Tropical Maize and Lipid Cane As Sustainable Bioenergy Crops

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RCN Conference on Pan American Biofuels & Bioenergy Sustainability

July 22-25, 2014

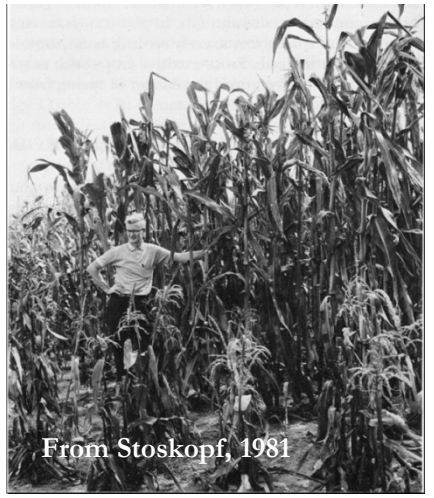
Golden Tulip Recife Palace

Recife, Brazil

What is Tropical Maize?

- Tropical Maize is Corn
  - Reproductive Asynchrony
  - **Tropical Maize = Tropical x Temperate Maize Hybrid**
  - High Biomass
  - High Stalk Sugars
  - Less Nitrogen requirement

History of tropical maize



CURRENT ANTHROPOLOGY Volume 44, Number 5, December 2003

Sweet Beginnings

Stalk Sugar and the Domestication of Maize[1]

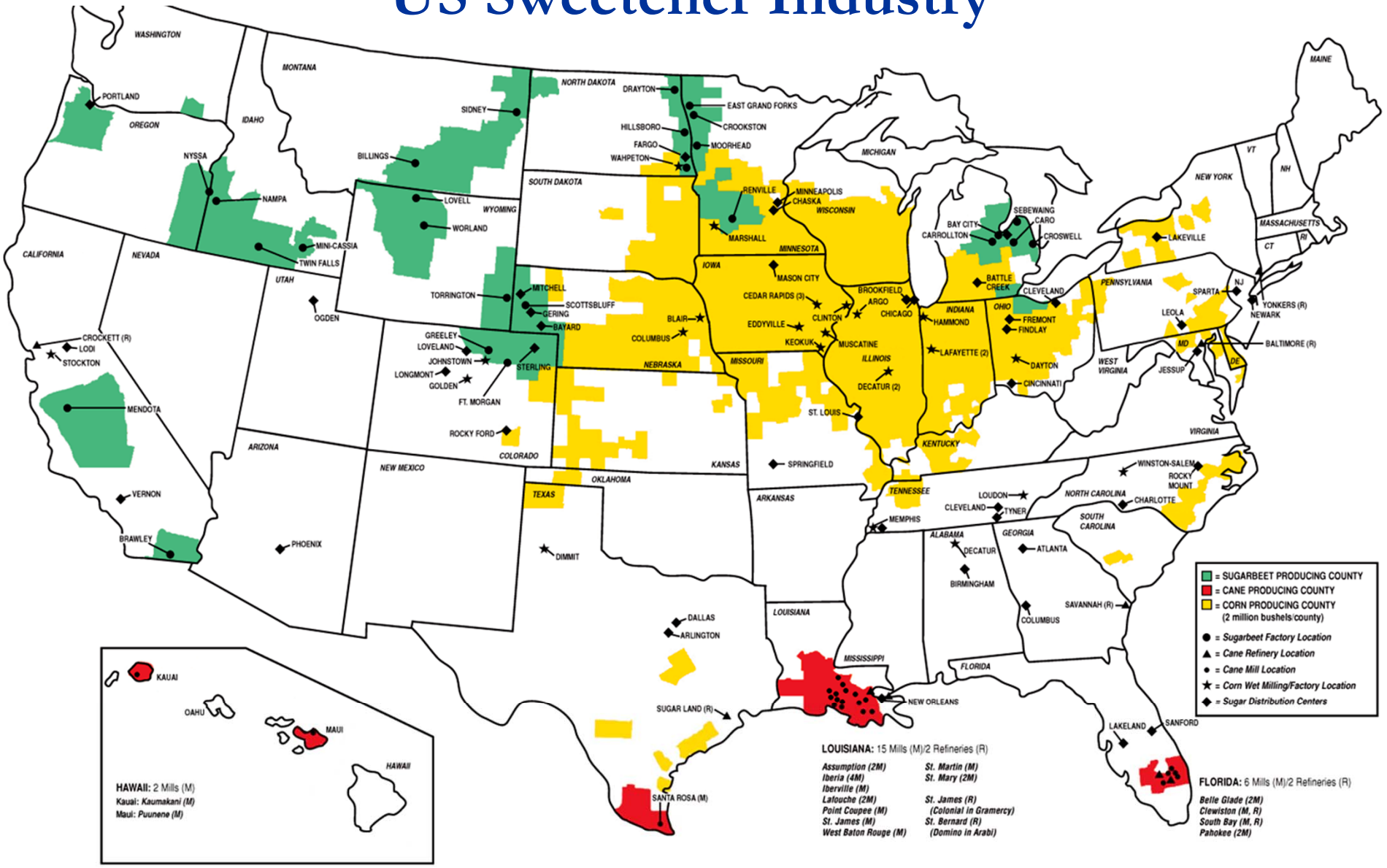
by John Smalley and Michael Blake

Teosinte (*Zea mays* ssp. *parviglumis*) appears now to be the most widely agreed-upon candidate for the ancestor of domesticated maize (*Z. mays* spp. *mays*), but there are, at best, only partial answers to questions of how, when, and where this process took place (Wilkes 1967, 1985; Beadle 1980; Iltis 1972, 2000; Matsuoka et al. 2002). In a break with conventional wisdom, Hugh H. Iltis (2000:36 and quoted in Crosswhite 1982) has recently suggested that the direct ancestor of maize "was initially domesticated not for its grain but for its sugary pith or other edible parts." We elaborate on his suggestion by proposing that during *Zea*'s initial period of domestication the stalk provided a key source of sugar for many uses, including the making of alcoholic beverages. Furthermore, we suggest that the social importance of

Nutrient Use Efficiency

- **TM produces more biomass and more sugar than commercial corn hybrids with < 50% N fertilizer requirement**

US Sweetener Industry

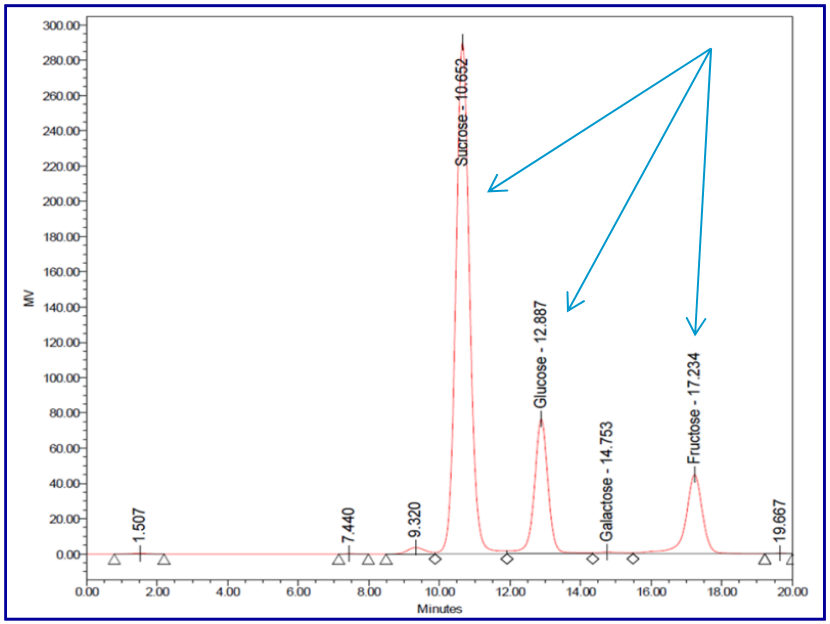


American Sugar Alliance, 2111 Wilson Blvd., Suite 600, Arlington, VA 22201
Phone: 703-351-5055 Fax: 703-351-6698 www.sugaralliance.org

2004

Tropical Maize

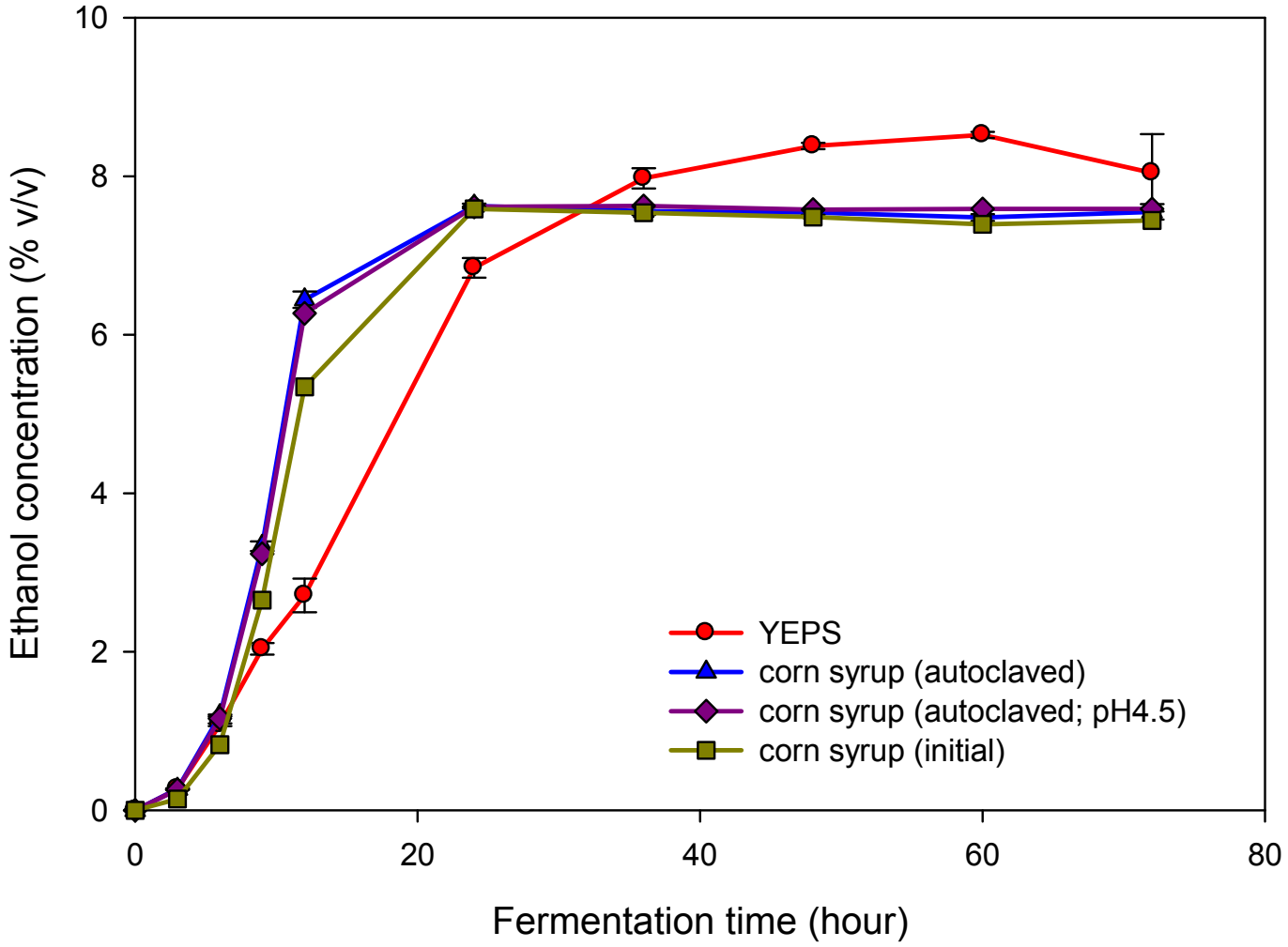
Preparing the syrup by using a press



HPLC profile of the tropical maize syrup. Three main sugars content—Sucrose, Glucose and Fructose

Chen, M., Kaur, P., Dien, B.S., Below, F.E., Vincent, M.L. and Singh, V. 2013. Accumulation of fermentation sugars during tropical maize development. World Journal of Microbiology and Biotechnology 29:1509-1515.

Tropical Maize



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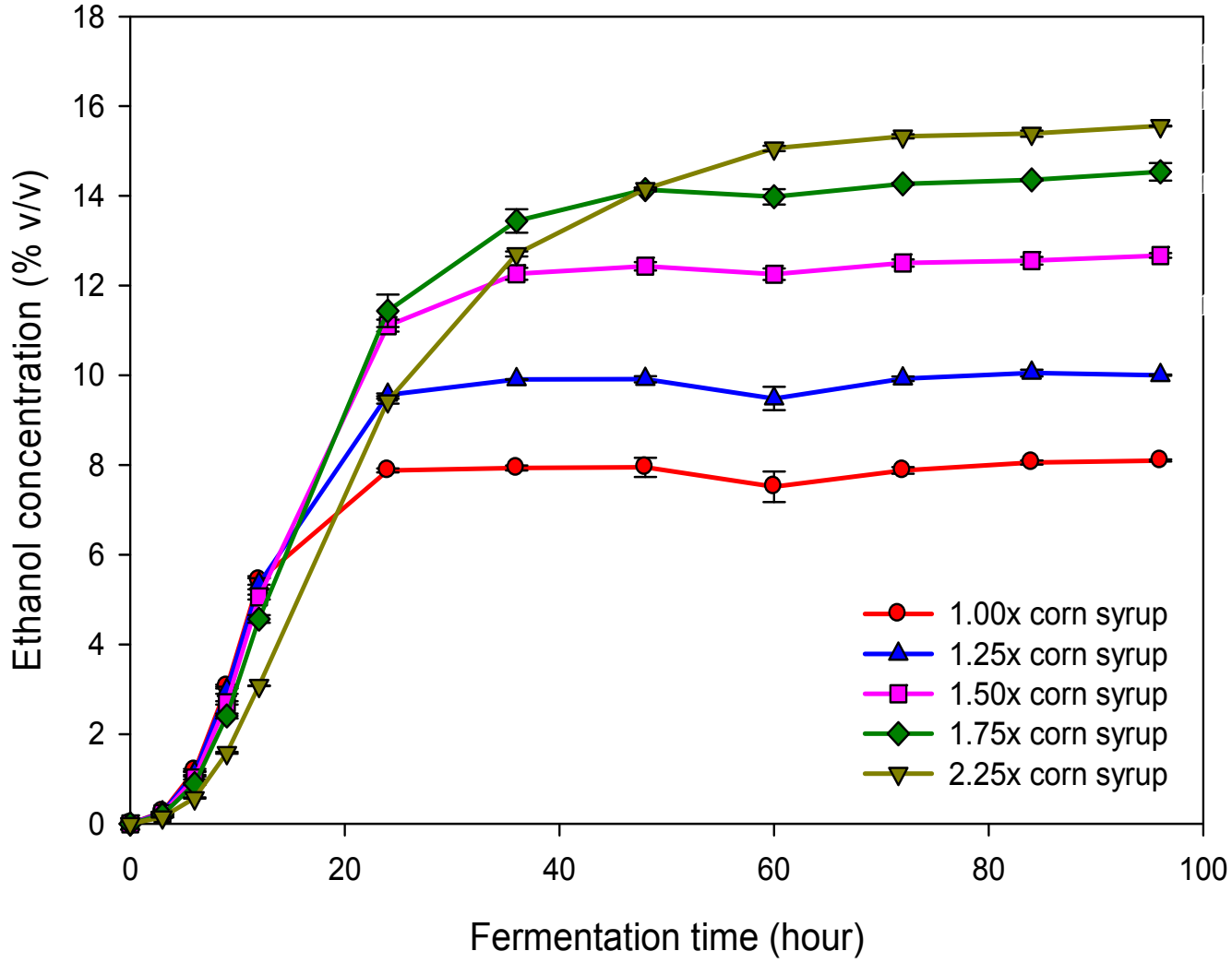
Tropical Maize



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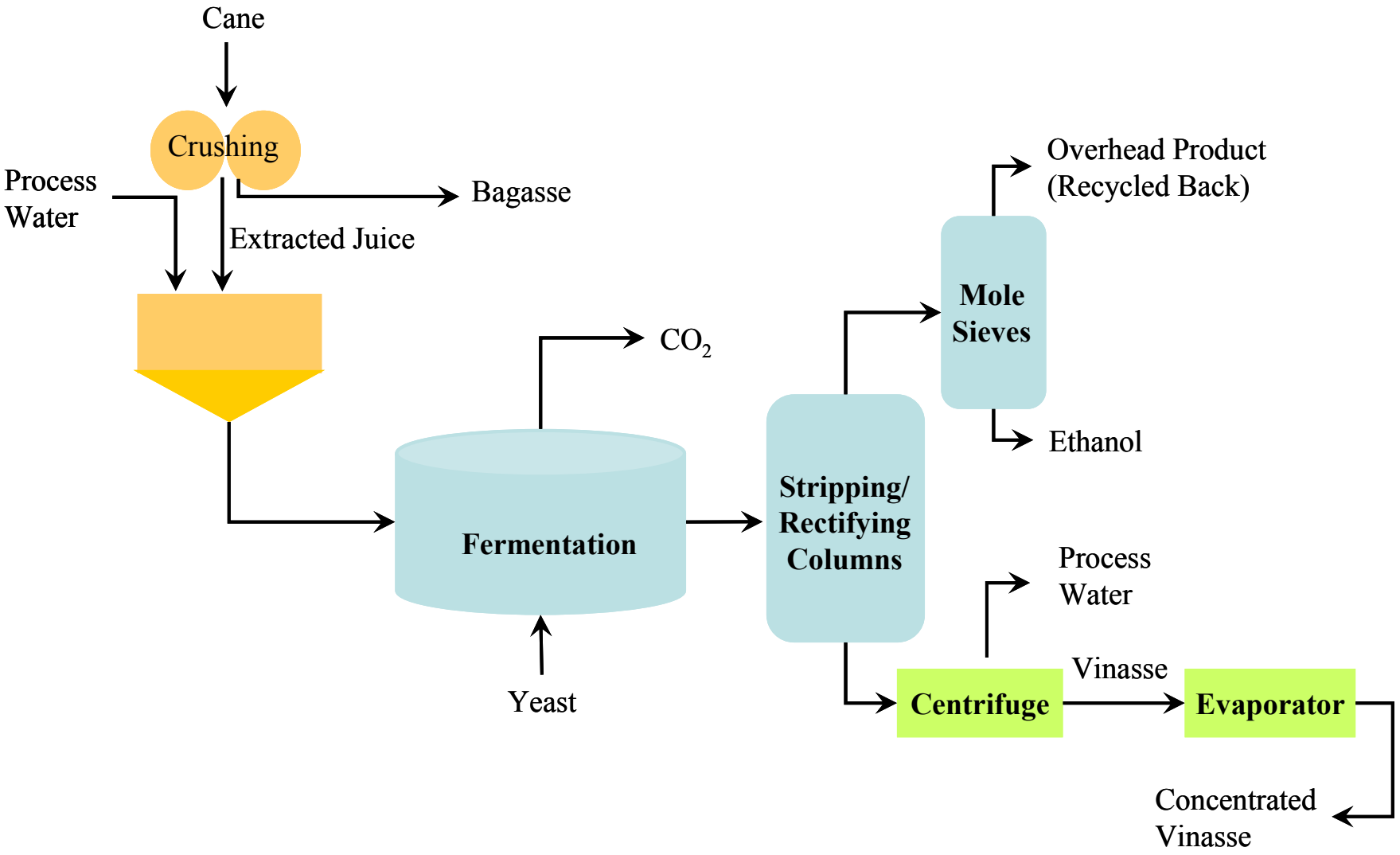
Conventional Sugarcane Ethanol Process



Tropical Maize

- Tropical maize requires few crop inputs such as nitrogen fertilizer, chiefly because it does not produce any ears.
- Require less processing than corn grain, corn stover, switchgrass, miscanthus.
- 25 percent or more sugar -- mostly sucrose, fructose and glucose
  - Easily fermented to ethanol
- Can be used in sugarcane to ethanol plant during the Inter-harvest

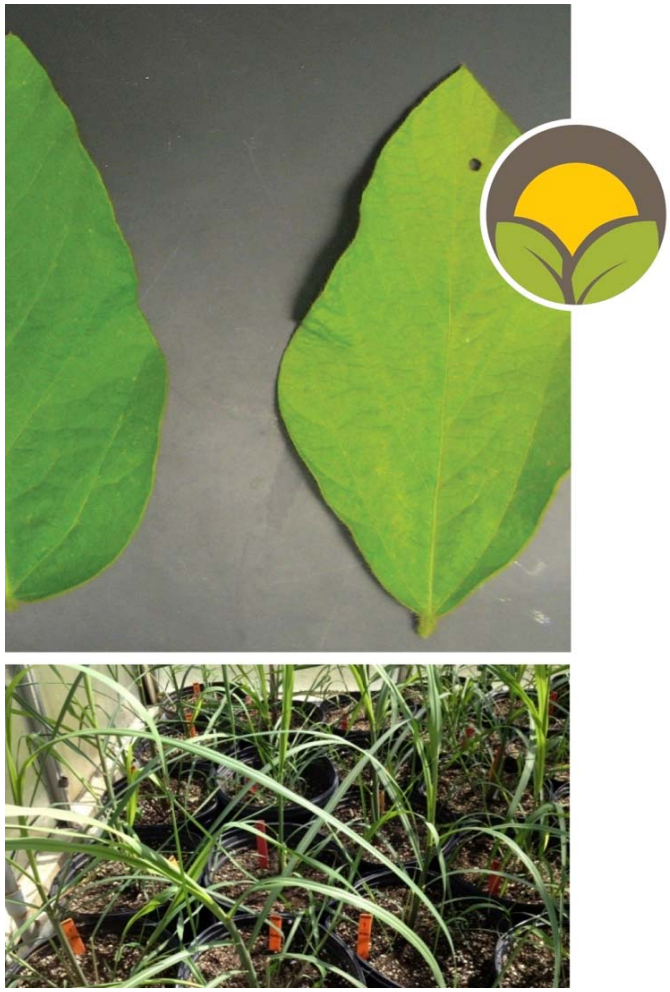
Lipid Producing Sugarcane (Lipid Cane)

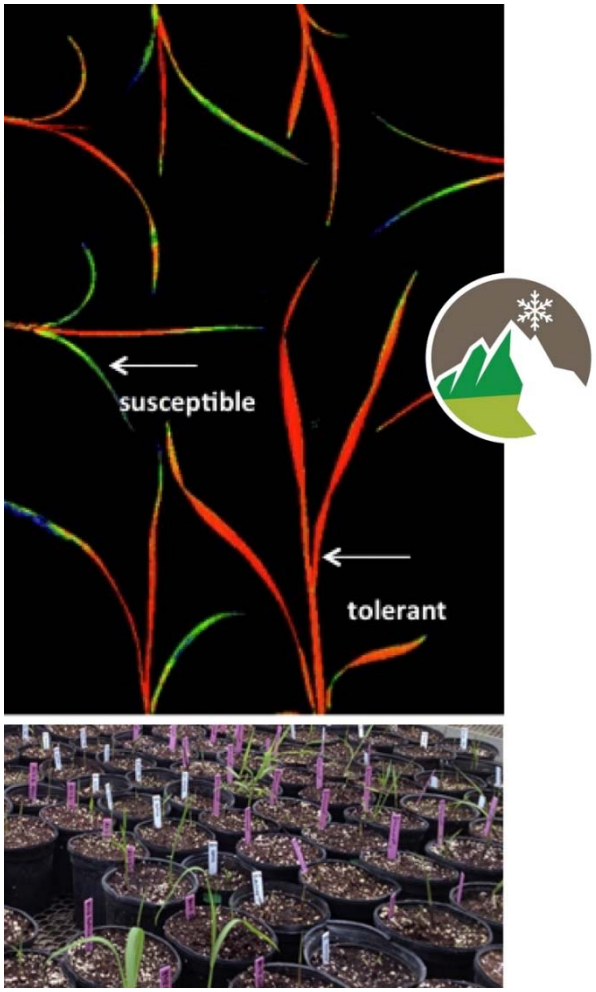
Make World's Most Productive Sugar Crop as the Oil Crop

- Plants already naturally produce oil
  - Use it as part of their metabolism
- By up-regulating the genes that make oil and down-regulate the genes that use it
  - Oil is stored in stems
- Currently we have achieved lipid cane with 2% oil (dry basis)
- Goal is to achieve 20% oil (dry basis) in Lipid cane

Accumulate Oil in Sugarcane

- Increase Photosynthesis
- Increase Cold Tolerance





Techno-Economic Analysis of Lipid Cane with Different Lipid Content

- Lipid cane techno-economic models were developed and compared with the current existing soybean and corn processing plants
- Lipid cane process model with lipid content of 0%, 2%, 5%, 10% and 20%
- Soybean-biodiesel process model with solvent (hexane) exaction
- Corn-ethanol process model with oil extraction from thin stillage

Lipid Cane

- Sugarcane producing lipids
- 2% lipid in stems, higher photosynthesis efficiency and improved cold tolerance
  - Goal – 20% oil in stems, 50% improvement in phytosynthesis
- Grown in land not used for food or other crops and can produce 40 billion gallons of biodiesel in the US

Thanks!

ILLINOIS