

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: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.0	9.5
Actual Paid	0.0	0.0	0.0	15.6
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	788525
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	0	788525
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

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?

eXtension was promoted through workshops and factsheets to provide an additional resource to stakeholders; webinar presentations were made.

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	160	2396	3	1030

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

Patent Applications Submitted

Year: 2014

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	5	6	11

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of workshops and presentations concerning new or alternative biofuel feedstocks.

Year	Actual
2014	6

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 increasing 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 benefits:costs of production (from land preparation to final ethanol production) for two biofuel crops (Miscanthus and switchgrass) through the construction of benefit:cost analysis sheets.
8	Stakeholders will have knowledge of the energy efficiency of biofuel production from switchgrass and Miscanthus through the calculation of energy balance sheets for these crops, providing indicators of sustainability for biofuel production.
9	Farm specific factors responsible for improving technical efficiency of biofuel production will be determined to minimize inefficiency in current production.
10	Optimization of biofuel crop, i.e. switchgrass yields, to changing climatic conditions.

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
2014	31

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

The established program of outreach 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:

79% of respondents increased their interest in growing native warm-season grasses

88% of respondents increased their knowledge in using native warm-season grasses for biofuel production.

4. Associated Knowledge Areas

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

Outcome #2

1. Outcome Measures

An increasing 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
2014	37

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

Demonstrations using a mobile biodiesel demonstration purchased through USDA NIFA Capacity Building grant funds were conducted. There were 5 different meetings in 5 different counties. Also, two local high schools requested demonstrations and were visited. The mobile biodiesel demonstration was also requested to be a part of the Tennessee State Fair Green Collar Exhibit in September 2014. Four fact sheets were developed, published, and uploaded to the TSU Cooperative Extension website (http://www.tnstate.edu/extension/publication_index.aspx). 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. A biofuel technology workshop was led through a different USDA NIFA Capacity Building grant to provide training on biofuels and biofuel production to middle school and high school students and teachers in June/July 2014.

Results

Based on survey results from the mobile biodiesel demonstration workshops:

Participants identified a significant increase in their knowledge, awareness, perceptions and interest in biodiesel production. For example, prior to the workshops, participants were uncertain whether biodiesel production was too difficult or not economically feasible for farmers to produce. After the workshops, they disagreed that it was too difficult and they disagreed that it was not economically feasible. Following the workshops, they were also more likely to produce their own biodiesel in the next 5 years, discuss the information with other farmers and create a cooperative for biodiesel production.

Based on survey results from the biofuel technology workshop:

57% of teacher respondents identified an increase in knowledge related to biofuel production

84% of youth respondents identified an increase in knowledge related to biofuel production.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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
2014	3

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 one graduate student. Two undergraduate students have also participated in different aspects of bioenergy research and extension.

Results

The graduate student presented her research during the University-Wide Research Symposium at Tennessee State University in 2014 and won 1st place in her division. One undergraduate participated in the National Biodiesel Conference and Expo in 2014. She was awarded a travel grant as part of the Next Generation Scientists for Biodiesel program with sponsorship from state soybean boards and the United Soybean Board.

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
2014	0

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

1. One Ph.D. student is working on the issue;
2. We have 500 plants in the greenhouse that will be uses for treatment experiments;
3. We are collecting recently set seeds. Several seedlings and those from stolons did produce seeds at this season;
4. The student is developing protocols to isolate nucleus from leaf and root tissues.

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. Plants were subjected to herbicide screening.

Results

One protocol using non-selective organic herbicide spaying on seedlings with two true leaves. The spay killed 99.9% of seedlings, and the few left will be treated again, and observe the phenotype.

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
2014	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

We have collected seeds from three different phenotype plants, and they are under observation for two seasons. But no molecular studies have been done to confirm they are true genetic mutants.

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
2014	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

Continued evaluation of putative lines. There are still no final results to be provided this year because of the difficulties in propagating those plants.

4. Associated Knowledge Areas

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

Outcome #7

1. Outcome Measures

Producers will have knowledge of benefits:costs of production (from land preparation to final ethanol production) for two biofuel crops (Miscanthus and switchgrass) through the construction of benefit:cost analysis sheets.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	50

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Since cellulose ethanol production is at relatively early stages, there is an information gap in feedstock production as well as processing. For example, producers are concern of risk and uncertainty associated with feedstock production and marketing. Producers need to have credible information on feedstock selection, various costs associated during production (i.e., input requirement, harvesting, transportation and storage costs), biomass harvest timing, pricing, etc. Information on reliable farm budgeting is essential to attract growers for energy crop farming. Since switchgrass and miscanthus are perennial grass species, producers needs to know the benefits of long term investment (benefits and costs over multiple year period).

What has been done

Benefit:cost analysis of long term investment (25 year project period) for switchgrass and miscanthus production and processing of these feedstocks to ethanol production; harvesting and hauling costs model and estimation for switchgrass; estimation of indicators such as break-even prices, feedstock cost per gallon, breakeven price of ethanol etc which is vital for decision making of feedstock producers as well as ethanol processors.

Results

Research results were communicated to producers through field day presentations, webinars, scientific manuscripts, conference proceedings.

4. Associated Knowledge Areas

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

Outcome #8

1. Outcome Measures

Stakeholders will have knowledge of the energy efficiency 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
2014	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Stakeholders should aware of energy efficiency of biofuel production from switchgrass and Miscanthus through the calculation of energy balance sheets for these crops, providing indicators of sustainability for biofuel production. The information will helpful to identify major energy inputs and thereby to use these inputs in optimal manner to conserve energy use in farms.

What has been done

Estimation of energy input for various input categories in producing miscanthus and switchgrass, estimate energy outputs of these two systems and calculate net energy balance of these two production systems.

Results

Two energy balance sheets were produced. Implications and application of the balance sheets were communicated to stakeholders through workshop presentations, field day exhibits and scientific publications and conference proceedings.

4. Associated Knowledge Areas

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

Outcome #9

1. Outcome Measures

Farm specific factors responsible for improving technical efficiency of biofuel production will be determined to minimize inefficiency in current production.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Technical issues relating to data collection for this portion of this program have precluded completion of this outcome.

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
511	New and Improved Non-Food Products and Processes

Outcome #10

1. Outcome Measures

Optimization of biofuel crop, i.e. switchgrass yields, to changing climatic conditions.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Production of bioenergy crops will be subject to the same climate-change challenges as other crops that other crops face. This program is examining how these challenges may specifically impact switchgrass production.

What has been done

As planned, five precipitation treatments were examined, including drought, ambient and wet treatments to switchgrass plants using the automatic precipitation control facility in 2014. Soil temperature and moisture were monitored and recorded every 15 minutes. Leaf photosynthesis, stomatal conductance, transpiration rates and soil respiration (CO₂ emission) were measured bimonthly using a Li-6400 Portable Photosynthesis System. Plant height, number of tillers per plant and pot, biomass were also measured. One whole growing season data have been collected.

Results

One growing season data have been collected. Multiple seasons of data will be required to formulate conclusive results.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

{No Data Entered}

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Evaluation studies are planned for future mobile biodiesel demonstration workshops and future biofuel technology workshops. These studies were performed for workshops in 2014 and the same questionnaires will be used to evaluate these programs in 2015. Results indicate 57% of teacher respondents identified an increase in knowledge related to biofuel production
84% of youth respondents identified an increase in knowledge related to biofuel production. Adjustments to the program are being made to increase the adoption rate of research results. In addition, the following items are being 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 and number of new varieties of biofuel feedstocks developed.

Key Items of Evaluation