V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Sustainable Energy - new feedstocks and improved feedstock production

☑ 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
202	Plant Genetic Resources				30%
204	Plant Product Quality and Utility (Preharvest)				30%
213	Weeds Affecting Plants				10%
511	New and Improved Non-Food Products and Processes				30%
	Total				100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.0	10.7
Actual Paid Professional	0.0	0.0	0.0	8.5
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	0	386136
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	0	386136
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	0	412605

V(D). Planned Program (Activity)

1. Brief description of the Activity

Disseminate research findings to the scientific community, stakeholders, agricultural, environmental, life science industries.
Conduct agronomic and economic analysis.
Recruit and train students, incorporating research training into teaching and extension curricula.
Design and implement field and laboratory research.

2. Brief description of the target audience

State, local and federal agencies, small and limited-resource farmers, researchers, educators, policy makers, consumers and bioenergy companies.

3. How was eXtension used?

Project PIs worked as part of the leadership team for the Farm Energy CoP at eXtension.org.

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

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

Patent Applications Submitted

Year: 2013
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	1	1	2

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of workshops and presentations concerning new or alternative biofuel feedstocks.
  Not reporting on this Output for this Annual Report

Output #2

Output Measure

- Publications relating to improved/optimized biofuel production.

Year	Actual
2013	19

Output #3

Output Measure

- Presentations related to research on new feedstocks and improved feedstock production.

Year	Actual
2013	25

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Producers will have increased knowledge of production options available for growing bioenergy feedstocks (Increased knowledge and understanding of the biofuels supply chain).
2	An increased number of producers will adopt production of bioenergy feedstocks (Implementation of sustainable biofuels systems).
3	Students will receive training in bioenergy production (Develop a diverse and educated workforce for a biofuels industry).
4	Protocols will be developed for mutagenesis and selection of herbicide resistant biofuel feedstock varieties (Increased knowledge and understanding of the biofuels supply chain).
5	Desirable biofuel feedstock varietal mutants will be recovered (Increased knowledge and understanding of the biofuels supply chain).
6	New varieties of biofuel feedstocks will be developed (Increased knowledge and understanding of the biofuels supply chain).
7	Producers will have knowledge of camellia as biofuel feedstock (Increased knowledge and understanding of the biofuels supply chain).
8	Demonstration sites for camellia as alternative feedstock will be established (Increased knowledge and understanding of the biofuels supply chain).
9	Camellia lines produced with enhanced fatty acid will be developed (Increased knowledge and understanding of the biofuels supply chain).
10	Producers in Tennessee will grow camellia as biofuel feedstock (Implementation of sustainable biofuels systems).
11	Producers will have knowledge of costs of production (from land preparation to final ethanol production) for two biofuel crops (Miscanthus and switchgrass) through the construction of enterprise budgets.
12	Stakeholders will have knowledge of the energy efficiently of biofuel production from switchgrass and Miscanthus through the calculation of energy balance sheets for these crops, providing indicators of sustainability for biofuel production
13	Factors responsible for improved efficiency of biofuel production will be determined.
14	Research to determine optimal harvest timing for switchgrass in Tennessee

Outcome #1

1. Outcome Measures

Producers will have increased knowledge of production options available for growing bioenergy feedstocks (Increased knowledge and understanding of the biofuels supply chain).

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	322

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Bioenergy, and biofuels in particular, are a mainstream concept as an alternative to the security and environmental issues related to fossil fuels. Many producers may be understandably skeptical about growing biofuel crops because of the lack of information available to them and the fact that there is currently no major market available for them to sell these products. However, it is important to disseminate this assistance to these producers because once the infrastructure and markets are fully established, producers will have the optimal tools available to them to succeed.

What has been done
Presentations of research data on the use of switchgrass or native-warm season grasses in general for forage and bioenergy (verbal, video, scientific meetings). Demonstrations using a mobile biodiesel demonstration purchased through USDA NIFA Capacity Building grant funds were conducted. One fact sheet was developed, published, and uploaded to the TSU Cooperative Extension website. A Twitter account (@TSUBioenergy) and website (http://www.tnstate.edu/faculty/jdekoff/) were maintained to provide information on the bioenergy program at TSU as well as other bioenergy-related topics.

Results
Based on survey results from outreach meetings:
73% of respondents increased their interest in growing native warm-season grasses
87% of respondents increased their knowledge in using native warm-season grasses for biofuel production.

4. Associated Knowledge Areas

KA Code	Knowledge Area
204	Plant Product Quality and Utility (Preharvest)

511 New and Improved Non-Food Products and Processes

Outcome #2

1. Outcome Measures

An increased number of producers will adopt production of bioenergy feedstocks (Implementation of sustainable biofuels systems).

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Bioenergy, and biofuels in particular, are a mainstream concept as an alternative to the security and environmental issues related to fossil fuels. Many producers may be understandably skeptical about growing biofuel crops because of the lack of information available to them and the fact that there is currently no major market available for them to sell these products. It is important, however, to disseminate this assistance to these producers because once the infrastructure and markets are fully established, they will have the optimal tools available to them to succeed.

What has been done
Research on optimization of production of feedstocks is conducted. Various outreach and educational efforts of research data and market conditions, similar to those employed for Outcome #1.

Results
Research in optimizing feedstock production in the Southeast is progressing, but project has not progressed far enough to measure grower adoption, nor have the commercial markets been established.

4. Associated Knowledge Areas

KA Code	Knowledge Area
204	Plant Product Quality and Utility (Preharvest)
511	New and Improved Non-Food Products and Processes

Outcome #3

1. Outcome Measures

Students will receive training in bioenergy production (Develop a diverse and educated workforce for a biofuels industry).

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Bioenergy is a new, environmentally-focused field that encompasses a range of scientific disciplines. It has great impact on the environment due to its importance in maintaining the world's environmental and economic integrity. The U.S. has recently increased its focus in the area of bioenergy through federal mandates and funding for research, infrastructure and feedstock development, and education to enhance the nation?s energy portfolio. This emphasis has created new opportunities in the 'green jobs' market which will require new efforts and new programs for training future professionals.

What has been done
Research has been conducted on optimal harvest timing of switchgrass for bioenergy production. This research has been performed with assistance from two graduate students.

Results
One graduate student graduated in May 2013 after successful thesis defense ('Identifying Strategies for enhancing switchgrass quality for use as a bioenergy feedstock'). This graduate student also presented her research during the University-Wide Research Symposium at Tennessee State University and won 2nd place in her division.
The second graduate student had the opportunity to work at the University of Tennessee in July 2013 to be trained and analyze data using NIR. She successfully presented her research proposal in October 2013 ('Effect of harvest timing on the quality of switchgrass for biofuel: changes in lignocellulose and potential energy production').

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

Protocols will be developed for mutagenesis and selection of herbicide resistant biofuel feedstock varieties (Increased knowledge and understanding of the biofuels supply chain).

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Competition from weeds is one major cause for inferior switchgrass establishment under field conditions, presenting an increased risk and cost for the growers.

What has been done
We expect that the tetraploidy genome structure of 'Alamo' could be a reason for screening mutant with phenotypes in the M0 generation. We have obtained diploid foxtail millet seeds to continue the mutagenesis selection for herbicide sensitive or tolerance traits.

Seeds were produced from those plants, and reseeded for the M1 generation. Some phenotypes were observed for seed production and more vigorous growth. Because we are only able to harvest a limited number of seeds, and those seeds have a very low germination rate, the major effort is to propagate those seeds and continue to observe those traits. We are planning on herbicide screening in the next season.

Results
One protocol for treating switchgrass 'Alamo' with sodium azide was developed.
More mutations were done in switchgrass 'Alamo' and Panicum hallii.

4. Associated Knowledge Areas

KA Code	Knowledge Area
213	Weeds Affecting Plants

511 New and Improved Non-Food Products and Processes

Outcome #5

1. Outcome Measures

Desirable biofuel feedstock varietal mutants will be recovered (Increased knowledge and understanding of the biofuels supply chain).

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
New sources of genetic variation are needed for biofuel feed stocks. Genetic improvement of switchgrass may lead to increased sustainability of biofuel production.

What has been done
Seeds of Panicum hallii as well as switchgrass were treated with sodium azide to evaluate for treatments with different types of stresses, to find more useful mutations.

Results
There are no new phenotypes created in the switchgrass mutation population. But in the Panicum hallii, we have seen several M1 plants that are flowering and producing a few fertile seeds during Dec. 2013-Feb. 2014. Those plants are growing in greenhouses. Those plants are evaluated to see if those traits continue in the next generation.

4. Associated Knowledge Areas

KA Code	Knowledge Area
213	Weeds Affecting Plants
511	New and Improved Non-Food Products and Processes

Outcome #6

1. Outcome Measures

New varieties of biofuel feedstocks will be developed (Increased knowledge and understanding of the biofuels supply chain).

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Tolerance to environmental stress including drought and salt and temperature are significant issues for biomass crop production in the face of climate changes.

What has been done
Testing of mutants for herbicide resistance and abiotic stress tolerance has continued, including Panicum hallii, which is a diploid and was sequenced. Genomic study of this species will be easier once mutants with phenotypes are selected.

Results
Continuing evaluation of putative lines. No final results can be provided in this year because of the difficulties in propagating those plants.

4. Associated Knowledge Areas

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

Outcome #7

1. Outcome Measures

Producers will have knowledge of camellia as biofuel feedstock (Increased knowledge and understanding of the biofuels supply chain).

Not Reporting on this Outcome Measure

Outcome #8

1. **Outcome Measures**

Demonstration sites for camellia as alternative feedstock will be established (Increased knowledge and understanding of the biofuels supply chain).

Not Reporting on this Outcome Measure

Outcome #9

1. **Outcome Measures**

Camellia lines produced with enhanced fatty acid will be developed (Increased knowledge and understanding of the biofuels supply chain).

Not Reporting on this Outcome Measure

Outcome #10

1. **Outcome Measures**

Producers in Tennessee will grow camellia as biofuel feedstock (Implementation of sustainable biofuels systems).

Not Reporting on this Outcome Measure

Outcome #11

1. **Outcome Measures**

Producers will have knowledge of costs of production (from land preparation to final ethanol production) for two biofuel crops (Miscanthus and switchgrass) through the construction of enterprise budgets.

2. **Associated Institution Types**

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual

2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Producers need to know the profit they could earn from growing bioenergy crops. They need credible information on production costs and revenue to make decision on long term investment. From biofuel processor point of view, information price need to pay for feedstock producer is important since it affect the feedstock cost per gallon of ethanol.

What has been done
Have completed data collection and analysis, constructed benefit:cost sheets considering 25 year project period for ethanol production.

Results
Net returns, feedstock cost per gallon of ethanol, breakeven price (minimum price needed to cover production and processing cost) of feedstock. A refereed journal article in the journal Renewable Energy.

4. Associated Knowledge Areas

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

Outcome #12

1. Outcome Measures

Stakeholders will have knowledge of the energy efficiently of biofuel production from switchgrass and Miscanthus through the calculation of energy balance sheets for these crops, providing indicators of sustainability for biofuel production

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Environmental groups have concerns over the net energy benefits of growing energy crops hence need justification. Policy makers also need information on energy benefits to promote bioenergy.

What has been done
Net energy balance model construction, data collection and analysis. Energy inputs were calculated for major inputs of feedstock production and Energy output were assessed based on per acre production of ethanol.

Results
Net energy model, energy input value tables for production inputs and Net Energy Values for each feedstock. Manuscript is in preparation.

4. Associated Knowledge Areas

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

Outcome #13

1. Outcome Measures

Factors responsible for improved efficiency of biofuel production will be determined.

Not Reporting on this Outcome Measure

Outcome #14

1. Outcome Measures

Research to determine optimal harvest timing for switchgrass in Tennessee

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Bioenergy, and biofuels in particular, are a mainstream concept as an alternative to the security and environmental issues related to fossil fuels. As feedstock markets emerge, it is important for producers to maximize their yield to maintain as much profitability as possible.

What has been done
In 2013, switchgrass samples were harvested in the field by students and are currently being processed for analyses. Data from switchgrass harvests in 2011 and 2012 is being prepared for manuscript publication.

Results
A research presentation was made to scientist at the American Society of Agronomy International Annual Meetings in November 2013 - 'Harvest Timing and Switchgrass Quality in Tennessee.' Two graduate theses were concluded "Identifying strategies for enhancing switchgrass quality for use as a bioenergy feedstock" and "Effect of harvest timing on the quality of switchgrass for biofuel: changes in lignocellulose and potential energy production."

4. Associated Knowledge Areas

KA Code	Knowledge Area
204	Plant Product Quality and Utility (Preharvest)
511	New and Improved Non-Food Products and Processes

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Other (Changes in faculty personnel.)

Brief Explanation

Camilina research has not progressed as scheduled to faculty vacancy in this area.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The following items will be measured to assess the success of this program: Increase in number of producers adopting production of bioenergy feedstocks. Number of students receiving training in bioenergy production. Number of new varieties of biofuel feedstocks developed. Number of camellia lines produced with enhanced fatty acid. Number of producers in Tennessee growing camellia as biofuel feedstock.

Key Items of Evaluation