UNIVERSITY OF FLORIDA

Water-Use Efficiency and Feedstock Composition of Candidate Bioenergy Grasses in Florida

PI: Lynn E. Sollenberger **Co-PIs:** John Erickson, Joao Vendramini, Robert Gilbert
Students: Jeff Fedenko (M.S.); Pedro Korndorfer (M.S.); Xi Liang (Ph.D.), Chae-In Na (Ph.D.), Arkorn Soikiew (M.S.), Kenneth Woodard (postdoctoral research associate)

Description: Florida ranks first in the USA in annual growth of plant biomass because of a large cultivatable land area, high rainfall, and long growing season. In order to capitalize on these advantages, the agricultural production sector and biomass conversion industries require information regarding which crops are adapted to particular Florida regions and local environments, how much biomass can be produced during what times of the year, which crops produce the most biomass per unit of water used, and which crops have the desired yield and composition for particular bioenergy applications. Research conducted to date has quantified the seasonal biomass supply provided by the most likely crops for use in Florida, identified crops and management practices that result in most efficient water use, and described the chemical composition of these plants to allow estimates of potential energy production per unit of biomass. Florida growers and industry representatives have gained access to this information through on-line resources, presentations by several of the project investigators at the Florida Farm to Fuel Conference, and by attending the Bioenergy Crop Field Day at the University of Florida Plant Science Research and Education Unit. Seven graduate students are being trained through this project and undergraduate students are gaining invaluable research experience via internships mentored by project investigators. Faculty involved in the FESC project have formed collaborations regarding agronomic and breeding projects with Speedling, Inc., SERF, and BP. Both SERF and BP plan to construct ethanol facilities in Florida that would create an estimated 400 temporary construction jobs and 140 permanent jobs each.

Budget: $191,981
Universities: UF
External Collaborators: Speedling, Inc., Nutri-Turf, Inc., British Petroleum (BP), and Southeast Renewable Fuels (SERF)

Progress Summary

Characterization of water use occurred in sweet sorghum, elephantgrass, energycane, and giant reed during 2009 and 2010. Measures of plant transpiration allowed for direct measurement of crop water use under real-world conditions so as to assist producers in selecting crops that are most sustainable for Florida. Results indicate that energycane and elephantgrass produce more biomass per unit of water than giant reed. For sweet sorghum, planting date affects water use efficiency, and optimal planting dates have been identified at various locations in Florida.

Six potential perennial bioenergy grasses were compared at three regional (North-central, South-central, and South) locations in Florida. Species were miscanthus, giant reed, erianthus, sugarcane, elephantgrass, and energycane. All plots were fully established by early summer 2009, and biomass yield and composition of the grasses was quantified during 2009 and 2010. Miscanthus yielded least at each location (2-5 tons dry biomass per acre), giant reed was generally intermediate (6-12 tons/acre), and elephantgrass, energycane, erianthus, and sugarcane yielded the most (13-17 tons/acre). Maximum ethanol production was estimated to range from approximately 80-90 gallons/ton of dry biomass for elephantgrass, energycane and erianthus, and was 104 gallons/ton for sugarcane bagasse. Our data show

that elephantgrass, energycane, erianthus, and sugarcane outyield giant reed and miscanthus in terms of biomass and potential ethanol per acre, and elephantgrass and energycane possess the most favorable management characteristics including ease of planting, efficiency of water use, and ease of harvesting.

Three sweet sorghum varieties (M81, Dale, and Topper 76-6) were planted at three dates during 2009 and 2010 at three locations in Florida to assess planting date and location effects on biomass production, sugar composition, and sugar yield. Planting occurred in March, May, and June. Across all sites, first crop green yields ranged from 21 to 33 wet tons/acre, with M81 yielding better than Topper 76-6 which yielded better than Dale. The May planting date yielded most. Regrowth crop green yields were affected by all treatments, ranging from 2 to 30 wet tons/acre with greater yields associated with earlier planting dates. Juice brix values ranged from 8 to 19% across all treatments, averaging 14.4 and 13.1% in the first and regrowth crops, respectively. Brix values were about 20% lower on the muck soil at Belle Glade compared to the sandy soil locations and about 20% lower in M81 compared to Dale and Topper 76-6. Combining first and regrowth harvests, this translates to estimated ethanol yields of 250 to 625 gallons/acre/year. Our results indicate that sweet sorghum production in Florida can be competitive with corn ethanol in the Midwest, but choice of variety, growing environment, and management practices will be critical to optimizing energy yields from sweet sorghum.

As a result of the studies conducted, we can now recommend bioenergy grass species and varieties for use throughout Florida based on adaptation to local environments, ease of establishment and harvest, water-use efficiency, and chemical composition. Agricultural producers and biomass conversion industries can use these data to guide site selection for production and conversion facilities, which plant species to grow, estimates of acreage needed to support a given conversion facility, and predictions of seasonal distribution of feedstock supply. Faculty involved in the FESC project have formed collaborations regarding agronomic and breeding projects with SERF and BP, both of whom plan to construct ethanol facilities in Florida that would create an estimated 140 permanent and 400 temporary construction jobs each.

New collaborations		
Partner name	**Title or short description of the collaboration**	**Funding, if applicable**
Southeast Renewable Fuels	Sweet Sorghum Agronomy and Breeding Program	Negotiations in progress
British Petroleum	Energycane Breeding Program	Negotiations in progress

Proposals						
Title	Agency	Ref #	Investigators/ Collaboraotors	Funding requested	Duration	Date submitted
An integrated systems approach to sustainable commercial production of biofuels and bio-based products for the southeast coastal region,	USDA-NIFA		Gallo, Sollenberger, Erickson, Vendramini, Gilbert, et al.	$43 million	5 years	October 2010
Woody biological nitrogen fixing plants for sustainable ligno-cellulosic biofuel feedstock	USDA/Sun Grant		James P. Muir, Joao Vendramini, et al.	$160,000	2 years	03/01/2011

Discovering The Desirable Alleles Contributing To The Lignocellulosic Biomass Traits In *Saccharum* Germplasm Collections For Energy Cane Improvement	DOE	DE-FOA-0000417	Jianping Wang, Robert Gilbert, and Neil Glynn Collaborators: Raymond Schnell, USDA-ARS, Joseph Binder, BP	$1,069,710	3 years	3/18/11

Grants Awarded					
Title	**Agency**	**Reference Number**	**Investigators/ Collaborators**	**Duration**	**Funding awarded**
Reproduction, Mechanisms of Spread, and Control Strategies for Elephantgrass, a Candidate Biomass Crop in the Caribbean Region	USDA		Sollenberger, Vendramini, and Erickson	9/1/2010 – 8/31/2012	$120,000
Sulfur, chloride and ash analyses of sweet sorghum for potential impacts of combustion on air quality	FDEP		Erickson	11/1/2010 – 10/31/2011	$3,081