



TOGETHER
for a sustainable future

OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.



TOGETHER
for a sustainable future

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org



16945-E

Distr.
LIMITED

ID/WG.476/7
26 July 1988

United Nations Industrial Development Organization

ORIGINAL: ENGLISH

First Interregional Consultation on the
Food-Processing Industry with Emphasis
on Sugar-Cane Processing

Havana, Cuba, 26-30 September 1988

THE SUGAR-CANE PROCESSING INDUSTRY AND
DIVERSIFICATION OF THE INDUSTRY IN CHINA*

Prepared by

Bao Guo Yu** and Chen Shi Zhi***
UNIDO Consultants

510

* The views expressed by the authors in this document do not necessarily reflect those of the UNIDO Secretariat. This document has not been edited.

** Chairman of Academic Committee, Sugarcane Industry Research Institute, Ministry of Light Industry, Guangzhou, People's Republic of China.

*** Senior Chemical Engineer, Sugarcane Industry Research Institute, Ministry of Light Industry, Guangzhou, People's Republic of China.

V.88-27130

CONTENTS

	<u>Page</u>
1. STATUS AND TREND OF CHINESE SUGAR CANE INDUSTRY	3
2. GENERAL FEATURE OF DIVERSIFICATION OF SUGAR CANE INDUSTRY IN CHINA	6
1/ The primary stage	6
2/ The steady development and mode of diversification of the industry	6
3/ Diversification other than utilization of cane by-products	7
4/ Diversification in conjunction with treatment of pollution	7
5/ Mode of recycling of biomass	8
3. DIVERSIFICATION ____ THE PATRON OF SUGAR CANE INDUSTRY	10
4. TREND OF DIVERSIFICATION OF THE SUGAR CANE INDUSTRY IN CHINA	11
1/ Bagasse and bagacillo	11
2/ Molasses	11
3/ Sucrose	12
5. CONCLUSION AND REMARKS	12

1. STATUS AND TREND OF CHINESE SUGARCANE INDUSTRY

Considerable progress has been made in the sugarcane industry during the past 30 years. In the 6th five-year plan (from 1981 to 1985), average increase in the annual production of sugar is 15.2%. In 1986, China produced 5.25 million tons of sugar, in which 4.33 million tons is produced from cane; 1987 is at about the same level. The above figure includes 50,000 tons of non-centrifuged sugar. Up to 1987, there are 450 cane mills with a total grinding capacity of 380,000 tons of cane per day. The majority of the mills ranged from 500 to 2,000 TCD. Only 9 mills exceed the capacity of 5,000 TCD. Besides, there are a number of very small mills, which possess the capacity of producing 200,000 tons of non-centrifuged sugar annually.

Ten provinces produce canesugar, e.g. Guangdong, Hainan, Guangxi, Yunan, Fujian, Sichuan, Jiangxi, Hunan, Zhejiang, Guizhou. Guangdong produces 46% of the total yield.

China now possesses the necessary facilities to develop her sugarcane industry; including cane growing, sugar manufacture, research work, designing, supply of equipments and instruments, construction and erection of mills, training colleges, etc. The facilities enable China to supply mills of up to 6,000 TCD. Sugar mills had been exported to certain countries in Asia and Africa.

Progress had also been made in the cane growing. In 1986/87 crop, 775,000 hectares of cane were harvested. The yield was about 50 tons/hectare. During the 1981-85 period, increase of cane is 11.6% per annum. Over 60 new varieties of cane were bred to meet the demand of different requirements, including high yield, high sucrose and early-matured varieties; also high yield and high sucrose cultivating technique; use of sex pheromones for controlling sugar cane stalk borer, etc. Rating of nitrogen, phosphorus and potassium fertilizers on cane; technique of applying rare-earth elements on sugarcane for raising yield and sucrose; Intercrop of cane with peanut, beans and potato, etc.

90% of canesugar is manufactured by sulfitation, the rest being carbonation. The main product is plantation white sugar with negligible amount of powdered and block brown sugar. During shut-down, certain mills use sulfitation process to refine imported

raw sugar. Recently, several mills used carbonation plus ionexchange or carbonation plus active carbon to produce high grade refined sugar.

Since 1950, there is only one cane mill imported, which is from Portland. Most of the cane mills have their transportation of cane, sugar, coal, limestone and bagasse mechanized. Certain mills are now using instrumental control in pan boiling and liming. Micro-computer has found their applications in chemical control reporting system and steam consumption reporting system. There are over ten factories using diffusion for extraction of cane juice. Factories using milling tandem have improved cane feeders in conjunction with intensive saturated maceration, even with imbibition water as low as 130-170% fibre, reduced extraction of sucrose still remained around 95-96.5%. Since the later part of 1960's, sulfitation mills had been using tubular reactor with ejection for sulfuring and liming. In recent years, a new sulfitation process using juice floatation had been developed for clarification, especially found its use in treating refractory juice. In pan boiling, program control by micro-computer was undertaken in some mills. All low grade massecuits are using continuous centrifuges. Reduced overall sucrose recovery is in the neighborhood of 85-89%.

In China, cane grows in the southern provinces, far away from the coal mines which is in North China. Hence energy conservation has important influence in the development of sugarcane industry. During the beginning of 1980's, energy consumption in most sugar mills were 4700-5100 Kcal/Kg sugar. Since then, much effort had been paid to the research work of conservation of energy. As a result, in 1986/87 crop, many sugar mills had reduced their energy consumption to 3800-4100 Kcal/Kg sugar. Several mills even reduced to 2800-3000 Kcal/Kg. It has been contemplated that provided first effect could be replaced by falling film evaporator and low heat content steam could be better utilized, energy consumption might be further reduced to less than 2500 Kcal/Kg.

During these years, the reduction of energy consumption is the result of the following devices:

A. Replacement of the 13 kg/cm² boilers by 25 and 39 kg/cm² boilers.

B. Better utilization of process steam, such as vapor from 1st and 2nd effects used for pan boiling; increase of the brix of syrup and restriction water used in pan boiling. Steam consumption reduced from 26-30% cane to 20-24 %cane, some even to 16%cane.

C. Bagasse dried by flue gas to 40-42% moisture.

D. Management of processing operation improved.

The capita consumption of sugar in China is 6 kg/annum. Since 1980, importation of sugar had been more than one million tons each year. The living standard in China has been increasing insistently. Therefore, it is reasonable to estimate that the capita consumption would reach the present average level in Asia, i.e. 9-10 kg/annum at the end of the century. Reckoning together with the increase of population, China has to raise her sugar production at least to 9-10 million tons /annum in 2000 A.D. Provided 80% might be canesugar China has to increase the annual production of canesugar by three million tons.

The main constraint that restricts the development of sugarcane industry in China is that the sugarcane producing districts are distributed along the coast of South China, such as Guangdong, Hainan, Fujiang and Guangxi. The climate in these provinces is favorable for growing cane, but cultivable land is limited. Competition between crops has been tough, resulting in the reduction of canefield area, especially in the Pearl River Delta, during recent years. Cane mills do not have sufficient cane to grind, thus lowered the gain. In the western part of Guangdong and northern part of Guangxi, as well as Hainan and Yunnan provinces, there are vast area of highlands and plains that are cultivable. But these districts lack irrigation, requiring big amount of investment for construction.

Comparatively low sucrose content (10-13%) and low fibre content (11-12%) in cane, are potentials in increasing production and economical gain in Chinese sugarcane industry, provided these drawbacks could be improved.

On the other hand, the technique of energy conservation has not been applied to the majority of sugar mills. In Yunnan and Hainan, some mills have to burn wood besides used up all of their bagasse. Big amount of wood were consumed in this regard, thus spoiled the natural resources. This is probably one of the factors that hinder the development of canesugar.

2. GENERAL FEATURE OF DIVERSIFICATION OF SUGAR CANE INDUSTRY IN CHINA

1/ The primary stage.

In the 1950's, the only destination of molasses was used to produce industrial alcohol and fusel oil. Bagasse was burned as fuel in sugar mills; filter mud was returned to the planters without charging, and was applied to the cane field as fertilizer.

2/ The steady development and mode of diversification of the industry.

During the 1960's and 1970's, a gradual realization of the advantages of diversification of cane led to moderate development of by-products utilization industry. The success of research work in bagasse storage and paper making from bagasse enabled a number of mills to build their own paper mills. Almost all bigger mills reconstructed their boilers to burn coal or coal plus bagasse as fuel. As a result, enough bagasse was saved for paper making. These paper mills usually ranged from 20 to 40 tons/day. Among the various paper products, printing paper is the major product to fulfill the immense demand of printing books and magazines. Bagasse is also used in particle board and fibre board manufacture. Pith separated from bagasse find their way in the production of furfural, xylitol, feed stuff and cultivation of mushroom in several sugar mills.

Molasses was utilized not only for industrial alcohol, medical alcohol, but rum and blending spirits, fodder yeast, edible yeast, citric acid, lysine and feed additives.

Besides used as fertilizer, filter mud from sulfitation mills had been extracted for refined cane wax in five mills, but capacity was rather small, usually not exceeding one ton/day. Filter mud from the carbonation factories had been a burden to cause pollution. Some mills succeeded in using it in cement production.

Sugar chemistry now begins to play the role in the diversification of the industry. It is now used to produce sucrose ester, dextrin, glucose-fructose syrup and oxalic acid.

Finally, cane tops have also been used in the beverage industry and made into cattle feed products.

In recent years, there had been a tendency to make multifold products. For example, molasses is used for making yeast, then a

number of derivatives from yeast, such as ribonucleic acid, and vitamine D₂ (ergocalciferol), and then from ribonucleic acid a series of products are made, like GMP (5'-guanosine monophosphate, e.i. intensified gourmet powder, strength of taste equivalent to 40 times the mono-sodium glutamate); AMP (adenosine monophosphate), which is used to make ATP (adenosine triphosphate). These are now put into production in Jiangmen Sugar Mill and can be treated as fourfold products. Another example is in Zhong Shan Sugar Mill, alcohol is used to make glacial acetic acid which is again used to make acetylanhydride, vinyl acetate and acetyl acetate; hence a three-fold production. Nowadays in China, there are more than 30 kinds of products that have been put into production. Jiangmen Sugar Mill produces more than 20 products. To mention some of them: alcohol, dry ice, edible yeast, cement, electricity, bleached pulp, corrugating base stock, glazed paper, typographic printing paper, offset printing paper, wrapping paper, fibre board, furfural, binding agent, ribonucleic acid, adenosine triphosphate, cytidine triphosphate, polyinosinate polycytidylate, fusel oil, cement, cinder brick, etc.

3/ Diversification other than utilization of cane by-products.

Due to limited supply of molasses, some sugar mills begin to use starchy material like cassava for the production of alcohol, lysine and citric acid, etc. Many bigger mills expanded their power station and connected to the electricity network for sale of their surplus electricity. Some mills produce soft drinks, food woven bags and milling rollers.

4/ Diversification in conjunction with treatment of pollution.

Recovery of potassium from the waste liquor of paper mills has been undertaken in several bigger mills, the waste liquor is also used to make binding agent.

Waste liquor from distillery is concentrated to above 65% brix, and is used in compound fertilizer, granules for animal feed, dehydrating agent for concrete, or burned to recover potassium and heat energy. It has also been used as concrete strengthener. Carbon dioxide from fermenters is recovered for soft drinks. Filter mud from carbonation process is used in making cement; coal ash made into cinder bricks. One sugar mill is now making use of the CO₂ in boiler flue gas for saturation of the limed juice in carbonation clarification.

5/ Mode of recycling of biomass.

Those cane plantations equipped with cane mills, more or less follow a mode of recycling of biomass resources, i.e. agriculture-- industry-- animal or fish raising-- agriculture.

It has been found that organic matter used as fertilizer is quite essential in maintaining the fertility of the soil of cane field, in addition to nitrogen, phosphorus and potassium. In this respect, these plantations also possess dairy farms or fish ponds besides cane mills. Cane tops, cane leaves, bagacillo, molasses or waste liquor of distillery are made into feedstuff for cattle. While molasses and filter mud (excluding carbonation) are mingled with cereals to form feed granules for raising fish. Excreta from cattle and fish are collected together with waste mud and waste liquor from sugar mill to form very valuable organic and inorganic fertilizer for the growing of cane. In this way, more cane and sugar are yielded, resulting in more cattle and fish raising; again more fertilizer for the cane growing. Thus, a recycling of the biomass results in a steady increase of production of sugar and meat.

In Hunan Province, there are 10 mills which belong to plantations. Although they are situated at too high a latitude, not suitable for growing cane; the mills had been losing money. But after they had developed diversification to a certain extent, these enterprises ran quite well in recent years. Sugar production had been increasing. Another example is Guangming Dairy Farm, which is near Shen Jen. Its sugar mill provides a certain amount of feedstuff for the compensation of supply of feed.

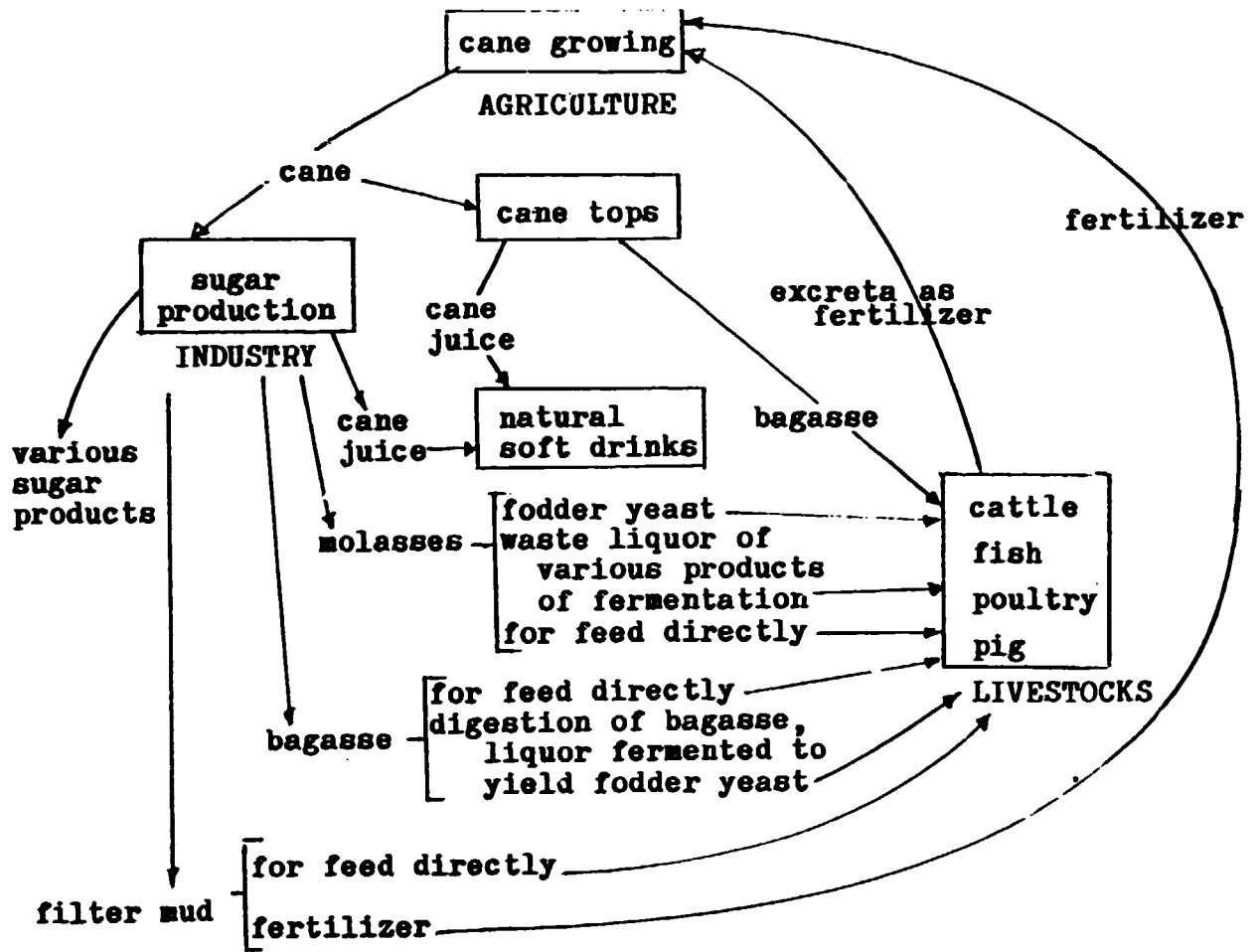


Diagram of Mode of Recycling of Biomass

3. DIVERSIFICATION — THE PATRON OF SUGARCANE INDUSTRY

Chinese sugarcane industry had experienced various kinds of challenges in the course of development, although nowadays the production is 17.2 times of that at the beginning of 1950's. Diversification has been playing the role of stabilizing and promoting the development in the following manner:

1/ Increase of varieties of product, value of output and profit, thus strengthen the ability to withstand hampers. Since 1986, along the coastal region, there had been an intensive competition among different crops, together with short of labor, area of canefield was reduced. Mills in these regions had very limited cane to grind. Therefore, these mills had been keen in developing diversification in order to produce more output from the limited amount of raw material. In several mills using bagasse as fuel, after efforts had been paid to energy conservation, 20-30% of the amount of bagasse can be saved, which might be enough for a small particle board plant of 5000-10,000 M³ per year in a 2000 TCD mill. In some cases, mills burned coal, making use all of the bagasse for particle board manufacture. Gain in profit had been as much as the profit of sugar products. Again, Jiangmen Mill (5000 TCD) as mentioned above, are producing more than 20 kinds of products, which figured out at 56% of the total value of production and 30% of the total profit of the factory in 1986.

In Sichuan Province, much efforts had been paid to the utilization of by-products. Investment of these diversification amounts to 20% of the total investment of the enterprise, but the profit and output value of diversification figure up to 65% and 51.5% of the total enterprise respectively.

2/ Treatment and utilization of wastes to reduce pollution. Vinasse from the distillery is to be concentrated to make compound fertilizer or sintered to recover potash. The waste liquor from paper mill is also concentrated and sintered to recover potash or made into binding agent. Thus penalty for the pollution can be avoided and in the mean time providing fertilizer and feed for the agriculture production.

3/ More employment, more resources for the development of industries and more commercial products for the market will be the result of diversification of sugarcane industry. These will render influences to the government, and subsequently leads to favorable policies for the development of sugarcane industry.

4. TREND OF DIVERSIFICATION OF THE SUGAR CANE INDUSTRY IN CHINA

1/ Bagasse.

There is a vast market for hard board in China. Provided the variety and quality can be further improved, the market would be still extended, e.g. medium density fibre board, mode board for concrete in civil engineering, fireproof board, outdoor board, pressed board of irregular shape, etc., are in great demand. One MDF board plant of 170 M³/day, imported from Siempelkamp by Shi Tao Mill is in construction. Two other MDF board plants are under discussion with Sands Defibrator. One 100 M³/day will be imported by Shunde Mill, and one 45 M³/day by Pearl River Mill. Recently, large scale newsprint paper plant with small portion of wood pulp besides bagasse acquires consideration.

Bagacillo.

Essential application of bagacillo would be for the production of feedstuff. The bagacillo after treated with alkali is to be mixed with molasses of concentrated vinasse and urea to make compound feed. Recently, Chang Chou City of Fujian Province and one cane plantation of Guangdong Province are in contact with the State University of Kansas in United States for the importation of know how to raise cattle by this kind of compound feed.

In the 1970's, China had already undertaken pilot plant test research project of 2 tons of bagacillo per day, for the biological and chemical degradation of cellulose to produce protein feed. In order to promote progress in this field, the Science Committee of Guangdong Province had discussed with Waterloo University of Canada for cooperation in research work of this technique last year.

Although several mills are producing furfural from bagacillo, still there is intention to import technology of hydrolysis without causing pollution, and the technique of using furfural to produce furfuralcohol and other products.

2/ Molasses.

60% of the molasses has been used in the manufacture of industrial alcohol, blending spirits, fodder yeast and food yeast. Nevertheless, efforts including importation are being made to produce more profitable products to fulfill the need of the market. Dong Guan and Mei San Mills imported high active yeast plants from BTI (Beverage Technique International) of Denmark and MAURI of Australia respectively. Both are already put into production. Zhan Jiang and Hui Zhou Districts are discussing importation of citric acid plants from VOGELBUSC of Austria.

Bei Jiao and Zhan Jiang Mills are discussing importation of sodium glutamate plants using cane molasses as raw material. A lysine plant of 1000 tons/ annum is imported from Germany (W.G.) by Fujian Province and is under construction. The Jiangmen Bio-engineering Development Centre imported high efficiency fermenters from STAPCOSA and centrifuge from WESTFALIA of West Germany. A small plant producing 3 tons of glycerol per day from molasses has been put into operation in Shu Wen County. In Jiangmen Mill efforts has been made to produce 5'-GMP (guanosine) and IMP (inosinic acid) as ingredients in preparing intensified gourmet powder which imitates meat taste.

3/ Sucrose.

Attempts are being made, looking for pathways in the production of high quality sucrose esters as food additive, xanthan gum, sorbitol and manitol, etc.

5. CONCLUSION AND REMARKS

The fluctuation of world price, the main characteristic of sugar industry, together with other factors hamper in a large extent the developing countries, which produce the major portion of canesugar. Due to lack of financial potential and advanced technique, the hamper renders serious damages to these countries, resulting in unstable development of the sugarcane industry. These developing countries, including China, realize that diversification of the sugar industry besides creating more output and more profit to the factory, also enabled the factory to produce a number of products instead of solely sugar; thus diminished the depression on the enterprise, whenever there might be hampers on the sugar cane industry.

During the course of the development of diversification, the developing countries not only make use of their own facilities, but also import technique and capital from developed countries. Besides domestic markets, a portion of the products will be sold to the developed countries for the return of investment. Thus international trade can be established and promoted in a mutual benefit basis. Relief on the hamper to the sugar industry enables stable development of the sugar industry, together with diversification of the industry. Increase in employment and income results in a better living standard of the inhabitants in the developing countries; again this would undoubtedly increase the sugar consumption, resulting in a further development of sugar production and its market.

Different developing countries have different environments, economical conditions and markets; hence different modes of diversifications. Therefore, an expert group meeting like this, is quite beneficial for interchange of informations and experiences; also establishing mutual communication between countries.

The Chinese sugarcane enterprises are quite keen in developing diversification of the industry. Some experience has already been accumulated in this field. Probably it might be proper moment for UNIDO to place a project in one of the cane plantation that is equipped with sugar mill, in China; making use of the present experience of the mode of recycling of biomass with compensation of importation of more advanced technique including energy conservation and others; so as to make the plantation a demonstrating mode for developing countries including China. The plantation will not only act as a mode in technology, but also in evaluation, administration and training. Besides UNIDO, assistance and cooperation from organizations like ITC and GEPLACEA are recognized to be essential for the achievement of the project.