

Production of Biofuel Crops in Florida: Sugarcane/Energycane¹

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Introduction

Sugarcane (*Saccharum* spp.) is a perennial grass most often grown in the US for the production of sugar and molasses; however, the sugars extracted from sugarcane can be easily fermented to produce ethanol. In addition to the fermentable sugars contained in sugarcane, the bagasse (biomass remaining after the juice is extracted from the stalks) is used by sugar mills to generate steam and electricity. The term energy cane is used to describe hybrids that have been selected for their ability to produce high amounts of cell wall biomass rather than sucrose. Sugarcane is considered an ideal energy crop because it produces readily fermentable sugars and very high yields of green biomass. The success of the Brazilian sugarcane industry in ethanol production has increased interest in producing sugarcane for ethanol throughout the world.

Current Potential for Use as Biofuel

The Brazilian sugarcane industry has been producing ethanol from sugarcane since the mid 1970s. The technology and equipment for producing ethanol from sugarcane juice is widely available. The

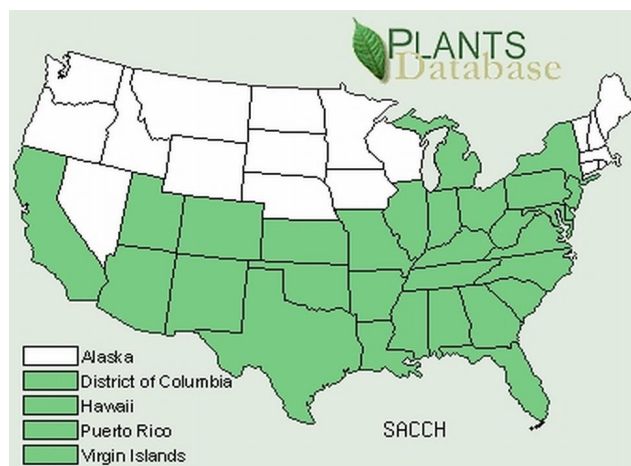


Figure 1. Occurrence of *Saccharum* L. in the United States. Credits:

<http://plants.usda.gov/java/profile?symbol=SACCH>

bagasse (crushed stalk) that remains after removal of the juice can be burnt to generate electricity or steam as part of a co-generation scheme. Additionally, the bagasse could be utilized as a feedstock if the technology for cellulosic ethanol production or biogasification becomes viable on a commercial scale.

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Figure 2. Sugarcane/Energycane Seedlings. Credits: Curtis Rainbolt.

Biology of Sugarcane

Sugarcane is a tropical perennial grass. Although sugarcane performs best in tropical and sub-tropical environments with temperatures between 70 and 90° F, it can be grown in most areas of the southern United States. However, sugarcane is highly sensitive to cold, and yields are reduced in areas that experience frequent frost and below freezing temperatures.

Commercial sugarcane varieties are complex hybrids of *Saccharum officinarum* and other *Saccharum* species. This hybridization results in a wide range of physical characteristics, pest and disease tolerance, fiber and sucrose content, and cold tolerance. Depending on the hybrid and the environment in which it is grown, mature sugarcane heights can reach over 16 ft. Likewise, stalk diameters can range from pencil-thin to over 2 inches. Once a sugarcane plant is relatively mature, it may change from the vegetative to reproductive stage under certain photoperiod and soil moisture conditions. At this point, the plant stops producing new leaves and develops an inflorescence. The inflorescence, or tassel, of sugarcane is a red to white colored, open-branched panicle. Each tassel consists of several thousand tiny flowers, each capable of producing one seed. The seeds are extremely small and it is estimated that it takes 113,500 seeds to weigh one pound. In general, sugarcane seeds are not viable. Thus, sugarcane is clonally propagated by means of "seed-cane" which is a section of a mature cane stalk with buds or "eyes" located at the nodes. Sugarcane is typically harvested after 9 to 14 months

of growth in Florida, but in Hawaii and some other countries it is harvested after 24 months of growth. Once an established sugarcane crop has been harvested, it ratoons annually from underground buds on basal portions of old stalks. The number of ratoons harvested from a single planting varies widely depending on harvest methods, growing conditions, and the particular variety being harvested. For more detailed information on sugarcane biology, please refer to EDIS publication #SC034, *Sugarcane Botany: A Brief Review*, (<http://edis.ifas.ufl.edu/SC034>).



Figure 3. Sugarcane/Energycane Field. Credits: Curtis Rainbolt.

Production

Although sugarcane can be grown throughout Florida, it is only produced commercially around the southern end of Lake Okeechobee. Currently, the entire crop (~400,000 acres) is used for the production of table sugar. About 75% of the crop is produced on the muck soils of the Everglades Agricultural Areas and the remainder is grown on sandy soils in Glades, Hendry, and Martin counties.

A well balanced nutrient supply is essential in order for sugarcane to reach optimum yield potential. The primary elements of concern are N, P, K, Mg, B, Cu, Fe, Mn, Si, and Zn. Most, if not all soils, require some level of fertilizer or amendment input to optimize the production of sugarcane. More detailed information on sugarcane fertility needs in Florida can be found at: (http://edis.ifas.ufl.edu/TOPIC_Sugarcane_Soils).

Weeds in sugarcane are primarily controlled by mechanical and chemical methods control (see EDIS publication #WG004 Weed Management in Sugarcane [<http://edis.ifas.ufl.edu/WG004>] for herbicides that are registered for use in Florida sugarcane). Most sugarcane varieties are selected for resistance to common plant diseases when released; however, resistance may break down over time making it important ill-advised to not rely on a single variety. Information on sugarcane diseases can be found at

(http://edis.ifas.ufl.edu/TOPICTopic_Sugarcane_Diseases).

The primary insect pests of Florida sugarcane are soil-inhabiting wireworms and grubs, a stalk borer, and aphids (see (http://edis.ifas.ufl.edu/TOPICTopic_Sugarcane_Insects) for an overview of insects and their control in Florida sugarcane).

Potential Yields

Average sugarcane yields in the Everglades Agricultural Area range from 32 to 38 tons of green biomass per acre over a 4 year period, and vary based on characteristics of soil type, crop year, harvesting, and other agricultural practices. Depending on variety and maturity at the time of harvest, sugar yields are typically 200 to 300 lbs of sugar per ton of green biomass.

Energy cane cultivars of sugarcane grown on phosphatic clay soils in central Florida (Stricker, et al. 1993) demonstrated average yields of 20 to 25 tons (80 to 100 tons fresh weight) over a 4 year period. Using an estimate of biomass conversion via cellulosic conversion to ethanol of 50 gallons/dry ton of biomass, yields of 900 to over 1100 gallons/acre appear to be possible.

Production Challenges

The major challenge to producing sugarcane for bioenergy in Florida will be expansion to growing areas north of Lake Okeechobee. The limited cold tolerance of current sugarcane varieties will result in considerably lower yields, decreased persistence, and higher production costs in areas that are subject to below freezing temperatures. Although, sugarcane

breeders continually strive to select varieties with greater cold tolerance, limited progress has been made.

Estimated Production Costs

The cost of producing sugarcane for bioenergy production will depend on factors such as field location, soil type, fertility and pest management inputs, and harvest method. Prices will also differ for sugarcane grown for biomass and sugarcane grown for sugar. Planting costs typically range between \$150 for mechanical planting and \$250 per acre for hand planting (Salassi and Breaux 2004). In the Everglades Agricultural Area, estimated sugarcane production costs range from \$30 to \$35 per ton, including harvesting. EDIS publication FE650 *Potential Feedstock Sources for Ethanol Production in Florida* (<http://edis.ifas.ufl.edu/FE650>). contains an analysis of ethanol production costs from sugarcane.

Environmental Concerns

Although sugarcane is already grown commercially for the production of table sugar, a challenge to ethanol production from sugarcane in Florida is the byproduct called vinasse (ethanol stillage). Each gallon of ethanol produced generates roughly 12 gallons of vinasse. In Brazil and Australia, vinasse is regarded as a valuable byproduct and it is land-applied as a fertilizer. Vinasse has high potassium, sulfur and micronutrient content and is often combined with mill mud which has high phosphorus, nitrogen and calcium content to make a complete fertilizer from recycled organic materials. Brazil has invested in a network of stainless steel pipelines to transport vinasse from the mills to lined storage ponds, and installed wells near these ponds to monitor water quality. Another concern with vinasse is its high biochemical oxygen demand, so care must be taken to avoid leaching into streams and lakes when applying it as a fertilizer. The effects of using vinasse as a fertilizer in Florida are not yet known and will require research.

Summary

Although sugarcane is grown commercially in Florida, it has not been utilized for ethanol production. Additionally, there is limited information on commercial production of sugarcane outside of the geographic area of the current industry. It should be noted that, at the present time, there is no commercial facility for fermentation of sugarcane sucrose to ethanol or conversion of sugarcane biomass to cellulosic ethanol.

Sources of Additional Information

- *Potential Feedstock Sources for Ethanol Production in Florida.*
(<http://edis.ifas.ufl.edu/FE650>).
- *Energy from Crops: Production and Management of Biomass/Energy Crops on Phosphatic Clay in Central Florida.*
(<http://edis.ifas.ufl.edu/EH213>).
- Plants Profile – *Saccharum* spp.
(<http://plants.usda.gov>).
- *Sugarcane Botany: A Brief View.*
(<http://edis.ifas.ufl.edu/SC034>).
- *Sugarcane Variety Census: Florida 2005.*
(<http://edis.ifas.ufl.edu/SC083>).
- *Nutritional Requirements for Florida Sugarcane.* (<http://edis.ifas.ufl.edu/SC028>).

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