A NEW PROCESS FOR THE PRODUCTION OF DEHYDRATED SUGAR CANE TOPS

P. Friedman and N. Ponce
Instituto Cubano de Investigaciones Azucarerias, La Habana, Cuba

Key words: Sugar cane; sugar cane tops, dehydrated, animal feed, forage, process, Cuba

ABSTRACT

Dehydrated sugar cane tops (DSCT) can be used as a fibrous forage for animal feed. The product has been produced by a highly labour intensive process in Thailand, Taiwan and the Philippines and exported to Japan, which annually imports about 1.5 Mt of different fibrous forages. In Cuba, about one quarter of the sugar cane agricultural residues are concentrated in dry cane cleaning stations where they can easily be collected for use as animal feed or fuel. A new process has been developed for DSCT production consisting of: classification, cutting, drying, baling, sacking and loading. This process and the first plant to produce 10 000 t/year, now under construction, are described.

INTRODUCTION

Fibrous forages comprise a significant part of world-wide trade in animal feeds. Japan, a leading importer of animal feed, imports annually about 1.5 Mt of different fibrous forages. Among these are dehydrated sugar cane tops (DSCT), a product which has been exported by Thailand, Taiwan and the Philippines. Due to factors such as the low world price for sugar, more profitable ways of using the land, and the presence of insects in the product, the import of DSCT has decreased in recent years. The production of DSCT in the countries mentioned above is highly labour intensive since the tops are collected by hand from the fields, hung on lines to be wind dried, dehydrated to the required moisture content in a drum dryer, cut, baled and finally sacked and strapped.

In Cuba, about one quarter of the sugar cane agricultural residues (SCAR) is eliminated in dry cane cleaning stations. During the 1987-88 harvest about 4 Mt of SCAR were concentrated in these stations and approximately 2.2 Mt were used to feed 1.5 M head of cattle while 10 Kt were used as fuel. A number of different SCAR processing alternatives are now in production and others are in research and development (Friedman3). In many cases, an average proportion of 20% SCAR/clean cane can be assumed. About 60-75% of SCAR is composed of green leaves and stalk (sugar cane tops). The rest is dry leaves, pieces of cane and other matter. Both the SCAR/clean cane ratio and the relative amounts of its components depend on factors such as the harvest system (manual or mechanised, green or burned cane), cane variety and agricultural yield.

In 1987 the Cuban Ministry of Sugar decided to develop a new mechanised process for the production of DSCT for the following reasons:

(i) good potential for export at an attractive price
(ii) more than 850 cane cleaning stations exist where the SCAR is concentrated and easily collected
(iii) development of a classifier which separates sugar cane tops from dry leaves
(iv) development of a pneumatic bagasse dryer
(v) existing experience in the cutting, handling and transport of SCAR
The conveyor is connected to the outside of the expansion boxes (Culturils) so that:

- The exhaust air is drawn off and the belt conveyor is kept free of dust and debris.

The following tables list the process steps and materials:

**Process Description**

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cleaning, preheating and loading of containers</td>
</tr>
<tr>
<td>2</td>
<td>Cleaning, preheating and drying of containers</td>
</tr>
<tr>
<td>3</td>
<td>Storing and cutting of containers</td>
</tr>
<tr>
<td>4</td>
<td>Classification, collection and transportation</td>
</tr>
<tr>
<td>5</td>
<td>The process is divided into two sections (preheating)</td>
</tr>
</tbody>
</table>

**Material Balance**

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>50 kg</td>
</tr>
<tr>
<td>Dye</td>
<td>15 kg/m²</td>
</tr>
<tr>
<td>pH</td>
<td>2.0 ± 0.5</td>
</tr>
<tr>
<td>Temperature</td>
<td>90 °C</td>
</tr>
<tr>
<td>Endorphine</td>
<td>30 parts</td>
</tr>
</tbody>
</table>

The specifications for the boxes are:

- Height: 70 cm
- Width: 70 cm
- Length: 200 cm
- Polyethylene, mesh, green

The specifications for DSCI are:

- Internal: 100 cm
- External: 150 cm
- Maximum length: 200 cm

**Product Specifications**

- Moisture content: 15% maximum
- Color: Beige
Figure 1. Process flow diagram and material balance for DSCT production, t/day
Figure 2. DSCT plant layout — Primero de Mayo sugar mill
Figure 3. Diagram of dry cane cleaning station and SCAR classifier:
1. air entrance, 2. expansion box, 3. adjustable damper, 4. trap for sugar cane tops, 5. dry leaves, 6. sugar cane tops, 7. adjustable hatch, 8. pile of dry leaves, 9. belt conveyor

for use as fuel or animal silage, or burned nearby. Two adjustments can be made, one at the damper at the expansion box outlet, and the other at the hatch at the front of the classifier. These adjustments are required since the characteristics of the SCAR vary in accordance with cane variety, agricultural yield and the time of day (in the morning the moisture content is higher than in the afternoon).

The horizontal belt conveyor transports the sugar cane tops to an inclined belt conveyor which discharges into a waiting cart. The carts have a capacity of 13 m³ and have a hydraulic discharge. They are transported to the mill in trains of three by a tractor. The number of carts and tractors per cane cleaning station depends on the distance from the mill and the quality of the roads.
Storage and cutting

The storage area for the wet sugar cane tops proceeding from the cane cleaning stations is designed to store the material produced in one day. The carts discharge the material onto a storage platform and a tractor with a scraper attachment pushes the cane tops toward an area where they can dry during the day. The cane tops discharged in the afternoon are dryer than those in the morning and can be used directly after discharging. Since the cane cleaning stations only work during the day, the tops which are discharged in the morning can be processed during the night.

The tractor pushes the wet cane tops onto a feeding table located at one corner of the storage area. The feeding table consists of a variable speed metal conveyor, a levelling screw and a second conveyor which transports the aligned cane tops to the cutting machine. The cutting machine is fed by a metal conveyor and pressure rollers which feed the moist cane tops to a wear plate where they are cut by blades screwed onto six cutting arms of a fly-wheel. These blades must be removed periodically and sharpened so that the product particle size is maintained within specification.

Air heating and drying

The wet cut sugar cane tops are dried in a pneumatic (flash) dryer designed by ICINAZ. This dryer is used in Cuba for bagasse drying (Arrascaeta and Friedman, Friedman et al) and installations are operating at three sugar mills and are being built at five others. Due to the very good gas-solid contact and the low residence time, in the order of 3-4 seconds, this dryer preserves the nutritional quality and appearance of the sugar cane tops better than does solar drying, which is very much slower.

The dryer consists of six main components (see Fig 4):
(i) rotary valve for feeding the wet material
(ii) drying tube, and gas ducts
(iii) cyclones to separate the dry product from the gas (2)
(iv) rotart valves for product discharge (2)
(v) induced draft fan
(vi) support structure

Stack gases cannot be used directly to dry the cane tops, as is the case in bagasse drying, since the soot in these gases would contaminate the product (when drying bagasse, which is burned in the boilers, this is an advantage, since unburned carbon and bagasse particles are recycled and atmospheric pollution is significantly reduced). Therefore clean air is used as the drying medium. To avoid the use of an auxiliary fuel to heat the air, the stack gases are used to interchange heat with the air in a heater which consists of modular sections used in bagasse boilers for preheating combustion air.

Baling and Loading

The belt conveyor from the dryer discharges the DSCT into a hopper which feeds the baling machine. The mechanical baler produces bales of 24.5 x 25.0 x 70.0 cm with an average weight per bale of 20 kg at a rate of three bales per minute. The bales are then inserted in polypropylene mesh sacks and placed in strapping machines where polypropylene straps are automatically tightened and tied. The bales are loaded onto a mobile belt conveyor which transports them to a container where they are loaded by hand. A container can carry about 600 bales of 20 kg with a total net weight of 12 t.

Cleaning, fumigation and storage of containers

A fork-lift is used to handle the containers. The empty containers are lowered from the trucks into the storage area where they are cleaned. The clean containers are brought
Figure 4. ICINAZ bagasse dryer
to the baling building and loaded. When fully loaded they are removed once again to the storage area and fumigated. After 24 hours the containers are aired and ready for transport to the port. The container storage area can accommodate 48 containers, sufficient for one week's operation.

ECONOMIC ASPECTS

Santana and Cordoves6 carried out an economic study of the process and produced the following cost breakdown:

<table>
<thead>
<tr>
<th>Item</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salaries</td>
<td>14</td>
</tr>
<tr>
<td>Depreciation</td>
<td>15</td>
</tr>
<tr>
<td>Electricity</td>
<td>14</td>
</tr>
<tr>
<td>Maintenance</td>
<td>6</td>
</tr>
<tr>
<td>Fuel</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

As can be seen, about half the cost is due to "other", which comprises the costs of the sacks and strap. This is not a process requirement but a marketing one. In Japan, this product is used by small farmers and handled manually. For this reason, small light weight bales must be used. The bales must be sacked and strapped since they are handled many times before they are consumed by the cattle. The increased costs of the product due to market packaging requirements are compensated by the high price paid for fibrous forage in Japan where meat and milk prices are much higher than in other countries.

REFERENCES


UN NOUEAU PROCÉDÉ DE PRODUCTION DE MORCEAUX DE CANNE À SUCRE DÉSHYDRATÉS

P. Friedman et N. Ponce
Instituto Cubano de Investigaciones Azucareras, Habana, Cuba

EXTRAIT

Des morceaux de canne à sucre déshydratés (DSCT) constituent un fourrage fibreux em-
UN PROCESO NUEVO PARA LA PRODUCCION DE COGOLLO DESHIDRATADO

P. Friedman y N. Ponce
Instituto Cubano de Investigaciones Azucareras, La Habana, Cuba

RESUMEN
El cogollo deshidratado es un ferraio fibroso utilizado como alimento animal. Ha sido producido, en un proceso manual, en Tailandia, Taiwan y las Filipinas y exportado a Japón, país que importa alrededor de 1.5 Mt/año de diferentes ferraia fibreses. En Cuba alrededor de la cuarta parte de los residuos agrícolas de la cosecha caña están concentrados en los centros de limpieza de la caña en seco donde pueden ser fácilmente recolectados para su utilización como alimento animal o combustible. Se ha desarrollado un nuevo proceso para la producción de cogollo deshidratado que consiste en: clasificación, troceado, secado, ensacado y carga. En este estudio se describe este proceso y la primera planta para producir 10 000 t/año, actualmente en construcción.