacting done on majority of cellulosic biomass harvested in Tennessee (Womac).
4	Number of growers producing switchgrass as an energy crop. (Jackson)
5	Number of acres of switchgrass grown in Tennessee as an energy crop. (Jackson)
6	Average yield of switchgrass varieties (from introduction to well-managed stands) in Tennessee, tons per acre. (West & Larson)
7	Farmer-owned biomass cooperative to help capture economic advantage of bioenergy production (Tiller).
8	Switchgrass weed control (Rhodes)
9	Switchgrass storage (Yu)
10	Seeding and Fertilization Rates for Biomass Crops (Tyler, West, and Larson)
11	Reducing hygroscopicity in wood composites (Wang)

Outcome #1

1. Outcome Measures

Research-oriented biorefinery to test range of processes for biomass to cellulosic ethanol (Tiller).

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	1	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment
511	New and Improved Non-Food Products and Processes
605	Natural Resource and Environmental Economics

Outcome #2

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	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
402	Engineering Systems and Equipment
511	New and Improved Non-Food Products and Processes
603	Market Economics
605	Natural Resource and Environmental Economics

Outcome #3

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	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
402	Engineering Systems and Equipment
511	New and Improved Non-Food Products and Processes
603	Market Economics
605	Natural Resource and Environmental Economics

Outcome #4

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	75	75

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
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- 205 Plant Management Systems
- 511 New and Improved Non-Food Products and Processes
- 603 Market Economics
- 605 Natural Resource and Environmental Economics

Outcome #5

1. Outcome Measures

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

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Average yield of switchgrass varieties (from introduction to well-managed stands) in Tennessee, tons per acre. (West & Larson)

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	1	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
512	Quality Maintenance in Storing and Marketing Non-Food Products
603	Market Economics
605	Natural Resource and Environmental Economics

Outcome #8

1. Outcome Measures

Switchgrass weed control (Rhodes)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	{No Data Entered}	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Weed competition has been cited by numerous state, regional and national expert scientists as the number one limiting factor to the successful establishment of switchgrass for biofuels.

What has been done

In 2008 we initiated a concentrated research and Extension educational program in switchgrass weed management in support of the Tennessee Biofuels Initiative.

Results

Our efforts led to the granting of numerous state and one federal label for herbicides for use in switchgrass for biofuel and helped to elevate the visibility of TN on the national biofuel research front. Moreover, it helped to protect the UTIA's initial \$1,175,850 investment in switchgrass producer contracts and, to the successful completion of the 5100 acres-planted goal by 2010.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
215	Biological Control of Pests Affecting Plants

Outcome #9

1. Outcome Measures

Switchgrass storage (Yu)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	{No Data Entered}	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

We need to make ethanol more competitive in the market place without impacting producer profits, while providing producers a potential value-added industry.

What has been done

Our research in the logistics of biomass feedstock for biofuel industry has expanded our knowledge on various preprocessing systems in the switchgrass supply chain. Based on our findings, a field experiment using an industrial baler to preprocess about 170 acres of switchgrass is currently being conducted in Vonore, Tennessee.

Results

Chopping and density baling has the potential of reducing feedstock cost delivered to a bio-refinery by about 40% compared with conventional hay methods. Adoption of this technology could reduce the cost of a gallon of ethanol created from cellulose by \$0.30/gallon.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
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

Outcome #10

1. Outcome Measures

Seeding and Fertilization Rates for Biomass Crops (Tyler, West, and Larson)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	{No Data Entered}	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Switchgrass can provide high cellulose biomass for conversion to biofuels such as ethanol.

What has been done

Seeding rate, nitrogen rate and cultivar studies have been underway for seven years on four different soil and landscape situations at the Milan Research and Education Center.

Results

These data have resulted in a lowering of the seeding rate recommendation from 9 kg/ha pure live seed to 6.7. The data have also indicated that in most situations the 67 kg/ha nitrogen rate is sufficient for maximum biomass over the seven growing seasons.

4. Associated Knowledge Areas

- KA Code** **Knowledge Area**
- 205 Plant Management Systems
- 601 Economics of Agricultural Production and Farm Management

Outcome #11

1. Outcome Measures

Reducing hygroscopicity in wood composites (Wang)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	{No Data Entered}	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Dimensional stability and durability are two main concerns about wood and wood-based composites. Hygroscopic nature of wood is the main reason for moisture absorption and consequently swelling and instability in dimensions of wood and wood-based products. Moisture also provides proper condition for growing fungus and molds on wood-based composites.

What has been done

Our research has demonstrated that extraction of some amorphous carbohydrates (hemicellulose and amorphous cellulose), which are the most hydrophilic component of wood, from wood strands can significantly decrease hygroscopicity and improve mold resistant and dimensional stability of oriented strandboard. Extracted sugars can use for producing different chemicals especially use for making bioethanol.

Results

This research has the potential for improving the nanoindentation testing methods for wood materials. A basic understanding of nanoindentation technique on wood material is required for continued improvement of characterization of bio-composites.

4. Associated Knowledge Areas

KA Code	Knowledge Area
511	New and Improved Non-Food Products and Processes
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
- null

Brief Explanation

{No Data Entered}

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

1. Evaluation Studies Planned

- After Only (post program)
- Retrospective (post program)
- During (during program)
- Time series (multiple points before and after program)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}