

Production of Biofuel Crops in Florida: Sugarcane/Energy Cane¹

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Introduction

Sugarcane, a complex hybrid of *Saccharum* spp., is a perennial grass most often grown in the United States for the production of sugar and molasses; however, the sugars extracted from sugarcane can be easily fermented to produce ethanol that is known as *first-generation ethanol*. Sugarcane byproducts (i.e., *bagasse*, which is biomass remaining after the juice is extracted from the stalks) and other energy grasses (such as energy cane, giant reed, elephant grass, and erianthus) can be used to produce cellulosic ethanol, known as *second-generation ethanol*. The term *energy cane* is used to describe hybrids of *Saccharum* sp. that have been selected for high biomass, high fiber, and low sucrose concentration. Due to high biomass and non-invasiveness, energy cane has high potential to be considered as feedstock for cellulosic ethanol production in Florida.

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. Due to high sugar prices and problems with disposal of *vinasse* (i.e., ethanol stillage), growers in Florida prefer to grow sugarcane for table sugar and not for ethanol. The bagasse that remains after removal of the juice

can be burned to generate electricity or steam as part of a co-generation scheme. The bagasse could also be utilized as a feedstock if the technology for cellulosic ethanol production or biogasification becomes viable on a commercial scale. In low-fertility soils (marginal soils) where sugarcane cultivation is not as profitable as on high-fertility muck soils (organic soils), growers may consider growing energy cane for cellulosic ethanol production if the economics will work. To increase genetic diversity in energy cane, we have recently released five new energy cane cultivars—UFCP 74-1010 (Sandhu et al. 2015b), UFCP 78-1013 (Sandhu et al. 2015a), UFCP 82-1655 (Sandhu et al. 2016), UFCP 84-1047 (Gordon et al. 2016a), and UFCP 87-0053 (Gordon et al. 2016b)—for marginal soils of Florida.

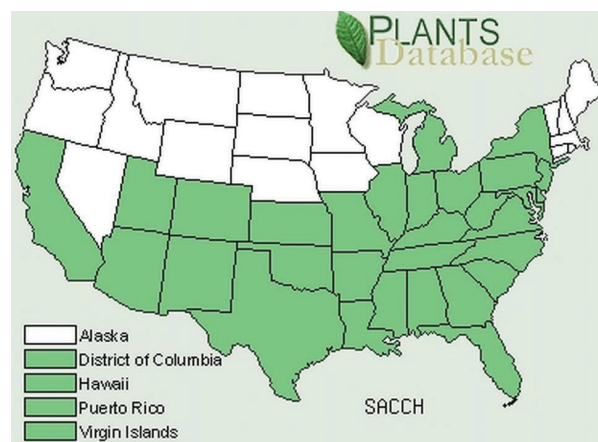


Figure 1. Occurrence of *Saccharum* L. in the United States, indicated by green areas of map
Credits: <http://plants.usda.gov/java/profile?symbol=SACCH>

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Figure 2. Sugarcane/energy cane seedlings.
Credits: UF/IFAS

Biology of Sugarcane

Sugarcane is a tropical perennial grass. Although sugarcane performs best in tropical and sub-tropical environments with temperatures between 70°F 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 subfreezing 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 two 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 113,500 seeds together 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 in 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/energy cane field.
Credits: Curtis Rainbolt, formerly of UF/IFAS

Production

Although sugarcane can be grown throughout Florida, it is only produced commercially around the southern end of Lake Okeechobee. Currently, the entire crop (396,528 acres) is used for the production of table sugar (VanWeelden et al. 2017). About 74% of the crop is produced on the muck soils of the Everglades Agricultural Area, 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 nitrogen (N), phosphorous (P), potassium (K), magnesium (Mg), boron (B), copper (Cu), iron (Fe), manganese (Mn), silicon (Si), and zinc (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 control methods (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 to not rely on a single variety. Information on sugarcane diseases can be found at http://edis.ifas.ufl.edu/topic_sugarcane_diseases. The primary insect pests of

Florida sugarcane are soil-inhabiting wireworms and grubs, lesser cornstalk borer, and aphids (see http://edis.ifas.ufl.edu/topic_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 30 to 40 tons of cane per acre, 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 lb. of sugar per ton of cane. Dry biomass yields of energy cane ranged from 12–14 tons/acre in newly released energy cane varieties grown in marginal soils of Florida.

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. Energy cane is relatively more cold tolerant and can be grown throughout Florida; however, the economics behind conversion of cellulose to ethanol is a major challenge.

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. 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. Planting and harvesting cost for energy cane is more or less similar to 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 vinasse (ethanol stillage). Each gallon of ethanol production 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 has 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.

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 the geographic area of the current industry. Energy cane in Florida is currently grown for experimental purposes only, and no commercial production has started yet.

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 of 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>)
- Nutritional Requirements for Florida Sugarcane (<http://edis.ifas.ufl.edu/sc028>)

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