## Lecture 21
## Sugarcane

***Saccharum officinarum*; Poaceae (Gramineae); Tribe Andropogoneae**




**Hunter of bees, Arana, Spain 7000 BCE**

**Honey**

**Bee in Ancient Egypt**

**Sweet Sap from Sugar Palm and Maple**

**Collection of sap from sugar palm**

**Collection of sap from sugar maple and evaporation in North America**


**Ancient Sugar Mill**
**Hawaii Sugar Planters Research Institute**

- **Sugar (sucrose) from sugarcane is the cheapest energy food.**
- **Sugarcane is the most important source of sugar followed by sugar beet.**
- **Generally sugarcane is a crop of the humid tropical lowlands, but does best in wet and dry tropics.**
- **Some still grown in Southern Europe and United States (Hawaii, Louisiana, Florida).**
- **Hawaii is now going out of the sugar business.**
- **Per capita consumption is very high in the United States, Europe, and English speaking countries in general.**

## History

- **Sugarcane cultivated in India in 400 BCE.**
- **The art of sugarcane cultivation was carried from India to China as well as to Arabia and to Europe during the Crusades.**
- **Southern Europe provided the world market during the Middle Ages.**
- **Sugarcane introduced to Madeira and Azores in 1420.**
- **Columbus took sugar to the New World in 1493.**
- **In 1791 Capt. Bligh (Mutiny on the Bounty fame) transported varieties of *S. officinarum* from Tahiti to Jamaica; previous cultivation was the thin stalked *S. sinsense* and *S. barberi* native to Bay of Bengal.**

- *S. officinarum* is probably native to the South Pacific (New Guinea) and is very tall; known as noble canes (There is no sugar industry there but canes are grown for chewing).
- The thick-stemmed types were successful in all sugar growing areas.
- However, with outbreaks of diseases and pests, breeding programs were developed and the pedigrees of modern cultivars are now very complex.
  - 19th century: Rise of beet sugar.
  - 20th century: Corn sweeteners & synthetic sweeteners.

**Sugar Cane Production (2001)**

| World Production | 1000 MT | Chief countries |
|---|---|---|
| World | 1,254,857 | |
| Africa | 87,504 | South Africa (23,896), Egypt (15,620), Mauritius (5,500) |
| North America | 164,056 | Mexico (49,500), Cuba (35,000), US (31,571) |
| South America | 421,303 | Brazil (339,136), Colombia (33,400), Argentina (15,000) |
| Asia | 547,001 | India (286,000), China (79,700), Thailand (49,070) |
| Europe | 84 | Spain (80), Portugal (4) |
| Oceania | 34,909 | Australia (31,039), Fuji (3,500), Papua New Guinea (367) |

**Sugar Beet Production (2001)**

| World Production | 1000 MT | Chief countries |
|---|---|---|
| World | 234,245 | |
| Africa | 87,504 | South Africa (23,896), Egypt (15,620), Mauritius (5,500) |
| North America | 24,185 | US (23,364), Canada (821) |
| South America | 3,172 | Chile (3,169), Ecuador (3) |
| Asia | 36,187 | Turkey (14,500), China (10,900), Iran (4,300) |
| Europe | 164,665 | France (26,715), Germany (24,398), Ukraine (15,489) |

## Botany

*Saccharum* species

*S. officinarum* (2*n*=80):
Thick-stemmed ("noble") canes from New Guinea

*S. sinense* (2*n*=118):
Thin-stemmed hardy canes from China

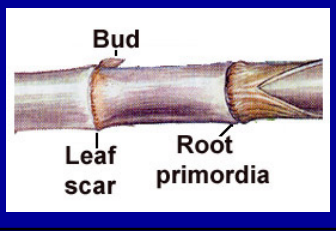
*S. barberi* (2*n*=variable):
Thin-stemmed hardy canes from India

*S. spontaneum*:
Wild canes of SE Asia; important in breeding

*S. robustum*:
Deeply penetrating roots, disease and drought resistant

## Morphology of Setts

Bud, Secondary shoot, Leaf scar, Root primordia




## Breeding

Crosses made by cutting inflorescence and placing shoot in water or dilute nutrient solution; seeds will set and mature on these cut shoots.

Breeding has been very important in increasing yields; especially Nobilization, the incorporation of *S. officinarum*.

In Java, yields per hectare were 1 t in 1840, 10 t in 1910, 20 t in 1940 and 32 t in l952.

Yields of cane and sugar content continues to increase.

Meteorological Inst. Hawaii Sugar Planters Research Inst.

Sugarcane Seedlings
Hawaii Sugar Planters Research Institute

## Culture

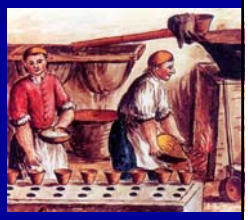
- Usually planted as a perennial crop but can also be grown as an annual.
- Asexually propagated by stem cuttings (setts) planted in furrows.
- Rows are 3 to 8 feet wide.
- Flowering can be prevented with diquat.
- Planted in wet seasons, harvested in dry season.

## Harvest

- Harvested when sugar content is as at a maximum.
- Needs a dry period to arrest growth to accumulate sugar.
- Flowering is not necessarily a sign of maximum sugar content.
- Once harvested it needs to be processed within 48 hr.
- In many countries two year old fields are cut but generally the cycle is 12–18 months.
- Harvest is traditionally by hand cutting (removing top and trash with a machete) but now is often machine harvested (Hawaii).
- Burning may be carried out to remove trash but this must be carefully done to avoid uncontrolled fires.

## Sugar Manufacture

Extraction of sugar in Sicily, 1584



Production of sugar in Venice

## Manufacture of Cane Sugar

- Extract juice by crushing
- Water added
- Re-crush
- Bagasse, canes after crushing, can be used as fuel
- Raw juice [sugars + nonsugars (dissolved solids) + water]
- Heated + lime (causes separation of insolubles), settled in clarifiers

- Successive boiling to concentrate. (Produces a dark hygroscopic material called gur in India, jaggery in Africa, panela in Latin America, rapadura in Brazil)
- Filter (vacuum pan centrifuged to crystallize sugar)
- Decolorized with carbon black
- Drying, screening
- Residue = "molasses"
  - 35% sucrose
  - 15% reducing sugars (glucose and fructose)
  - Distilled to produce rum (colorless), alcoholic spirit

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- Extract juice by crushing
- Water added
- Re-crush
- Bagasse (used as fuel)
- Raw juice is heated
- Lime added, causing separation
- Insolubles settle in clarifiers
- Successive boiling to concentrate
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- Centrifuged to crystallize sugar
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Sugarcane, Nerja, Spain, 1972

Loading Sugarcane, Fodder on Donkey, Nerja, Spain, 1972

Field of Sugarcane, Sao Paulo 1965

Sugarcane harvest, Puerto Rico, 1972

Sugar Mill, Ponte Nova, Brazil, 1963

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Sugarcane Harvesters

Loading sugarcane, Maui, Hawaii

Sugar refinery, Ewa plantation, Hawaii

Sugar refinery, Ewa plantation, Hawaii