V(A). Planned Program (Summary)

Program # 21

1. Name of the Planned Program

Sustainable energy--research

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%	10%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%	0%	10%	
202	Plant Genetic Resources	0%	0%	20%	
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%	10%	
511	New and Improved Non-Food Products and Processes	0%	0%	20%	
	Total	0%	0%	100%	

V(C). Planned Program (Inputs)

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

Year: 2010	Extension		Research	
	1862	1890	1862	1890
Actual	0.0	0.0	29.2	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	792283	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	792283	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	792283	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Sustainable energy inlcudes projects that lead to energy independence by providing science that can be used to create biofuels, design optimum forest products and crops for bioenergy production, and also to produce bio-based industrial products.

2. Brief description of the target audience

Ag Industry
General public
bioenergy industry
government officials

V(E). Planned Program (Outputs)

1. Standard output measures

2010	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	{NO DATA	{NO DATA	{NO DATA	{NO DATA
Actual	0	0	0	0

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

Patent Applications Submitted

Year: 2010
Plan:
Actual: 19

Patents listed
Improved Klebsiella Oxytoca for Ethanol Production
Embedded RFID Tag in Injection Molded Package Using In-Mold Labeling Process
Ethanol Production in Minimal Medium
Method to Design and Utilize Hybrid Peptides Having Antimicrobial Activity
Succinate and Malate Production by Engineered E. Coli
Biocatalyst for Complete Conversion of Hemicellulose Hydrolysates to Biobased Products
Transhydrogenase Genes Increase Furfural Tolerance
Material and Methods to Regulate Carbon Allocation and Biomass Growth
Transhydrogenase Genes Increase Furfural Tolerance
Optimizing Cellulase Usage for Improved Mixing and Flow
Furfural Resistant Mutant
Biomass Conversion Using Recombinant Termite Ligno-Cellulases
Leaf Area Regulator to Increase Plant Photosynthetic Capacity and Biomass
Transhydrogenase Genes Increase Furfural Tolerance
Furfural Resistant Mutant
Engineering the Pathway for Succinate Production
Escherichia coli B Engineered for Lactic Acid Production (DIV)
Isolation and Targeted Suppression of Lignin Biosyntetic Genes from Sugarcane

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2010	Extension	Research	Total
Actual	0	20	20

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	Reduce the cost of harvesting and handling and storing biomass
2	To identify sorgum germplasm for potential bioenergy crop in Florida
3	Identify plant species that are viable candidates for bioenergy systems
4	Identify and characterize limiting genetic factors for improving biomass/bioenergy grasses, cerals and turf.
5	To assess the supply of biofuel feed stock available for conversion in biofuel in the southeastern US and where to establish biofuel plants.

Outcome #1

1. Outcome Measures

Reduce the cost of harvesting and handling and storing biomass

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

What has been done
We have genetically modified Escherichia coli and other bacteria to produce ethanol from glucose, xylose, and other sugars present in lignocellulosic biomass. These genetic and metabolic engineering studies are extended for cost-effective conversion of biomass to various fuels and chemicals to minimize the need for imported petroleum.

Results
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. BP has announced the construction of a full scale lignocellulose to ethanol plant in Florida using our licensed technology. Myriant Technologies has announced the construction of 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. With the completion of the Biofuels Pilot Plant on campus, additional research has made significant progress in reducing the complexity and increasing the efficiency of lignocellulose-based bioprocesses. For ethanol, conversions yielding over 80 gal ethanol per ton of bagasse have been achieved. Engineering design has been completed and construction is underway for a new

state funded research facility, the Stan Mayfield Biorefinery Pilot Plant. This facility 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
204	Plant Product Quality and Utility (Preharvest)
206	Basic Plant Biology
511	New and Improved Non-Food Products and Processes

Outcome #2

1. Outcome Measures

To identify sorgum germplasm for potential bioenergy crop in Florida

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)
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. This project is aimed at improving maize and sorghum as feedstocks for bioenergy production.

What has been done
A collection of publicly available sweet sorghum accessions will be planted at the UF Plant Science Research and Education Unit in Citra, FL, evaluate for photoperiod adaptation, biomass yield, juice yield, sugar content of the juice, and disease resistance (anthracnose, ergot). The best lines will be evaluated at two other locations in Florida. Objective 5. Crosses between the most promising lines will be made to generate breeding populations from which selections can be

made for superior performance. Selections will be tested in different locations and advanced to inbred lines.

Results
Data analysis led to the identification of four distinct groups of sorghum genotypes: a. sorghums that are able to withstand drought and that are conservative with water when it is available (i.e. use the water for vegetative growth). b. Sorghums that are able to withstand drought and that transpire a lot of water when it is available; c. Drought-sensitive sorghums that use water for biomass production when the water is available; d. Drought-sensitive sorghums that transpire when water is available. We have selected individual sorghum genotypes as the basis for mapping populations to identify genomic regions associated with water use and drought tolerance. Two grant proposals were submitted in 2010 that build on the results obtained from this HATCH project.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
205	Plant Management Systems
206	Basic Plant Biology
511	New and Improved Non-Food Products and Processes

Outcome #3

1. Outcome Measures

Identify plant species that are viable candidates for bioenergy systems

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)

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

What has been done

Activities include several research projects for which data were collected during the reporting period. Projects included: 1) evaluation of planting date, cultivar, and location effects on sweet sorghum yield, sugar concentration, and fiber component concentrations; 2) evaluation of yield and chemical composition of six perennial grasses with potential for use as bioenergy crops; 3) evaluation of the use of municipal biosolids as a nutrient source for production of bioenergy crops; 4) determining the effect of harvest frequency on yield, yield distribution, and persistence of potential bioenergy crops; 5) evaluation of harvest management on N use efficiency and nutrient recycling in bioenergy crops; 6) measurement of the effect of frost and time since a frost event on dry matter yield, concentration, and nutrient composition of bioenergy crops. A Perennial Grass Bioenergy Field Day was held on July 15, 2010 at the Plant Science Research and Education Unit to show producers, industry representatives, extension personnel, and other scientists the ongoing research and results to date. One hundred persons attended

Results

Research to date has demonstrated that the two most promising bioenergy species for Florida are elephantgrass and energycane. Our statewide programs have interacted with producers and industry partners to provide planting material of released cultivars and provide information on most effective management programs. Participants who came to the bioenergy field were provided management information for the various species. Results of our studies follow. Three varieties of sweet sorghum, Dale (early maturity), Topper 76-6 (medium-late maturity) and M81-E (late maturity), were grown at the three sites in Florida.

4. Associated Knowledge Areas

KA Code	Knowledge Area
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
206	Basic Plant Biology
511	New and Improved Non-Food Products and Processes

Outcome #4

1. Outcome Measures

Identify and characterize limiting genetic factors for improving biomass/bioenergy grasses, cerals and turf.

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)
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.

What has been done
This research program integrates advanced genetic transformation technology and functional genomics to identify, isolate and engineer limiting factors for molecular improvement of cereals, turf and biomass/bioenergy grasses. Results will be analyzed with molecular, biochemical and physiological techniques under controlled environment and field conditions (monitored and approved by USDA-Aphis). Results will be presented in form of peer reviewed journal publications, posters and oral presentations at scientific conferences as well as in formal courses (e.g. AGR 5303 Molecular genetics for crop improvement).

Results
(1) Improving the turf quality of bahiagrass, while maintaining its persistence will increase the popularity of this low input turfgrass while maximizing positive impacts on natural resources. (2) Sterile, interspecific hybrids of the biofuel and forage crop napiergrass and pearl millet will increase biosafety of feedstock production by eliminating the rapid spread of this potentially

invasive species through pollen or wind dispersed seeds. (3) Chloroplast engineering can support high level expression of cell wall degrading enzymes. We demonstrate that transplastomic plants allow efficient production of enzymes with superior functionality for biofuel production. Candidate expression cassettes like the GH10 xylanase that are highly expressed in tobacco without deleterious effects on the plants are then subcloned to support integration into the specific grass plastome by homologous recombination. (4) Down-regulation of lignin biosynthesis pathway enzymes and in planta expression of cell wall degrading enzymes are promising strategies to increase the efficiency of biofuel production from the abundant ligno-cellulosic sugarcane residues, leaf litter and bagasse. Transgenic sugarcane lines with RNAi suppression of the lignin biosynthetic genes 4CL and COMT were generated. Subsequent experiments will identify the the effects on lignin quantity and composition. Findings should allow to correlate altered lignin in sugarcane with fermentable sugar yields and or reduced pre-treatment requirements of the ligno-cellulosic sugarcane biomass as well as 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. Expression of the GH10 xylanase in sugarcane sucessfully supported hydrolysis of xylan

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)

Outcome #5

1. Outcome Measures

To assess the supply of biofuel feed stock available for conversion in biofuel in the southeastern US and where to establish biofuel plants.

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)

The purpose of this study is to analyze the costs associated with the construction of cellulosic ethanol plants along the state. Feedstock available in Florida are sugar cane baggase, wood residue, and yard waste from municipal solid waste (MSW). Risk based models will be constructed to assess the feasibility of plants using biomass for conversion into ethanol. Net present value is the factor that will determined ultimately the economic success of this plant in the state of Florida. Relatively little research has been done on the economic feasibility of cellulosic ethanol plants that includes the stochastic risk associated with the biomass supply and the output values for the ethanol produced. Ethanol plant level risk models, using plant construction costs and budgets for converting biomass into ethanol, will provide a dollar measurement of the projected costs and returns to building a plant for this purpose. The model will also allow for analysis of policy related to ethanol production and the risks associated with output prices.

What has been done

Assess the supply of biofuel feed stock available for conversion into biofuel in the southeastern U.S. and to assess the feasibility of locating biomass conversion plants where supply of feedstock is highest. Specific objectives include: 1)survey the literature and selected waste management companies to determine the amount of biomass that could be diverted to a biofuel conversion facility; 2)determine the potential ethanol yield and total production capacity for feedstock identified in selected locations; 3)assess the plant costs and operating capacities for facilities that can convert feedstock into biofuel and; 4)develop a plant location model to identify efficient technologies and locations for biofuel plants.

Results

The results of this research contrbuted to identifying critical economic factors affecting the success of a biomass conversion plant for agricultural residue, yard waste and wood waste. The results were published in a book chapter and were presented at 2 conferences realtng to renewable energy.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

The weak economy and reduction of funding in the state continues to impact research. Also, weather conditions common to the tropics including hurricanes, weather extremes from drought to flooding have impacted Florida over the past year.

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

1. Evaluation Studies Planned

Evaluation Results

The University of Florida was awarded the nation's 5-millionth patent in a special ceremony at the U.S. Commerce Department. It recognized groundbreaking scientific work by Lonnie Ingram of the University of Florida Microbiology Department. Dr. Ingram and his team worked with a bacteria that could convert plant waste into ethanol, a cleaner-burning substitute for gasoline. By genetically modifying an E. coli bacteria in the lab, Ingram's team created an organism capable of converting all sugars in plant cells into fuel ethanol. The technology made it possible to use almost any organic biomass - from corn stalks and straw to yard trimmings and forestry wastes - to make fuel. Florida continues to build on these studies related to bio-energy and the production of new forms of fuel and to design and to produce value-based industrial products.

Key Items of Evaluation

The University of Florida was awarded the nation's 5-millionth patent in a special ceremony at the U.S. Commerce Department. It recognized groundbreaking scientific work by Lonnie Ingram of the University of Florida Microbiology Department. Dr. Ingram and his team worked with a bacteria that could convert plant waste into ethanol, a cleaner-burning substitute for gasoline. By genetically modifying an E. coli bacteria in the lab, Ingram's team created an organism capable of converting all sugars in plant cells into fuel ethanol. The technology made it possible to use almost any organic biomass - from corn stalks and straw to yard trimmings and forestry wastes - to make fuel. The purpose of this study is to analyze the costs associated with the construction of cellulosic ethanol plants along the state. Feedstock available in Florida are sugar cane baggase, wood residue, and yard waste from municipal solid waste (MSW). Risk based models will be constructed to assess the feasibility of plants using biomass for conversion into ethanol.

Research has also been done in the area of Net present value that will determined ultimately the economic success of this plant in the state of Florida. Relatively little research had been done on the economic feasibility of cellulosic ethanol plants that includes the stochastic risk associated with the biomass supply and the output values for the ethanol produced. Ethanol plant level risk models, using plant construction costs and budgets for converting biomass into ethanol, which can provide a dollar measurement of the projected costs and returns to building a plant for this purpose. A model has been developed that contrbutes to identifying critical economic factors affecting the success of a biomass conversion plant for agricultural residue, yard waste and wood waste.