

# Latin America Thematic Network on Bioenergy - LAMNET

## Joint Workshop - South Africa

**Timing:** 19<sup>th</sup> August 2002 – 21<sup>st</sup> August 2002

**Location:** Kwa-Shukela Convention Centre  
170 Flanders Drive, Mount Edgecombe (Durban)  
P O Box 804 Westville 3630  
Republic of South Africa

# WORKSHOP PROCEEDINGS

## (Part 2)



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This workshop was organised by WIP-Munich, Germany and Illovo Sugar Ltd., South Africa, within the framework of the LAMNET project as a joint event of the following Thematic Networks funded by the European Commission, DG Research:

**CARENSEA** - Cane Resources Network for Southern Africa  
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**SPARKNET** – Sustainable Energy Policy and Research ‘Knowledge Network’ on cost effective, ecologically sound and healthy energy alternatives for low-income rural households  
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## WEDNESDAY, 21<sup>ST</sup> AUGUST 2002 - Technical Tour

### Visit at GLEDHOW SUGAR MILL

#### Introduction

Mr. S. Rau, General Manager of Gledhow Sugar Mill, operated by Illovo Sugar Ltd, welcomes the participants (Pict. 1, 2) of the tour and introduces data on sugar cane production, provision and processing. In more detail he explains the sugar production at Gledhow Sugar Mill. This sugar mill is one of the fifteen sugar mills in South Africa. The mill has a complete sugar cane processing and refinery system. The sugar mill has expanded its cane processing capacity in the last few years, as a result of the incorporation of the sugar cane processing component of the Glendale Mill.

About 7.5 – 10 tons sugar cane produce 1 ton of sugar. The milling process of sugar can be classified into nine main sections, namely: cane planting and management, cane harvesting, cane provision and preparation, juice extraction, clarification, water evaporation, crystallization, centrifuging, packing and finally distribution.

#### *Sugar cane planting*

After every harvesting season, about 10% of the fields are replanted with sugar cane, but thereby only open spaces are filled up. A replanting process of one field, as a whole, will only take place either after the 9<sup>th</sup> or 10<sup>th</sup> season of harvesting. This is influenced by several factors, such as the deviation of the actual cane yield from the projected yield per ha. The maximum and minimum average temperatures in summer are 30 °C and 25 °C respectively. Winter average temperature, maximum and minimum are 20 °C and 10 °C respectively.

Rhizomes and/or ‘sprouts’ – which are longer parts of sugar cane with a length of approx. 20 cm - are used for planting sugar cane, which are placed in rows (Pict. 3, 4). There are special sugar cane varieties, grown in nurseries that are used to produce sets. Sprouts are treated with special chemicals to protect them from infection, while still waiting for germination.

The irrigation system used varies from flood irrigation to overhead sprinklers. The latter has a greater efficiency when compared with the former, but a lower efficiency when compared with drip irrigation, which of course is more expensive and labor intensive. During most of the sugar cane plantation, water supply is largely dependent on rainfall.

The time taken by the crop to reach maturity (Pict. 5) varies from 12 months to about 18 months, depending on the management practices applied.

#### *Sugar cane harvesting*

Sugar cane is harvested either unburned or burned at Gledhow Mill plantation area.

#### *Cane harvesting without burning (Pict. 6, 7, 9)*

Sugar cane that is harvested without burning cannot be clearly classified as green sugarcane harvesting, because the plants leaves are mostly dry prior to harvesting. Harvesting the sugar cane without burning is not basically to optimize biomass yields or collection for increasing output diversity from sugar cane, but simply to reduce air pollution from smoke in the urban environment. For the given reason to burn sugar cane prior to harvesting, the economic viability of trash and tops is not recognized by the company, but further adds costs to the harvesting process as shall be shown later in the section.

Each cutter or laborer is expected to cut 3 ton of sugar cane per day, one tone less than in the case of burned cane.

The advantages of harvesting unburned sugar cane are:

- (a) reduction of smoke accumulation in the atmosphere, and further reduction of the direct cycling of atmospheric CO<sub>2</sub> used during the process of photosynthesis by the plants,
- (b) accumulation of trash on the field surface reduces water loss through direct evaporation, while optimizing the process of evapotranspiration,
- (c) regulation of the soil temperature, particularly close to the soil surface, which is subject to greater temperature fluctuations,
- (d) decomposition of the trash, addition of organic nutrients into the soil,
- (e) control of surface water run-off, thus reducing the process of surface soil wash and erosion, particularly as most of the sugarcane plantation for Gledhow Sugar Mill are grown on steep slopes.

Disadvantages

- (a) the direct economic profits of unburned cane harvesting are not fully realized by the mill,
- (b) the leaves are already dry when the sugar cane is harvested, which are low in nutrient contents, when compared with green leaves,
- (c) the leaves are left on the soil surface to form a mulch, a process that exposes the leaves to uncontrolled fires,
- (d) in case of uncontrolled fire, the sugar mill has contributed to environmental pollution and has lost all the advantages of the process; additionally, costs for removing trash from the sugar cane stalks are inferred on the sugar mill
- (e) the harvesting process is rather slow, thus reducing the yield per hour per person, thus increasing the costs of harvesting.

#### *Burned cane harvesting (Pict. 8)*

When sugar cane is ready for harvesting, the plants, which rather have more dry leaves than green leaves are set ablaze. The cane is cut and tied in bundles of about 4 tons. The burned cane is immediately harvested and transported to the mill by trucks and tractors. The time allowed to lapse between burning and delivery of burned sugar cane to the mill is five days, and after which the cane is no longer suitable for milling. The reason is that there is a larger decrease in sucrose content per unit time thereafter if the cane is burnt as compared to unburned harvesting.

#### ***Cane preparation***

Sugar cane is delivered to the mill by road. At the mill, the cane is first weighed at the weighbridge, given specific consignment or identification codes, before being offloaded directly onto the moving table (Pict. 10, 11). The cane then travels continuously through a system of conveyors to the cane preparation units, namely cane knives and shredders (Pict. 12).

At the cane knives the stick of cane is cut into smaller pieces of 20mm to 50mm in length before being fed into the shredder, which literally shreds all the fibres and opens the inner part of the cane for the extraction process.

At the cane delivery samples are removed continuously, which are analysed to determine the sucrose content providing the basis for the payment of farmers.

### ***Juice extraction***

The mill uses two juice extraction methods, namely diffusion and milling process (physical crushing).

**Diffusion:** The prepared cane passes through a huge vessel called a diffuser. Hot water is continuously sprayed onto the moving bed of finely prepared cane, thereby leaching out the sucrose from the cane (Pict. 15).

**Milling:** The prepared cane passes through a chain of large heavy rollers, which squeeze out the juice. This process is repeated several times down the tandem of mills (Pict. 13,14). The dry fibre discharged from the last mill is called bagasse. The bagasse that is produced is the main source of fuel for boilers, through the co-generation process (Pict. 16, 17, 18, 19, 20).

The milling process is more expensive when compared with the diffusion system.

### ***Clarification***

The mixed juice is heated, where a milk of lime is added to it. The lime neutralizes the acids and forms a precipitate that is settled out in the clarifiers. The precipitate is then filtered to recover any remaining sucrose before returning it to the fields in the form of filter mud, as a source of fertilizer. The clear juice from clarifiers is then pumped across to the evaporators.

### ***Evaporation***

The clear juice is pumped to the multiple effect evaporators. This system consists of a series of vessels arranged that each vessel has a greater vacuum than the preceding one, and thereby allowing boiling at a lower temperature. Steam from the boilers is sent to the first vessel and the resultant vapour from it is used to boil the juice in the next vessel and so on. The next vessel boils under a higher vacuum. In this process, about 85% of the water in the juice is evaporated, concentrating the juice solids from about 12% to 65%.

### ***Crystallization***

Crystallization is accomplished by further evaporating water under carefully controlled conditions, in vacuum pans. As the water is evaporated, the sugar reaches concentrated levels. At this stage, seed crystals, in a form of slurry, are added, which act as condensing surfaces (nuclei), growing into large crystals. Computers are used to control the process. The dense mixture of crystals and mother liquor is known as massecuite. After discharging from the vacuum pans, it passes through crystallisers, which are large open vessels with slow moving stirrers, where under the action of stirring and cooling, more sugar is exhausted from the mother liquor and is disposed onto the crystal surface.

### ***Centrifuging (Pict. 21)***

The centrifuging stage is designed to separate the sugar crystals from the mother liquor. The massecuite is fed into the centrifuge, which comprises a perforated basket lined with a metallic screen and acts as a filter medium. The basket rotates at a high speed and the sugar remains behind, while the mother liquor, known as molasses, passes through the basket perforations. The resultant molasses is delivered to the Glendale Alcohol Distillery. The sugar is discharged and then passed through a drier before being dispatched.

### ***Packing and Distribution***

The dry raw (natural) sugar may be refined to give white sugar, through a decolorization process. Both the white and brown sugar is then packed in bags from 1,000 kg and smaller, where the 5 kg bag is the smallest, before distribution. Distribution is by road transportation. Large quantities are also shipped overseas from the deep water harbour Richards Bay (intermediate shipment from the mill to the port by road transport) .

### Visit at SAPPI Paper Mill

The reason to visit SAPPI was to demonstrate the **bagasse utilisation** as input material for products and not only for energy. During the cropping season approximately 2000 tons of bagasse are produced per day in the Gledhow Sugar Mill. The bagasse is delivered to SAPPI, a paper production unit in close vicinity to Gledhow Sugar Mill. The long fibres of the bagasse, which comprise about 40% of the total, is separated by SAPPI in an exchange for an amount of coal equivalent. After the dissolving process remaining bagasse is sent back to the sugar mill using the bagasse for co-generation of process electricity and heat.

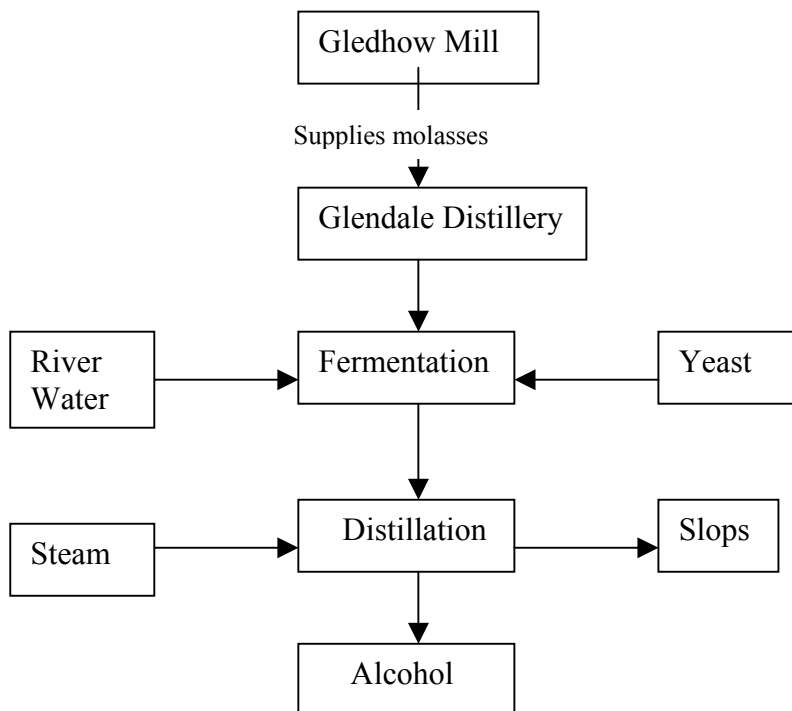
For the paper mill the advantage is to receive relatively cheap input material. The disadvantage is, that the fibres are not so long as the fibres of wood. However, in a mixture of wood fibres and sugar cane bagasse fibres a paper with different quality aspects can be produced for a large number of users.

### Visit at the Glendale distillery

#### Introduction

The Glendale alcohol distillery (Pict. 22, 23) is part of Gledhow Mill, but only focusing on the processing of the fermentation of molasses to alcohol and subsequent distillation. Gledhow Mill supplies the Glendale Distillers with molasses at the price that is controlled by the industry. The average cost of transporting 1 ton of molasses from Gledhow is less than US\$30. The closeness of the distillery to Gledhow Mill reduces the transport costs of the molasses, while further adding value to the industry. Furthermore, alcohol production is a profitable process, that adds to output diversity from sugar cane resources, while further reducing output waste to the environment.

#### Alcohol production



Processing of molasses to alcohol at Glendale Distillers (Pict. 24,25).

### **Concentrated Molasses Solubles Plant**

The quality of molasses shows slight variation, but with a general yield of about 4 % alcohol per 1 ton of molasses. The distillery produces about 15,000 liters of potable alcohol per day which is equivalent to a fermented molasses throughput of 350 to 400 m<sup>3</sup>.

The fermentation/distillation process of molasses produces a large amount of acidic slops at a pH that can be as low as 4. Lime is then added to the slops to raise the pH to about 7. The process of increasing the pH of the concentrates creates a problem, as the lime tends to deposit along the pipes and the distillery. It is for this reason that the operation is shut down for 15 day in a year to clean the distillery.

In the process of molasses fermentation per annum, an appreciable amount of vanasse (Concentrated Molasses Solubles – CMS) is produced. The CMS is very rich in potassium. To produce high value fertilizers, nitrogen and phosphorus are added to the vanasse. This type of fertilizer has a large and growing market. The reason for the market for CMS is that fertilizers are generally imported, and local production therefore reduces purchase costs, while providing better profits.

Stream water is used in the distillery. The water is purified first to serve as industrial water and/or domestic water. The distillery uses about 2 million liters of water per month. The industrial waste water is not discharged back to the stream, but pumped onto the sugar cane fields, providing important supplements of soil nutrients. Currently, this process water is provided free of charge, but there are fears that costs soon will be attached to the water consumed, introduced through the new national government water policy.

The industry also uses coal as source of energy, which obviously is the most expensive input. The boiler ash is used for road surfaces and brick making.

The distillery is operated all-year round, including weekends. Since there is a period where there are no molasses produced by the sugar mill at Gledhow (4 months) in a year, extra molasses are stored to be used when supplies from the Gledhow mill cease temporarily.

### **Product**

The distillery produces about 96.4% of plain spirits as the major product, while Rum is an optional product. Additionally, venasse and modified fertilizers are produced, providing high economic value to this industry.

### **Conclusion**

In conclusion, the production of potable alcohol from Glendale Distillery provides added value to Gledhow Sugar Mill, while further reducing the total waste to be disposed, thereby releasing a major environmental concern of the sugar mills industry.

## Technical Tour - Conclusion and Outlook

The visit at Gledhow Sugar Mill, Sappi Paper factory and Glendale Distillery was an excellent showcase for a ‘closed-loop’ production and ‘added-value generation’ based on sugar cane. The combination of the three factories produces

- sugar as brown and white sugar
- paper by using a mixture of bagasse fibres – as a remainder from the sugar cane milling and juice extraction - and wood fibres
- alcohol by using the molasses as a remainder from the sugar crystallization
- energy – steam and electricity - by using the ‘return bagasse fibres’ coming from the paper factory
- fertilizers
  - by using ashes from bagasse fueled boilers
  - by using the bleaching liquids from the sugar production
  - by using the concentrated remainders from vinasse coming from the distillery

Beside this multi-purpose utilization of sugar cane, which is demonstrated by Illovo Sugar Ltd in several sugar mills, there are, however, other cases and sugar mills all over the world where the utilization of the solid residues, and mainly of bagasse, can be improved by using novel technologies.

The pelletising technology for bagasse and/or a variety of biomass feedstocks will be an important step in providing energy from biomass on a year-round basis and the discussion on this subject during the workshop was of specific interest to the sugar industry.

However, not only the Gledhow sugar mill can use pelletising technology. The SAPPi paper factory produces solid residues which still contain fibers and thus energy and/or material which can be made available for a further utilization.

Pellets are easier to transport and to store, because of their higher density. Additionally, pellets can be used to fuel boilers, and to adapt the fuel quantity to energy generation needs, because of their increased and more constant heating value and compact shape.

In addition to the direct energy production based on bagasse and/or biomass pellets, other products can be provided on the basis of pelletising. This is mainly charcoal for domestic fuel and activated coal on for the chemical industry and for water purification. As an example: In areas without access to clean and healthy water sources approximately one kilogram of activated coal is sufficient to clean the drinking water needed per capita and year.

### Technical Tour: Visit at Gledhow Sugar Mill



Pict. 1: Mr. Rau, General Manager of Gledhow Sugar Mill (left), Denis Tomlinson



Pict. 4: Sprouts are distributed and covered



Pict. 2: The audience at Gledhow



Pict. 5: Sugar cane prior to harvest



Pict. 3: Sugar cane ‘rhizome’ and/or ‘sprout’



Pict. 6: Harvested and baled sugar cane



Pict. 7: Loading of sugar cane bale for intermediate transportation to the truck



Pict. 10: Unloading of trucks at the sugar mill



Pict. 8: Burned sugar cane stalks prior to baling



Pict. 11: Feeding to the two sugar lines – left the diffusion and right the milling line



Pict. 9: Unloading and weighing of bales at the truck area



Pict. 12: Feeding of the hammer mill



Pict. 13: Milled sugar cane feeding to extraction



Pict. 15: The cane diffusion line



Pict. 16: Sugar cane after juice extraction - fibrous bagasse



Pict. 14: The juice extraction rollers



Pict. 17: Bagasse feeding to intermediate storage



Pict. 18: Boiler for steam generation



Pict. 21: Sugar centrifuge



Pict. 19: Monitoring/control station of the boilers



Pict. 20: Steam turbines / electricity generation

## Technical Tour: Visit at Glendale Distillery



Pict. 22: Site view of Glendale distillery



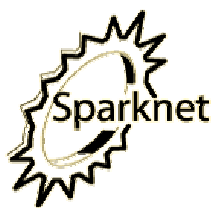
Pict. 23: The audience at Glendale



Pict. 25: Alcohol distillation columns



Pict. 24: Front: Molasse storage tank,  
Background: Distillation columns



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