



## Ethnobotanical Leaflets



# Sugar Cane: Past and Present

By Peter Sharpe

Sugar cane is composed of six species of perennial grasses of the genus *Saccharum* L., in tribe Andropogoneae of the Gramineae. There are two wild species, *S. spontaneum* L. and *S. robustum* Brandes & Jeswiet ex Grassl, and 4 cultivated species, *S. officinarum* L., *S. barberi* Jeswiet, *S. sinense* Roxb., and *S. edule* Hassk. (Purseglove 1979). The four cultivated species are complicated hybrids, and all intercross readily. All commercial canes grown today are inter-specific hybrids (Wrigley 1982).

## DISTRIBUTION

Sugar cane is believed to have originated in the South Pacific. *S. spontaneum* occurs in the wild from eastern and northern Africa, through the Middle East, to India, China, Taiwan, and Malaysia, and through the Pacific to New Guinea. The center of origin is probably in northern India where forms with the smallest chromosome numbers occur. *S. robustum* is found along river banks in New Guinea and some of its adjacent islands and is indigenous to the area. *S. officinarum* (or noble cane) most likely originated in New Guinea. This cane is only suited for tropical regions with favorable climate and soil. *S. barberi* probably originated in India. *S. sinense* occurs in portions of India, Indo-china, southern China and Taiwan. *S. edule* is thought to be a sterile form of *S. robustum* and is found only in New Guinea and nearby islands (Purseglove 1979).

Cane sugar is currently grown primarily in tropical regions. The highest latitudes at which cane is grown is in Natal, Argentina and at the southern extremes of the Australian industry (approximately 30 degrees S), and at 34 degrees N in northwest Pakistan, and 37 degrees N in southern Spain (Jenkins 1966).

## HISTORICAL RECORD

Sugar cane has been known for at least 2200 years. Alexander's army saw sugar cane during its conquest of India in 326 BC (Purseglove 1979). Nearchus mentioned sugar cane in western India in 325 BC. Sugar cane was probably introduced into China around 110 BC when a botanical garden was founded near Peking for the introduction of exotic-plants (Deerr 1949). Theophrastus described 'honey produced

from reeds,' while Dioscorides, in the first century AD, described 'a honey called sakkharon collected from reeds in India and Arabia Felix with the consistency of salt and which could be crunched between the teeth'. The mountains and deserts of Afghanistan, Baluchistan, and eastern Persia served as natural barriers against the spread of cane to other areas for centuries. It eventually reached Persia in the sixth century. The Arabs were responsible for much of its spread as they took it to Egypt in 641 AD during their conquests. They also carried it with them as they advanced around the Mediterranean. Sugar cane spread by this means to Syria, Cyprus, and Crete, eventually reaching Spain around 714 AD. The sugar industry in Spain was very successful, with about 30,000 ha of cane being cultivated by about 1150 AD. Around 1420 the Portuguese introduced cane into Madeira, from where it soon reached the Canary Islands, the Azores, and West Africa (Purseglove 1979). Columbus transported sugar cane from the Canary Islands to Hispaniola (now the Dominican Republic) on his second voyage in 1493 (Deerr 1949, Purseglove 1979).

The first New World sugar cane mill began grinding in about 1516 in the Dominican Republic. Sugar production spread to Cuba, Jamaica, Puerto Rico, and the other Greater Antilles by the end of the 1500's (Hagelberg 1985).

## **PROPAGATION**

Sugar cane propagation is through stem cuttings of immature canes 8-12 months old. These are called "setts", "seed", "seed- cane" or "seed-pieces". The setts are best if taken from the upper third of the cane because the buds are younger and less likely to dry out. The setts can be planted at a 45 degree angle or laid horizontally in a furrow. It takes 12,500 - 20,000 setts to plant one hectare (Purseglove 1979). The setts are lightly covered with soil until they sprout (10-14 days) and then the sides of the furrow are turned inward (McIlroy 1963). Sugar cane is a perennial crop which usually produces crops for about 3-6 years before being replanted. The first crop is called the "plant crop" and takes 9-24 months to mature, depending on location (Purseglove 1979). Reaping is usually done by hand with a cutlass, although mechanical harvesters are being developed. The cane is cut close to the ground because the lower stem has the highest sugar content and it aids in ratooning, the emergence of new crops from the stems and trash (leaves and tops) left behind (McIlroy 1963). Ratoon crops take about one year to mature. As many as four or more ratoon crops may be produced before replanting is necessary, mostly due to the slow decline in yields (McIlroy 1963, Purseglove 1979).

## **DISEASES AND PESTS**

There are many diseases and pests which may effect sugar cane. Bacterial diseases include gumming disease, *Xanthomonas vasculorum* (Cobb) Dows., in which yellowish stripes occur at the leaf tips and the vascular bundles exude a yellowish gum when cut, and leaf scald, *Xanthomonas albilineans* (Ashby) Dows., in which yellow stripes occur on the leaf blade, many side-shoots are produced, and the vascular bundles of the stalk are red (Purseglove 1979).

Fungal diseases such as red rot (*Colletotrichum falcatum* Went), root rot (*Pythium graminicolum* Subr.),

pineapple disease (*Thielaviopsis paradoxa* (de Seynes) C. Moreau), downy mildew (*Sclerospora sacchari* Miy), and smut (*Ustilago scitaminea* Syd.) can also cause damage. Red rot causes the setts to be seriously damaged at low temperatures. Root rot was responsible for the failure of "Otaheite" (a noble cane) in Mauritius in 1846 and several other areas later. Pineapple disease attacks the setts causing the center to turn black and smell like overripe pineapples. Downy mildew is currently only found in the western Pacific and was responsible for severe losses in Queensland until rigorous controls were initiated. Smut causes black whiplike organs to emerge from the center of the leaf-roll and is important in southeastern Asia and South Africa (Purseglove 1979).

Mosaic is a viral disease, whose vectors include *Aphis maidis* Fitch, was first recognized in Java in 1892 and causes severe stunting in some cases. Other viral diseases include ratoon stunting, chlorotic streak, Fiji disease, and Sereh disease (Purseglove 1979). The most destructive insects of sugar cane are stem-borers, the larvae of several genera of moths. The larvae burrow into the stem and on emergence cause loss of sucrose and weakened stems. Biological control, the use of natural parasites, is the most effective control for these (Purseglove 1979). Other pests include termites in India and white grubs in Queensland. Rats are also a problem in many areas, for they eat the cane and introduce pathogens. The Indian mongoose, *Herpestes*, was introduced in the West Indies around 1870. This was a failure because they found they were able to catch birds easier (Purseglove 1979).

## **BREEDING**

All species of sugar cane are easily crossed. There are also reported crosses of sugar cane with, other genera, such as *Zea* and *Sorghum*, although none are of commercial value at the present (Wrigley 1982). Flowering cane is not desirable in commercial plantations because it indicates the end of vegetative growth and sugar production. Flowering can be avoided by extension of day-length by exposure of the cane to electric lights for short periods at night during the time when flowering usually occurs, therefore extending the productive life of the cane (McIlroy 1963). The greatest advance in sugar cane breeding came in 1888 when it was realized that sugar cane could set fertile seed which could be used to produce better cane varieties. Prior to this it was believed that all cane was sterile because one of the varieties of *S. officinarum*, Creole cane, which was the only variety known in the Western world for a long time, was sterile (Deerr 1949). The original breeding stations were in areas where cane flowers naturally, but are now found in many areas due to techniques such as manipulation of day length and temperature (Wrigley 1982). The pollen grain has a short viability, as does the seed. However, the flowers seldom set the 1 mm long seeds (McIlroy 1963). About 1 in 10,000 seedlings resulting from the thousands of crossings made annually is worth selection for trials, and less than 1 in 10 of these is likely to become a commercial variety (Wrigley 1982).

The goal of cane breeding is to produce an economic yield of sugar sustained over several ratoons. Sugar canes are highly polyploid, wind pollinated outbreeders. They are clonally propagated, highly heterozygous, and intolerant to inbreeding. New varieties are sought from the first generation progeny of crosses between clones. There are five species of interest to cane breeders. *S. officinarum* ( $2n=80$ ) has good sugar quality and low fiber, although it is susceptible to most of the main diseases, except

gumming disease and smut. *S. spontaneum* (2n=40-128) is a source of resistance to many diseases, including "Sereh", mosaic, gumming, red rot, and downy mildew. *S. barberi* (2n=82-124) are considered the most important breeding canes and are immune to gumming and mosaic and resistant to downy mildew, but susceptible to smut and red rot. *S. sinense* (2n=82-124) is difficult to breed, but has given rise to some useful breeding lines. *S. robustum* (2n=60-194) has been used to some extent in breeding lines (Wrigley 1982).

Breeding and selection of cane is not a simple process since viable seeds are seldom produced. Breeding occurs at the experiment stations which are able to provide the proper conditions and techniques required. The setts of new varieties are then distributed to the cane growers. Through selective breeding the yield has been increased by 85%.

## **YIELDS**

Sugar cane yields the highest number of calories per unit area of any plant (Heiser 1981), producing up to 10 tons of sucrose per hectare in Barbados. Trinidad produces 90-120 tons of millable cane per hectare from the plant crop and 45-90 tons from ratoons. The highest yields of 22 tons of sucrose per hectare occur in Hawaii, but the crops take two or more years to mature there. Recovery of raw sugar from cane varies from 11-13 percent (Purseglove 1979). In 1980 the world production of sugar from cane and beets was about 86 million tons. Almost 65% of this (about 55.5 million tons) came from cane (Paturau 1982). Substantial increases in yields have occurred over the past 100 years due to improved cultural practices, particularly fertilizer use, disease and pest control, field and factory. mechanization, and breeding of higher-yielding varieties.

## **PROCESSING AND USES**

Sugar cane was originally grown for the sole purpose of chewing in southeastern Asia and the Pacific. The rind was removed and the internal tissues sucked or chewed. Noble canes are the best for chewing due to high sugar and juice contents. Production of sugar by boiling the cane juice was first discovered in India, most likely during the first millennium BC (Purseglove 1979).

Today, sugar cane has many industrial uses and is one of the most widely used and cheapest domestic products (Jenkins 1966). In sugar factories the harvested cane is shredded and crushed with heavy rollers to retrieve the juice which contains 10-20% sucrose. The pH is raised with lime and the mixture is heated to around 100 degrees C for several hours. The lime causes suspended materials, proteins, waxes, and fats to precipitate. Further impurities are allowed to settle in large containers and are removed from the bottom. This residue is known as filter cake or filter mud. The clear juice is again heated in a series of evaporators to form crystals and separated from the molasses in centrifuges. About 1 ton of raw sugar can be extracted from 8-9 tons of cane (McIlroy 1963). This raw brown sugar can be further refined to produce white sugar (Heiser 1981). Sugar cane has many other uses besides the production of sugars. Molasses is a by-product of the manufacturing of cane sugar. It is a residual syrup from which no more crystalline sucrose can be obtained by simple techniques. Approximately 2.7% of a ton of cane can be

extracted as molasses. In 1980 nearly 30.8 million tons of molasses were produced, with Brazil leading production with about 5.2 million tons (Paturau 1982). The uses of molasses are many. Starting around 1850 it was often used as a fertilizer for cane soils, however this use is negligible today. Its use as a stockfeed can be dated back to at least 1811 in Germany. Today, at least 600,000 tons are used annually in the U.S. alone. Its most important feed characteristic is its high carbohydrate contents (Paturau 1982).

Molasses can also be distilled and fermented to produce various items. Molasses, along with cane juice and other by-products can be fermented to produce an alcoholic distillate, otherwise known as rum. Rum, or very similar liquors, are written about as far back as 2000 BC. It can also be traced back to the colonization of the West Indies in the 1600's. Ethyl alcohol (ethanol) is another alcohol produced from molasses, which in itself has many uses. The main uses are in vinegar, cosmetics and pharmaceuticals, cleaning preparations and solvents, and coatings. One of the future uses of ethanol which is currently being studied is as a gasoline extender. Still other products produced from molasses are butanol (a solvent), lactic acid (a solvent), citric acid (mostly for foods and beverages), glycerol, yeast, and many others (Paturau 1982).

Another useful by-product of sugar production is bagasse, the fibrous residue left after the juices are extracted from the cane. It is the main source of fuel in sugar factories. It can also be used in making paper, cardboard, fiber board, and wall board (Purseglove 1979).

The filter mud can contain up to 15% cane wax. When extracted, this wax can be used in the production of polishes and insulation. Only about one ton of wax is obtained from 1,000 tons of cane, so the process is economically feasible only under certain circumstances (McIlroy 1963).

It is quite possible that further uses of sugar cane will be developed in the future, but even now it can be seen that sugar cane is a very important and useful plant crop worldwide.

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Last updated: 26-Oct-98 / du