V(A). Planned Program (Summary)

Program # 13

1. Name of the Planned Program

Sustainable Energy--Research

☑ 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
201	Plant Genome, Genetics, and Genetic Mechanisms	0%	0%	30%	
202	Plant Genetic Resources	0%	0%	10%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	0%	0%	10%	
204	Plant Product Quality and Utility (Preharvest)	0%	0%	10%	
205	Plant Management Systems	0%	0%	10%	
206	Basic Plant Biology	0%	0%	30%	
	Total	0%	0%	100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	4.0	0.0
Actual Paid Professional	0.0	0.0	24.4	0.0
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	326046	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	326046	0
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

Projects will relate to the development of potential of energy crops, as well as refining and developing new process technologies. Some projects will include conducting environmental assessments and using the information to improve the quality. Other projects will define the economics of energy production.

2. Brief description of the target audience

Residents of Florida
Growers and producers
Fuel producers
Industry

3. How was eXtension used?

{No Data Entered}

V(E). Planned Program (Outputs)

1. Standard output measures

2012	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: 2012
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2012	Extension	Research	Total
Actual	0	21	21

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- {No Data Entered}

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Demonstrate potential of energy crops
2	Refine and develop new process technologies
3	Conduct environmental assessments that provide evidence as to the value of sustainable energy
4	Define the economic values of energy production

Outcome #1

1. Outcome Measures

Demonstrate potential of energy crops

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)
Genetically enhanced maize and sorghum have the potential to yield considerably more fermentable sugars per acre, thereby limiting the total acreage required to meet anticipated demands for feedstocks.

What has been done
This project is aimed at improving maize and sorghum as feedstocks for bioenergy production.

Results
Impact: Obj. 4: Plants in rain-fed plots had on average lower biomass and grain yields, but there were several exceptions where the opposite was true. The parents for the RIL population behaved consistently with prior observations, in that the deep-rooted cultivar tolerated limited water much better (higher biomass and grain yield, minimal delay in flowering). Several hundred DNA polymorphisms were detected between these two parents, so that mapping root architecture traits will be feasible. Obj. 5: Generation advancement resulted in F4 and F5 populations ready for larger-scale, multi-location evaluations for biomass and sugar yield.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems

206 Basic Plant Biology

Outcome #2

1. Outcome Measures

Refine and develop new process technologies

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)
Significant amount of lignocellulosic biomass accumulates as agricultural waste. In addition, biomass crops can be cultivated for fermentation to chemicals and fuels.

What has been done
This Multistate project attempts to develop both biological and engineering technologies to convert agricultural waste, such as sugarcane bagasse, corn stover, etc., and selected woody biomass into fuels, such as ethanol and various chemicals.

Results
Impact: Our research group continues to make genetic improvements in biocatalysts for the conversion of lignocellulose-derived sugars into ethanol, lactic acid, succinate, and other products which replace petroleum. Myriant Technologies is constructing the world's largest succinate plant (bioplastics) in Louisiana using our licensed technology. Lactic acid commercialization by Purac continues to expand with production facilities in Spain. Fundamental research at UF continues to identify and solve problems associated with the bioconversion of woody biomass, providing new opportunities in this area. At the Biofuels Pilot Plant on campus, additional research has made significant progress in reducing the complexity and increasing the efficiency of lignocellulose-based bioprocesses. Scale-up processing has improved from 10L fermentations to 100L and the development of the seed train to be used for full-scale industrial fermentations (more than 30,000 L) are now being optimized. Presently, the amount of steps for seed cultivation has been reduced and some conditions for seed growth have been established. Construction of the new state funded research facility, the Stan Mayfield Biorefinery Pilot Plant is finished and all macinery is undergoing testing. This facility is expected to be fully operational. It will be used to further develop an integrated process at a scale of 3-5 tons of biomass per day.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources

Outcome #3

1. Outcome Measures

Conduct environmental assessments that provide evidence as to the value of sustainable energy

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 case for bioenergy research is compelling for economic, national security, and environmental conservation reasons. Florida is well positioned to capitalize on the national need for bioenergy crops. The Florida climate conveys unique advantages for bioenergy crop production including a long growing season, generally high rainfall during the warm season, and high temperatures to optimize plant growth. In addition, Florida farmers have a major need for alternative crops and non-traditional markets. Many of these conditions also apply regionally throughout the Southeast.

What has been done
This project will bring together public, private, and commercial entities to develop new technology to address the need for new energy sources.

Results
Impact: Miscanthus, giant reed, erianthus, sugarcane, elephantgrass, and energycane were compared in regional trials throughout Florida. Biomass yield was quantified in November 2009 and 2010 and in August and November 2011 and 2012. Yields of elephantgrass, energycane, erianthus, and sugarcane were not different in 2009, but all were greater than giant reed and miscanthus. In 2010, yields were greater for elephantgrass, energycane, and sugarcane at Citra, but erianthus performed better and elephantgrass worse at Ona. Dryer weather at Ona resulted in

reduced yields in 2010 vs. 2009. Data from 2011 and 2012 are currently being summarized and assimilated into publications. In addition, research is underway to measure the soil carbon contribution of these bioenergy grasses. Samples will be taken in January 2013 to represent the effects of four years of bioenergy crop production. Characterization of water use occurred in energycane, elephantgrass, and giant reed. Energycane and elephantgrass produced more biomass per unit of water thanIn addition, we will be able to couple seasonal crop water use data with yield data (e.g., biomass, lignocellulose and/or simple sugars) to estimate ethanol produced per unit of water used by the crop during production. Results indicate that energycane and elephantgrass produce more biomass per unit of water than does giant reed. Elephantgrass had the greatest water-use efficiency of all species tested. Graduate student Arkorn Soukiew included these data in his thesis that was completed during 2012. Graduate student Chae-In Na has conducted two years of research evaluating the effect of harvest frequency and timing on biomass yield and composition of two elephantgrasses (UF-1 and Merkeron) and L79-1002 energycane. There was no effect of harvest frequency in either year, but UF-1 elephantgrass outyielded all other grasses. Theoretical ethanol yields were greater for UF-1 than the other grasses in the test. UF-1 appears to be well qualified for cultivar release.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
205	Plant Management Systems

Outcome #4

1. Outcome Measures

Define the economic values of energy production

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
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

Florida is still being heavily impacted by the economic situation. Public higher education in Florida has lost more than 50% of state funding and research has been

impacted by other losses caused indirectly by the economic down turn including a reduction of funding opportunities available at the national level. In some cases faculty who leave or retire are not being replaced because of economic issues. Changes in state, county and federal appropriations can also affect the outcomes related to the Florida research land-grant mission. Because of limited resources in Florida and continuing devolution research projects can always be affected by changing public and governmental priorities policies, regulations and laws.

Natural and national disasters can also affect research field studies and multistate research. Natural disasters such as tropical storms and hurricanes are common annual occurrences in this state and often cause severe damage to plants and the environment in which active research is taking place.. Severe weather conditions such as droughts frequently led to large-scale fires which can also impact studies. In 2012 we were heavily impacted by severe storms and fires. We also had other weather extremes such as floods leading to large scale damage especially along the coastal regions and the panhandle of the state. All of these can have a direct and indirect impact on research.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Florida is involved in research related to biomass as a means of alternative energy. Many cultivars are being studied as a source of bioenergy. Other forms of alternative energy are also being researched for profitability and sustainability.

Key Items of Evaluation

This research program will identify and characterize limiting genetic factors for improvement of cereals, turf and biomass/bioenergy grasses. through genetic engineering or plant breeding. The improvement of environmental and biotic stress tolerance of these crops, will enhance their productivity and persistence and will result in a more efficient use of natural resources. Alternatively, quality improvement in grasses and cereals that are well adapted to stress can significantly increase their value. Biomass grasses represent a promising feedstock to produce low-cost ethanol, their improvement using biotechnological approaches will reduce costs associated with biomass conversion to fuel. Risk assessment and development of risk management strategies are essential components of this molecular grass improvement program.

Impact: Down-regulation of lignin biosynthesis pathway enzymes and/or in planta expression of cell wall degrading enzymes will increase the efficiency of bio-ethanol production from abundant ligno-cellulosic sugarcane residues. Transgenic sugarcane lines with integration of different RNA interference cassettes for lignin biosynthetic genes were generated in this project. Transgenic sugarcane lines with RNAi suppression of COMT suppressed sucessfully lignin biosynthesis as indicated by reduced lignin content and altered lignin composition. Subsequent experiments demonstrated the effects of target gene suppression on plant performance under field conditions and biomass quality. Findings allowed to correlate altered lignin in sugarcane with fermentable sugar yields as well as plant performance. A moderate reduction in lignin (4 to 5%) increased the saccharification efficiency by 19-20% without compromising plant performance. Xylan is after cellulose, the most abundant polysaccharide in sugarcane residues and must be hydrolyzed to its component sugars before fermentation to ethanol. Endoxylanases are the main enzymes involved in xylan hydrolysis. Accumulation of the hyperthermostable GH10 xylanase in sugarcane leaves supported the conversion of sugarcane xylan to fermentable

xylobiose. Suppression of flowering may increase the production of vegetative biomass and the yield of sucrose. This project also supported the development of improved genetic transformation protocols for sugarcane reducing the time in tissue culture and resulting in better performance of the resulting transgenic plants. Interspecific hybrids between napiergrass and pearl millet were compared with the napiergrass cultivar Merkeron and recently generated napiergrass breeding lines regarding biomass production. One of the insterspecific hybrids and several of the napiergrass breeding lines produced significantly more biomass than Merkeron. In contrast to Merkeron, interspecific hybrids were sterile and did not produce wind dispersed seeds and several high yielding napiergrass breeding lines flowered late in the season when cold temperatures prevented formation of viable seeds. Sterile, interspecific hybrids or late flowering hybrids of this vegetatively propagated biofuel and forage crop will increase biosafety of feedstock production by eliminating the rapid spread of this species through wind dispersed seeds. Higher biomass yields of the superior hybrids will contribute to an economically and environmentally sound feedstock production system. This improved germplasm will be valuable to the biofuels industry and as forage crop in subtropical regions. Bahiagrass persists well in Florida with low inputs, improving the turf quality of bahiagrass will facilitate turf management and enhance the environmental benefits of turf by reducing input requirements. The above described change in knowledge resulted in one patent application, six peer reviewed publications and numerous abstracts and invited presentations at national and international conferences as well as additional grant funding from federal and private industry sources. FLA-AGR-004913