

# SUGAR PRODUCTION FROM SUGAR CANE

## The Basic Process

Sugar cane must be crushed to extract the juice. The crushing process must break up the hard nodes of the cane and flatten the stems. The juice is collected, filtered and sometimes treated and then boiled to drive off the excess water. The dried cane residue (bagasse) is often used as fuel for this process. The remaining liquid is allowed to set into a solid mass known as jaggery, gur, chancaca or panela. (Gur is used in the rest of this document.)

## Yields

The yield of gur from sugar cane depends mostly on the quality of the cane and the efficiency of the extraction of juice. The table below gives some extreme values.

	High quality cane	Poor quality cane
Juice per 100kg of cane	50kg	40kg
% sugar in juice	22	17
Gur per 100kg of cane	10kg	7kg

High quality cane has a good juice content with high sugar levels (20%+). Poor quality cane or cane that has been harvested early may have similar juice content but the sugar levels will be reduced.

The efficiency with which juice can be extracted from the cane is limited by the technology used. The simple three roller crushers used by most artisanal producers will never extract more than 50kg of juice from each 100kg of cane.

Yields are also improved by careful control of the boiling process. Boiling should be completed as rapidly as possible and the conditions kept as clean as possible.

## Crushing

Most artisanal sugar producers use a simple crusher consisting of three metal rollers. This is driven by either animal or diesel power. A crusher driven by a single ox can be expected to process around 50kg of cane per hour. A 5HP diesel set could increase this to around 300kg per hour. Figures 1 and 2 show both types in operation in Bangladesh. In these pictures the rollers are set vertically; many machines have horizontal rollers. Suppliers of this machinery are given in appendix 1.

Important points to remember during crushing are:

- Cane must be crushed within 24 hours of being cut. After this time the sugar begins to 'invert' into different sugars that will not set solid.
- Crushing efficiency is the most important factor in good sugar yields. Every possible amount of juice needs to be squeezed from the cane.

**Juice treatment**

Juice should be filtered through a cloth before boiling in order to remove any solids such as dirt or particles of cane.

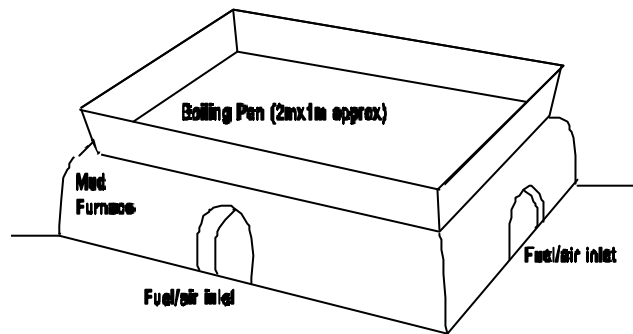
Large-scale sugar processors add lime to the juice in order to coagulate impurities which then settle out. (This is rarely done at the artisanal level.) The juice is then neutralised with sulphur dioxide. Small-scale producers add a variety of clarificants to the juice including wood ash. All of these have the effect of settling out impurities. Many producers also add 'Hydros' (sodium hydrogen sulphate) at the final stages of boiling. This releases sulphur dioxide into the juice and lightens the colour of the final product. (Note that a high sulphur content often remains in the final product.)

**Juice Boiling**

This is done in large pans over open fires or simple furnaces (see figure 3). The essential requirement is for clean pans and tools. Sediment settles to the bottom of the pan during boiling and is dredged out. Scum rises to the top and is skimmed off. (Both of these wastes can be fed to cattle.) A large pan such as that pictured in figure 3 would hold about 100kg of juice reducing to around 20kg of gur. The pans are usually made from galvanised mild steel sheets.

The end point of the boiling process is judged from experience; from the sight and sound of the boiling juice. Small samples can be removed to see if they set solid when cooled. For those with access to simple sugar measuring devices, this usually corresponds to a Brix (sugar content) of 90-95%.

After removal from the heat, the pans of juice are usually stirred rapidly to incorporate air and promote an even crystallisation. The cooling juice is then poured into pots or moulds to set.



Note: Furnace extends about 1m deep underground.

**Cleanliness**

Cleanliness is vital to the whole process. Once the juice has been heated, impurities will speed the 'inversion' of sugar and lead to reduced yields. All boiling pans and tools need to be thoroughly cleaned between uses.

**Tools**

The tools required are very simple Filtration before boiling is done through a fine woven cloth. Scum is removed from the boiling juice by a simple perforated scoop on a long handle. Sediment is removed by scraping a stretched cloth along the bottom of the pan. Once the pan has been removed from the heat, a simple rake is used to stir the thickened juice.

**Mass Balance**

For the technically minded, the weights of the gur, juice and cane can be related as follows:

$$\text{Weight of gur} = \text{Weight of cane} \times \frac{\text{weight of juice}}{\text{weight of cane}} \times \frac{\text{sugar in juice}}{\text{sugar in gur}}$$

Typical figures would be:

$$10\text{kg gur} = 100\text{kg cane} \times \frac{50\text{kg juice}}{100\text{kg cane}} \times \frac{19\% \text{ sugar in juice}}{95\% \text{ sugar in gur}}$$

**Appendix 1: Crushing Equipment Manufacturers**

CIMAG - Com E Ind de Maquinas Agricola  
Rua St Terezinha 1381  
13970 ITAPIRA SP  
Brazil

A manual mill with a throughput of around 100 litres per hour. (More suitable for juice drinks than gur production.)

Penagos Hermanos & CIA Ltda  
Apartado Aereo 689  
Bucaramanga  
Colombia

A vertical roll, animal powered crusher, capacity of 4-6 tonnes of cane per day. A horizontal roll 4.5kW (6hp) crusher with a throughput of 400kg of cane per hour.

Other models up to 1.7 tonnes per hour.

Tanzania Engineering and Manufacture Design Organisation  
P O Box 6111  
Arusha  
Tanzania

Electrically powered 2.2kW (3hp) crusher with a capacity of 20 litres of juice per hour.

Dias and Dias  
690 Negombo Road  
Mabole  
Wattala  
SRI LANKA

2hp and 6hp crushers with capacity up to around 400kg per hour.

technical brief

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Agro Machinery Ltd  
PO Box 3281  
Bush Rod Island  
Monrovia  
Liberia

Intermediate Technology Development Group

Nafees Industries  
Samundari Road  
Faisalbad  
Pakistan

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